ISBN:978-81-957858-1-0

2022

# RESEARCH

# ASPECTS OF MULTIDISCIPLINARY AREAS

VISHAL SAGAR BH
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PUBLISHED BY: ASIAN PUBLICATION CORPORATION
ADDRESS: 11/100, RAJENDRA NAGAR, SECTOR-3, SAHIBABAD-201005

**ResearchAspectsofMultidisciplinaryAreas**

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ISBN(Print):978-81-957858-1-0



PublishedbyAsianPublicationCorporation –Sahibabad,India. First published in 2022.

# ResearchAspects of Multidisciplinary Areas

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# Guidelines for Handling, Treatment and Disposal of Waste Generated during Treatment/ Diagnosis/ Quarantine of COVID-19 Patients

*Meenakshi[1]andRamneet Kaur[2]*

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**Abstract**

In order to deal with COVID-19 pandemic, State and Central Governments have initiated various steps, which include setting up of quarantine centers/camps, Isolation wards, sample collection centers and laboratories. Following specific guidelines for management of waste generated during diagnosticsandtreatmentofCOVID-19suspected/confirmedpatients,arerequiredtobefollowed by all the stakeholders including isolation wards, quarantine centers, sample collection centers, laboratories, ULBs and common biomedical waste treatment and disposal facilities, in addition to existing practices under BMW Management Rules, 2016. These guidelines are based on current knowledge on COVID-19 and existing practices in management of infectious waste generated in hospitals while treating viral and other contagious diseases like HIV, H1N1, etc.

**Keywords:**Pandemic,BMW,Guidelines,Covid

**Introduction**

These guidelines will be updated if need arises. This revision-4 of guidelines issued to provide revised guidance on segregation of general solid waste and biomedical waste from quarantine centers/home-care/healthcarefacilitiestreatingCOVID-19 patients andto recommendon disposal ofPPEs.GuidelinesbroughtoutbyWHO, MoH&FW, ICMR, CDCand otherconcerned agencies from time to time may also be referred for understanding other aspects related to COVID-19. Guidelines for handling, treatment and disposal of COVID-19 waste at Healthcare Facilities, Quarantine Camps/ Quarantine-homes/ Home-care, Sample Collection Centers, Laboratories, SPCBs/PCCs, ULBs and CBWTFs is given below.

**(A) COVID-19Isolationwards:**

Isolation wards are those where COVID-19 positive patients are being kept for treatment / diagnosis) Healthcare Facilities having isolation wards including temporary Healthcare Facilities likerailcoachwards,COVIDCareCentersetc.1forCOVID-19patientsneedtofollowthesesteps to ensure safe handling and disposal of biomedical waste generated during treatment; - Keep separatecolor-codedbins(withfootoperatedlids)2/bags/containersinwardsandmaintainproper segregation of waste as per BMWM Rules, 2016 as amended and CPCB guidelines for implementationofBMWManagementRules.-Asaprecautiondoublelayeredbags(using2bags)



ISBN:978-81-957858-1-0

should be used for collection of waste from COVID-19 isolation wards so as to ensure adequate strength and no-leaks; - Collect and store biomedical waste separately prior to handing over the same CBWTF. Use a dedicated collection bin labeled as “COVID-19” to store COVID-19 waste and keep it separately in a temporary storage room prior to handing over to authorized staff of CBWTF. Biomedical waste collected in such isolation wards can also be lifted directly from ward into CBWTF collection van.

**(B) SampleCollectionCentersandLaboratoriesforCOVID-19suspectedpatients:**

ReportopeningoroperationofCOVID-19samplecollectioncentersandlaboratoriestoconcerned SPCB/PCC. Guidelines given at section

(a) forisolationwardsshould beappliedsuitably incaseof testcentersandlaboratories.

(b)Pre-treat viral transport media, plastic vials, vacutainers, eppendorf tubes, plastic cryovials, pipette tips as per BMWM Rules, 2016 and collect them in red bags.

(c) Responsibilities of persons operating Quarantine Centers/Camps/Home Quarantine or Home Carefacilities4LessquantityofbiomedicalwasteisexpectedfromquarantineCamps/Quarantine Home/ Homecare facilities. However, the persons responsible for operating quarantine camps/centers/home-care for suspected COVID-19 persons need to follow the below mentioned steps to ensure safe handling and disposal of waste; - General solid waste (household waste) generatedfromquarantinecentersorcampsshouldbecollectedinbags,securelytiedandhanded- over to municipal solid waste collector identified by Urban Local Bodies for final disposal.

(d) General solid waste should comprise of waste generated from kitchen, packaging material, wastefoodmaterial,wastepapers,wasteplastics,floorcleaningdust,etc.includingleft-overfood, disposableutensils,waterbottles,tetrapacks,usedbysuspectedquarantinedpersonsand COVID- 19 patient at homecare or home quarantine.

(e) Only the used masks, gloves and tissues or swabs contaminated with blood / body fluids of COVID-19patients,includingusedsyringes,medicines,etc.,ifany generatedshouldbetreatedas biomedical waste

Clarifications: - Quarantine Camps / Quarantine-Home are the places where suspected people or thecontactsofsuspected/confirmedcaseswhohavebeendirectedbyauthorizedhospitalsorlocal authoritiestostayathomeforatleast14daysormoreforobservationforanysymptomofCOVID-19,ifany.-Homecare–HomecarefacilityisahomewherecareistobeprovidedtoaCOVID-19 positivepatientathome.4-BiomedicalwasteatQuarantineCamps/Home-caremayalsocomprise of used syringes, date expired or discarded medicines, used masks/gloves and in case of patients with other chronic diseases may also include drain bags, urine bags, body fluid or blood-soaked tissues/cotton, empty ampoules etc. - Biomedical waste generated from Quarantine Camps / Quarantine-Home/Home-carewouldbetreatedas‘domestichazardouswaste’asdefinedunder



ISBN:978-81-957858-1-0

SolidWasteManagementRules,2016,andshallbedisposedofasperprovisionsunderBiomedical Waste Management Rules, 2016 and these guidelines.

**(d) Duties of Common Biomedical Waste Treatment Facility (CBWTF):** - Report to SPCBs/PCCs about receiving of waste from COVID-19 isolation wards / Quarantine Camps / Quarantined homes / COVID-19 Testing Centers; - Operator of CBWTF shall ensure regular sanitizationofworkersinvolvedinhandlingandcollectionofbiomedicalwaste;-Workersshallbe provided with adequate PPEs including three layer masks, splash proof aprons/gowns, nitrile gloves,gumboots and safety goggles; - Use dedicatedvehicle to collect COVID-19 ward waste. It isnotnecessarytoplaceseparatelabelsonsuchvehicles;-Vehicleshouldbesanitizedwithsodium hypochloriteoranyappropriatechemicaldisinfectantaftereverytrip.-COVID-19wasteshouldbe disposed-off immediately upon receipt at the facility. In case it is required to treat and dispose of more quantities of biomedical waste generated from COVID-19 treatment, CBWTF may operate theirfacilitiesforextrahours,bygivinginformationtoSPCBs/PCCs.-OperatorsofCBWTFshall maintain separate records for collection, treatment and disposal of COVID-19 waste.

**(e) Duties of SPCBs/PCCs -** Shall maintain records of COVID-19 treatment wards / quarantine centers / quarantines homes in respective States. - Ensure proper segregation, collection and disposal of biomedical waste as per BMW Rules, 2016 and this guidance document; - Allow CBWTFs to operate for extra hours as per requirement; - May not insist on authorisation of quarantinecampsassuchfacilitiesdonotqualifyashealthfacilities.However,mayallowCBWTFs to collect biomedical waste as and when required; - In case of States not having CBWTFs as well asruralorremoteareas,nothavingaccesstoCBWTFs,theexistingcaptivefacilitiesofanyhospital may be identified for disposal of COVID19 waste as per provisions under BMW Rules, 2016 and theseguidelines.Thismayincludepermittinguseofdeepburialpitsfordisposalofyellowcategory wasteasperstandardsprescribedinSchedule IIofBio-medicalWasteManagementRules,2016.2 -CoordinatewithCBWTFsandULBsinestablishingadequatefacilitiesforcollectionanddisposal of COVID-19 waste.

**(f) DutiesofUrbanLocalBodies**

Urban Local Bodiesareresponsiblefor ensuring safe collection and disposal ofbiomedical waste, ifany,generatedformQuarantineCamps/QuarantineHomes/HomeCareforCOVID-19suspected persons. Information on each Quarantine Camps/ Quarantine Homes/ Home-Care should be available with local administration and provide updated list to SPCBs/PCCs from time to time; - Ensurethatgeneralsolidwasteandbiomedicalwastegeneratedfromquarantinecamps/quarantine homes/Homecareisnotmixed.Thebiomedicalwasteandgeneralsolidwasteshouldbecollected separately. Inform the persons responsible for operating isolation wards, quarantine centers and residents of homecare units to collect solid waste and biomedical waste in separate bags securely tiedpriortohandovertoauthorizedwastecollectorsofULBs.ULBsshouldensurethatleft-over



ISBN:978-81-957858-1-0

food and general solid waste is not collected in yellow bags; 1 - In quarantine camps, ensure that biomedical waste is collected directly by CBWTFs identified by ULB. Biomedical waste from quarantine camps to be lifted by CBWTFs on call basis as and when the biomedical waste gets generated. Provide contact details of CBWTF operator at Quarantine Camps; - Provide necessary support, security including authorization to staff of CBWTFs;

**(g) Managementofwastewaterfrom HCFs /IsolationWards**

As per the information available at CDC, the risk of transmission of virus that causes COVID-19 through sewerage systems is thought to be low. Transmission to operators may be possible during treatment of sewage treatment plants, however there is no evidence to date that this has occurred. Therefore, following guidance recommended for HCFs and the operators of STPs; - Responsible agenciesareHealthcareFacilities/IsolationWards/operatorsofterminalsewagetreatmentplants (PHED/Jal Board/etc.). - HCFs and the agencies operating Sewage Treatment Plants should continuetoensuredisinfectionoftreatedwastewaterasperprevailingpracticestoinactivatecorona viruses.-OperatorsofETPs/STPsattachedwithdischargefromHealthcareFacilitiesandisolation wards should adopt standard operational practices, practice basic hygiene precautions, and wear personal protective equipment (PPE) prescribed for operation of STPs. PPEs should include Goggles, face mask, liquid repellent coveralls, waterproof gloves and Rubber boots. - During the period of COVID-19 pandemic, utilization of treated wastewater in utilities within HCFs may be avoided.



ISBN:978-81-957858-1-0

# CareandMaintenanceofLaboratoryEquipmentUsedinHistotechnology

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**Abstract**

Laboratory equipment needs to be in peak condition if you want best performance and or results. Avoiding unknows and contamination ensure most accurate performance and reliable results in a lab. Inside a scientific laboratory, one can find expensive apparatus and equipment pieces that are usedforresearch,experiments,andmedicaltesting.Fundingasciencelaboratoryisexpensive,and thosewhoareusingitshouldalwaysrememberthattheyneedtomaintainorderinsidethefacility. Many research centre across the world with a built-in laboratory have a series of rules and regulations that the scientists and staff should always follow. These rules and regulations would prevent the laboratory from excessive wear and tear, and it would protect the expensive apparatus and equipment inside.

**Keywords**:Laboratory, Equipment,Cleaning,Histotechnology,Maintenance.

## CleaningyourLaboratory Equipment

Housekeeping remains the biggest problem in a lab. The exteriors of your equipment should be wipeddowndailyandafullcleanshouldbedoneonceaweek.Cleaningwillalsohelptomaintain the safety of the laboratory environment; restoring the laboratory after accidental spills and to prevent contamination of on-going experiments.

## CalibrationofLaboratoryEquipment

Regular calibrationof equipment is vitally important; if calibrations are not done when required, youmayfindyourresultsmaybequestionableduetolackofaccuracyorconsistency.There are various services available for calibration which could range from basic preventative maintenance to advance accuracy.

## MaintenanceofLaboratoryEquipment

Maintaining Laboratory equipment if vital it prolongs the lifespan of the equipment and ensures optimum performance. In some cases, laboratory equipment requires replacement but other times, especiallylargerlaboratoryequipment,youcansimplyreplacepartsorperformotherrepairwork.

## ReplacementofLaboratory Equipment

Inspiteofpropermaintenance(servicing/repairs/calibrations),equipmentwilleventuallyreachthe end of its workable life. When the time comes, it is advised to purchase quality equipment from reputablemanufacturerswhichensuresdurability,accuracyandreliability.
Contactoneofourrepresentativeswhocanassistyouwithyourdecisiononyourreplacements.



ISBN:978-81-957858-1-0

The fume hoods and the fume chamber are where the sample is being isolated or quarantined to avoid being inhaled by anyone inside the facility. This is important especially in a chemistry lab where experiments are being conducted more often. With the fume hood and the fume chambers activated, those who are working inside the facility would not be at risk of inhaling the chemicals that are produced by experiments. It is also important for the staff members to look after the fume hoodsandfumechambers,checkingiftherearetracesofchemicalsleftinsidetheapparatus.Having an equipment piece that is filled with trace minerals can be deadly and this is what the science laboratory is trying to avoid.

To clean the fume hoods and the fume chambers, the laboratory should look for an outsourced cleaner or a direct hire. The decision on who the research facility would choose is based on the experiences of the applicant, and they should also show their skills on cleaning the fume hoods as well as the fume chambers. After the cleaning process is completed, the staff inside the laboratory would be able to use their equipment without thinking about the harmful chemicals coming from theequipment.Theyshouldalsolookatthesealsoftheapparatus,andmakesurethatthechemicals beingtestedinsideitarecontained.Itwouldbeabiggerproblemifmorepeoplestartedgettingsick because the fume hoods and the fume chambers are not locked tightly.

Sometimes,thefumehoodsandthefumechambersmightexperienceminordamagesfromusingit over and over through the years. The facility should invest in repairing these minor damages because if they will be ignoring it, these small damages can become larger and it would cost the facilityalotofmoneytobuynewequipment.Thefumehoodsandthefumechamberscannormally experienceseveraldamagesbecauseofhowitis designed.Whensomeoneisusingthis equipment continuously, it can alert the user that the equipment is already running for so many hours and it might fail if it is not properly maintained.

Thefacilityshouldalsorememberhowtheywouldcalibratetheirfumehoodsandfumechambers. Most laboratory staff tend to forget this stage, and they would just resort into using the equipment immediately after it has been announced that the repairs have been completed. Calibration is important in getting the most accurate data, and some laboratory apparatuses and equipment are having an incorrect reading because it has not been calibrated. Make sure to remember this stage every time the equipment is undergoing maintenance.

## MakingtheLaboratory CountertopsCleanand Organized

Thelaboratorycountertopsarewherethesinkisinstalled,anditcanbefoundinsidethelaboratory being used as a platform where other items or devices will be placed upon. The laboratory countertopsshouldbekeptcleanallthetime,andthestaffcanuseaclothtoremovethestainsthat have appeared on the laboratory countertops. Alternatively, they can also use specialized cleaning chemicalsthatwouldmaketheircountertopslooksparklingclean.Thelaboratorycountertopsare



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amongtheeasiesttowearbecauseitcanbedamagedanytime,andmanylaboratorycountertopsare stained by different chemical reactions or being chipped off because of accidental scratches.

**TakingCareoftheLaboratory Sinks**

The laboratory sink is commonly located on a countertop, and this is where the scientists are washing their hands and the smaller equipment like test tubes and cylinders before coming into contactwithaspecimen.Iftherearechemicalexperimentsthataregoingoninsidethefacility,itis importantbecausethesinkcanactasimmediatedisposalforhazardouschemicals,andifsomeone came into contact with these chemicals, they can reach for the sink and have it washed off. A laboratorywithoutaworkingsinkcan bedangerous,andscientificexperimentscan end uphaving awry results. It is recommended that science laboratories should have a sink equipped on their countertops.

To clean the laboratory sinks, the laboratory can either outsource someone who can do the job or hiresomeonewhocancleanitdirectly.Whencleaningthelaboratorysink,makesurethatthewater is running, and then start looking for any obstructions that are present in the tubes. Make sure that anychemicalthathasbeendisposedofintothesinkhasbeenflushedoutcompletely.Thecleaners should also do a test whether the sink is efficient in flushing out all ofthe water, and if it does not flushoutthewatercompletely,theyneedtodoanalternativeapproachonhowtheycanremoveall of the dirt and external materials that might have clogged the sink. Once the task is complete, the staff inside the laboratory would notice that the sink started working fine once again.

**PreventingtheFragileGlassContainersandBeakersfrom Breaking**

Theglasscontainersareimportantinalaboratorysettingbecausethisiswheremostofthesamples arebeingkept.Withoutthesecontainers,thesampleswouldneverbestoredproperly,andtheycan be prone to breakage. The glass containers should always be washed with soap and water after it has been used as a storage container for a liquid or solid sample. The glass containers can be kept on a rack that would hold them vertically, and it would also lower down the chances of the glass containers from breaking. If a glass container slipped off the hand of the staff working inside the facility, they would need to clean it up immediately because the small broken glasses can easily injure someone.

Beakers are containers that have a particular measurement helping scientists obtain a sample that has a definite amount, and they require the same treatment as glass containers. Beakers are also fragile and can break easily if someone accidentally dropped it. To take care of beakers, the staff should always clean it with soap and water after it has been used for an experiment. They should bewipedwithacleanclothafterithasbeenwashedandleaveitasitdries.Beakersshouldbestored on a shelf or cabinet so they are protected from damage by outside forces.

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ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# Significance of Implementing Quality Management System in the Medical Laboratory Management

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**Abstract**

Medical lab management is a type of discipline that consists of laboratory medicine that has expandedsignificantlyinthelastfewdecades.Themaximumrangeofquantitiescalculatedandthe variety and complexity of the analytical techniques, procedure, instruments used have increased day by day systematically. The turnaround time for the submission of a specimen to the receipt of a result has decreased day by day and the performance of different analytical methods has continuously improved. Simultaneously with these changes, the clinical use of results has also altered.Themajorityofresultsfrompatienttohospitalareusedformanagementratherthanasaids to diagnosis. Frequently, laboratory tests areperformed prior to the actual clinical examination. In manycountrieslikeIndialaboratorytestsareperformedforfurthertreatmentproceduresratherthan diagnosispurposeandalsoforpreventingpatientsagainstmedicines.Nowday'shospitalspractices also changed with significant ramification on laboratory services. For example, most serious newborn babies are treated in neonatal intensive units.

**Keywords:**QualityManagement,Laboratory Testing

**Introduction**

The changing day to day spectrum of diseases, for example, the growing number of patients with certain acquired immunodeficiency syndrome also puts pressure on laboratories to expand them. Thus,laboratorymedicalprofessionsarenotstaticandchangingwillcontinuetooccur.Evenmore rapidlyastimeprogresses.Thelaboratoryfieldchangesdramatically.Morethantwentyyearsago, labs did not question order: quality was assumed. Though in a public set up those managing laboratories are not directly concerned with the rising cost of testing but in the private set up labs are concerned because it cuts on their profitability. The main challenge is to cut costs without compromising quality. Although laboratory costs represent a small percentage of the budget, they affect the entire system of laboratory management significantly. Health managers are confronted with growing challenges of controlling escalating costs beyond the rate of inflation without any compromise on quality. Many physicians believed that well over half of the diagnostic tests performed do not really contribute to patients' diagnostic therapy. For the above reasons many laboratories do modification and improvement in the laboratory's services will be introduced withoutsignificantnew expenditure onstaff andequipment.Itisthereforebeholden upontrainees



ISBN:978-81-957858-1-0

in laboratory medicine to develop adequate skills in laboratory management. Responsibilities for excessive laboratory use can be assigned primarily to the following four groups:

| | |
|---|---|
| Group1 | Practicingphysicians |
| Group2 | Physiciansin training |
| Group3 | Patients |
| Group4 | Clinical Laboratory |

Consumers of health care i.e., doctors and patients expect nothing less than perfection, accuracy and quality are assumed. An improvement in the condition of a patient is the gold standard for decision making. Accurate and timely testing can improve the patient's conditions. Measuring outcomes is the challenge. One area where the laboratory can affect patients' care for the better is to ensure that testing should be done appropriately, (Medical Laboratory Observer, June, 1989 by Annemarie Barros).

Duringthelast fewyears,clinicallaboratorieshavebeen faced withchallengesfrom allsideswith allegations of quality deficiencies, fraud, excessive charges and reimbursement. Since 1982, there havebeenmanylegislativeandregulatoryissuesrelatedtolaboratorytesting.Congress,theHealth Care Departments Financing Administration and the Health Human Services Department’s inspector general have been focusing on charge abuses and reimbursement.Each year private independenthospitalslaboratorieshavebeenhitwithreducedpaybackfromgovernmentagencies. Someprivateagencieshavedevelopedsomeguidelinesforsometestswhicharerecommendedby doctors, theywill reimbursetheircash. In 1987, when theBlueCrossandBlueShield Association published testing guidelines in cooperation withAmerican College of Physicians, the listwas said to be purely educational. But it was widely accepted that individual Blue Cross/ Blue Shield plans would eventually use the guidelines as criteria to deny claims for tests deemed medically unnecessary.Meanwhile an updated version of the list , adding more tests, is planned for release soon. The Code of Ethics of the American Society for Clinical Laboratory Science (ASCLS) sets forth the principles and standards by which clinical laboratories professionals practice their profession.

**Pledgetothe Profession**

Asaclinicallaboratoryprofessional, Istriveto:



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| |
|---|
| Maintain and promotestandards ofexcellencein performing and advancing the art and science of my profession. |
| Preservethedignityandprivacyofthe others |
| Upholdandmaintain the dignity andrespect ofour profession. |
| Seektoestablishcooperativeandrespectfulworkingrelationshipswithotherhealthprofessionals. |
| Contributetothegeneralwellbeingofthe community. |
| Iwillactivelydemonstratemycommitmenttotheseresponsibilitiesthroughoutmyprofessional life. |

This book chapter addresses change and quality improvement in health care. It was developed out ofmistakesmadeandlessonlearned and focused onthedifferent labsasa majorpartofthehealth system. Quality is essential to health care system survival whether it is cared by managed care, an integrated delivery system or standalone system.

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ISBN:978-81-957858-1-0

## EthicsinMedicalLaboratoryPractice

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**Abstract**

Branch of medicine, which involves taking decisions about the wellbeing of individual patients as wellascateringtotheoverallwellbeingofthesocietythroughcontinuedlearningthroughscientific observationandinterventionsonpatients,LaboratoryMedicineisalsomandatedwithethicalusage of patient data and other materials for the optimum utilization of the same for benefit of the individualandthesociety.“Decisionsaboutdiagnosis,prognosisandtreatmentarefrequentlybased on results and interpretations of laboratory tests. Irreversible harm may be caused by erroneous tests.

**Keywords**:MLP.Medicine,Ethics,Wellbeing,Interventions

**Introduction**

A Code of Ethics may be described as an expression of basic values - the principles and standards by which we should conduct ourselves. Numerous laboratory professional organizations have developed codes of ethics, with common principles of conduct which act as guidelines to professional members of those organizations. The International Federation of Biomedical Laboratory Science (1) advises to maintain strict confidentiality of patient information and test results, safeguard the dignity and privacy of patients and above all be accountable for the quality and integrity ofclinical laboratoryservices being provided. Onsimilarlines theAmerican Society ofClinicalPathologistsadviselaboratoryprofessionalstotreatpatientsandcolleagueswithrespect, careandthoughtfulness;performdutiesinanaccurate,precise,timelyandresponsiblemanner;and safeguard patient information as confidential, within the limits of the law.

**Thecoreethicalprinciples ofall thesedocuments include:**

| |
|---|
| (i)Respectforpersons,i.e.,Acknowledgementofautonomyandprotectionofthosewith diminished autonomy; |
| (ii)Beneficence,i.e.,thedutytoactinthebestinterestsofpatientsorresearchsubjectswiththe goal of maximizing benefits and minimizing harm (nonmaleficence); |



ISBN:978-81-957858-1-0

(iii) Justice, i.e., the duty or obligation to treat patients equally and to distribute, by allocating fairly, what is rightly due in terms of benefits, risks and cost.

**I. Consent**

Most often the laboratories receive patient samples for testing. In such a setting obtaining consent for such exercise is the responsibility of the treating physician. In the hospital setting this is often 'implied',especiallywhenthepatientisadmittedandsometimesnotinapositiontogiveconsent (2).Hence,itisoftenapracticetotakeablanketconsentforsuchdiagnostictestswhichdonotadd significant risk to the patient. However, it is a good practice to take consents for such diagnostic procedures which might be adding significant risk to a patient's life.

**II. Genetictesting**

In principle, the'right to autonomy'should allowpeopleto decidewhether genetictesting is to be performed or not. However, different governments have different policies regarding 'newborn screening', which is performed automatically, without physician orders. Once a disease or risk for disease is detected, patients and physicians face a dilemma whether to disclose the results of the tests to other family members who we now know to have increased risk (3). This may help individualsandthesocietyasawholedevicebetterpreventiveandtherapeuticstrategiesandhence the principle of beneficence overrides the individual's right to autonomy. If the diseases detected are treatable, the benefit to the public outweighs the autonomy of the individual.

**III. Incidentalfindings**

These are results that have potential health or reproductive importance and are unintentionally discovered while processing for other tests. Incidental findings may be carefully evaluated of the benefitsagainstthepotentialrisksandmayinvolveevaluatingtheresult'saccuracy,significanceto health, and clinical actionability. In the resource limited settings in developing countries, it often has other ramifications like cost of treatment and potential benefit of such treatment. Moreover, societal benefits must also be considered simultaneously before ruling in favor of the patient's autonomy (4).

**IV. Errordisclosure**

DisclosureoferrorsinLaboratoryMedicinesettingscomeswithuniquechallengesrelatedtoerror reportingbecausethelaboratoriesusuallyhavenorelationshipwiththeaffectedpatient.Hencethe disclosurehastohappenthroughthetreatingcounterparts.Severalbarrierstodisclosingerrorsexist viz.uncleardefinitionsoferror,fearthatpatientsmaynotunderstandtheerror,worrythatclinicians maynotbeabletoproperlyexplaintheerror,anddisclosureoferrorthatwasactuallycommitted



ISBN:978-81-957858-1-0

by someone else (5). The process of disclosing medical errors is gradually becoming formalized into the health care process.

**V. Testutilization**

One of the major problems in resource limited settings is inappropriate test utilization. In developing countries like India, the healthcare system is run parallelly through government and private mechanisms. In the private setting patients generally pay from out of their pocket to meet the expenses incurred during their treatment etc. Only a small percentage of patients are covered under insurance (6).On the other hand, in the government facilities the services are either free or atasubsidizedrate.However,thewaitingperiodsinthosesystemsarelongandoftentheancillary facilities are inadequate, hence not preferred by people who can afford. Hence, inappropriate test utilizationisaprobleminboththescenarios:intheprivateset-upunethicalpracticesforprofiteering might be discouraged by the labs; in government set up inappropriate test utilization should be discouragedasitleadstomis-utilizationofpublicmoney.Laboratoriansshouldadvocateforproper test utilization and communicate with physicians when they feel testing has been ordered inappropriately.

**VI. Direct-to-Consumer(DTC)testing**

DTClaboratorytestingisgrowingrapidlyallovertheworldalongwiththedevelopingworld.DTC allowsconsumersto ordertheirownlaboratorytests providing greaterautonomy in somecases, is moreaccessiblethangoingthroughstandardhealthcareprovidersandmaybelessexpensive,which is also a source of justice for patients with limited financial means. However, it has several limitations; consumers are less likely to properly interpret their own laboratory tests and may find erroneousinformationwithoutexpertguidance.Thisbecomesevenmoreevidentinlow-prevalence disease which increases the chances for false positive results. Hence, although not directly under the purview of the laboratories, ethically laboratories are bound to provide support to their customers (7).

**VII. Emerging disease setting**

Theemergence of COVID-19 and some othernovel diseases in recent years have presented a new challengetoethicalprinciples(8).Alotofquestionshavecomeupintheseunusualcircumstances like how the decisions are taken to ascertain which risks are acceptable for laboratory workers? Who decides what risks to patients areacceptable to protect laboratory workers or to protect other patients? But most importantly in resource limited settings where there is shortage of appropriate personal protective equipment (PPE) creating awareness among lab staff about the level of PPE required for each lab activity. Importantly, there should be initiatives to spread awareness among staff to mitigate their apprehensions.

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ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# Streptomycin:Structureanditsfunctionasapromotor

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**Abstract**

Streptomycin is a pseudotrisaccharide having a mono substituted aminocyclitol to which a disaccharideisattached.Streptomyciniseffectiveagainstmostoftheorganismswhichareinhibited bypenicillin.Inaddition,however,itexertsapotentactionagainstgram-negativeorganismswhich are uninfluenced by penicillin. While bacteriologic experiments suggest a very wide field of usefulness for streptomycin, direct experience in the treatment of human diseases has greatly restricted the scope of its application. Experience thus far indicates that because penicillin is non-toxic while streptomycin possesses toxic actions which are sometimes quite serious. There is also the fact penicillin is administered in quantities measured in milligrams and streptomycin in quantities of grams and these large amounts of the drug are not practical for some of the special technics of administration such as suspension in wax and oil for delayed absorption. Thus far, streptomycin has been found especially useful in urinary infections caused by the Escherichia coli and some other, gram-negative bacterial infections of the urinary tract such as the Bacillus lactis aerogenes, Bacillus proteus and Bacillus pyocyaneus. It is highly effective in Friedlander's pneumonia, Hemophilus influenzas meningitis and tularemis. It has also been found effective in pneumonias, abscesses, peritonitis and other infections caused by the gram- negative bacteria frequently found in the urinary tract. It appears to be without value in virus infections. One of the most stirring aspects ofstreptomycin action is theobservation that it cures certain forms ofanimal tuberculosisandthenowwell-establishedclinicalexperienceshowingthatitmaychecksomeforms of human tuberculosis, especially those in exudative stage. There was considerable discussion in the conference concerning the details of its role in the therapy of human tuberculosis.

**Keywords**:Streptomycin,Susceptibility,Influenza,Tuberculosis, Antibiotics

## Introduction

Twootherphasesofstreptomycintherapyreceivedspecialconsideration.Thereissomeindication that different members of the same bacteria species show wide difference in susceptibility to streptomycin and it is now well established that for most infections, resistance to streptomycin is acquired quite rapidly, in a matter of days to weeks. The limits the application of the drug to brief coursesoftreatmentinnecessitatestheuseoffullyeffectivedoses,fromtheoutset.Thenextpoint is the matter of toxicity. Streptomycin is not an innocuous drug. In addition to the various allergic drugreactionssuchasskinrash,fever,itmayproduceseriousrenaldamage,itmayaffecttheblood-formingorgansanditexertsanactiononthecentralnervoussysteminvolvingthevestibular



ISBN:978-81-957858-1-0

apparatus and the eights nerve causing vertigo, tinnitus and impaired hearing, some of the effect becoming permanent. These effects are apt occur after prolonged of the drug, after three or four weeks. They are more frequent with the larger doses, Doses larger than those usually necessary. One needs to keep them in mind, for the full scope of the applications of the streptomycin has not yet been established and a good deal of the exploration is still necessary to establish the full potentialities of streptomycin in human infections. In the present state of our knowledge, there is justification in giving streptomycin in a trial in serious bacterial infections in which the other specific anti- microbial agents have failed. It is suggested that an IN VITRO test of the sensitivity of the organism may help to establish the indication for its trials in such cases. Streptomycin Belongs to a group of compounds, it is as antibiotics which are produced by microorganisms and whichpossessthepropertyofinhibitingthegrowthandevenofdestroyingothermicroorganisms .Antibiotic vary greatly in their chemical nature, mode of action upon different organisms. And effectanimal upon thebody. Streptomycin, antibiotic synthesized by the soil organism Streptomyces griseus. Streptomycin was discovered by American biochemists Selman Waksman, Albart Schatz, and Elizabeth Bugie in 1943 The drug acts by interfering with the ability of a microorganism to synthesize certain vital proteins It was the first antimicrobial agent developed after penicillin and the first antibiotic effective against a wide variety of diseases. *Streptomycin* is an antibiotic medication used to treat a number of bacterial infections. This includes tuberculosis, Mycobacterium avium complex, endocarditis, brucellosis, Burkholderia infection, plague, tularemia, and rat bite fever. It is an aminoglycoside antibiotic produced by the soil actinomycete Streptomycesgriseus.Itactsbybindingtothe30Sribosomalsubunitofsusceptibleorganismsand disrupting the initiation and elongation steps in protein synthesis. It is bactericidal due to effects that are not fully understood. Streptomycin irreversibly binds to the 16S rRNA and S12 protein within the bacterial 30S ribosomal subunit. As a result, this agent interferes with the assembly of initiation complex between mRNA and the bacterial ribosome, thereby inhibiting the initiation of protein synthesis. In addition, streptomycin induces misreading ofthe mRNAtemplateand causes translationalframeshift,therebyresultsinprematuretermination.Thiseventuallyleadstobacterial cell death.

**STRUCTUREOFSTREPTOMYCIN**:Streptomycinischaracterizedchemicallyasanaminoglycoside antibiotic. It consists of three components linked glycosidically.

1) Streptidine(inositolwithtwoguanido groups)
2) Streptose(methyl pentose)and
3) Streptoscamine(N-methyl-L-glycosamine)



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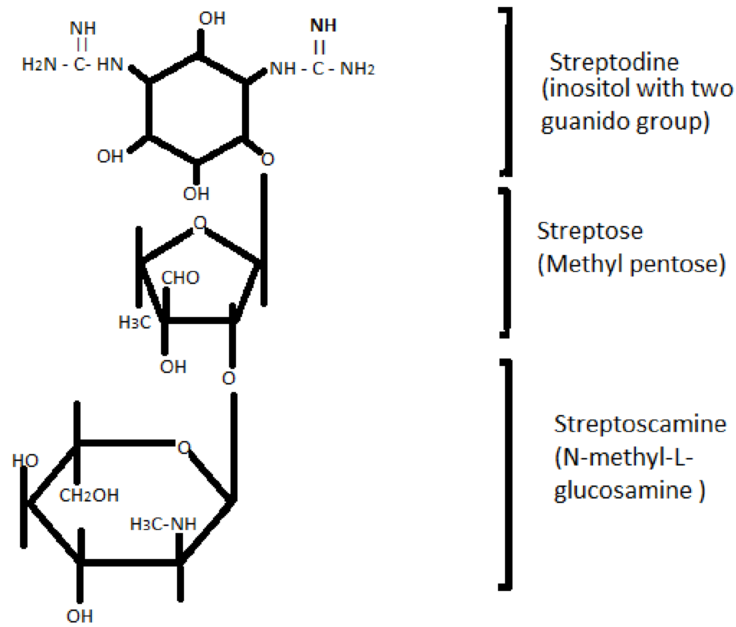
Both guanido groups of streptidine are essential for the antibiotic activity and removal of one group reduces antibiotic activity upto 90%




Chemicalstructureofstreptomycin

**PRODUCTIONOFANTIBIOTICBYSTREPTOMYCIN:**

The isolation of streptomycin was the culminatingpoint of a painstakingSearch for antimicrobial agents producedbyantinomycetes , a group of organism closelyrelated to the bacteria. This was precededbylong and continuous research,dating backto 1915 ,on actinomycetes theirOccurrence and abundance in nature, their systematic or taxonomic position ,the role in soil process notability in the decomposition of plant and animal residues andintheformationofhumusandfinallytheirassociativeandantagonisticeffectuponbacteria and fungi . it was finally established that as many as 20 to 50 percent of all the actinomycetes found in the soil and in other natural substrates had the capacity to inhibit the growth of the other microorganism.

Streptomyces grisesus, the organism which comprised the streptomycin producing strain, was known in our laboratories from the beginning of our work on actinomycetes ,although it was not tested at that time for its antibiotic-producing properties .The ability of actinomycetes to exertinjurious effectsuponbacteriaand fungihas been knownformanyyears.Lieskeshowed in 1921 that certain strain are able to bring about lysis of many bacteria and antagonize their growth. This process is active in nature some of the bacteria are affected, and others are not. Otherinvestigators notably Gratiaand Dath and Rosenthal, demonstratedin 1925 that cultures oforganismdesignatedasstreptothrix,andnowknowntobeactinomycetesinsoil:80culture



ISBN:978-81-957858-1-0

wereisolated ,ofwhich47wereabletorepressbacterialgrowth,butonly27liberatedintothe medium substances which had the capacity to inhibit the growth of gram positive bacteria, but not of gram negative bacteria and fungi.

Theproduction ofantibioticsby actinomycetesin 1939 , only two preparations wereknownto processantimicrobialproperties.Thesewerenottruerecognizedassuch.Onewasobtainedby gratia and had the capacity to lyse dead typhoid cells and certain living bacteria, it was later designatedbyWelschasactinomycetin.Theotherwasbelievetobelysozyme,whichhadlytic principle.

The first true antibiotic to be derived from a culture of an actinomyces was isolated. The organism,Actinomycesantibioticus,yieldedasubstancewhichwasdesignatedasactinomycin. It was soon crystallized, and its chemicals and biological properties were established. This antibiotic proved to active against various gram positive bacteria but to a much lasser degree upon the gram negative organisms. It proved to be extremely toxic to experimental animals.

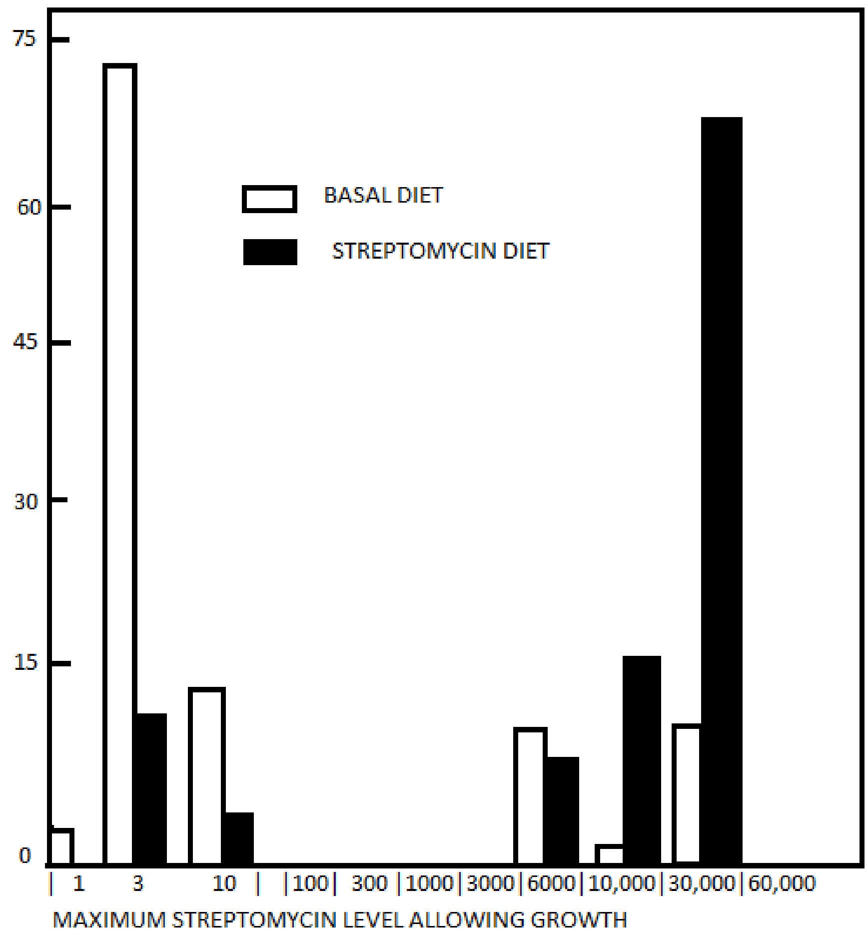
**GROWTHPROMOTER:**Inaninvestigationofmicrobiologicalaspectsconnectedwiththeuse of streptomycin and other antibiotic supplements in turkey nutrition , in this case it was observed that cases of considerable drug fastness in the intestinal microflora since the development of antibioticresistantstrainsofmicrobeshasabearingonthesuccessfuluseofantibioticasnutrional supplements. culture for this purpose isolated from two types of material.

In one type of experiment , intestinal contents were obtained at autopsy from turkey poults which for about a month had been fed an adequate , high soyabean- oil meal ration to which was added 50mg of streptomycin per kg of ration . In a second type of experiment the intestinal microflora wasfollowedbyperiodicculturingfromhatchinguntil5to6weeksfrombothsourcesweretreated inasimilarfashion.sincethisworkisonephaseofageneralstudyoftheoveralleffectofantibiotic ontheintestinalmicrofloraofpoultry,quantitativeplatingofintestinalcontentsandfecalmaterial contents and fecal material ere carried out on a vsriety of culture media.

The use of streptomycin as a growth promoting supplement in turkey poults results in the appearance within three days of streptomycin-resistant coliform bacteria.



ISBN:978-81-957858-1-0




In thistablethedistributionofstreptomycin resistancein coliform cultureisolatedatrandomfrom intestine of turkey poults , calculated as percentage of total number of culture in each of the following categories :the blank line =195 culture from poults on basal diets : the black line = 122 culture from poults on streptomycin diet.

**CLINICAL USES** : Streptomycin in combination with penicillins is used in the treatment of enterococcal carditis , tuberculosis , and plague.

Becauseoftheriskofototoxicity ,streptomycin shouldnotbeusedwhenotherdrugswell serve.

Owing to their toxic potential, neomycin, and kanamycin are usually restricted to topical (for the conjunctiva or external ear ) or oral use (eg , eliminatebowel flora). Gentamicin is also available for tropical use.

Because of their toxicity with prolonged administration, aminoglycosides should not be used for more than a few days unless deemed essential for a successful or improved outcome.



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Once the microorganism is isolated and its sensitivities to antibiotics are determined, the aminoglycoside shouldbe discontinued if the infecting microorganism is sensitive to less toxic antibiotics.

**DOSAGEAND ADMINISTRATION** :

1. TUBERCULOSIS:It was the first antibiotic discovered that was effective against TB. Today it is widely used as a first line TB medicine in patients that have previously been treated for TB. Streptomycin is added to first line regiments because patients that are resistant to both rifampicin and isoniazid are classified as having MDRTB ; these patients should not be retreated with first line medicine but instead initiated onto a second line regimen.

| Adults: | Adults with liver damage- creatinine < 30 ml/min: | children : |
|---|---|---|
| 15-20 mg/kg daily [max dose 1000 mg] | 12-15 mg/kg 2 or 3 times a week | 20-40 mg/kg [max dose 1000 mg] |
| streptomycin is administred via injection daily or 5 days a week during the intensive phase, in the first two months of treatment | | |

Streptomycin is usually administered daily as a single intramuscular injection. A total dose of not more than 120g over the course of therepy should be given unless there are no other therapeutic options.Inpatientsolderthan60yearsofagethedrugshouldbeatareduceddosageduetotherisk of increased toxicity.

2. TULAREMIA:Oneto2gdailyindivideddosesfor7to14daysuntilthepatientisafebrile for 5 to 7 days.
3. PLAGUE :Two grams of streptomycin daily in two divided doses should be administered intramuscularly .Aminimum of 10 days of therapy is recommended.
4. BACTERIALENDOCARDITIS:

a. Streptococcalendocarditis:inpenicillin–sensitivealphaandnon–hemolyticstreptococcal endocarditis . streptomycin may used for 2 weeks treatment concomitantly with penicillin.



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Thestreptomycinregimenis1gforthefirstweekand500mgforthesecondweek.Ifthe patient is over 60 years of age , the dosage should be 500mg for the entire 2 week period .

b. Enterococcal endocarditis : Streptomycin in doses of 1 g for 2 week and 500 mg for an additional 4 weeks is given in combination with penicillin . Oxotoxicity may require termination of the streptomycin prior to completion of the 6 week course of treatment.

5. CONCOMITANT USEWITH OTHERAGENTS : For concomitant use with other agents towhichtheinfectingorganism isalsosensitive.Streptomycinisconsideredasecondline agent for the treatment of gram negative bacteremia , meningitis, and pneumonia; brucelloosis;granulomainguinale;chancroid,andurinaryinfection.

| Approx. conc. mg/ml | volume(ml) of solvent |
|---|---|
| 200 | 4.2 |
| 250 | 3.2 |
| 400 | 1.8 |

For adults: 1-2 grams in divided doses every six to twelve hours for moderate to severe infections.Doesshouldgenerallynotexceed2gramsperday.

Forchildren:20to40mg/kg/day(8to20mg/1g/day)individeddosesevery6to12hours. (Particularcareshouldbetakentoavoidexcessivedosageinchildren.) The dry lyophillized cake is dissolved by adding Water for Injection USP in an amount to yieldthedesiredconcentrationasindicatedinthefollowingtable:

Sterile reconstituted solutions should be protected from light and may be stored at room temperatureforoneweekwithoutsignificantlossofpotency.

Parenteraldrug products should be inspected visually for particulate matter and discoloration prior to administration, whenever solution and container permit.



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**SIDE EFFECTS**:

Along with its needed effects, a medicine maycausesomeunwanted effects. Although not allofthesesideeffectsmayoccur,iftheydooccur,theymayneedmedicalattention.

Checkwithyourdoctorornurse immediatelyifanyofthefollowingsideeffectsoccur: More common

- Black,tarry stools.
- Burning,crawling,itching,numbness,prickling,“pinsandneedles”,ortingling feelings
- Chestpain
- Chills
- Clumsiness
- Cough
- Dizzinessorlight-headedness
- Feelingofconstantof selfor surrounding
- Fever
- Large, hive-like swelling on the face, eyelids, lips, tongue, throat, hands, legs, feet, or sex organs.
- Nausea
- Painfulordifficulturination
- Sensationof spinning
- Sore throat
- Swollen glands

**Less common**

- Back,leg,orstomach pains
- Bleedinggums
- Bloodyorcloudy urine
- Blurred vision
- Changein vision
- Dark urine



ISBN:978-81-957858-1-0

- Deafness
- Fastheartbeat
- Dry mouth
- Headache
- Itching
- Muscleweakness



ISBN:978-81-957858-1-0

## DifferentTypesofBloodvialsandtheirsignificanceinMedicalLabSciences

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2. *RIMTUniversity,Mandi Gobindgarh,Punjab*

**Abstract**

Laboratory tube collection is a process applied when withdrawing blood samples from patients beforetheygettestedinthelaboratory.Itfollowstheprinciple,whichismostcommonlyknownas the "order of draw." Different tests and biochemical assays require varying types of sample collection tubes. The reason why tubes are color-coded is for practical and easy identification. In- vitro analysis of blood samples can be performed in clinical laboratories. However, these blood samplescomeindifferentforms.Testingprocedurescanrequireanyofthefollowingbloodsample types:serumorplasma. Inperformingmultiplecollectionsofvenousand/orarterialbloodsamples in a single patient, a color sequence of withdrawing and its indications based on the Clinical & Laboratory Standards Institute (CLSI) is the recommended procedure.

**Keywords**:Vial,BloodCollection,BloodTesting

### Introduction

### (A). Redtop

Theredbottleislesscommonitisusedforbiochemistryandserologytestsrequiringserumwhich might be adversely affected by the separator gel used in the yellow bottle. • Additive: None or contains silica particles which act as clot activators. • What additive does:Clot activator promotes bloodclottingwithglassorsilicaparticles.•LaboratoryUses:Serumtesting(glucose,cholesterol, triglycerides, HDL, potassium, amylase, alkaline phosphates, BUN, CK, liver enzymes), blood bank, serology (RH Typing, Antibody screening, Red Cell Photo typing, DAT, RPR, monospot, rheumatoid factor, ANA) Figure 4: red top test tube 2-Yellow top • Additive: anticoagulant SPS (Sodium Polyanetholsulfonate) & ACD (acid citrate dextrose) • What additive does: Prevents the blood from clotting and stabilizes bacterial growth.


### (B). Yellowtop



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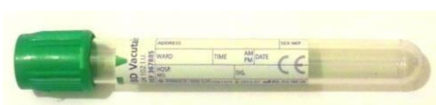
Additive:anticoagulantSPS(SodiumPolyanetholsulfonate)&ACD(acidcitratedextrose)•What additive does: Prevents the blood from clotting and stabilizes bacterial growth. • Laboratory Uses: Blood and bodily fluid cultures (HLA, DNA, Paternity) Tubes with SPS – For Blood and bodily fluidcultures(HLA,DNA,Paternity).TheSPSaidsintherecoveryofmicroorganismsbyslowing down/ stopping the actions of complement, phagocytes, and certain antibiotics. Tubes with ACD are for cellular studies, HLA typing, paternity testing.

3-Blue top 

Thebluebottleisusedforhematologytestsinvolvingtheclottingsystem,whichrequireinactivated whole blood for analysis. • Additive: Sodium Citrate13 • What additive does: Binds and remove calcium to prevent blood from clotting • Laboratory uses: Coagulation (clotting process-P. T) PT (Prothrombin Time – evaluates the extrinsic system of the coagulation cascade & monitors coumadin therapy) APTT/ PTT (Activated Partial Thromboplastin Time – evaluates the intrinsic system of the coagulation cascade & monitors heparin therapy) FDP (Fibrinogen Degradation Products) TT (Thrombin Time) Factor assays.

4-Greentop

Thislesscommonlyusedbottleisforbiochemistrytestswhichrequireheparinizedplasmaorwhole blood for analysis. • Additive: Heparin (Sodium/Lithium/Ammonium) • What additive does: Inhibits thrombin formation to prevent clotting • Laboratory uses: Chemistry Testing (Plasma determinations in chemistry): ammonia, carboxyhemoglobin & STAT electrolytes, chromosome screening, insulin, renin and aldosterone



5- Purpletop (Lavender)

Thesebottlesaregenerally usedforhematologytestswherewholebloodis required foranalysis.• Additive: EDTA (Ethylenediaminetetraacetic Acid) • What additive does: Removes calcium preventing clotting of blood • Laboratory uses: Hematology testing (ESR, CBC w/diff., HgBA1c) blood film for abnormal cells or malaria parasites, reticulocytes, red cell folate, Monospot test for EBV, parathyroid hormone (PTH)



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6- Greytop

Additive:PotassiumoxalateandSodiumfluoride•Whatadditivedoes:Sodiumfluorideactsasan antiglycolytic agent to ensure that no further glucose breakdown occurs within the sample after it is taken. Potassium oxalate removes calcium and acts as an anticoagulant. • Laboratory uses: Chemistry testing, especially glucose(sugar) and lactate, Glucose tolerance test (GTT)14


7- Royalbluetop

Additive:SodiumHeparinalsoSodiumEDTA•Whatadditivedoes:InhibitsThrombinformation toprevent•Laboratoryuses:Chemistrytraceelements(suchasZinc,Copper,LeadandMercury), toxicology, and nutritional chemistry testing.

8- Blacktop

Additive:SodiumCitrate•Whatadditivedoes:Formscalciumsaltstoremovecalci



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

## PreparationandsterilizationofExplantsforinoculation.

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2. *RIMTUniversity,Mandi Gobindgarh,Punjab*

**Abstract**

Preparation and sterilization of Explant for inoculation. The first important condition for the successfultissuecultureproceduresisthemaintenanceofasepticcondition.Sterilizationeliminates microorganism and thus avoids contamination by bacteria and fungi. To maintain an aseptic environment, all culture vessels, media and instruments used in handling tissue, as well as the explant itself is should be surface sterilized. During sterilization, the living materials should not lose their biological activity and only contaminants should be eliminated; therefore, explants are surface sterilized only by treatment with disinfectant solution at suitable concentrations for a specified period. The disinfectants widely used are sodium hypochlorite, calcium hypochlorite, ethanol, mercuric chloride, hydrogen peroxide, silver nitrate and bromine water. Hypo-chlorite is known to be a very effective killer of bacteria, even micro molar concentrations are enough to reducebacterialpopulationssignificantly.However,littleisknownabouttheexactmechanismsof its bactericidal activity.

**Keywords:**Inoculation,Explant, Population

**Introduction**

Surface sterilizing plant material is an important step when establishing a plant tissue culture protocol. Commonly used disinfectants for plant tissue culture and methods for disinfecting green capsules, dry seeds, and orchid seeds disinfecting are detailed below.

**Somecommonlyusedchemicalssterilantareas follows:**

**1%sodiumhypochlorite**(NaClO)**:**

It is generally available with 5 % active chlorine content, so 20 % can be used for normal sterilization.

**Calciumhypochlorite**Ca (ClO)2:

This comes in the powder form. Generally, 100 ml of Ca (ClO)2 is used. The desired weight of hypochloriteisaddedintothewater,agitatedfor10min,allowedtosettleandtheclarifiedfiltered supernatant solution is used for sterilization. The filtrate is used immediately because of deliquescent (take up water) nature. Calcium hypochlorite enters the plant tissue slowly as comparedtosodiumhypochlorite.Thestandardconcentrationusedisoftheorderof4to10%and the soaking time varies from 5 to 30 min.



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**Bromine Water:**

1to2%brominewatersolution isusedfor thesterilization purpose.

**Mercuricchloride:**

It is dissolved in water to create the solution. Concentration of 0.01 to 0.1 % for 2 to 10 min, depending upon the tissue, is used. Mercuric chloride is an extremely toxic substance for plant, so rinsing must be very thorough at least five times.

**Alcohol:**

70 % alcohol is used for sterilization of plant material by dipping them for a period of 30 sec to 2 min. Generally, alcohol aloneis not sufficient to kill all themicroorganisms and theplant material after alcohol treatment is treated another chemical sterilant.

**Antibiotic**

Cefotaximeantibioticat50mg/Lconcentrationinthenutrient mediumisgenerallyusedtocontrol bacterial infection.

Explantsaftertreatmentwithsterilantsmustbethoroughlyrinsedwithsteriledistilledbecause retention of such toxic chemicals will seriously affect the establishment of culture.

**MaterialRequired:**

**Apparatus**:LaminarAirFlow,Autoclave,pHmeter,Weighingbalance,Magneticstirrers,Scalpel, Surgical blades etc.

**Reagents & Chemicals:** Tween 20 (liquid detergent)**,**0.1% $HgCl_2$**,**70% alcohol**,**sterile distilled water

**Glassware:**Beakers,sterilepetri plates,sterileblades, sterileforceps,muslin cloth

**Procedure:**

1. Plant part to be used was first thoroughly examined so as it should not be diseased or under ant stress.

2. If you see symptoms of any pathogenic attack or plant to be under stressed conditions then it is advisable to not to use that plant.

3. Suitable size of part from either root, shoot, leaf or bud could be used which will be called asExplant.

4. Aftercuttingtheexplantwithscalpeltransferthemintobeakercontainingsufficientwater,soas the explants are completely submerged. Add few drops of liquid detergent – Tween 20.

5. Now,wewillinitiate thestepsfor surfacesterilizationofthe explants



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Step-1

- Tumblingunderrunningtapwater(30min.)

Step-2

- Washingwith1%anti-fungal(Bavistin)(10min.)

Step-3

- TumblingunderrunningtapwatertowashoffBavistin(30min.)

Step-4

- Transfertheexplantintolaminarairflowhoodforfurtherworkto avoid contamination.
- WashingtheexplantswithHgCl2(0.1%HgCl2solution)forrequiredtime-60sec Step-

5

- Washingexplantswithautoclaveddistilledwater(3times)

Step-6

- Washwith 70%alcohol for30secondstoremovewaterfrom the surface
- Explantsarenow readyfor inoculation

**OBSERVATIONS**

ExplantswerepreparedandSterilizationforinoculationtoobtainnewlydeveloped plant.



ISBN:978-81-957858-1-0

# Ayurveda-AsHolisticHealing

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**Abstract**

Ayurveda accepts the laws of uniformity in nature, and suggests that medicinal substances and living bodies are similar in composition, being products of the same cosmic forces. Hence, herbs and drugs influence the body according to their nature and attributes. Substances of opposite attributes can be used to correct conditions of imbalance within the body. In ayurveda, all bodily processes are believed to be governed by a balance of the 3 doshas. Whichever dosha appears to dominate a person's behavior and physique is called his constitution type. Each constitution type hasparticularstrengthsandsusceptibilities.'Tridoshasareconsideredsimilartoaetiologicalfactors responsible to derange normal health condition.

**Keywords**:Ayurveda, Herbal medicine

## Introduction

Tridoshaj theory: Tridposha, which means three dosha. Dosha is a Sanskrit word, which means "abnormal". It is one of the main parts of the basic principles of ayurveda. The 3 main doshas (humours) are: vata (the energic humour), pitta (the thermogenic humor), kapha (the cohesive humour). Herbal preventive medicine basic ideas balance and harmony is the key to successful preventive medicine. Herbal medicine can transform metabolic and physiological processes. - nutritionmustbeofa quality thatenables thebodytorenewitselfin a way thatensureshealthand wholeness. A conscious and free-flowing emotional life is fundamental to achieving any inner harmony. Herbal actions, tonics and alternatives. The plant kingdom is an abundant and rich resource for treatment & prevention of diseases. Detoxification and eliminative programmes. The herbalapproachtodetoxificationisbasedupontheperceptionthatthehumanbodyisaself-healing and homeostatic organism, and that the therapist simply has to support normal processes. Herbal actionsandeliminationThereareherbalactionswhosephysiologicalimpactmakesthemespecially indicated for the support of the different pathways of elimination in the body: - for the digestive systemandcolon-laxative - forthekidneys andurinary system- diuretic- for the liver andblood - hepatic, alterative - for the lymphatic system-alterative, lymphatic tonic - for skin - diaphoretic, alterative-fortherespiratorysystem-expectorant,anti-catarrhal-andforsystemicingeneraltonic, alterative, adaptogen, antimicrobial.

## Herbalapproachtotheimmunesystem



ISBN:978-81-957858-1-0

Theimmunesystemhasbecomeanincreasinglycrucialissueinrecentyears.Notonlyinmedicine but in many aspects of our lives, having a grasp of the new concepts concerning human immunity has become essential in understanding our world and making personal choices. There are many waysofusingherbstoenhanceimmunologicalvitality.Allthemanydiverseherbaltraditions,with theiruniqueculturalrootsandexpressions,havevaluableinsightsintotreatmentsandspecificherbs for the system. Ayurvedic compound formulations are dividing into two groups viz

(1) Kasthausadhi: -predominantly plantdrugs, and

(2) Rasausadhi:-Predominantlymetalsandminerals.ThereareseveralcategoriesofKasthausadhi formulation such as Asavarista, Avaleha, Ghrta, Churna, Taila, etc. and of Rasausadh is such as Bhasama, Pisti, Lauha, Mandura, Kupipakva Rasayana etc.

1 ASAVA&ARISTSAsavas& Aristsaremedicinalpreparationsmadebyfermentationprocess, generating alcohol. Thus, facilitating the extraction of the active principles contained in the drugs. The alcohol, so generated, also serves as a preservative. Examples: - Ashokarista, Lohasava, Drakshasava.

2 AVALEHA Avaleha or lehya prepared either the addition of jaggery, sugar or sugar-candy and boiled with prescribed drug juice or decoction. Examples: - Chyawanprash, Gulukand.

3 GHRITA Ghritas are preparations in which ghee is boiled with prescribed kasayas (decoction) and kalkas of drugs according to the formula. Examples: - Brahmi Ghrit, Triphala Ghrit etc.

4 CHURNA Churna is afine powder of drug or drugs. Examples: - Hingvastaka Churan, Triphala Churan.

5 TAILA Tailas are preparation in which taila is boiled with prescribed Kajsayas (decoction) and Kalkas of drugs according to the formula. Examples: - Bhringraj Taila, Laung Taila

6 BHASMA Powder of substance obtained by calcinations is called Bhasma. Examples: - Lauh Bhasma, Mandur Bhasma .

7 PISTI Pisties are prepared by triturating the drug with the specified herbal extract and exposing to sun or moon-light. Examples: - Mukta Pisti, Praval Pisti, etc.

8 LAUHA Lauha are preparation of Loha Bhasma as main ingredient added to other drugs. Examples: - Guduchi Lauh.

9 MANDURA These are preparations containing sodhita mandura along with other drugs. Examples: - Punernava Mandur, Triphla Mamdur etc.

10 SATTVASattvaiswaterextractablesolidsubstancecollectedfromadrug.GHANSATVisthe drugconcentratederivedfromextractablewatersolubleextractfromthedrugpart.Theconc.ratio ofGhansatvtothedrugisabout1:10to1:30,dependinguponthepartofHerbusedforpreparation.



ISBN:978-81-957858-1-0

11 ARKAArkaisaliquidpreparationobtainedbydistillationofcertainliquidsorofdrugssoaked inwaterusingconvenientdistillationapparatus.Examples:-ArkGulab,GiloeArk,PudinaArketc.

12 KVATHA CURNA Certain drugs or combination of drugs are made into coarse powder and keptforpreparationofkasaya.Suchpowdersarecalledkvathcurna.Examples:-AmritadiKwatha Churan, Patoladi Kwatha Churan

13 GUGGULU Guggulu is an exudate obtained from the plant Commiphora mukul. Examples: - Triphal Guggulu, Yograj Guggulu, Rasnadi Guggulu etc.

14 DRAVAKADravakasareliquidpreparationobtainedfromlavanasandksaras.

15 VATI/GUTIKAMedicinespreparedintheformoftabletsorpillsareknownasVatiandGutika. These are made from one or more drugs of plant, animal or mineral origin. Examples: - Lasunadi Vati, Khadiradi Vati etc.

16 PARPATI Parpati is a rasa preparation. The name is derived from the method by which flakes of the compound are obtained. Examples: - Lauh Parpati, Shwet Parpati etc.



ISBN:978-81-957858-1-0

# SignificanceofNanobiotechnology

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**Abstract**

Nanotechnology is currently being utilized for tissue engineering and regenerative medicine. Nanostructurescanmimictissue-specificbio-environmentsbydesigningconstructswithparticular biochemical, mechanical and electrical properties. The Use of Nanostructures for Tissue EngineeringScaffoldsTissueengineeringrequiresaporousscaffoldthatwillserveasbothsubstrate and support for tissue growth.The scaffold forms the necessary spatial composition for directing cells to grow into the correct anatomical shape.The nanostructures developed for use as tissue engineering scaffolds can have variable functionality dependent on their design.For example, neural tissue requires electrical conductivity whilst bone and cartilage cells necessitate enhanced mechanical properties.

**Keywords**:Nanotechnology,CarboParticle,Nanotubes,Engineering

## Introduction

Thepropertiesofnanostructuresvarydependentonthenanomaterialused.Carbonnanotubeshave been proposed for use in tissue engineering because they can conduct electricity, are chemically stable and are strong enough for use as scaffolds. Moreover, filamentous carbon nanotubes have a structural composition that is comparable to the extracellular matrix which supports surrounding cells.Thismeans that carbonnanotubesmayhavetheabilitytostimulatecellfunctioninthesame way as the extracellular matrix.

## CarbonNanotubesforBoneTissueEngineering

Bonetissueengineeringrequiresthecomplexformationofcelltypessuchasosteoblasts,osteoclasts and osteocytes within a non-cellular mineral component.Previously, nanomaterials chosen for bonetissueengineeringwerelimitedduetotheirlowmechanicalstrength.Studiesinthelastdecade haveshownthathighstrengthcarbonnanotubesarefullycompatiblewithbonecells.Multi-walled carbon nanotubes have also been proven to produce bone repair that can be fully integrated into new bone.

## CarbonNanotubesforNeuralTissue Engineering

Nanotubes are especially suited for neural tissue engineering as their structure mimics the natural tubularformsofmicrotubulesandaxons.Carbonnanotubesarecharacterizedbyrelativelyhigh



ISBN:978-81-957858-1-0

conductivity which is necessary for maintaining electrical signals between neuronal cells. Studies have found that neuronal cells can grow neurites onto carbon nanotube substrates.

**CarbonNanotubesforCardiacTissueEngineering**

The electrical conducting property of carbon nanotubes is also being put to use in cardiac tissue engineering.Regeneratingcardiactissuewouldimprovetheprognosisofheartpathologiessuchas cardiovascular defects and heart failure.Carbon nanotubes are being used to develop devices for functional regenerative purposes. Through embedding carbon nanotubes into gelatin methacrylate hydrogels, a two-dimension patch was formed which allowed for the engineering of cardiomyocytes.The cells produced displayed synchronous beating as the carbon nanotubes promoted cell-cell adhesion and improved cell-cell electrical coupling.

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ISBN:978-81-957858-1-0

## Liver:thelargestorganofthebody

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**Abstract**

It is the largest gland in the body and weighs between 1- 1.25 kg. It is divided into right and left lobes. The right lobe is much larger than the left one. Liver is an extremely vascular organ (approximately 1/5th of the liver volume is blood). It plays a vital role in metabolism. Production and excretion of bile Storage of glycogen Metabolism of carbohydrates, proteins, fats. De-aminationofaminoacids(removalofnitrogencontainingportionofaminoacidanditsconversion to ammonia which in-turn combines with carbon-di-oxide to form urea which is excreted by the kidneys.)Production of plasma proteins – Liver forms 90-95 % of the plasma proteins, albumin, globulinandfibrinogen.Storageofvitamins(A,D&B12)andiron.Productionofclottingfactors. Productionofheatduetometabolism.Detoxificationoftoxicsubstancessuchasalcoholanddrugs.

**Keywords**:Liver,Metabolism,Hepatitis, Inflammation,Cirrhosis

**Introduction**

**Thegall bladderbile:** It is astoragefacility forbileproduced by theliver. Asmall pouch-shaped organtuckedawayundertheliver,thegallbladderformsapartofbiliarysystem,joinedtothebile ductbythecysticduct.Agreenish-yellow/brownish-yellowfluidthatissecretedbytheliver,stored intheGallbladderanddischargeintoduodenumthroughbiliarytractandbilehelpsinthedigestion and absorption of fats.

**Liver function tests (LFTs):** LFT’s are the blood test parameters showing the functioning of the liver-Whentheseparametersarewithinreferencerange,itshowsnormalfunctioningoftheliver / healthy liver. When these parameters are above the normal reference range, it shows abnormal liverfunction/liver damage/poor liverfunction•TotalbilirubinReferencerange 0.2–1.2mg/dL • DirectbilirubinReferencerange0.1–0.4mg/dL•Aspartatetransaminase(AST/SGOT)Reference range 5 to 47 IU/L • Alanine transaminase (ALT/SGPT) Reference range 7 to 56 IU/L • Alkaline phosphatase (ALP) Reference range 30 to 120 IU/L • Albumin Reference range 3.5 to 5.3 g/Dl. Diseases associated with liver sluggish liver are anorexia, nausea, malaise, hyperbilirubinemia Jaundice, hepatitis (inflammation of liver), fatty liver (accumulation of fat in the liver), cirrhosis / fibrosis of liver (scarring of liver), gall bladder stones, hepatotoxicity induced by alcohol and at/ chemotherapy, Sluggish liver (anorexia, nausea, malaise), ‘sluggish liver’ is a non-technical medical term that is used to describe a liver that is not functioning optimally. Generally, this term is used when theliveris freeofdisease, but performing at areduced rate. - anorexia,thesymptom



ISBN:978-81-957858-1-0

ofpoorappetitewhateverthecause.-nauseaisthesensationofuneaseanddiscomfortintheupper stomachandheadwithanurgetovomit.-malaiseisageneralizedfeelingofdiscomfort,illness,or lack of well-being. Malaise is a symptom that can occur with almost any significant health condition. It may start slowly or quickly, depending on the type of disease. Hyperbilirubinemia a condition where there is a high level of bilirubin in the blood. Bilirubin is a natural byproduct of the breakdown of red blood cells; however, a high level of bilirubin may indicate a problem with the liver. Jaundice causes skin and the whites of your eyes to turn yellow. Too much bilirubin in the blood causes jaundice. Bilirubin is a yellow pigment in hemoglobin, the substance that carries oxygeninyourredbloodcells.Asredbloodcellsbreakdown,yourbodybuildsnewcellstoreplace them. The old ones are processed by the liver. If the liver cannot handle the blood cells as they breakdown,bilirubinbuildsupinthebodyandskinmaylookyellow.Hepatitisisaninflammation of the liver, most commonly caused by a viral infection. There are five main hepatitis viruses, referred to as types a, b, c, d and e. Fatty liver fatty liver, also known as fatty liver disease (fld), is a reversible condition where large vacuoles of triglyceride fat accumulate in liver cells due to alcohol intake, high fat diet or improper metabolism cirrhosis / fibrosis of liver chronic liver diseases lead to fibrosis which leads to derangement of the architecture, portal hypertension and mayproducesuchanirreversiblerearrangementofthecirculationastocausecirrhosis.Gallbladder stones (cholelithiasis) a gallstone is a crystalline concretion formed within the gallbladder by accretion of bile components. Gallstones are small, pebble-like substances that develop in the gallbladder. Bile contains water, cholesterol, fats, bile salts, proteins, and bilirubin—a waste product. Two types of gallstones areseen, 1. Cholesterol stones 2. Pigment stones. Hepatotoxicity induced by alcohol and chemotherapy drugs are an important cause of liver injury. More than 900 drugs(i.e.Paracetamol,anticancermedicinesetc.)Toxinsandalcoholhavebeenreportedto cause liver injury, and drugs account for 20-40% of all instances of hepatic failure.



ISBN:978-81-957858-1-0

## Ethnobotany-eatweedsandyouwillbenourished

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**Abstract**

The foods that we eat often carry with them particular ties to cultural traditions, stories, memories and histories. In this way, foodsand thediverseplant speciesfrom which they areproduced, often connect communities of people across diasporas and across generations. Plants, as with humans, havealongevolutionaryhistoryacrosschangingecologicalzonesandtheserelationshipsbetween humans and plants are an important part of the entangled history of human evolution across the globe. For example, some plants that have become weeds were introduced to North America by early colonizers and settlers bringing familiar European plants with them. Escaping cultivation, thesenon-nativeplantsfoundtheirplaceinsettlementlandscapesandeventuallyspreadbeyondthe point of introduction. Yet others arrived accidentally in contaminated shipments of grain destined to be sown as field crops or stuck in the shoes and clothing of a new human immigrant or refugee. Someofthosefieldcropseedssuccessfullyescapedcultivation,establishedwithoutassistance,and became weeds.

**Keywords:**Weeds,Nourishment,Ethnobotany,Diet, Crops.

### Introduction

**Ethnobotany**is the study of a region's plants and their practical uses through the traditionalknowledgeof a local culture and people. An ethnobotanist thus strives to document the local customs involving the practical uses of local flora for many aspects of life, such as plants as medicines,foods,intoxicantsandclothing.RichardEvansSchultes,oftenreferredtoasthe"father of ethnobotany", explained the discipline in this way: Ethnobotany simply means investigating plants used by societies in various parts of the world. Since the time of Schultes, the field of ethnobotanyhasgrownfromsimplyacquiringethnobotanicalknowledgetothatofapplyingittoa modern society, primarily in the form of pharmaceuticals. Intellectual propertyrights and benefit- sharing arrangements are important issues in ethnobotany.

### History

The idea of ethnobotany was first proposed by the early 20th century botanist John WilliamHershberger. While Hershberger did perform ethnobotanical research extensively, including in areas such asNorth Africa,Mexico,Scandinavia, andPennsylvania,[6]it was not until RichardEvans Schultesbegan his trips into theAmazonthat ethnobotany became a more well known science.However,thepracticeofethnobotanyisthoughttohavemuchearlieroriginsinthefirst



ISBN:978-81-957858-1-0

century AD when a Greek physician by the name of Pedanius Dioscorideswrote an extensive botanical text detailing the medical and culinary properties of "over 600 mediterranean plants" namedDeMateriaMedica.HistoriansnotethatDioscorideswroteabouttravelingoftenthroughout the Roman empire, including regions such as "Greece,Crete,Egypt, andPetra",[8]and in doing so obtained substantial knowledge about the local plants and their useful properties. European botanicalknowledgedrasticallyexpandedoncetheNewWorldwasdiscoveredduetoethnobotany. Thisexpansioninknowledgecanprimarilybeattributedtothesubstantialinfluxofnewplantsfrom the Americas, including crops such as potatoes, peanuts, avocados, and tomatoes. The French explorerJacquesCartierlearnedacureforscurvy(ateamadefromtheneedlesofa coniferoustree, likely spruce) from a local Iroquois tribe

MedievalandRenaissance

Duringthemedievalperiod,ethnobotanicalstudieswerecommonlyfoundconnected withmonasticism. However, most botanical knowledge was kept in gardens such as physicgardensattached to hospitals and religious buildings. It was thought of in practical use terms for culinaryandmedicalpurposesandtheethnographicelementwasnotstudiedasa modern anthropologist might approach ethnobotany today

Ageof Reason

In1732,CarlLinnaeus carriedoutaresearchexpeditioninScandinaviaaskingthe Samipeopleabouttheir ethnological usageofplants.Theageofenlightenment sawarisein economicbotanicalexploration.AlexandervonHumboldt collecteddatafromtheNewWorld, andJames Cook's voyages brought back collections and information on plants from the South Pacific.Atthistimemajorbotanicalgardenswerestarted,forinstancethe RoyalBotanicGardens,Kewin 1759. The directors of the gardens sent out gardener-botanist explorersto care for and collect plants to add to their collections.

Asthe18th century becamethe19th, ethnobotany sawexpeditions undertaken with more colonial aims ratherthantradeeconomics such as that ofLewis and Clarkewhich recorded both plants and the peoples encountered use of them. Edward Palmercollectedmaterial cultureartifacts and botanical specimens from people in the North American West (Great Basin) and Mexico from the 1860stothe1890s.Throughallofthisresearch,thefieldof"aboriginalbotany"wasestablished— thestudyofallformsofthevegetableworldwhich aboriginalpeoplesuseforfood,medicine, textiles, ornaments and more

Developmentand applicationinmodernscience

The first individual to study theemicperspective of the plant world was a German physician workinginSarajevoattheendofthe19thcentury:LeopoldGlück.Hispublishedworkon



ISBN:978-81-957858-1-0

traditional medical uses of plants done by rural people in Bosnia (1896) has to be considered the first modern ethnobotanical work.

Otherscholarsanalyzedusesofplantsunderanindigenous/localperspectiveinthe20th century:MatildaCoxeStevenson,Zuniplants(1915); FrankCushing,Zunifoods(1920);Keewaydinoquay Peschel, Anishinaabe fungi (1998), and the team approach of Wilfred Robbins,JohnPeabodyHarrington,andBarbaraFreire-Marreco,Tewapuebloplants(1916).Inthe beginning,ethonobotanicalspecimensandstudieswerenotveryreliableandsometimesnothelpful. This is because the botanists and the anthropologists did not always collaborate in their work. The botanistsfocusedonidentifyingspeciesandhowtheplantswereusedinsteadofconcentratingupon howplantsfitintopeople'slives.Ontheotherhand,anthropologistswereinterestedinthecultural role of plants and treated other scientific aspects superficially. In the early 20th century, botanists and anthropologists better collaborated and the collection of reliable, detailed cross-disciplinary data began. Beginning in the 20th century, the field of ethnobotany experienced a shift from the raw compilation of data to a greater methodological and conceptual reorientation. This is also the beginning of academic ethnobotany. The so-called "father" of this discipline is Richard EvansSchultes, even though he did not actually coin the term "ethnobotany". Today the field of ethnobotanyrequiresavarietyofskills:botanicaltrainingfortheidentificationandpreservationof plantspecimens;anthropologicaltrainingtounderstandtheculturalconceptsaroundtheperception of plants; linguistic training, at least enough to transcribe local terms and understand native morphology, syntax, and semantics.

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ISBN:978-81-957858-1-0

# Bacterial Biofilms: Development, Dispersal, and Therapeutic Strategies in the Dawn of the Post Antibiotic Era

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**Abstract**

Biofilmformationconstitutesanalternativelifestyleinwhichmicroorganismsadoptamulticellular behaviorthatfacilitatesand/orprolongssurvivalindiverseenvironmentalniches.Biofilmsformon bioticandabioticsurfacesbothintheenvironmentandinthehealthcaresetting.Inhospitalwards, theformationofbiofilmsonventsandmedicalequipmentenablespathogenstopersistasreservoirs that can readily spread to patients. Inside the host, biofilms allow pathogens to subvert innate immune defenses and are thus associated with long-term persistence. Here we provide a general review of the steps leading to biofilm formation on surfaces and within eukaryotic cells, highlightingseveralmedicallyimportantpathogens,anddiscussrecentadvancesonnovelstrategies aimed at biofilm prevention and/or dissolution

**Keywords:**Biofilm,Bacteria,Attachment

**Introduction**

Bacterial Adherence on Surfaces—What Does It Take to Stick and Stick Around Bacterial aggregation and subsequent biofilm maturation consists of reversible and irreversible stages and involves numerous conserved and/or species-specific factors. The first step involves the introduction of bacteria to a surface, a process which is at least in part stochastic, driven by Brownian motion and gravitational forces, and influenced by surrounding hydrodynamic forces. Within a niche, bacteria encounter attractive or repelling forces that vary depending on nutrient levels, pH, ionic strength, and temperature. Medium properties, along with bacterial cell-surface composition affect velocity and direction toward or away from the contact surface Motile bacteria have a competitive advantage, utilizing flagella to overcome hydrodynamic and repulsive forces. The importance of flagellar motility for initial attachment has been documented for several pathogens,including*P.aeruginosa*,*Vibriocholerae,Listeriamonocytogenes*,and*E.coli*.Insome bacterial species, chemotaxis also plays a role in directing attachment in response to nutrient composition; mutations in the CheR1 methyltransferase have been shown to alter the amino acid responseof*P.aeruginosa*andimpairattachmentandbiofilmmaturation.Previousstudiesshowed that chemotaxis is dispensable in *E. coli*, however, recent investigations have revealed that disruption of the methyl-accepting chemotaxis protein II (*tar*), imparts biofilm defects in UPEC



ISBN:978-81-957858-1-0

Upon intercepting the surface, adherence is mediated by additional extracellular adhesive appendages and secreted adhesins. However, the decision to “stick” is not absolute; initial attachment is dynamic and reversible, during which bacteria can detach and rejoin the planktonic population if perturbed by hydrodynamic forces (sloughing bacteria off the surface), repulsive forces, or in response to nutrient availability

**BiofilmMaturation—KeepingItTogether**

Surface contact triggers responses that lead to gene expression changes, up-regulating factors favoringsessility,suchasthoseimplicatedintheformationoftheextracellularmatrix.Inthecase of*E. coli*, relatively little is known about matrix constituents. Cellulose was first identified as an importantcomponentofcommensal*E.coli*pelliclebiofilms,andwaslatershowntobecoexpressed withcurliinUPECandgastrointestinal*E.coli*isolates.Curliareamyloidfibersthatarecriticalfor theformationofpelliclebiofilms,ascurliinhibitors(curlicides)inhibitpellicleformationandcurli mutantscannotformpellicles.Additionalstudiesshowedthatpolyglucosamine(PGA)andcolanic acidcontributetobiofilmarchitecture,withPGAbeingprevalentamongclinicalisolates,including UPEC. More detailed analyses are required for a complete characterization of the extracellular matrix in pathogenic *E. coli.*

Extracellularmatrixcompositionhasbeenmoreextensivelyinvestigatedin*P.aeruginosa*,andhas beenshowntovarydependingonenvironmentalconditions.TwoprimaryEPScomponentsarePel andPslaugments*Pseudomonas*attachmenttomucinandairwayepithelialcells,whereasincreased expressionof*pel*insmallcolonyvariantsisolatedfromcysticfibrosispatientshasbeenassociated with*P. aeruginosa*persistence in lung airways . Recently, Borlee and colleagues identified CdrA, alargesecretedadhesin,whichisexpressedinthebiofilminresponsetohighlevelsoftheuniversal signal3,5-cyclicdiguanylicacid(c-di-GMP)andbindsPsl,stabilizingbiofilmstructures.Alginate, another*P. aeruginosa*EPS component, has been associated with increased resistance to antibiotic treatmentsandhostimmunedefensesduringchronicinfect.AsisthecasewithPelandPsl,alginate production is subject to regulation by fluctuating levels of c-di-GMP. Recent studies have shown thatasurface-bounddiguanylatecyclaseMucRpositivelyactivatesalginatesynthesis,presumably throughhighlocalconcentrationsofc-di-GMP(Hayetal.2009).InadditiontoEPS,severalstudies haveshownthateDNAiscriticalforcell-to-cellconnectionsandstabilization of*Pseudomonas*biofilms. Young*Pseudomonas*biofilms are more sensitive to DNase treatment compared with mature biofilms, indicating a stabilizing role for eDNA during the initial biofilm stageswhenEPScomponentsarenotasabundant.Asthebiofilmmatures,eDNAamountsincrease through lysis of a bacterial subpopulation in response to the *P. aeruginosa*quinolone signal (Pqs) quorum sensing system. Allesen-Holm et al. showed that eDNA is organized in distinct patterns andlocalizesinthestalk portionofthemushroom-shapedbiofilms.Thislocalizationmayact as a scaffold for the formation of the mushroom structure, as type IV pili show high eDNA binding affinity,inducingtheaccumulationofmigratingbacteriatowardareasofhigheDNAconcentration.



ISBN:978-81-957858-1-0

The contribution of eDNA to biofilmarchitecture has also been reported for *E. faecalis*, making it one of the few known*E. faecalis*matrix components. Thomas et al. first reported that eDNA is criticalfor*E.faecalis*biofilmsandidentifiedthatthesecretedenzymesGelE(zincmetalloprotease) and SprE (serine protease) influence biofilm formation by affecting cellular autolysis and DNA release. In a separate study, Mohamed et al. reported that a mutant lacking the Atn autolysin had 30% reduction in biofilm. Guiton and colleagues later established that Atn plays a role in the temporal regulation of DNA release at specific stages during biofilm formation

**EscapefromtheMatrix—DispersingMechanisms**

Within the mature biofilm there is a bustling community that actively exchanges and shares productsthatplayapivotalroleinmaintainingbiofilmarchitectureandprovidingafavorableliving environment for the resident bacteria. However, as biofilms mature, dispersal becomes an option. Besides passivedispersal, brought about by shear stresses,bacteriahaveevolvedways to perceive environmental changes and gauge whether it is still beneficial to reside within the biofilm or whether it is time to resume a planktonic lifestyle. Biofilm dispersal can be the result of several cues,suchasalterationsinnutrientavailability,oxygenfluctuationsandincreaseoftoxicproducts, orotherstress-inducingcondition.InUPEC,increaseinextracellularironinducesbiofilmdispersal, whereas*P. aeruginosa*biofilms disperse in response to increased amounts of various carbon and nitrogen sources. Several sensory systems monitor the levels of small molecules, as a proxy to environmental changes, and alter gene expression accordingly, promoting dispersal. Among other signals, the universal c-di-GMP has been extensively implicated in the shift between sessility and motilityinbacteria,including*P.aeruginosa*and*E.coli*.Typically,anincreaseinc-di-GMPfavors sessility, whereas reduced c-di-GMP leads to up-regulation ofmotility. Maet al. recently reported that a c-di-GMP binding protein, BdcA, is at least partly responsible for the reduction of available c-di-GMP in biofilm communities, down-regulation of EPS, and up-regulation of swimming and swarmingmotility;aphenomenonthattheinvestigatorsshowedalsooccursin *Pseudomonas* species and *Rhizobium mellioti* .

EPS-degrading enzymes, such as alginate lyase in *P. aeruginosa,*also contribute to bacterial detachmentfromthematrix.In*E.coli*,theCsrAproteinwasshowntorepressPGAsynthesis,also aiding in dispersion. Besides down-regulating EPS, surfactant molecules are produced, reducing surface-bacterialinteractions;forexample,althoughcontrolledrhamnolipidproductioncontributes to channel formation within mature*P. aeruginosa* biofilms, an increase in rhamnolipid levels aids bacterial dispersal. In addition, studies have identified flagellated subpopulations within *P. aeruginosa*biofilms, which emigrate from the biofilm, creating microcolonies with a central void. Voidswithinthebiofilmarealsocreatedbycelldeath,servingasanadditionaldispersalmechanism that frees resident livebacteria, as shown by studies in *P.aeruginosa*.Dispersing bacteria have the capacity to reinitiate the process of biofilm formation, on encountering a suitable environment.



ISBN:978-81-957858-1-0

Studies using *Bacillus subtilis* as a model organism revealed another sophisticated dispersal mechanism that may be widespread among bacteria. *B. subtilis*forms robust biofilms, which lose theirintegrityafter5–8d;Kolodkin-Galandcolleaguesfoundthatbiofilmdisassemblyisfacilitated by a mixture ofD-amino acids (D-leucine, D-methionine,D-tyrosine, and D-tryptophan) that are producedduringthestationaryphaseofgrowthandgetincorporatedintothepeptidesidechainsof peptidoglycan in place of the terminal D-alanine. This D-amino acid incorporation interferes with theanchoringofadhesivefibersonthecellsurface,leadingtofiberdissociationandlossofbacterial adherence, without influencing bacterial growth or expression of matrix components Exogenous additionoftheD-aminoacidmixtureortheindividual D-aminoacidsdisruptedpreformedbiofilms of*B.subtilis*and otherbacterial speciesFurtherstudies revealed that D-amino acids work together withnorspermidine,anotherfactorproducedby *B.subtilus*,tocausebiofilmdisassembly.Thus,D- amino acid/norsperimidine treatment may hold promising potential in preventing or eradicating biofilms

**THELIFEWITHIN—INTRACELLULARBIOFILMS**

Accumulating evidence indicates that many bacterial pathogens previously considered as strictly extracellular can persist inside the host by adapting an intracellular lifestyle that involves the formation of bacterial communities with biofilm-like properties. These intracellular bacterial communities(IBCs)werefirstdocumentedforUPEC,usingamurinemodelofinfection,triggering events that lead to bacterial internalization. Although internalized UPEC are expelled in a TLR-4-dependentprocesssomebacteriaavoidtheexocyticprocessandescapeintothehost-cellcytoplasm, where they replicate into IBCs

IBCs progress through several developmental stages that show distinct morphological characteristics. During the first 6 h following bladder inoculation, UPEC divide rapidly (doubling time of ∼30–35 min) resulting in small clusters of loosely associated rods (early IBCs), morphing into coccoid-shaped bacteria, with an average length of 0.7 µm that begin packing into a tight biomass.Then,between6and8h,thegrowthratedropsdramatically,resultingindoublingtimes >60min.Atthisstage,bacteriaaretightlypackedtogetherformingahighlyorganizedsphereinside the cell that comprises the mature middle-stage IBCThe number of IBCs can range between 3 and 700 IBCs in an infected bladder; each IBC is clonal and composed of $\sim 10^4$–$10^5$bacteria. IBC bacteria aresurroundedbynumerousfibersthatemanatefromthebacterialsurface,resemblingan extracellular matrix and encasing bacteria in individualized compartments. Polysaccharides, such as the sialic acid capsule, are also present throughout the IBC and function, in part, to protect the bacteria from neutrophil attack. Similar to extracellular biofilms, IBCs are heterogeneous, composed of subpopulations with different gene expression patterns.

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ISBN:978-81-957858-1-0

# Introductiontostress management

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**Abstract**

Stress is a fact of life, wherever you are and whatever you are doing. You cannot avoid stress, but you can learntomanageitsoitdoesn'tmanageyou.Changesinourlives—suchasgoingtocollege,gettingmarried, changing jobs, or illness—are frequent sources of stress. Keep in mind that changes that cause stress can also benefit you. Moving away from home to attend college, for example, creates personal-development opportunities—newchallenges,friends,andlivingarrangements.Thatiswhyit'simportanttoknowyourself and carefully consider the causes of stress. Learning to do this takes time, and although you cannot avoid stress, the good news is that you can minimize the harmful effects of stress, such as depression or hypertension. The key is to develop an awareness of how you interpret, and react to, circumstances. This awareness will help you develop coping techniques for managing stress. For example, as an Army platoon leader, managing stress will require techniques that include an awareness of yourself and your Soldiers.

**Keywords**:Stress,Experience,Overwhelming,Perception,Lifeevents

## Introduction

Stressisthewayhumanbeingsreactbothphysicallyandmentallytochanges,events,andsituations in their lives. People experience stress in different ways and for different reasons. The reaction is basedonyourperceptionofaneventorsituation.Ifyouviewasituationnegatively,youwilllikely feel distressed—overwhelmed, oppressed, or out of control. Distress is the more familiar form of stress. The other form, eustress, results from a "positive" view of an event or situation, which is why it is also called "good stress." Eustress helps you rise to a challenge and can be an antidote to boredom because it engages focused energy. That energy can easily turn to distress, however, if somethingcausesyoutoviewthesituationasunmanageableoroutofcontrol.Manypeopleregard public speaking or airplane flights as very stressful—causing physical reactions such as an increased heart rate and a loss of appetite—while others look forward to the event. It's often a question of perception: A positive stressor for one person can be a negative stressor for another.

## Causesof Stress

Themostfrequentreasonsfor"stressingout"fall intothreemain categories:

1. Theunsettlingeffectsofchange

2. Thefeelingthatanoutsideforceischallengingorthreateningyou

3. Thefeelingthatyou havelostpersonal control.



ISBN:978-81-957858-1-0

Lifeeventssuchasmarriage,changingjobs,divorce,orthedeathofarelativeorfriendarethemost common causes of stress. Although life-threatening events are less common, they can be the most physiologically and psychologically acute. They are usually associated with public service career fields in which people experience intense stress levels because of imminent danger and a high degree of uncertainty—police officer, fire and rescue worker, emergency relief worker, and the military.Youmaynotplantoenterahigh-stresscareer,butasacollegestudent,youmayfindthat the demands of college life can create stressful situations. The National Institute of Mental Health (NIMH) notes some of the more common stressors for college students:

• Increasedacademicdemands

• Beingonyour ownin a newenvironment

• Changesinfamilyrelations

• Financialresponsibilities

• Changesinyoursociallife

• Exposuretonewpeople,ideas,and temptations

• Awarenessofyoursexualidentityand orientation

• Preparing for life after graduation. Symptoms of Distress Symptoms of stress fall into three generals, but interrelated, categories—physical, mental, and emotional. Review this list carefully. If you find yourself frequently experiencing these symptoms, you are likely feeling distressed:

• Headaches

• Fatigue

• Gastrointestinalproblems

• Hypertension(highblood pressure)

• Heartproblems,suchaspalpitations

• Inabilitytofocus/lackofconcentration

• Sleepdisturbances,whetherit'ssleepingtoo muchoraninabilityto sleep

• Sweatingpalms/shakinghands

• Anxiety

• Sexualproblems.Evenwhenyoudon'trealizeit,stresscancauseorcontributetoseriousphysical disorders. It increases hormones such as adrenaline and corticosterone, which affect your metabolism,immunereactions,andotherstressresponses.That can lead toincreasesin yourheart



ISBN:978-81-957858-1-0

rate,respiration,bloodpressure,andphysicaldemandsonyourinternalorgans.Behavioralchanges are also expressions of stress.

Theycan include:

• Irritability

• Disruptiveeatingpatterns(overeatingorunder eating)

• Harshtreatmentofothers

• Increasedsmokingoralcoholconsumption

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ISBN:978-81-957858-1-0

# GoodLaboratoryPractice(GLP)Regulation

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**Abstract**

Goodlaboratorypractice(GLP)isaqualitysystemofmanagementcontrolsforresearchlaboratories andtheuniformity,consistency, reliability,reproducibility,quality,and integrity of products in development for human or animal health (including pharmaceuticals) throughnon-clinicalsafetytests;fromphysio-chemicalpropertiesthroughacutetochronictoxicity tests. GLP was first introduced in NewZealand andDenmarkin 1972, and later in the US in 1978 inresponsetotheIndustrialBioTestLabs scandal.Itwasfollowedafewyearslaterby theOrganizationforEconomicCo-operationandDevelopment(OECD)PrinciplesofGLPin1992; theOECDhassincehelpedpromulgateGLPtomanycountries.GLPappliestonon-clinicalstudies conducted for the assessment of the safety or efficacy of products in development (including pharmaceuticals) for people, animals, and the environment.[1]GLP, a data and operational quality system,isnotthesameasstandardsforlaboratorysafety-appropriategloves,glassesandclothing tohandlelabmaterialssafely.TheprinciplesofGLPaimtoensureandpromotesafety,consistency, highquality,andreliabilityofchemicalsintheprocessofnon-clinicalandlaboratorytesting.GLP is not limited to chemicals and also applies to medical devices, food additives,food packaging, coloradditives,animalfoodadditives,othernon-pharmaceuticalproductsoringredients,biological products, and electronic products. One of the fundamental purposes of the Principles of GoodLaboratory Practice (GLP) is to ensure the quality and integrity of test data related to non-clinicalsafety studies. The way in which study data, supporting human, animal and environmental safetyassessment, is generated, handled, reported, retained and archived has continued to evolve in linewith the introduction and ongoing development of supporting technologies. However, the mainpurposeoftherequirementsofthePrinciplesofGLPremainsthesameinhavingconfidenceinthequality, the integrity of the data and being able to reconstruct activities performed during theconduct of non-clinical safety studies.

**Keywords:**GLP,Quality,Management,Responsibilities,Accuratedata

## Introduction

Thepurposeof GLP is to

- Ensurequalitytestdata
- Ensuresoundlaboratorymanagement
- Ensurerobustconductanceoflaboratory testing



ISBN:978-81-957858-1-0

- Ensureaccuratereporting oftest findings
- Ensuresafearchival oflaboratory data

TheGLPPrinciplesbasicallyencompassesfollowingpoints

1. Testfacilityorganizationandpersonnel

- Test facility management should designate personnel to assume responsibility for the quality assurance programmer, and these personnel should not be involved in the conduct of the regulatory work being assured. Test facility management should ensure that there is a quality assurance programs, with designated personnel, and assure that the quality assurance programs is being performed in accordance with the principles of GLP.
  - **StudyDirector'sResponsibilities**
    - Hastheresponsibilityfortheoverallperformance ofthestudyandthefinalreport.
    - Approvesthestudyplanand amendmentsand communicatethem totheQA personnel.
    - Ensuresthat SOPs,study plansand theiramendments are available tostudy personnel.
    - EnsuresthattheSOPsarefollowed,assesstheimpactofanydeviationsandtakes appropriate corrective and preventive action.
    - Ensuresthatrawdataaredocumentedandrecorded.
    - Computerizedsystemsare validated.
    - Signanddatethefinalreportto indicateacceptanceof responsibility.
  - **StudyPersonnel Responsibilities**
    - Knowledgeof theGLP principles
    - Accesstothestudyplan andappropriate SOPs
    - ComplywiththeinstructionsoftheSOPs
    - Recordrawdata
    - Studypersonnelare responsibleforthequalityof theirdata
    - Exercisehealthprecautionstominimizerisk
    - Ensurethe integrityof thestudy

2. QualityAssurance(QA) programme



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- Quality control is the process, procedures and authority used to accept or reject all components, drug product containers, closures, in-process materials, packaging material, labeling and drugproducts and theauthority to reviewproduction records to assurethat no errors have occurred, that they have been fully investigated.
- The quality and reliability of test data count on the state and condition of the test system which is used in its production.
- ThetestfacilityshouldhaveadocumentedQualityAssuranceProgrammetoguaranteethat studies performed comply with these Principles of Good Laboratory Practice.
- TheQualityAssuranceProgrammeshouldbeperformedbyanindividualorbyindividuals designated by.
- The Quality Assurance personnel should be responsible of maintaining copies of all approvedstudyplansandStandardOperatingProceduresinuseinthetestfacilityandhave access to an up-to-date copy of the master Schedule, verifying that the study plan contains theinformationrequiredforcompliancewiththesePrinciplesofGoodLaboratoryPractice, conducting inspections to determine if all studies are conducted in accordance with these Principles of Good Laboratory Practice.
- InspectionsshouldalsodeterminethatstudyplansandStandardOperatingProcedureshave been made available to study personnel and are being followed.
- Inspectionsaremadeinorder todeterminecomplianceof thestudy withGLP principles.
- Threetypesofinspection arebasicallycarriedout:Study-basedinspections,Facility-based inspections, Process-based inspections.
- These inspections should involve those parts of a study that have particular importance for thevalidityofthedataandtheconclusionstobedrawnfromthere,orwheredeviationsfrom the rules of GLP would most heavily have a powerful effect on the integrity of the study.
- Quality Assurance thus has to find a balance in their inspectional activities, evaluating the study type and “critical phases”, in order to achieve a well supported view of the GLP compliance at the test facility and within the studies conducted.
- In the final reports it should be confirmed that the methods, procedures, and observations are accurately and completely described, and that the reported results accurately and completely reflect the raw data of the studies.
- Inspectionsofthefinalreportsaredone foraccurateandfull description.



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- Theauditofthefinalreport,henceservestoascertainthequalityandintegrityofthespecific study with its detailed assessment of GLP compliance throughout the study and with its concomitant review of all relevant information, records and data.

3. Facilities

- GLPrequiresthattestfacilitiesbeofappropriatesize,constructionandlocationtomeetthe requirements of the study and minimize disturbances that would interfere with the validity of the study.
- They should be designed to provide an adequate degree of separation between the various activities of the study.
- Separation renders the assurance that different functions or activities do not interfere with each other or affect the study.
- Minimizingdisturbancebyseparationcanbe achievedby:
  - Physical separation: this can be achieved by walls, doors or filters, or by the use of isolators. In new buildings or those under transition or renovation, separation will be part of the design.
  - Separation by organization, for example by the establishment of defined work areas within a laboratory carrying out different activities in the same area at different times, allowing for cleaning and preparation between operations or maintaining separation of staff, or by the establishment of defined work areas within a laboratory.
- Isolationoftestsystems andindividualprojectstoprotectfrombiologicalhazards.
- Suitableroomsforthediagnosis, treatmentandcontrolof diseases.
- Storageroomsfor suppliesand equipment.
- Separateareasforreceiptsandstorageofthetestandreference items.
- Separationoftestitems fromtest systems.
- Archive facilities for easy retrieval of study plans, raw data, final reports, samples of test items and specimens.
- Handlinganddisposal of waste insuch awaynottojeopardizetheintegrity ofthestudy.
- Documentedinspection, cleaning,maintenanceandcalibrationof apparatus.

4. Test systems

- Equipment,includingvalidatedcomputerizedsystems,usedforthegeneration,storageand recovery of data, and for controlling environmental factors relevant to the study should be suitably located and of appropriate design and adequate capacity.



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- Equipmentrecordsshouldinclude:nameoftheequipmentandmanufacturer,modelortype for identification, serial number, and date equipment was received in the laboratory, copy of manufacturers operating instruction(s).
- Equipment used in a study should be periodically inspected, cleaned, maintained, and calibrated according to Standard Operating Procedures.
- Recordsoftheseactivitiesshould bemaintained.
- Calibrationshouldbetraceabletonationalorinternationalstandardsof measurement.
- Instrumentationvalidationisaprocessnecessaryforanyanalyticallaboratory.
- Dataproducedby“faulty”instrumentsmaygivetheappearanceofvalid data.
- Thefrequencyforcalibration,re-validationandtestingdependsontheinstrumentandextent of its use in the laboratory.
- Chemicals, reagents, and solutions should be labeled to indicate identity, expiry date and specific storage instructions.
- Informationconcerningsource,preparationdateandstabilityshouldbeavailable.
- Appropriatedesignand adequatecapacityofapparatus usedforthegenerationof data.
- Integrityofphysical/chemicaltestsystemsandbiologicaltestsystems.
- Properconditionsforstorage, housing,handlingand care.
- Humanelydestructionofinappropriatetestsystems.
- Recordsofsourcedateof arrivalandarrival conditionsoftest systems.
- Acclimatizationofbiologicalsystemstothetest environment.
- Properidentificationoftestsystemsin theirhousingorcontainerorwhenremoved.
- Cleaningandsanitizationofhousingsorcontainers.

5. Testandreferenceitems

- Recordsincludingtestitemandreferenceitemcharacterization,dateofreceipt,expirydate, quantities received and used in studies should be maintained.
- Handling, sampling, and storage procedures should be identified in order that the homogeneity and stability are assured to the degree possible and contamination or mixup are precluded.
- Storage container(s) should carry identification information, expiry date, and specific storage instructions.



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- Each test and reference item should be appropriately identified (e.g., code, Chemical Abstracts Service Registry Number [CAS number], name, biological parameters).
- For each study, the identity, including batch number, purity, composition, concentrations, or other characteristics to appropriately define each batch of the test or reference items should be known.
- In cases where the test item is supplied by the sponsor, there should be a mechanism, developedinco-operationbetweenthesponsorandthetestfacility,toverifytheidentityof the test item subject to the study.
- Thestabilityoftestandreferenceitemsunderstorageandtestconditionsshouldbeknown for all studies.
- If the test item is administered or applied in a vehicle, the homogeneity, concentration and stability of the test item in that vehicle should be determined.
- For test items used in field studies (e.g., tank mixes), these may be determined through separate laboratory experiments.
- A sample for analytical purposes from each batch of test item should be retained for all studies except short-term studies.
- The register for all reference substances and reference materials should be maintained and contain the following information:
- a)theidentification number ofthe substanceor material
- b)aprecise description of thesubstanceor material
- c)the source
- d)thedate of receipt
- e)thebatchdesignation orotheridentificationcode
- f)the intended useof the substance
- g)thelocationofstorage inthelaboratory, andanyspecialstorageconditions
- h)expirydateorretest date
- i) certificate (batch validity statement) of a pharmacopoeial reference substance and a certified reference material which indicates its use, the assigned content, if applicable, and its status (validity)
- j)inthecaseofsecondaryreferencesubstancespreparedandsuppliedbythemanufacturer, the certificate of analysis



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6. StandardOperatingProcedures(SOP's)

- Standard Operating Procedures (SOPs) are intended to describe procedures that are routinely employed in the performance of test facility operations. Indeed they are defined as "documented procedures which describe how to perform tests or activities normally not specified in detail in study plans or test guidelines."
- Atest facility should havewrittenStandardOperating Procedures approved by test facility management that are intended to ensure the quality and integrity of the data generated by that test facility.
- Revisions to Standard Operating Procedures should be approved by test facility management.
- Each separate test facility unit or area should have immediately available current Standard Operating Procedures relevant to the activities being performed therein.
- Publishedtextbooks,analyticalmethods,articlesandmanualsmaybeusedassupplements to these Standard Operating Procedures.
- LaboratorymanagementmustbesurethattheSOPsusedinthelaboratoryareusefulindaily operationsandtheyshouldbescientificallysoundandalso,theyshouldalwaysbeupdated as necessary and rewrites should be the part of the routine process.
- While writing SOP guidelines there must be some precautions such as avoiding restrictive languagesuchas"vortexforexactly1minute"butincludeclearinstructionssuchas"vortex untilhomogenized"ifthatsatisfiesthepurpose.Unnecessarystepsshouldnotbeaddedsuch as "consult the manual" unless personnel are required to follow this step.
- Study personnel should easily access the study plan and appropriate Standard Operating Procedures should be applicable to their involvement in the study.
- It is their responsibility to comply with the instructions given in these documents. Study personnel should exercise health precautions to minimize risk to themselves and to ensure the integrity of the study.
- DeviationsfromStandardOperatingProceduresrelatedtothestudyshouldbedocumented and should be acknowledged by the Study Director and the Principal Investigator(s), as applicable.

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ISBN:978-81-957858-1-0

# GoodLaboratoryPractice(GLPs)RegulationsandAccreditation

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**Abstract**

The quality control department of a company oversees good laboratory practice. However, it is ultimatelytheresponsibilityofeverymemberofstaffinvolvedwith laboratorytesting. Intheearly 70's FDA (United States Food and Drug administration) have realized cases of poor laboratory practicethroughouttheUnitedStates.FDAdecidedtocheckover40toxicologylabsin-depth.They revealedlotdishonestactivitiesandalotofpoorlabpractices.Examplesofsomeofthesepoorlab practices found were equipment not been calibrated to standard form, therefore giving wrong measurements, incorrect or inaccurate accounts of the actual lab study and incompetent test systems. Although the term "good laboratory practice" might have been used informal already for some time in many laboratories around the world GLP originated in the United States and it had a power-full effect worldwide.

**Keywords**:Qualitycontrol,GLPs,Principles,Regulation,Accreditation

## Introduction

History of Good Laboratory Practice (GLP) GLP is an official regulation that was created by the FDAin 1978. The OECD(Organization forEconomicCo-operation and Development)Principles of Good Laboratory Practice were first created by an Expert Group on GLP set up in 1978 under the Special Programme on the Control of Chemicals. The GLP regulations that are accepted as international standards for non-clinical laboratory studies published by the US Food and Drug Administration in 1976 supplied the basis for the work of the Expert Group, which was guided by the United States and consisted experts from the following countries and organizations: Australia, Austria, Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, the United States, the Commission of the European Communities, the World Health Organization and the International Organization for Standardization. Eventually after United States other countries started making GLP regulations in their home countries. (Lori et al., 2009). Those Principles of GLP were officially suggested for use in member countries by the OECD Council in 1981. They were set about as an essential part of the Council Decision on Mutual Acceptance of Data in the Assessment of Chemicals, which expresses that "data denoted in the testing of chemicals in an OECDmembercountryinaccordancewithOECDTest Guidelines andOECDPrinciplesofGood Laboratory Practice shall be accepted in other member countries for the aims of assessment and other uses relating to the protection of man and the environment.

## DefinitionofGLP



ISBN:978-81-957858-1-0

The quality is the capability to systematically produce the same product to meet the same specificationstimeaftertime.GLPwasalteredtoprotecttheintegrityandqualityoflaboratorydata usedtobackupaproductapplication.Thedefinitionoftheterm“GoodLaboratoryPractice”itself, whichidentifiesGLPas“aqualitysystemrelatedwiththeorganizationalprocessandtheconditions under which non-clinical health and environmental safety studies are planned, performed, monitored, recorded, archived and reported.” can be considered as an example of a brief and accuratedefinition.GLPdescribesgoodpracticesfornon-clinicallabstudiesthatsupportresearch or marketing approvals for FDA-regulated products (Seiler, 2005). Purpose of GLP Everyone makes mistakes that’s why GLP is needed. GLP principles are a good idea even if you are not required to follow the standards. There are some simple rules such as: Say What You Do (with written standard operating procedures), do what you say (follow the procedures), be able to prove it(withgoodrecordkeeping)(JeanCobb,2007).Theprinciplesofgoodlaboratorypractice(GLP) istosupportthedevelopmentofquality andvalidityoftestdata used fordeterminingthesafetyof chemicals and chemicals product (Clasby, 2005).

The principles of good laboratory practice Good Laboratory Practice is based on four principles: The Management; The Quality Assurance; The Study Director; and The National Compliance MonitoringAuthority.Allofthemserveimportantfunctionsintheconcordanceofperformingand monitoring safety studies, and it should be kept in mind that all of them are required for GLP to achieve quality data. 2.2.1 Although GLP differs from other quality systems in aspects that are important not only for the traceability of data but especially for the full reconstruct ability of the study, there are certain co-occurrences between GLP and other quality systems like accreditation schemes. (Seiler, 2005).

2.2.2 The aim of this chapterwill be to give enough information about the GLP in details with the test facility organisation and personal, the facilities of quality assurance programme, test system, archive and waste disposal, apparatus, material, and reagents, physical, chemical, biological test systems,receipt,handling,samplingandstorageandcharacterisationofthetestandreferenceitems, standard operating procedures, performance of the study, reporting of study results, storage and retention of records and materials.

2.2.3Theconcernsofthe chaptermaybesummarizedas follows:

1. Testfacility management
2. Qualityassurance programme
3. Meetingtherequirementsofthetest facility
4. Equipment
5. Receipt,handling,samplingandstorage



ISBN:978-81-957858-1-0

6. Standardoperating procedures.

7. Performanceofthestudy.

8. Reportingof study results

9. Storageandretentionofrecordsandmaterials.

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ISBN:978-81-957858-1-0

# TheAntibioticResistanceCrisis

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**Abstract**

The rapid emergence of resistant bacteria is occurring worldwide, endangering the efficacy of antibiotics, which have transformed medicine and saved millions of lives. Many decades after the first patients were treated with antibiotics, bacterial infections have again become a threat. The antibiotic resistance crisis has been attributed to the overuse and misuse of these medications, as well as a lack of new drug development by the pharmaceutical industry due to reduced economic incentives and challenging regulatory requirements.TheCentersforDiseaseControlandPrevention(CDC)hasclassifiedanumberofbacteriaas presenting urgent, serious, and concerning threats, many of which are already responsible for placing a substantial clinical and financial burden on the U.S. health care system, patients, and their families. Coordinatedeffortstoimplementnewpolicies,renewresearchefforts,andpursuestepstomanagethecrisis are greatly needed

## HistoryofAntibiotics

The management of microbial infections in ancient Egypt, Greece, and China is well-documented.[4] The modern era of antibiotics started with the discovery of penicillin by Sir Alexander Fleming in 1928. Since then, antibiotics have transformed modern medicine and saved millionsoflives.Antibioticswerefirstprescribedtotreatseriousinfectionsinthe1940s.Penicillin was successful in controlling bacterial infections among World War II soldiers. However, shortly thereafter, penicillin resistance became a substantial clinical problem, so that, by the 1950s, many oftheadvancesofthepriordecadewerethreatened.[7]Inresponse,newbeta-lactamantibioticswere discovered,developed,anddeployed,restoringconfidence.[4,7]However,thefirstcaseofmethicillin-resistant*Staphylococcus aureus* (MRSA) was identified during that same decade, in the United Kingdom in 1962 and in the United States in 1968.[4,5]

Unfortunately,resistancehaseventuallybeenseentonearlyallantibioticsthathavebeendeveloped (Figure 1).[5] Vancomycin was introduced into clinical practice in 1972 for the treatment of methicillin resistance in both *S. aureus*and coagulase-negative staphylococci.[4,5]It had been so difficult to induce vancomycin resistance that it was believed unlikely to occur in a clinical setting.[4] However, cases of vancomycin resistance were reported in coagulase-negative staphylococci in 1979 and 1983.[4]Fromthelate1960s throughthe early1980s, thepharmaceutical industry introduced many new antibiotics to solve the resistance problem, but after that the antibiotic pipeline began to dry up and fewer new drugs were introduced.[7] As a result, in 2015, many decades after the first patients were treated with antibiotics, bacterial infections have again become a threat.



ISBN:978-81-957858-1-0

**BenefitsofAntibiotics**

Antibiotics have not only saved patients' lives, they have played a pivotal role in achieving major advancesinmedicineandsurgery.[2]Theyhavesuccessfullypreventedortreatedinfectionsthatcan occur in patients who are receiving chemotherapy treatments; who have chronic diseases such as diabetes,end-stagerenal disease, orrheumatoid arthritis; orwhohavehad complex surgeries such as organ transplants, joint replacements, or cardiac surgery.[2,3,5,16]

Antibiotics have also helped to extend expected life spans by changing the outcome of bacterial infections.[13,16] In 1920, people in the U.S. were expected to live to be only 56.4 years old; now, however, the average U.S. life span is nearly 80 years.[6] Antibiotics have had similar beneficial effects worldwide. In developing countries where sanitation is still poor, antibiotics decrease the morbidity and mortality caused by food-borne and other poverty-related infections

**ANTIBIOTIC-RESISTANTBACTERIALINFECTIONS**

Antibiotic-resistant infections are already widespread in the U.S. and across the globe.[1]A 2011 national survey of infectious-disease specialists, conducted by the IDSA Emerging Infections Network, found that more than 60% of participants had seen a pan-resistant, untreatable bacterial infection within the prior year.[7] Many public health organizations have described the rapid emergence of resistant bacteria as a "crisis" or "nightmare scenario" that could have "catastrophic consequences."[8]TheCDCdeclaredin2013thatthehumanraceisnowinthe"post-antibioticera," and in 2014, the World Health Organization (WHO) warned that the antibiotic resistance crisis is becoming dire.[15] MDR bacteria have been declared a substantial threat to U.S. public health and nationalsecuritybytheIDSAandtheInstituteofMedicine,aswellasthefederalInteragencyTask Force on Antimicrobial Resistance.[1]

Among gram-positive pathogens, a global pandemic of resistant *S. aureus*and Enterococcus species currently poses the biggest threat.[5,16]MRSA kills more Americans each year than HIV/AIDS, Parkinson's disease, emphysema, and homicide combined.[1,12]Vancomycin-resistant enterococci (VRE) and a growing number of additional pathogens are developing resistance to many common antibiotics.[1]The global spread of drug resistance among common respiratory pathogens, including *Streptococcus pneumoniae* and *Mycobacterium tuberculosis*, is epidemic

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ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

## AnIntroductiontotheHumanBody

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**Abstract**

Anatomy and Physiology courses are branches of biology that help us to understand life. And anatomy is the study of the FORM of living things. Gross anatomy=science of macroscopic anatomy; studying large body structures visible with the naked eye. Surface anatomy=the study of internal structures as they relate to the overlying skin surface. Regional anatomy=considers the regions of the body such as head and the extremities and all the systems in the particular region. Systemicanatomy=givesattentiontoallthestructuresofaparticularsysteminthebodyregardless of location. Microscopic anatomy=concerned with structures too small to be seen with the naked eye.Cytologystudyofcells,theircomponents,andtheirfunctions.Histology=studyoftissuesand their functions. Physiology is the study of the function of the parts that make up living things. Complementarity of Form and Function Physiology and anatomy are closely interrelated both theoretically and practically, for anatomical details are significant only because each has an effect onfunction,andphysiologicalmechanismscanbefullyunderstoodonlyintermsoftheunderlying structuralrelationships.Althoughourknowledgeisincomplete,itisquiteclearthatlivingsystems aresubjecttothesamelawsofphysicsandchemistryasarebuildings,oceans,andmountainranges. Many advances in our understanding of the human body only came after advances in one of the physical or applied sciences.

**Keywords**:HumanBody,Anatomy,Function,Cytology,Microscopy,Physiology

### Introduction

StructuralOrganization oftheHumanBody

A. Chemicallevel–theleastcomplexlevel;composedofatoms,thesmalleststableunitsofmatter arranged to form molecules and compounds that possess specific functional properties and unique three-dimensional shapes.Examples:water molecules, glucose, proteins, etc.
B. Cellular level – Interactions between molecules and compounds form the organelles of cells. Cellsarethestructuralbuildingblockofallplantsandanimals,canbeproducedonlyfrompre-existingcells,andarethesmallestunitscapableofperformingallvitallifefunctions.Examples of cells:muscle cells, blood cells, nerve cells, etc.
C. Tissuelevel–specializedgroupsofcellsandcellproductsthatworktogethertoperformoneor morespecificfunctions.Examples:muscletissue,nervetissue,connectivetissue,andepithelial tissues.



ISBN:978-81-957858-1-0

D. Organ level – consists of two or more tissues working in combination to perform several functions.The type of tissues that compose the organ dictates the function of the organ. Examples:heart, lungs, stomach, etc.
E. OrganSystemlevel–organsinteracttoformorgansystems.Organsandtheorgansystemsthey compose perform vital life functions of the body.You need to be able to name the 11 organ systems,identifythebasicorgansthatformeachorgansystem,andgivemajorfunctionsofeach organ system.

1. Integumentarysystem=composedofskin,hair,andnails;externalsupportandprotectionofthe body and temperature regulation.
2. Skeletal system=composed of bones; internal support and flexible framework for body movement, forms blood cells, and stores minerals.
3. Muscularsystem=composedofmusclesattachedtotheskeleton;locomotion,support,andbody heat production.
4. Respiratory system=composed of the lungs, trachea, larynx and nasal passages; exchange of respiratory gases, such as oxygen and carbon dioxide, between the air and circulating blood.
5. Nervous system=composed of the brain, spinal cord, and peripheral nerves; directs immediate response to stimuli, usually by coordinating the activities of other organ systems.
6. Circulatory system=composed of heart and blood vessels; internal transport of nutrients and oxygen to body cells while wastes and carbon dioxide are transported away from body cells.
7. Lymphatic/Immunesystem=composedofthelymphnodes,spleen,thymusgland,bonemarrow, and tonsils; houses the immune system cells of the body, provides protection against infection and disease, transports tissue fluid (called lymph) and absorbs fats.
8. Endocrinesystem=composedofhormonesecretingglandssuchasthethyroid,pituitary,adrenal gland,pancreas,pineal,etc.;secretionofhormonesthatdirectlong-termchangesintheactivities of other organ systems.
9. Urinarysystem=composedofthekidneys,ureters,urinarybladder,andurethra;filterstheblood to remove nitrogenous wastes, eliminates excess water, salts, and waste products, and controls pH and electrolyte balance.
10. Digestive system=composed of the salivary glands, esophagus, stomach, small intestine, large intestine, liver, and gallbladder.Intake, breakdown, and absorption of food in order to acquire nutrients, minerals, vitamins and water and the elimination of feces.
11. Reproductivesystem=composedofovaries,uterus,vagina,andmammaryglandsinfemales AND the testes, scrotum, prostate gland, seminal vesicles and penis in the male; production of sperm and egg as well as secretion of sex hormones and copulation.


ISBN:978-81-957858-1-0

F. Organism=alivingbeingthathasacellularstructureandthatcanindependentlyperformall physiologic functions necessary for life. In multicellular organisms, including humans, all cells, tissues, organs, and organ systems of the body work together to maintain the life and health of the organism. The organism level is the most complex level of organization.

**FunctionsofHuman Life**

A.Biology isthe study of life.

1. Despitetremendousdiversity,alllivingthingsperformthesamebasicfunctionsand exhibit the same basic characteristics.
2. Characteristicsoflifeinclude:
   a. Organization – Separation of one area from another; organism, cell, organ, etc.Ability to control what enters and exits each area.
   b. Metabolism-Allchemicalreactionsinacell/organism(bothanabolismand catabolism). Generally, can be:
      i. Anabolic–Smaller,simplermoleculesarecombinedtocreate a larger, more complex substance. Will require an input of energy – endergonic.
      ii. Catabolic – Larger, more complex substances are broken downintosmaller, simpler,molecules.Will releaseenergy – exergonic.
      iii. Adenosine triphosphate (ATP) –A key chemical compound used to store and release energy. Conversion ofADPtoATP is anabolic. Conversion ofATP toADP is catabolic.
   c. Responsiveness – The ability of an organism to adjust to changes in its internal and external environments. Examples: Moving toward food and water, or internal homeostasis of body temperature.
   d. Movement - Coordinated, intentional change in location or position, including internal movement of organs, substances.
   e. Development, growth and reproduction – Changes in an organism over the life cycle.
      i. Development – All of the changes the body goes through in life. Including growth and repair, and differentiation – Unspecialized cells become specialized in structure and function to perform specific tasks.



ISBN:978-81-957858-1-0

ii. Growth -Anincreasein body sizethroughan increasein the number of existing cells, non-cellular material around those cells, and rarely, the size of existing cells.

iii. Reproduction–Theformationofaneworganismfromparent organisms. For humans, from the interaction between male and female reproductive systems.

**RequirementsforHumanLife**

A. Oxygen
   1. Ourprimaryatmospheric gasessentialforhumansurvival
   2. Braincellsrequirelotsofenergy andthereforerequirelotsofoxygentoperform
   3. Withoutoxygen braindamagecan occurwithin 5 minutes and deathwillfollow within 10 minutes of oxygen deprivation.

B. Nutrients
   1. Essentialnutrientsforhumansconsistof:
      a. organiccompounds(carbohydrates,lipids,proteins,nucleotides, vitamins)
      b. inorganiccompounds(waterandminerals).
   2. Nutrientsthehumanbodyneedsalargesupplyofarecalledmacronutrients,in contrast to micronutrients that the body needs very small amounts of.

C. NarrowRangeofTemperature
   1. Hyperthermia–ifbodyisoverheatedforprolongedperiodoftimeitcanleadtoheat stroke and death. Sweating helps cool the body down using evaporation.
   2. Hypothermia–ifthebodyistocoldit canleadto shockand death.Shiveringhelps generate heat within the body.

D. AtmosphericPressure

Pressure – the force exerted by a substance in contact with another substance. We can withstand a certain range in pressures exerted on the human body via the gasses in the atmosphere or the diving in the ocean.

**Homeostasis**

A. Homeostasisisastateofequilibriumorbalance.
   1. Maintaining a “steady state”; constancy within narrow limits; balance or equilibrium;adynamicstateinwhichinternalconditionsremainrelativelyconstant despite changes in the external conditions.
   2. Vital to an organism’s survival; failure to maintain homeostasis results in illness, disease, or even death.



ISBN:978-81-957858-1-0

3. Homeostatic control is not precise-it maintains a normal range rather than an absolute value, or set point.For example:bloodpH ranges between 7.35 and 7.45 but the set point is 7.40.
4. Homeostatic regulation involves feedback mechanisms that consist of three components:
   a. Receptor=detects changes in either the internal or external environment, or stimulus.
   b. Controlcenter=receivesandprocesstheinformationsuppliesbythereceptor and sends out commands.
   c. Effector=respondstothecommandsbyopposingthe stimulus

B. Negativefeedbackmechanismsprovide stability.

1. Shutsofforreducestheoriginalstimulus.
2. Helpstostabilizesituation;essentialformaintaininghomeostasis.
3. Examples:bodytemperature,heartrate,breathingrateanddepth,andblood-glucose levels.

C. Positivefeedbackmechanismsaccelerateaprocesstocompletion.

1. Intensifyorenhanceoforiginal stimuli.
2. Amplify and reinforce a change brought on by the stimulus; not typically used for homeostasis.
3. Examples:bloodclottingandlaborcontractions.

**AnatomicalTerminology**

Wordroots,prefixes,and suffixesarethebasisfor thelanguageof anatomy

1. arter-=artery
2. a-=without
3. aer-=air
4. –algia=pain
5. artho-= joint
6. auto-=self
7. bio-=life
8. –blast=germ; immature
9. bronch-= windpipe;airway
10. cardi-,cardio-, -cardia=heart
11. cerebr-=brain
12. cervic-=neck



ISBN:978-81-957858-1-0

13. chondro-= cartilage
14. cranio-= skull
15. cyt-,cyto-=ahollowcell
16. derm-=skin
17. –ectomy= excision
18. end-,endo-=within
19. epi-=on
20. ex-=outof, awayfrom
21. gastro-= stomach
22. hemo-=blood
23. hemi-=one-half
24. histo-= tissue
25. homo-=same
26. hetero-= different
27. hyper-=above;more than
28. hypo-=under;lessthan
29. inter-=between
30. iso-=equal
31. leuk-,leuko-=white
32. lyso-,-lysis, -lyze=to burst; to loosen
33. meso-=middle
34. micr-=small
35. morph-,morpho-= formor shape
36. myo-=muscle
37. nephr-=kidney
38. neur-,neuri-,neuro-= nerve
39. –ology = thestudy of
40. –osis= state
41. ost-,oste-,osteo-=bone
42. oto-=ear
43. path-,-pathy,patho-=disease
44. peri-= around
45. phago-=to eat
46. –phil,-philia =love
47. –phot, photo-=light
48. physio-=nature
49. pre-= before
50. pulmo-=lung



ISBN:978-81-957858-1-0

51. retro-= backward
52. sarco-= flesh
53. scler-,sclera-=hard
54. –scope=to view
55. sub-=below
56. super-= above
57. –trophy = nourishment
58. vas-=vessel

A. Superficialanatomyandregionalanatomyindicatelocationsonorinthebody.

1. Abdominal=anteriortorsobelowdiaphragm
2. Acromial=pointofshoulder
3. Antebrachial=forearm
4. Antecubital=frontof elbow
5. Axillary=armpit
6. Brachial=arm
7. Buccal=cheek
8. Calcaneal=heel
9. Carpal=wrist
10. Cephalic=head
11. Cervical=neck
12. Costal=rib
13. Coxal=hip
14. Cranial=skull
15. Crural=leg
16. Cubital=orolecranal;backofelbow
17. Cutaneous=skin
18. Digital=fingersortoes
19. Dorsumordorsal=back
20. Epigastric=uppermiddleareaof abdomen
21. Facial=face



ISBN:978-81-957858-1-0

22. Femoral=thigh
23. Fibular=sideofleg
24. Gluteal=buttock
25. Hallux=greattoe
26. Inguinal=groin
27. Lumbar=orloin;lowerback
28. Mammary=breast
29. Manus=hand
30. Mastoid=belowandbehindear
31. Mental=chin
32. Nasal=nose
33. Occipital=backoflower skull
34. Olecranal=backofelbow
35. Oral=mouth
36. Orbital=orocular;eye
37. Otic=orauris;ear
38. Palmar=palmofhand
39. Patellar=kneecap
40. Pectoral=chest
41. Pedal=orpes,foot
42. Pelvic=lowertorso
43. Perineal=areabetweenanusandgenitals
44. Phalangeal=fingersor toes
45. Plantar=soleoffoot
46. Pollex=thumb
47. Popliteal=behind knee
48. Pubis=pubic region
49. Sacral=betweenhips



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50. Scapular=shoulderblade
51. Sternal=breastbone
52. Sural=calf
53. Supraclavicular=abovecollarbone
54. Tarsal=ankle
55. Temporal=sideofskull
56. Thoracic=chest
57. Umbilical=areaaround umbilicus
58. Vertebral=spinalcolumn
59. Volar-palmorsole

B. Abdominopelvicquadrantsandregions

1. Abdominopelvic quadrants
   a. Rightupperquadrant=containsliver
   b. Leftupperquadrant=containsthestomachandspleen
   c. Leftlowerquadrant=containsdescendingcolon
   d. Rightlowerquadrant=containsthececumandascendingcolon.
2. Abdominopelvic regions
   a. Umbilical=centermostregiondeeptoandsurroundingthenavel.
   b. Epigastric=superiortotheumbilicalregion
   c. Hypogastric=locatedinferiortotheumbilical region
   d. Rightandlefthypochondriac=flankstheepigastric regionlaterally.
   e. Rightandleftlumbar=lieslateraltotheumbilicalregion
   f. Rightandleftiliac(inguinal)=lateraltothehypogastric region

C. Directionalandsectionaltermsdescribespecificpointsof reference.

1. Directionalterms
   a. Superior(cranial)=above;towardtheheadendorupperpartofthestructure or body.
   b. Inferior (caudal) =below; away from the head end or toward the lower part of the structure or body.
   c. Anterior(ventral)=towardorat thefrontofthebody.



ISBN:978-81-957858-1-0

d. Posterior(dorsal) =towardorat thebackofthebody.
e. Medial=towardorat thelongitudinalaxisofthe body.
f. Lateral=awayfromthelongitudinalaxisofthebody.
g. Intermediate=betweenamoremedialandamorelateralstructure.
h. Proximal=closer to the origin of the body part or the point of attachment of a limb to the body trunk.
i. Distal=fartherfrom the origin ofabody part orthepoint of attachment.
j. Superficial(external) =towardoratthebodysurface.
k. Deep(internal)awayfrom thebodysurface;more internal.

2. Sectionaltermsor planes
   a. Sagittal=averticalplanethatdividesthe bodyintoright andleft parts.
      i. Midsagittal(median)=theplanedividingthebodyexactlyinthe midline.
      ii. Parasagittal=allothersagittalplanesoffsetfromthemidline
   b. Frontal (coronal) =any plane dividing the body into anterior and posterior portions.
   c. Transverse(horizontal)=aplanedividingthebodyintosuperiorandinferior portions.
   d. Oblique=cutsmadediagonallybetweenthehorizontalandverticalplanes.

D. Bodycavitiesprotectinternalorgansfromshockorimpactsandallowthemtochangeshape.

1. Dorsalbodycavity=composedoftwosmallercavities:
   a. Cranialcavity=containsthe brain
   b. Vertebralcavity=contains thespinalcord
2. Ventral body cavity=also known as the coelom; houses internal organs of the body collectively called the viscera or “guts”.Divided into two smaller cavities:
   a. Thoracic cavity
      i. Pleuralcavity=rightandleft;containsthelungs
      ii. Mediastinum=space between the pleural cavities; containing the thymus, lymph vessels, esophagus, trachea, and nerves.Embedded within the mediastinum is the pericardial cavity, which houses the heart.
   b. Abdominopelvic cavity
      i. Abdominalcavity=containsdigestive organs
      ii. Pelviccavity=containsbladder,reproductiveorgans,andrectum



ISBN:978-81-957858-1-0

3. Thedorsalandventralbodycavitiesarelinedwithserousmembraneswhichsecrete a watery, lubricating fluid.
    a. Meningeslinethedorsalbody cavity.
    b. Pleuralinethepleural cavity.
    c. Pericardiumlinesthepericardialcavity.
    d. Peritoneumlinestheabdominalcavity;someorgansareretroperitonealsuch as the urinary and reproductive organs.
4. Otherless significantcavities ofthe body
    a. Nasalcavity=forthe passageof air intotherespiratory tract
    b. Orbitalcavity=areaoftheskullthathousesthe eye
    c. Middleearcavity=containstheossicles
    d. Synovialcavity=arejointcavitiesfilledwithsynovialfluid

MedicalImaging

A. X-Raymachineprojectshighenergyelectromagneticradiationagainstanareaofthe body with ametal platebehind it.TheX-rays areslightly blocked by thesofttissue and fully blocked by bone or teeth resulting in a white “shadow“
B. ComputedTomography(CT)ThepatientliesonaplatformwhiletheComputerized AxialTomography(CAT)machinegeneratesmultipleX-raysasitrotatesaroundthe patient.TheseX-raysor“slices”arethenassembledtocreateaverydetailedimage. Softtissuemassescannowbemeasuredtothemillimeterwiththedrawbackoflarge radiation exposure.
C. Magnetic Resonance Image (MRI) uses electromagnets and radio waves to scan patients. The scan does not expose patients to large doses of radiation like a CT however it is very loud and the tube might trigger claustrophobia.
D. Positron Emission Tomography (PET) uses a short-lived radioactive contrast that will travel to areas with high metabolic activity such as cancer. The isotope will breakdowncausingphotonstobereleasedanddetectedbythescannersresultingin animage.PETscansshowusactivitywithinourbodies(physiology)whileCTand MRIs show us structures (anatomy).
E. Ultrasonography uses high frequency sound waves to generate an image. It is the least invasive imaging technique and commonly used to monitor pregnancy.



ISBN:978-81-957858-1-0

## Antibioticresistanceleadstolongerhospitalstaysinproblem

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**Abstract**

Antimicrobial resistance happens when germs like bacteria and fungi develop the ability to defeat thedrugsdesignedtokillthem.Thatmeansthegermsarenotkilledandcontinuetogrow.Resistant infectionscanbedifficult,andsometimesimpossible,totreat.Antimicrobialresistanceisanurgent globalpublichealththreat,killingatleast1.27millionpeopleworldwideandassociatedwithnearly 5milliondeathsin2019.IntheU.S.,morethan2.8millionantimicrobial-resistantinfectionsoccur eachyear.Morethan35,000peopledieasaresult.When*Clostridioidesdifficile*—abacteriumthat is not typically resistant but can causedeadly diarrhoea and is associated with antimicrobial use—isaddedtothese,theU.S.tollofallthethreatsinthereportexceeds3millioninfectionsand48,000 deaths.Antimicrobialresistancehasthepotentialtoaffectpeopleatanystageoflife,aswellasthe healthcare, veterinary, and agriculture industries. This makes it one of the world's most urgent public health problems.

**Keywords:**Resistance,Antibiotic,Antimicrobial,Veterinary, Healthcare,

### Introduction

Antibioticsaremedicinesusedtopreventandtreatbacterialinfections.Antibioticresistanceoccurs when bacteria change in response to the use of these medicines. Bacteria, not humans or animals, becomeantibiotic-resistant.Thesebacteriamayinfecthumansandanimals,andtheinfectionsthey cause are harder to treat than those caused by non-resistant bacteria. Antibiotic resistance leads to higher medical costs, prolonged hospital stays, and increased mortality. The world urgently needs tochangethewayitprescribesandusesantibiotics.Evenifnewmedicinesaredeveloped,without behavior change, antibiotic resistance will remain a major threat. Behavior changes must also include actions to reduce the spread of infections through vaccination, hand washing, practicing safer sex, and good food hygiene.

### Scopeofthe problem

Antibiotic resistance is rising to dangerously high levels in all parts of the world. New resistance mechanisms are emerging and spreading globally, threatening our ability to treat common infectiousdiseases.Agrowinglistofinfections–suchaspneumonia,tuberculosis,bloodpoisoning, gonorrhea, and foodborne diseases – are becoming harder, and sometimes impossible, to treat as antibioticsbecomelesseffective.Whereantibioticscanbeboughtforhumanoranimalusewithout aprescription,theemergenceandspreadofresistanceismadeworse.Similarly,incountries



ISBN:978-81-957858-1-0

without standard treatment guidelines, antibiotics are often over-prescribed by health workers and veterinarians and over-used by the public. Without urgent action, we are heading for a post-antibiotic era, in which common infections and minor injuries can once again kill.

**Preventionand control**

Antibiotic resistance is accelerated by the misuse and overuse of antibiotics, as well as poor infectionpreventionandcontrol.Stepscanbetakenatalllevelsofsocietytoreducetheimpactand limit the spread of resistance.

**Individuallevel:**Topreventandcontrolthespreadofantibioticresistance,individualscan:

- Onlyuseantibiotics whenprescribed byacertifiedhealth professional.
- Neverdemandantibioticsifyourhealth workersaysyoudon’tneed them.
- Alwaysfollowyourhealthworker’sadvicewhen usingantibiotics.
- Nevershareoruseleftover antibiotics.
- Preventinfectionsbyregularlywashinghands,preparingfoodhygienically,avoidingclose contact with sick people, practising safer sex, and keeping vaccinations up to date.
- Prepare food hygienically, following the WHO Five Keys to Safer Food (keep clean, separate raw and cooked, cook thoroughly, keep food at safe temperatures, use safe water andrawmaterials)andchoosefoodsthathavebeenproducedwithouttheuseofantibiotics for growth promotion or disease prevention in healthy animals.

**Policy makers**

Topreventand controlthespreadofantibioticresistance,policymakerscan:

- Ensurearobustnationalactionplan totackleantibioticresistanceisin place.
- Improvesurveillanceofantibiotic-resistantinfections.
- Strengthen policies, programmes, and implementation of infection prevention and control measures.
- Regulateand promotetheappropriateuseanddisposal ofquality medicines.
- Makeinformation available on theimpact of antibiotic resistance.

**Healthprofessionals**

Topreventand controlthespreadofantibioticresistance,healthprofessionalscan:

- Preventinfections byensuringyourhands,instruments,andenvironmentare clean.
- Only prescribe and dispense antibiotics when they are needed, according to current guidelines.



ISBN:978-81-957858-1-0

- Reportantibiotic-resistantinfectionstosurveillance teams.
- Talk to your patients about how to take antibiotics correctly, antibiotic resistance and the dangers of misuse.
- Talk to yourpatients about preventing infections (forexample, vaccination, hand washing, safer sex, and covering nose and mouth when sneezing).

**Healthcareindustry**

Topreventandcontrolthespreadofantibioticresistance,thehealthindustrycan:

- Investinresearchanddevelopmentofnewantibiotics,vaccines,diagnosticsandothertools.

**Agriculturesector**

Topreventandcontrolthespreadofantibiotic resistance,the agriculturesector can:

- Onlygiveantibioticstoanimalsunderveterinarysupervision.
- Notuseantibioticsforgrowthpromotionortopreventdiseasesinhealthy animals.
- Vaccinateanimalstoreducetheneedforantibioticsandusealternativestoantibioticswhen available.
- Promote and apply good practices at all steps of production and processing of foods from animal and plant sources.
- Improvebiosecurityonfarmsandpreventinfectionsthroughimprovedhygieneandanimal welfare.

**Recentdevelopments**

While there are some new antibiotics in development, none of them are expected to be effectiveagainst the most dangerous forms of antibiotic-resistant bacteria.

Giventheeaseandfrequencywithwhichpeoplenowtravel,antibioticresistanceisaglobal problem, requiring efforts from all nations and many sectors.

**Impact**

When infections can no longer be treated by first-line antibiotics, more expensive medicines must beused.Alongerdurationofillnessandtreatment,ofteninhospitals,increaseshealthcarecostsas well as the economic burden on families and societies.

Antibiotic resistance is putting the achievements of modern medicine at risk. Organ transplantations, chemotherapy and surgeries such as caesarean sections become much more dangerous without effective antibiotics for the prevention and treatment of infections.



ISBN:978-81-957858-1-0

# CognitiveWorkloadAffectsOcularAccommodationandPupillaryResponse

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**Abstract**

Duringlastdecades,computerandsmartphonetechnologyhasgrosslyaffectedtheamountoftime weengageinperformingneartasksandhashypotheticallycontributedtotheglobalriseofmyopia. Generally,nearworkisanimportantfactorinmyopia,butit´sroleisnotfullyexplainedyetitcould be due to the altered physiology during reading and studying, but it could also be just due to the prolonged time spent in this setting. It is also not clear how different psychological (or other) processes might contribute to it.

**Keywords**:Cognitiveworkload,Microfluctuations,Restlessness,Autonomic nerves

## Introduction

Inlearning,bydefinition,thecognitivedemandishigh.Theextrasympatheticarousalarisingfrom cognitive load is proven to have the capacity of altering the optical properties of the visual system most notably accommodation and pupils. The pupillary behavior is well explored: elevated cognitive activity consistently causes mydriasis (enlargement of the pupils), whilst the effect of cognitiononaccommodationislessclear–somestudiesfoundthatelevatedcognitiveeffortcauses induced transient myopia (i.e. retained positive accommodation), whereas others revealed accommodative fatigue and decreased accuracy. Both pupils and accommodation vary in time; small changes are referred to as micro fluctuations. Pupils' physiological restlessness (hippus) is presumablycausedbydynamicequilibriumofbothautonomicnervesystems,withparasympathetic input being dominant.In accommodation, oscillations are caused mainly by cardio-pulmonary cyclesbutdependalsoontheabsolutevalueofaccommodation.Inworkergonomics,thelong-term decrease of pupil size is considered a reliable measure of fatigue, whereas the alterations of accommodation are not believed to be associated with fatigue. An important factor of oscillations might be the modality of the presentation of stimuli: when looking into the source of light, i.e. the back-illuminateddigitalscreen,theaccommodativesystemisnotasaccurateaswhenobservingan object which is illuminated by secondary light source. Studies show that myopic progression is closely related to the duration and level of education, to school grades as a measure of engagement[24]and to seasonal variations of near work intensity. Some authors found also a connection to intelligenceand proposed that the prevalence of myopia could be linked to the stressfulness of the school system. For instance, in the developed Asian region with traditionally rigorous schooling system, myopia is increasing and has now reached highest prevalence on the planet, whereas recent studies in the Scandinavian region which anecdotally has one of the most flexibleandstudent-centeredschoolsystemshowthatmyopiathereisactuallystayinglow,despite



ISBN:978-81-957858-1-0

unfavorable environmental lighting conditions. There is the genetic component to the myopia growth as well – the COMET study found that parents of myopic children themselves were also moremyopic than average and had higher educational levels than average. Asian race seems to be more prone to short-sightedness; Asian students reach higher myopia growth rates during their studies, regardless of whether they are educated in home- or international environment. Since learning and studying is inevitably associated with high cognitive activity, we wanted to examine whether cognition has a measurable effect on physiological properties of the optical part of the visualsystem,andifyes,istheeffectdifferentwithdifferenttypesofcognitiveactivities.Causing stress to the visual system might in the short run result in a fatigue and in the long run, hypothetically, represent a factor in myopia growth.

**Conclusion**

In the study, we found important influences of cognitive effort on pupils and accommodation. We discovered that pupil size was a good measure of cognitive effort in numerical tasks. However, in other domains, such as textual tasks or the Stroop task, pupils did not reliably represent increased mental activity. Accommodative responses varied more in textual tasks than in tasks in the other two domains. In the most difficult condition with textual information that required logical reasoning,theaccommodativeresponsedecreasedsignificantlyovertime(theaccommodationlag increased). In the numerical task with the highest level of difficulty, the oscillations of accommodation werethe smallest. Thus, theresults ofourstudy showthattheeffects ofcognitive load vary across domains and are therefore not generalizable. Although our results are not fully conclusive, we can hypothesize that when performing demanding near tasks, at least one physiologicalparameterisalteredtowardlessfavorablevalues.Pupilsarelargerinconflictingtasks andwhenreadingtextswithlowreadability(asintheStrooptask)orwhenperformingcontinuous calculationsandthechangeinaccommodativeresponseovertimeislargerintasksrequiringlogical reasoningandinference.Thesefindingsareconsistentwithcurrentviewsontheeffectsofeducation on myopia growth and point to some potential risk factors.

Inclinicalpractice,goodmyopiamanagementincludesopticalandpharmacologicalinterventions, butalsoadvisingaboutenvironmentalfactors.Patientsarecounseledonhowtoperformnearwork and how to adopt good ergonomics. We hypothesize that when reading, the content presented to young progressing myopes should be well matched to their comprehension ability, as excessive cognitive load appears to be a disturbing factor in the physiology of near vision. In addition, we would encourage school systems to favor clear, readable, and comprehensible texts and to encouragestudents to releasing strain whilereasoning, ifpossible,forexample, by fixating distant objects. Alternative ways of conducting high cognitive load learning activities, such as outdoor content discussions, might work as preventive strategies. Further studies should be conducted on the optical properties of the visual system in different learning situations to better understand potential educational risk factors for myopia growth.



ISBN:978-81-957858-1-0

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| Medline



ISBN:978-81-957858-1-0

# Modified Suction Apparatus to Reduce the Transmission Risk of COVID-19 among Healthcare Providers

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**Abstract**

Coronavirus disease (COVID-19) has posed immense challenges for healthcare workers, among them are procedures related to suctioning of bodily fluids during surgery or intensive care. These procedures are potentially aerosol-generating and can lead to disease transmission. We have modifiedtheusualsuctionapparatusinasimpleandeasytodomannersothatallsuctionedmaterial firstpassesthrough the0.1%sodiumhypochloritesolution,whichisvirucidalanddecontaminates thesuctionedmaterial.Thisinnovationmayhelpinaddressingthesafetyconcernsofallhealthcare providers working in operation rooms and intensive care units.

**Keywords:**COVID,Modification,COVIDtransmission, Prevention,Suction bottle.

## Introduction

This low-cost modification of the suction apparatus can help in decontaminating the suctioned fluids and prevent the spread of transmissible disease like COVID-19. Many coronavirus diseases (COVID-19) patients require emergency surgical procedures. A bigger challenge is to treat emergency patients, where mandatory reverse transcription polymerase chain reaction (RT-PCR) testing for COVID-19 cannot be done due to dire urgency before definitive treatment is administered. COVID-19 virus is shed in nasopharyngeal secretions and even viremia has been documented. Theoretical risks oftransmission from suctioning infectedblood and nasopharyngeal productstohealthcareworkerscannotberuledout.[2]Thenasalcavityhasahigherviralload.Thus neuro-otorhinolaryngology and gastrointestinal procedures can carry higher risks. All possible precautionsmustbetakenforpatientswherenasopharyngealapproachmightbe required.[4]Healthcare providers, working on the floor of operation rooms, wards, and intensive careunitsareparticularlyatriskbecausetheymustfrequentlyemptythesuctioncontainers. Wehavemodifiedtheexistingsuctionbottlecapsandhavefittedthemwithalongerinnermetallic tube.Onthismetallictube,anotherrubber/siliconetubecanbeattachedwhichgoesuptothebottom ofthecontainer [Figure1]andVideo1].Wepartiallyfillthesuctioncontainerwitha0.1%freshly prepared sodium hypochlorite solution, which is a known viricidal compound.[5]This way, all the products sucked from the surgical field will pass through the sodium hypochlorite solution which automaticallysterilizesthem.Thedrawbacksareminorlossinpowerofsuctionandmorefrequent changeofcontainersisrequiredduetofrothing.Twocontainersjoinedintandemcanbeutilizedto avoid early blockage of the suction system.



ISBN:978-81-957858-1-0


Figure1:(a)Originalsuctionbottlecap(b)Modifiedsuctionbottlecapwithametallictube(Arrow) (c)Rubbertubeofappropriatelengthisattachedtotheinnermetallictube(d)Tubeshouldbelong enoughtoreachthebottomofthecontainer,whichisfilledwith0.1%sodiumhypochloritesolution (e)Suctionbeingusedintheneurosurgicalprocedure(f)Collectionofbloodandirrigationproducts in the modified suction container

This low-cost minor modification in the suction system helps in addressing the safety concerns of allhealthcareprovidersworkingintheoperatingrooms,intensivecareunits,andhigh-dependency units during this COVID-19 pandemic and has the potential to reduce the transmission.

**Conflictsof interest**

Therearenoconflictsofinterest.

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ISBN:978-81-957858-1-0

## CardiopulmonaryResuscitation(CPR)

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**Abstract**

Cardiopulmonary resuscitation (CPR) comprises a group of interventions performed to provide oxygenationandcirculationtothebodyduringcardiacarrest.Themostwidelyacceptedguidelines for cardiopulmonary resuscitation in North America are produced by the American Heart Association (AHA). These are published every 5 years, following the International Liaison Committee on Resuscitation (ILCOR) meeting. This activity describes the evaluation and managementofpatientswhomayrequirecardiopulmonaryresuscitationandhighlightstheroleof the interprofessional team in improving care for affected individuals.

**Keywords:**CPR,Interventions,Cardiopulmonary,Resuscitation,Oxygenation

**Objectives:**

Explainthesteps involvedinrecognizing out-of-hospitalcardiacarrest.

Explainhowtoperform one-rescuer cardiopulmonaryresuscitationonavictimofout-of-hospital cardiac arrest.

Explainhowtoperform cardiopulmonaryresuscitationon infantsandchildren.

Explaintheimportanceofimprovingcoordinationamongsttheinterprofessionalteamtoenhance care for patients requiring cardiopulmonary resuscitation.

**Introduction**

Cardiopulmonary resuscitation (CPR) is a collection of interventions performed to provide oxygenation and circulation to the body during cardiac arrest. Our current modern-day approach to this process stemmed from the work of a handful of doctors in the 1950s and has now evolved intotheprocessthatwillbediscussedfurtherhere.ThemostwidelyacceptedguidelinesinNorth Americaarethoseproducedbythe AmericanHeartAssociation(AHA).Thesearepublishedevery 5 years after the International Liaison Committee on Resuscitation (ILCOR) meeting.

**Etiology**

Every year almost 350,000 Americans die from heart disease. Half of these will die suddenly, outsideofahospital,becauseofthesuddencessationofspontaneousorganizedcardiac function.The most common cause of sudden cardiac arrest in adults is ventricular fibrillation. Althoughadvancesinemergencycardiaccarecontinuetoimprovethechancesofsurvival,sudden cardiac arrest remains a leading cause of death in many parts of the world. As of 2016, cardiac disease continues to be the leading cause of death in the United States.



ISBN:978-81-957858-1-0

**Epidemiolo**eventy percent of cardiac arrests that occur outside of a hospital occur in the home. Half of these cardiac arrests are unwitnessed. Despite advances in emergency medical services, the survival rate remains low. Adult victims of non-traumatic cardiac arrest that receive resuscitationattemptsbyemergencymedicalserviceshaveasurvivalratetohospitaldischargeof only10.8%.Incomparison,adultpatientswhoexperiencecardiacarrestinahospitalsettinghave rates of survival to hospital discharge of up to 25.5%.

**Pathophysiology**

The definitive treatment for ventricular fibrillation is electrical defibrillation. This is most often performedusinganautomatedexternaldefibrillator(AED).IfanAED isnotreadilyavailablefor defibrillation, brain death is likely to occur in less than 10 minutes. CPR is a means of providing artificial circulation and ventilation until defibrillation can be performed. Conventional manual CPR, combining chest compressions with rescue breathing, can provide up to 33% of normal cardiac output and oxygenation when done properly.

HistoryandPhysical

PatientsrequiringCPRareunconsciousandunresponsivewithabsentpulses.Thereisaprognostic benefitindeterminingthelasttimethepatientwasseennormal,orbetteryet,thetimewhenpulses were lost. Additionally, collateral history from bystanders, family members, friends, and the primary care physician can help etiologic evaluation.

Therearenospecificphysicalexaminationfindings,butsignsofcyanosisandreducedperipheral perfusion can suggest a cause for the arrest.

Evaluation

Theabsenceofapalpablepulseinanunresponsivepatientindicatestheneedfor CPR. Treatment /

Management

Note: The technique described here is intended for a healthcare provider performing one-rescuer CPRonanadultvictimintheout-of-hospitalsetting.Themodificationsforchildren,infants,and in-hospital CPR are listed below. These recommendations are current as of the 2015 American Heart Association's Guidelines Update for CPR and Emergency Cardiac Care.

Theimmediaterecognitionofcardiacarrestisessentialtoinitiatetheemergencymedicalservices (EMS) response and begin CPR as soon as possible. In this era of universal mobile phone availability, it is now possible to call 911 while remaining with the victim. Make sure that the sceneissafe,thencallforhelp.Simultaneously,beginCPRbyfirstperformingchestcompressions (C),followed by opening theairway (A)and deliveringrescuebreaths (B)(theCAB sequenceas compared to the former ABC sequence). The hands are placed on the lower half of the sternum, andchestcompressionsare begunata rate of100to120compressionsper minute.Thegoalisto



ISBN:978-81-957858-1-0

depress the sternum to a depth of at least two inches while avoiding excessive depth of compressions. The chest wall should be allowed to recoil fully on the upstroke to maintain coronaryarteryperfusionpressure.Thirtycompressionsareperformed,followedbyabriefpause fortworescue breaths. Because of the critical contribution of chest compressions to coronary artery perfusion, interruptions in chest compressions should be minimized, and any interruptions should be as short as possible when needed.

After30chestcompressions,therescuerperformsaheadtilt/chinliftmaneuvertoopentheairway (assumingthereisnosuspicionofacervicalspinalinjury). Ifacervicalspineinjuryissuspected, the airway is opened using the jaw-thrust maneuver without extending the head. Two rescue breathsareadministered:therescuertakesa"regular"breath(notdeeporexcessive)anddelivers arescuebreathlastingapproximatelyonesecond, whichshouldbeenoughjust toallowthechest to rise. The process is repeated for a second rescue breath prior to resuming chest compressions.

Ideally,ahealthcareproviderinclinedtointerveneasanout-of-hospitalrescuershouldhaveready access to a barrier device such as a rescue mask. However, this is not always the case. Mouth-to- mouth rescue breaths have been the alternative, which many untrained rescuers are hesitant to perform,especiallyonanunknownvictim.Thisisadecisionthathealthcareprovidersmustmake for themselves. Compression-only CPR has been accepted as appropriate for untrained lay rescuers.Ifextenuatingcircumstancesprohibitahealthcareproviderintheout-of-hospitalsetting from performing rescue breathing without a barrier device, compression-only CPR should be performed until EMS arrives.

Thecycle of30 chest compressions alternatedwith two rescuebreaths is continued until an AED becomes available or until additional help arrives.If an AED arrives, its pads should be applied to the front and back of the patient, taking care to minimize any delay in restarting chest compressions.Most modern devices verbalize further instructions—after attached to the patient, AEDs will detect the current cardiac rhythm and advise whether the patient should receive defibrillation. If the AED advises a shock, cease chest compressions and stay clear of the patient until defibrillation is completed.After defibrillation is completed, or if no shock is advised, immediatelyresumecyclesofchestcompressionsandrescuebreathsfollowingtheCABsequence until additional help arrives.

DifferentialDiagnosis

A quick physical exam focused on palpable pulses and mental status is important as sometimes drug overdose, including heavy alcohol intake, may mimic cardiac arrest.

Prognosis

According to 2015 AHA data, survival to hospital discharge in patients who experience out-of-hospitalcardiacarrestremainslowat 10.6%.8.3%ofpatients experiencingcardiacarrestout-of-



ISBN:978-81-957858-1-0

hospital will be discharged with good neurologic function.Witnessed cardiac arrests in patients receiving high-quality CPR have a better prognosis, with 25.5% of patients surviving to hospital discharge.

Complications

Cardiac arrest carries a dismal prognosis--most patients do not survive.In those that do survive, their hospital course can be complicated by varying degrees of neurologic injury due to hypoxic encephalopathy.All organ systems can suffer ischemic injury.Chest compressions, when performed correctly, can cause rib fractures, which may be complicated by pneumothorax.

DeterrenceandPatientEducation

Intheeventofcardiacarrest,thepatient'sfamilyand/ortheirsurrogateorpowerofattorneyshould benotified.Itisimportanttoascertainthepatient'scodestatus,andanypriordirectivesshouldbe honored if appropriate documentation in accordance with laws of the local jurisdiction can be obtained.

PearlsandOtherIssues

**PediatricCPR**

By definition, infant CPR applies to patients whose age is less than one year. Child CPR applies to patients from oneyear of age through puberty. From puberty onward, adult CPR guidelines apply.ThemodificationsforinfantandchildCPRarelistedbelow.AllotheraspectsofCPRfollow theadultguidelines,includingstartingtheprocesswiththeCompressionfirst(CAB)sequenceand therateofcompressionsbeing100to120perminute.Thesternumshouldbedepressedtoadepth ofapproximatelyone-thirdoftheanteroposteriordiameterofthechest;thisisabouttwoinchesin the child and 1.5 inches in the infant.

**Child CPR Modifications**

Chest compressions on a child areperformed by placing theheel ofone ortwohands (depending on the sizeof the child) over the lower half of the sternum. Thechest is compressed to a depth of approximately two inches at a rate of 100 to 120 per minute. After 30 compressions, administer twosequentialbreathsandreturntochestcompressions.Continuethecycleof30compressionsto two breaths until help arrives.

**InfantCPRModifications**

Chest compressions on an infant are performed by placing two fingers on the sternum just below thenippleline.Theinfant'schestiscompressedtoadepthofapproximately1.5inchesatarateof 100 to 120 per minute. After 30 compressions, administer two sequential breaths and return to chest compressions. Continue the cycle of 30 compressions to two breaths until help arrives.



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**In-hospitalCPR**

Multiple rescuers are generally available in the hospital setting, and ventilation is usually performed with a bag-valve-mask (BVM) device. BVM ventilation needs to be performed by a providerskilledinitsuse. Ifthepatientisnotintubated,CPRisdonebyoneproviderperforming chest compressions while the second provider provides breaths with BVM ventilation. The ratio of compressions to breaths in this situation changes to 15 compressions to two breaths. Once a patient is intubated, it is unnecessary to perform cycles of compressions and ventilation--chest compressions are performed continuously, while rescue breaths are given independently via the BVM at a rate of 10 per minute (one breath every six seconds). Novice operators frequently tend to provide BVM ventilations at a higher rate than this.

**EnhancingHealthcareTeamOutcomes**

All healthcare workers, including nurses and pharmacists, must know how to perform CPR. In fact,manyhospitalsnow makeitmandatory that healthcare workershave avalidCPRcertificate to work. When done promptly and properly, CPR can save lives.

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ISBN:978-81-957858-1-0

## DryEyeDisease:AnImmune-MediatedOcularSurfaceDisorder

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**Abstract**

Dry eye disease is a multifactorial disorder of the tears and ocular surface characterized by symptoms of dryness and irritation. Although the pathogenesis of dry eye disease is not fully understood, it is recognized that inflammation has a prominent role in the development and propagation of this debilitating condition. Factors that adversely affect tear film stability and osmolarity can induce ocular surface damage and initiate an inflammatorycascade that generates innate and adaptive immune responses. These immunoinflammatory responses lead to further ocularsurfacedamageandthedevelopmentofaself-perpetuatinginflammatorycycle.Herein,we review the fundamental links between inflammation and dry eye disease and discuss the clinical implications of inflammation in disease management.

**Keywords**:Dryeyes,Inflammation,Pathogenesis,Cytokines,Ocularsurfaces,Chemokines

**Introduction**

**Immunoinflammatorypathways:**Theocularsurfacesystemconsistsofthecornea,conjunctiva, lacrimal glands, meibomian glands, nasolacrimal duct, and their associated tear and connective tissue matrices, as well as the eyelids and eyelashes, all integrated by continuous epithelia and interconnectednervous,endocrine,immune,andvascularsystems.Factorsthatdisturbthedelicate homeostatic balance of the ocular surface system can adversely affect tear film stability and osmolarity, resulting in osmotic, mechanical, and inflammatory damage. Exposure of ocular surface epithelial cells to elevated tear osmolarity activates stress-associated mitogen-activated proteinkinases,suchasc-JunN-terminalkinase,extracellularsignal–relatedkinase,andp38.Mitogen-activated protein kinase signaling pathways stimulate the transcription factors nuclear factor κB and activator protein 1, thereby initiating the production of proinflammatory cytokines, chemokines, and matrix metalloproteinases (MMPs). These inflammatory mediators promotetheactivation(maturation)ofimmatureantigen-presentingcells(APCs)andinducetheir migration to draining lymphoid tissues (Figure 1). The APCs are responsible for priming naive T cells in the lymphoid compartment, leading to the expansion of autoreactive $CD4^{+}$helper T cell ($T_H$)subtype1and$T_H$17cellsubsets.Tcellssubsequentlyinfiltratetheocularsurface,wherethey secreteadditionalproinflammatorycytokines.HelperTcellsubtype1–secretedinterferon(IFN)γ upregulates the production of chemokines, chemokine receptors, and cell adhesion molecules (CAMs) that facilitate the ingress of pathogenic immune cells, including $T_H$17 cells that secrete interleukin(IL)17,whichfurtherpromotesepithelialdamagebystimulatingtheproductionof



ISBN:978-81-957858-1-0

proinflammatory cytokines and MMPs. Regardless of the origin, a self-perpetuating cycle of inflammation develops that is central to the pathogenesis of DED.

**Epitheliopathy**: It is one of the most easily recognizable clinical features of DED. Staining the ocularsurfacewithdiagnosticdyes,suchasfluorescein,rosebengal,andlissaminegreen,provides apracticalmethodforevaluatingocularsurfaceintegrity.Dryeyediseaseincreasesepithelialcell densityandthickness,decreasesepithelialcellsize,andincreasesepithelialcellturnover.Inflammationo ftheocularsurfaceisintimatelylinkedtothisepithelialdysfunction.The proinflammatorycytokinesIL-1andIFN-γcausesquamousmetaplasiaofocularsurfaceepithelial cells,andIFN-γdecreasesgobletcelldifferentiation.ApoptosisofocularsurfacecellsinDEDcan be induced by intrinsic (stress-associated mitogen-activated protein kinase) and extrinsic (tumor necrosis factor [TNF] and Fas/Fas ligand) pathways. The MMPs (eg, MMP-9) are produced in responsetodesiccatingstressandpromotecornealextracellularmatrixdegradationandepithelial cellloss.HelperTcellsubtype17–secretedIL-17wasrecentlyshowntodisruptcornealepithelial barrier function.

**Lymphangiogenesis**

Traditionally,angiogenesishasbeenthoughttoinvolvelymphangiogenesisandhemangiogenesis, producing afferent lymphatic vessels and blood vessels, respectively. Dry eye disease involves a unique form of pathologic angiogenesis that produces lymphangiogenesis without associated hemangiogenesis, and this is observed in experimental and clinical settings. The presence of lymphatic endothelial marker 1–staining monocytic cells in the conjunctiva has been described and linked to the growth of lymphatic vessels into the cornea. Immunohistochemical analysis of dry eye corneas identified the infiltration of lymphatic endothelial marker 1–expressing macrophages and lymphatic vessels (Figure 2).Dry eye induction increases the expression of factors that promote lymphangiogenesis, including vascular endothelial growth factor (VEGF) C and VEGF-D and associated receptors VEGFR-2 and VEGFR-3. Vascular endothelial growth factorAisalsoupregulated,contributingtolymphangiogenesisthroughtherecruitmentofVEGF- C– and VEGF-D–producing macrophages. In addition, recent datasuggest that $T_H$17-secreted IL- 17 upregulates expression of VEGF-C and VEGF-D and promotes corneal lymphangiogenesis in DED.PathogenicimmunecellsarepresentintheregionallymphnodesofDED-inducedmice.The identificationofnewlyformedlymphaticvesselsinthecorneaprovidesapotentialroutebywhich antigensandAPCscantravelfromtheocularsurfacetothesedraininglymphnodes.Accordingly, blockage of lymphangiogenesis may prove to be an effective treatment for DED.

**Neuropathy**

The corneal epithelium has approximately 7000 nerve endings per square millimeter, making the cornea one of the most densely innervated tissues in the human body. The nervous system is an importantcomponentoftheocularsurfacesystem,andoptimalfunctioningofthecornealnerves



ISBN:978-81-957858-1-0

is essential for the maintenanceof ahealthy ocularsurface. In healthy corneas, nerve endings are located between epithelial wing cell layers, where they are protected from external stimuli. Decreaseddensityandalteredmorphologicstructureofthesubbasalnerveshavebeenreportedin DED-induced corneas. These abnormalities are generally found to correlate with DED severity. Elevated tear osmolarity induces inflammatory-mediated epitheliopathy that results in the exposure of corneal nerves to mechanical and inflammatory insults. Inflammatory cytokines in turn increase the synthesis of neurotrophic factors that stimulate nerve growth, potentially explaining the altered nerve morphologic structure (nerve sprouts, tortuosity, and thinning) commonly observed in DED. Corneal nerve abnormalities lead to further ocular surface damage and help perpetuate the vicious inflammatory cycle of DED.

Fundamentallinksbetweeninflammationanddryeye

**Molecularmediators**

Cytokines

Cytokines are signaling molecules that mediate intercellular communication. The production of proinflammatorycytokinesisupregulatedbyosmotic,inflammatory,andmechanicaldamage.The term*interleukin*alludes to intercellular communication between leukocytes; however, many different cell types are capable of producing and responding to cytokines. For example, virtually all nucleated cells, including epithelial cells of the ocular surface, are capable of producing IL-1, IL-6, and TNF. Clinical studiesconsistently report elevated levels of these cytokines in the tears of patients with DED. Similar trends are noted in the conjunctival epithelium, which contains elevated levels of IL-1, IL-6, TNF, and transforming growth factor β1. Several additional cytokines have been isolated from the ocular surface of patients with DED, including IL-2, IL-4, IL-5, IL-10, and IFN-γ.These clinical findings have been corroborated by studies involving experimental models of DED (Figure 3).

Chemokines

Chemokines are cytokines that regulate the chemotaxis, or directed migration, of immune cells. The chemokine IL-8 (CXCL8) is consistently identified in the tears and conjunctiva of patients with DED. Interleukin 8 can be produced by any cell with a toll-like receptor (eg, epithelial cells andmacrophages),anditisaneutrophilchemoattractantinvolvedintheinnateimmuneresponse. TheclosleyrelatedchemokinesCXCL9,CXCL10,andCXCL11areelevatedinthetearfilmand ocular surface of patients with DED. These latter chemokines are produced in response to IFN-γ and function as T-cell chemoattractants on binding to the chemokine (CXCR3 motif) receptor. Animal models of DED provide further evidence of chemokine activity. The chemokine (CC motif) ligands CCL3 (macrophage inflammatory protein 1α) and CCL4 (macrophage inflammatoryprotein1β)areupregulatedinDED.Thesechemokinesareproducedby



ISBN:978-81-957858-1-0

macrophages, recruit inflammatory cells (such as neutrophils), and upregulate the production of proinflammatory cytokines. Another potent T-cell chemoattractant, CCL5 (RANTES), is upregulated in DED. The chemokine receptors CCR1, CCR2, CCR5, and CXCR3 have been implicated in the pathogenesis of DED and represent promising targets for immunomodulation.

MatrixMetalloproteinases

Matrix metalloproteinases are endopeptidases involved in tissue remodeling. Corneal epithelial cellsproduceMMP-1,MMP-3,MMP-9,andMMP-13inresponsetohyperosmolar stress.ExperimentaldryeyeincreasesMMP-1,MMP-3,MMP-9,andMMP-10levelsinthetears and corneal epithelium ofmice. Elevatedlevels ofpro–MMP-9 and increased activity ofMMP-9 havebeenidentifiedinthetearsofpatientswithdryeye.KnockoutofMMP-9tempersttheseverity of experimental dry eye, implicating MMP-9 in the pathogenesis of DED. Not only is MMP-9 producedbygranulocytes,butitisalsoinvolvedintheactivationoflatentCL-8β.TheMMPsare thought to modulate the severity of DED by promoting corneal extracellular matrix degradation andepithelialcellloss.Doxycycline,atetracyclinederivative,ameliorates DEDbyinhibitingthe activity of MMPs, primarily MMP-9, promoting ocular surface integrity.

MajorHistocompatibilityComplexClassIIandCostimulatory Molecules

TheexpressionofvariouscelI-associatedimmunomodulatorymoleculesisincreasedinDED.The ocularsurfaceofpatientswithdryeyecontainselevatedlevelsofHLAtypeDR(HLADR),CD40, CD154 (CD40L), CD80, CD86, Fas, and Fas ligand. HLADR is a major histocompatibility complex (MHC) class II cell surface receptor involved in antigen presentation. CD40, CD154, CD80, and CD86 are costimulatory molecules involved in APC–T-cell interactions. Increased expressionofthesemoleculessuggeststhatantigen(presumablyautoantigen)presentationoccurs efficiently in DED. Fas is a death receptor that induces apoptosis on binding to Fas ligand. The presence of these molecules in the conjunctiva and lacrimal glands of patients with dry eye is indicative of cellular infiltration, as these molecules are responsible for regulating the activity of immune cells.

Adhesion Molecules

Cell adhesion molecules are cell surface proteins that facilitate cellular migration by binding to extracellularmatrixcomponents.Celladhesionmoleculespromotetheinfiltrationofimmunecells intotheocularsurfaceofpatientswithdryeye.Elevatedlevelsofintercellularadhesionmolecule 1andvascularCAM-1havebeenidentifiedintheconjunctivaandlacrimalglandsofpatientswith dry eye.Intercellular adhesion molecule 1 binds to lymphocyte function–associated antigen 1. Vascular CAM-1 is expressed by the vascular endothelium and binds to immune cell–expressed very late antigen 4, also known as integrin α4β1. Treatment with monoclonal antibodies against murineintercellularadhesionmolecule1andlymphocytefunction–associatedantigen1resulted



ISBN:978-81-957858-1-0

in decreased ocular surface inflammatory infiltrates in experimental DED. Topical inhibition of very late antigen 4 decreases dry eye severity and suppresses inflammation in a murine model of DED.

**Cellular mediators**

Antigen-PresentingCells

Antigen-presenting cells are sentinel cells of the immune system that respond to danger signals (eg,microbialpathogens)byinternalizing,processing,andpresentingantigens. Thephenotype,or stateofmaturation,ofanAPCdeterminesitsfunction.ImmatureAPCsexpresslowlevelsofMHC class II and costimulatory molecules (eg, CD80 [B7.1]); although immature APCs are proficient at capturing antigens, they are inefficient at presenting antigens and promoting T-cell activation. Inflammatory microenvionments can induce APC maturation via increased expression of MHC class II and costimulatory molecules, rendering APCs efficient at priming T cells. Antigen-presenting cells of the ocular surface include monocytes and macrophages, dendritic cells (DCs), andLangerhanscells(LCs).TheLCsaretheonlycellsinthecornealepitheliumthatconstitutively express MHC class II.The peripheral corneal epithelium contains MHC class II–positive and MHC class II–negative LCs, while the central cornea contains only MHC class II–negative, costimulatory molecule–negative LCs; however, LCs of the central cornea are capable of expressing MHC class II and costimulatory molecules following inflammatory stimuli. The anterior corneal stroma contains differentiated and undifferentiated resident monocytic cell–derived DCs.Recently, the presence of a unique population of (non-LC) langerin-positive DCs wasreportedinthecornealstroma.Incontrast,MHCclassII–positiveDCsareabundantlypresent in the conjunctiva. In vivo microscopy reveals that DED dramatically increases the presence of DCsinthecentralcornealepitheliumofpatients.Similarly,inDED-inducedmurinecorneas,there isevidenceofaninfluxofCD11b$^{+}$APCs(Figure4).TheAPC-mediatedprimingofT$_{H}$1andT$_{H}$17 cells against autoantigens has been proposed as a potential source of autoimmunity in DED.

EffectorT Cells

T-cell infiltration of the ocular surface is a pervasive finding in DED (Figure 5). CD4+ T cells, includingIFN-γ–secretingT$_{H}$1cellsandIL-17–secretingT$_{H}$17cells,arethoughttobetheprimary effectorTcellsofDED.AlthoughtherelativecontributionsofT$_{H}$1andT$_{H}$17cellsremainunclear, recentfindingssuggestthatT$_{H}$17cellshaveaprominentroleinthepathogenesisofDED.Thisis an important finding, particularly given that T$_{H}$1 and T$_{H}$17 cells differentiate via divergent pathways.ElevatedexpressionofIL-6haslongbeenrecognizedinDED;however,theroleofIL-6 in the pathogenesis of DED has been largely unknown. It is understood that IL-6 and transforminggrowthfactorβpromotethedifferentiationofT$_{H}$17cells,whiletransforminggrowth factorβsuppressesT$_{H}$1-mediatedresponses.Theattenuatingeffectsof CD4$^{+}$CD25$^{+}$Foxp3$^{+}$regulatoryTcells(Tregs)havebeendescribedinmodelsofocularsurface



ISBN:978-81-957858-1-0

inflammation,buttheinabilityofTregstosuppressDEDhasbeenincompletelyexplained.Itwas recently demonstrated that the $T_H17$, but not $T_H1$, cell subset is resistant and functionally antagonistic to Treg-mediated suppression in DED, and in vivo blockade of IL-17 significantly decreases DED severity.

RegulatoryTCells

RegulatoryTcellsareadistinctfamilyofTcellsinvolvedinthesuppressionofimmuneresponses. Treg abnormalities in systemic autoimmune diseases associated with DED, such as Sjögren syndrome,systemiclupuserythematosus,andrheumatoidarthritis,havelongbeen recognized.TregabnormalitieswererecentlyimplicatedinthedevelopmentofexperimentalDED. Nude mice that lack $CD4^+CD25^+Foxp3^+$Tregs were adoptively transferred with DED-primed T cells and subsequently developed Sjögren syndrome–like DED. Tregs have been shown to suppress DED-associated ocular surface inflammation. The resistance of effector T cells, particularly$T_H17$cells,toTreg-mediatedsuppressionhasbeenidentifiedasanimportantfactorin the pathogenesis of DED.

NaturalKillerCells

Natural killer (NK) cells are large granular lymphocytes capable of secreting proinflammatory cytokines and killing infected or transformed cells. Although NK cells, T cells, and B cells are derived from common bone marrow–derived lymphoid progenitors, they differ significantly in phenotype and function. Natural killer cells have been implicated in the pathogenesis of various autoimmune diseases; however, little is known about the function of NK cells in DED. Investigations of NK cell activity and frequency in Sjögren syndrome have yielded varying results.Natural killer cells do not seem to infiltrate the conjunctival epithelium of patients with dry eye.However, IFN-γ–secreting NK cells located in draining lymph nodes have been implicated in the early development of experimental DED.

Clinicalimplicationsofinflammationindryeye

**Inflammationasameasureofclinical disease**

Numeroustestsandguidelinesareavailabletohelpdirecttheclinicalmanagementof DED.[90]Unfortunately,decisionmakingisoftencomplicatedbyalackofconcordanceamongthe signs and symptoms ofDED. Someofthetechniques being used to investigateinflammation and dry eye in the experimental setting may one day be available in the clinical setting to help overcome this incongruity. As previously described, many markers of inflammation can be identifiedinthetearsandconjunctivaofpatientswithDED.Someofthesemarkers,includingIL-6andHLADR,correlatewithclinicalmeasuresofdiseaseseverityandtreatmentefficacy. Invivo confocal microscopy is being used to examine the effects of ocular surface inflammation on immunecellinfiltrationandonmorphologicstructureofepithelialcells,subbasalnerves,and



ISBN:978-81-957858-1-0

meibomian glands.As experimental techniques that evaluate ocular surface inflammation are further refined, they may become valuable tools in the physician's options. Diagnostic methods that combine conventional tests with experimental measures of inflammation (eg, the scraping cytology score system) have been proposed, potentially bridging the gap between bench and bedside.

**Anti-inflammatory treatment**

CyclosporineA

CyclosporineAexertsimmunosuppressiveactivitythroughseveralpathways.Itformsacomplex withcyclophilinthatinhibitsthecalcineurinphosphatasepathwayresponsibleforthetranscription of T-cell–activating cytokines (such as IL-2).Cyclosporine A binds cyclophilin D, inhibiting the activityofthemitochondrialpermeabilitytransitionporeandsubsequentcytochromec–mediated apoptosis.TheimmunomodulatoryactivityofcyclosporineAisusedinthetreatmentofimmune-baseddisorders,suchastransplantrejection,psoriasis,ulcerativecolitis,rheumatoidarthritis,and DED. Topical administration of cyclosporine A has been shown to increase tear fluid secretion, possibly by promoting the local release of parasympathetic nervous system–associated neurotransmitters.ThebeneficialeffectsofcyclosporineAtreatmentinDEDarewellestablished; however,itisclearthatmanypatientswithDEDdonotshowaconsistenttherapeuticresponseto topical cyclosporine A. The cumulative findings of several clinical trials indicate that long-term treatmentwithcyclosporineA,0.05%,ophthalmicemulsioncanyieldpositiveresultswithregard to objective and subjective findings, including corneal surface staining, Schirmer test with anesthesia, blurred vision, and frequency of artificial tear application. In addition, topical cyclosporineAtreatmentmaybeassociatedwithasignificantimprovementinmanyofthecellular and molecular markers of disease severity. Increased frequency of topical cyclosporine A administration may be of benefit to patients refractory to the standard dosing regimen. Although higher dosing frequencies may increase treatment efficacy, some patients experience bothersome adverse effects (eg, burning or irritation) that impair medication tolerability.

Corticosteroids

Corticosteroids are steroid hormones that can be used to suppress inflammation. Corticosteroids bindtoglucocorticoidreceptorsandinhibittheexpressionofproinflammatorymolecules,promote the expression of anti-inflammatory molecules, and stimulate the apoptosis of lymphocytes. ExperimentalstudieshavedemonstratedtheefficacyofcorticosteroidsinthetreatmentofDEDat thecellular,molecular,andclinicallevels.Clinicaltrialshavedemonstratedtheefficacyoftopical corticosteroid treatment at diminishing symptom severity and minimizing ocular surfacestaining.Systemic corticosteroid administration may also be effective in the treatment of severe acutedryeyerefractivetomoretraditionaltreatmentmodalities.Unfortunately,long-termtopical orsystemiccorticosteroiduseisassociatedwithdeleteriousadverseeffects,suchasocular



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hypertension, cataracts, and opportunistic infections. Repetitive short-term pulsatile administration of topical corticosteroids is a promising method of harnessing their beneficial effects, while minimizing the risk of adverse events.

TetracyclineDerivatives

Tetracycline derivatives are unique in that they possess antibacterial and anti-inflammatory properties. They exert antibacterial activity by reversibly binding to the bacterial ribosome and inhibiting the production of proteins. Tetracycline derivatives have been noted to possess immunomodulatory properties at submicrobial doses. Experimental investigations have demonstratedthatthetetracyclinederivativedoxycyclinecaninhibitc-JunN-terminalkinaseand extracellularsignal–relatedkinasemitogen-activatedproteinkinasesignalinginepithelialcellsof theocular surface exposed to hyperosmolarstress, downregulating the expression ofCXCL8 and proinflammatorycytokinesIL-1βandTNF.DoxycyclineinhibitstheactivityofMMPs(eg,MMP- 9) and supports ocular surface integrity. In addition, the tetracycline-derivative minocycline inhibits the expression of cell-associated proinflammatory molecules, including MHC class II. A novel topically applied liposome-bound form of tetracycline has shown some promise in the treatment of experimental DED. The anti-inflammatory benefits of orally administered tetracycline derivatives have been used in the treatment of chronic immunomediated diseases, including dry eye secondary to ocular rosacea and blepharitis. Despite extensive evidence from experimental trialsindicatingthepotentialbenefitsofadministrationoftetracyclinederivativesinthetreatment of DED, there is limited clinical evidence of their efficacy.

EssentialFattyAcids

Essential fatty acids (EFAs) are biologically necessary fatty acids (FAs) that must be ingested because they cannot be synthesized de novo by the human body. Humans require 2 EFAs for optimal health, -3 (α-linolenic acid) and -6 (linoleic acid) FAs. Essential fatty acids are the precursors of eicosanoids (prostaglandins, prostacyclins, thromboxanes, and leukotrienes) that modulateimmuneresponses.Omega-3 FAsaregenerallyclassifiedas anti-inflammatory,while- 6 FAs are generally proinflammatory. Omega-3 FAs block the production of proinflammatory eicosanoids (prostaglandin $E_2$ and leukotriene $B_4$) and cytokines (IL-1 and TNF). The anti-inflammatory effects of -3 FAs have been used in the treatment of immunomediated disorders, including Sjögren syndrome. Investigations on the use of EFAs in the treatment of DED have producedconflictingresults;however,mostoftheavailableevidencesuggeststhatadministration ofEFAs,particularly-3FAs,canlessenDEDseverity.Severalclinicaltrialshaveinvestigatedthe systemic administration of various EFAs and demonstrated beneficial effects with regard to the signs and symptoms of DED. Topical administration of -3 FAs significantly decreased ocular surface staining, cytokine expression, and immune cell infiltration in an experimental model of murinedryeye.TopicaladministrationofresolvinE$_1$,an-3FAderivative,increasedtear



ISBN:978-81-957858-1-0

production,helpedmaintainocularsurfaceintegrity,decreasedcyclooxygenase2expression,and decreasedimmunecellinfiltrationinexperimental dryeye. AvailabledatasuggestthatEFAscan ameliorate DED; however, more evidence is needed to identify the most efficacious forms and doses of EFAs.

Novel Therapeutics

The past several years have yielded a veritable explosion of new information about the immunopathogenesis of DED. The successful application of cyclosporine in the clinical managementofDEDhasimplicatedtheinflammatorymediatorsofDEDaspromisingtargetsfor therapeuticintervention.Athoroughreviewofthetherapeuticagentsbeinginvestigatedisbeyond the scope of this article. Our laboratory has been involved in the evaluation of anti-inflammatory agents using a short-term experimental model of murine dry eye. Positive results have been reported using various therapeutic agents that target inflammatory mediators, including CCR2, very late antigen 4, and IL-17, to name a few. Other laboratories have reported positive results using medications that inhibit inflammation. Needless to say, interest in evaluating potential therapeutic agents for DED has increased exponentially.

Inconclusion,theevidenceimplicatinginflammationinthepathogenesisofDEDhasopenednew avenues for the treatment of this complex disorder. The successful application of anti-inflammatory medications in the treatment of DED provides hope for the millions of individuals who daily experience this deleterious condition. We anticipate that the advent of novel immunomodulatory agents will herald a new era of DED treatment.

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ISBN:978-81-957858-1-0

## LaserInSituKeratomileusis(LASIK)

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**Abstract**

Laser in situ keratomileusis (LASIK) is a laser-assisted surgical procedure for the correction of visual refractive errors. This activity will review the indications, laser, equipment, contraindications, complications, and long-term prognosis of patients who undergo LASIK. The activity will highlight the role of the interprofessional team.

**Keywords**:Lasser,Keratomileusis,Refraction,Astigmatism,Keratomileusis

### Introduction

Laser-assisted in situ keratomileusis (LASIK) is a common ophthalmologic surgical procedure used to correct refractive error. LASIK was patented in 1989 by Dr. Gholam Peyman. The first publicationofLASIKusedinpatientcare wasbyDr.IoannisPallikarisetal.,intheearly 1990s.Thisprocedurequicklybecamepopularduetodecreasedtimeofrecoveryandpost-surgical complications,withnodecrease inefficacy. Sinceitsimplementationinclinicalpractice, LASIK is among the most scrutinized and studied surgical procedures to have gone through FDA inspection. Thirty years later, with advancements in technique and equipment, LASIK continues to provide efficient, predictable, and safe outcomes with patients reporting satisfaction with the procedure as compared to using spectacles or contact lenses.

### AHistoricalPerspective

Understanding the impact of LASIK in refractive correction requires knowledge of its development.Thefirstsignificantbreakthroughinrefractivetherapycameinthe1930s,withradial keratotomybyDr.TsutomuSatoinJapan.BymakingincisionsdeepintoDescemet'smembrane, the flattening of the cornea helped correct myopia. However, many complications, like corneal decompensation, came from these deep incisions. Alternative methods were developed, such as thehexagonalkeratectomybyDr.AntonioMéndezinMexico.Atthistime,itwasstilldifficultto correct patients with astigmatism or the asymmetric shape of the cornea. Keratomileusis is the medical term for corneal reshaping, which came about in the 1950s and '60s with the work of Spanish ophthalmologist José Barraquer. His technique initially involved the microkeratome, a mechanical instrument that, with its oscillating sharp blade, cuts the top layer of the cornea away tocreatealenticuleandrevealunderlyingstroma.Anadditionalcutthroughthestromawasmade, andthelenticulewassuturedbackintoplace.Thistechniquecametobeknownasanteriorlamellar keratoplasty (ALK).He also developed a procedure called keratophakic, which corrected hyperopiabyfreezingandshapingdonorcornealstromawithacryolatheandthenplacingitinto



ISBN:978-81-957858-1-0

the patient's cornea. His microkeratome, however, was rudimentary and led to imprecise treatments. The microkeratome was further improved in the 1980s through Barraquer's student, Dr. Luis Ruiz. Variations on corneal excision and replacement by implantation also followed throughtheyears,butitcamewiththeriskoftissuerejectionandcornealtearing.Theexcimer,or "excited dimer"laser and its medical use, was discovered in 1970 by Dr. Stephen Trokel and Dr. Rangaswamy Srinivasan in the early 1980s. These works led the way to the development of photorefractivekeratectomy(PRK).Dr.MargueriteMcDonaldwasthefirsttoperformthisin the late1980s.Thistechniqueusesanoblegascombinedwithahalogentocreatealasertoablatethe superficial layers of the cornea. PRK allowed for more precise reshaping and further refractive correction.

LASIK is essentially a combination of ALK and PRK, which was first utilized in the early1990s.Advances in lenticule flap creation were made to allow for a hinged cap instead of a free cap. With the innovation of the femtosecond laser, developed by Dr. Imola Ratkay-Traub, Dr. Tibor Juhasz, and Dr. Ron Kurtz in the early 1990s, a corneal flap could be created without a mechanical blade and then replaced without sutures.

**Anatomy andPhysiology**

Therefractivepoweroftheeyeisattributed,inpart,tothecornea. Itisresponsibleforabouttwo- thirds of the eye's power of refraction. LASIK alters the cornea's refractive power in myopic, hyperopic, and astigmatic patients.

Thecorneaistheone-halfmillimeterthicktissuecomprisingtheanteriorsurfaceoftheeye.Ithas five layers consisting of, from superficial to deep, a squamous epithelial layer, the anterior basementmembrane(Bowman's),astromafilledwithkeratocytesandcollagen,andtheposterior basementmembrane(Descemet's)witha singlelayerendotheliumseparatingitfromtheanterior chamber of the eye.

LASIK surgery changes the refractive power of the cornea first by creating a hinged corneal flap from the epithelium, Bowman's membrane, and the superficial part of the corneal stroma. The more posterior layers of the stroma are exposed for ablation treatment. Thus, for a myopic treatment, central corneal curvature is decreased with the ablation, and the total refractive power of the eye decreases to attain emmetropia, or normal vision (see figure 1). For a hyperopic treatment, the paracentral area is flattened, leading to a steeper central cornea and an increase in refractivepower(seefigure1).Aftertargetedlasertherapytothestroma,theflapisreplaced,and reepithelialization occurs over the flap margin. Sutures are not necessary.

**Indications**

LASIKisanoptioninpatientswithlowtohighmyopia,withorwithoutastigmatism. Ithasbeen shownthatLASIKcanimprovemyopiafrom-2.00to-20.00D;however,itisgenerallyindicated



ISBN:978-81-957858-1-0

inpatientswithlowtomoderatemyopia,from-0.5Dupto-9.00D,asthesepatientshaveahigher probability of reaching emmetropia. This procedure is also reported as safe and efficacious in patientswithhyperopiaandastigmatism.WhileLASIKcantreathyperopiawithmorepredictable outcomesupto+6.00D,itisrecommendedtoperformLASIKforhyperopicpatientsofupto +4.00Dandastigmatismupto5.00D.Theophthalmicsurgeondecidesonchoosingexcimerlaser ablation or other treatment options for the patient based on the type and severity of the refractive error,aswellasotherfactorssuchasthepatient'sage,cornealthickness,crystallinelenschanges, keratometry, and corneal topography results, among others.

Currently,LASIK is the most common laser treatment for refractive error. In addition to its applications for a wide variety of refractive errors, patients suffer relatively little pain compared with techniques that do not create a flap, with recovery time to baseline being only a few days. It is essential to clarify with the patient the realistic expectations of LASIK. These procedures are typicallyhighincostandarenotusuallycovered byinsurancebecause companiesconsiderthese proceduresascosmeticandnotmedicallynecessary.Thishighcost,roughly$1,500to$2,500per eye,can be attributed to the use of two lasers (excimer laser and femtosecond laser) in most practices. In addition, the patient should be informed that LASIK does not correct presbyopia; thus,readingglassesmaystillbenecessary.Amyopicshiftwithcataractformationmayalsooccur at a later age.

**ContraindicationsAbsolute**

**Contraindications**

**Refractive Instability**

Changesgreaterthan0.5Dinthelastyearconstituteinstability,andLASIKisnot recommended forpatients since it is a permanent procedure and operating on eyes that change rapidly may lead to severe complications such as postoperative ectasia. According to the FDA guidelines for LASIK, conditions that may lead to refractive instability include pregnancy, nursing, and uncontrolled diabetes mellitus.

**CornealEctasia**

Anormalcornealthicknessisaround540-550microns.Ifthepreoperativecorneaislessthan500 microns,orifthepostoperativeresidualstromalthicknessislessthan250microns,itincreasesthe risk of developing keratectasia by 5%.

**Keratoconus**

A cone-shaped cornea is an absolute contraindication for LASIK due to the risk of the condition causingcornealectasia.Apractitionermustalsobeawareofsubclinicalkeratoconus,including



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forme fruste keratoconus (FFK), which is, by definition, keratoconus that is not detectable with slit-lamp and corneal topography testing. Therefore, it may be a false negative.

**UncontrolledSystemic Diseases**

Systemic lupus erythematosus, Sjögren syndrome, rheumatoid arthritis, Graves disease, Crohn's disease,andotherdiseasesthatcausekeratoconjunctivitissiccaorotherformsofocularpathology.

**ActiveInfection**

Bacterial blepharitis and keratitis can increase the riskof spreading infection and inflammationthrough the cornea into the eye.

**RelativeContraindications**

**Age**

While LASIK is generally not advised for children due to the changes in refraction during adolescence,ithasbeensuccessfulinpatientsunder18yearsoldwithhighmyopiaorothersevere pathologies.

**HerpesZosterOphthalmicusorHerpesSimplexKeratitis**

Active infection by Herpes should be treated before surgery occurs. A study determined that it is safe to operate on patients with a history of ocular Herpes; however, it is recommended to wait one year for the virus to be in remission before surgical intervention.

**Cataract**

Patients with mild cataracts may still receive LASIK surgery, but with the caveat that when the cataract progresses, visual acuity may be impaired despite LASIK. Intraocular lens implantation following cataract surgery is an indicated alternative procedure to LASIK.

**Glaucoma**

PatientswithglaucomawhoundergoLASIKmaydevelopafalsedecreaseinintraocularpressure (IOP) after surgery due to decreased corneal thickness. In addition, advanced patients with glaucomahavetheriskofincreased damagetotheopticnerveduringsurgeryduetothe transient increase in intraocular pressure from the initial suction applied on the cornea.

**CornealDystrophy(CD)**

Certain diseases like Fuchs endothelial corneal dystrophy may be accelerated with surgical interventions such as LASIK.Patients with other forms of corneal dystrophies, such as granular cornealdystrophyandlatticecornealdystrophy,mayreceiveLASIK,butrecurrenceofthedisease is a possibility.

**Keloidosis**



ISBN:978-81-957858-1-0

It is suggested by some sources that patients with a history of keloids may have their surgical results complicated by the disease. However, it has been reported that patients with keloids undergoing refractive surgery report good outcomes.

**PupilSize**

It has been historically reported that patients with a larger pupil size may have an increased risk for postsurgical visual complications, such as halos/star-bursting with light, and glare.However, with the advent of new technology lasers, larger ablation, and blend/transition zones, the correlation of large pupil size and visual complications is diminishing.

**Equipment**

**ExcimerLaser**

Therearevariousexcimerlasersapprovedbythe UnitedStatesFederalDrugAgency(USFDA), each with advantages that may be chosen according to the patient's needs. Differences among lasers include beam size, beam repetition speed, and other benefits such as eye-tracking. Today, the technical approach called custom-LASIK is often utilized, either using topography-guided (using the measured corneal topography to configure the laser) or wavefront-guided (calculating the light refraction off of the cornea to configure the laser) approaches. These customized lasers may be used in conjunction with spot or slit-scanning lasers and help decrease post-surgical complications by shaping the cornea with more precision.

**Femtosecond Laser**

Flapcreationcanbemadewithvariousapproaches,asdescribedinthetechniquesection;however, the general approach with LASIK currently is to create the flap using a femtosecond laser. The advantage ofthelaserovermechanical techniques is that theflap can be createdthinner and with more precision, which leads to better results and fewer flap-related complications after surgery.

**Preparation**

Before a screening examination, contact lenses should be temporarily discontinued 1 to 2 weeks in advance to allow the corneal surface to stabilize, thus giving more accurate measurements. A thorough history and physical examination should be completed to help identify any contraindications to LASIK. In addition to visual acuity testing, a full eye examination must be performed prior to considering surgery. This exam should include an assessment of general eye health by slit-lamp exam, fundoscopic exam, dry eye evaluation, and intraocular pressure.

Thecorneaisevaluated bykeratometryandpachymetry.Goodcandidates forLASIKwillhavea normalcornealthicknessofapproximately550microns.Topographyandtomographyarecrucial forgoodrefractivescreeningandhavebecomethestandardofcareforpre-operativescreeningto rule out keratoconus.



ISBN:978-81-957858-1-0

Foramoredetailedevaluationofcandidacy,theRandlemancriteriacanhelpscreenpatientswho are at high risk for developing post-surgical corneal ectasia. The criteria consider variables such astopographicalresults,cornealthickness,age,andsphericalmanifestrefraction.Ascoreof4or more is considered a high risk for developing post-LASIK ectasia.

Once the patient is approved for LASIK, the Munnerlyn formula is used to calculate the ablation zone and depth for LASIK treatment, which incorporates the thickness of tissue ablated, the diameter of the optic zone, and the dioptric correction. The percentage of tissue altered (PTA), whichconsiderscornealthickness,ablationdepth,andflapthickness,alsohelpsphysicianspredict risk for post-LASIK corneal ectasia; it has been shown that a PTA of 40% or more is correlated with the development of ectasia.

**TechniqueorTreatment**

**Pre-Surgery**

All equipment should be checked for safety, and to ensure patient topographical data is imported into the excimer laser. The patient should be given education on the routine of the procedure, as well as signing an informed consent document.

**SurgicalTechnique**

Ingeneral,LASIKsurgeryisperformedinthefollowingmanner:thepatientisbroughttothetable andplacedinacomfortablesupineposition.Thefelloweyeistapedclosed,andtheoperativeeye is positioned open with a speculum. The eye is anesthetized with eye drops. A suction ring is placed on the cornea, whilethecornea is marked forflap creation by either amicrokeratome or a femtosecondlaser.Withthelaser,theflapisdelineatedthroughtheformationofmicro-cavitation bubbles in a cleavage plane. The flap has a customized diameter, thickness, side-cut angle, hinge length, and hinge position. The femtosecond laser has largely superseded the microkeratome for flap creation.

After the flap is created, the surgeon carefully reflects the flap to reveal the underlying stroma. The surgeon positions and signals the excimer laser to provide sculpting to the stromal surface throughphotoablation.Thesurgeon thenreplaces theflapto itsoriginalposition.Itissafeforthe patient to receive LASIK in both eyes on the same day.

**Post-Surgery**

The patient instills preservative-free artificial tears because dry eyes are a common side-effect of surgery. Patients are advised to use artificial tears frequently, but if symptoms persist, the use of punctal plugs may be prescribed. The patient is also given antibiotics, and steroidal eye drops to use for 5 to 14 days after the surgery. The patient follows up with their surgeon as prescribed by theirpractice,and after examination, may requireadditional minor LASIKadjustmentstocorrect



ISBN:978-81-957858-1-0

residual refractive error, known as an enhancement procedure, usually within a year of the initial procedure. Enhancement procedures occur in about 10% of patients and more frequently in patients with high initial corrections, over 40 years old, or with astigmatism.

**AlternateProcedures**

Thereareotherlaser-assistedproceduresthatmaybeoptionsforthepatientwithrefractiveerrors. In addition, with advances in technology, variations to LASIK have been implemented successfully in practice.

**PRK**

One study shows that while LASIK has better results for visual acuity sooner after the surgery, patientswithPRKtendedtomaintainbetterrefractionyearsaftertheinitialsurgery. Anotherstudy shows better outcomes with PRK, in patients with low to high myopia, with fewer complications comparedtoLASIK,despiteotherstudiesreportingbetteroutcomeswithLASIK.Multiplestudies showsimilaryetexcellentoutcomesinbothprocedures.Thephysicianmustuseclinicaljudgment in deciding which procedure will result in optimal outcomes for the patient. While pain has itorically been labeled as a disadvantage of PRK, the use of bandage contact lenses and NSAIDs have led to a smooth post-op recovery with little pain.

**FemtosecondLenticuleExtraction(FLEx)orSmallIncisionLenticuleExtraction(SMILE)**

Thefemtosecondlaserremovesthesquamousepitheliumwithoutleavingaflap. Itisindicatedin patients with higher myopia (-6.00 D to -12.00 D) compared to LASIK. Studies have shown similarclinicaloutcomesascomparedtoLASIK,withfewerincidencesofdryeyesaftersurgery.

**LaserEpithelialKeratomileusis(LASEK)**

Lasek is a procedure where an alcohol solution is used to assist in the removal of the superficial corneal layer. Epi-LASEK uses an epi-microkeratome to remove the layer. Both techniques are variants of PRK and can be considered as viable alternative procedures.

**Complications**

**Dry Eyes**

One of the most common transient side-effects from LASIK is dry eyes due to a lack of tear production.Thisisduetotheinterruptionofthelacrimalreflexasaresultofnervoustissuebeing severed during the procedure. Various studies have shown dry eyes to occur in 85% to 98% of patients one week after surgery.This number drops to around 60% at 1 month . Artificial tears and/or punctal plugs are applied until the nerves regenerate.

**Visual Aberrations**



ISBN:978-81-957858-1-0

20% of patients will report some form of visual change.Some patients may suffer from visual changes such as glare, halo, or star-bursting patterns around lights, haze, and decreased contrast sensitivity.TheFDAreportsthatvisualdisturbancestendtostabilizethreetosixmonthsafterthe procedure.

**DiffuseLamellar Keratitis**

Patients may also report blurriness and foreign body sensation that may be caused by diffuse lamellarkeratitis(DLK),or“sandsofSahara”syndrome,asterileinflammatory response.Inflammatorycellinfiltratesoccurbeneaththecornealflapinterface.Thisphenomenon may happen in as many as 1 in 50 cases of LASIK. DLK usually presents one to two days post-operatively and resolves with appropriate corticosteroid treatment after one week.

**CornealFlapComplications**

The incidence of microstriae, macrostriae, buttonholing, incomplete cap, free cap, cap dislodgement, and epithelial ingrowth after surgery, is a low-risk event, with 0.1-4% of patients reporting some form of complication.It has been shown that corneal flap complications can lead to visual acuity loss.

**Post-LASIK Ectasia**

Athincorneabeforesurgerymayincreasetheriskofdevelopingectasiaorfurtherthinningofthe cornea. The incidence has been reported from 0.04% to 0.6%.Femtosecond-assisted LASIK can help prevent this complication dueto the thinnerflaps created.Theuse oftheRandleman criteria, as described in the preparation section, can also screen for patients who are at high risk of developing ectasia.

**InfectiousKeratitis**

Less than 0.1% of patients will develop an infection after LASIK.The most common sources of infection come from gram-positive organisms, such as *Staphylococcus species,*or atypical mycobacteria, especially if the onset of infection is one-two weeks after surgery.

**RareComplications**

Ischemic optic neuropathy, retinal detachment, vitreous hemorrhage, and posterior vitreous detachment, are potential but very rare complications of LASIK, occurring in less than 0.1% of patients.

**ClinicalSignificance**

While LASIK may be used in refractive errors, it was shown that this procedure is reliable in patientswithmyopiaof-6.0Dorlessandastigmatismoflessthan2.0D.Arecentmeta-analysis studyshowedsimilarimprovementofvisualacuityandpatientsafetywithLASIKcomparedto



ISBN:978-81-957858-1-0

other refractive surgical procedures.This procedure has the added advantages of rapid recovery anddecreasedpostoperativepain. Severalstudiesreporta92%to95%rate ofsatisfactionamong patients who obtained LASIK surgery.

**EnhancingHealthcareTeamOutcomes**

TheprofessionalteaminLASIKtreatmenttypicallyconsistsofophthalmicsurgeons,optometrists, nurses,medicalassistants,andtechnicians.Teammembersworktogetherintheoutpatientsetting todeterminethebestcandidatesforLASIKtopreventunnecessarycostsandcomplicationstothe patient.Theteam,onthedayofsurgery,isresponsibleforadheringtostandardclinicalprotocols, includingobtainingthepatient’sinformedconsentfortheprocedure,thecorrectmarkingofwhich eye will receive each specific treatment, the proper placement, and preoperative evaluation of necessaryequipmentfortheprocedure,atimeoutcalledbeforetheoperation,andpatienteducation throughout the treatment process. Communication among team members is vital, concerning any changes in patient status at any time before, during, or after the procedure and optimizes patient outcomes.[ Level 5]

**Nursing,AlliedHealth,andInterprofessionalTeam Interventions**

The team educates the patient regarding the procedure and obtains informed consent before surgery.They perform instrumentation checks with correct placement and distribution duringthe procedure and ensure sterility. Communication with other team members is crucial for patient safety.

**Nursing,AlliedHealth,andInterprofessionalTeam Monitoring**

The team guides the patient through post-procedure education for proper eye care, including the administrationofprescribedeyedrops.Theyassistwithpatientfollow-upinanoutpatientsetting, with eye examinations to document visual acuity and visual changes.

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ISBN:978-81-957858-1-0

# IntroductiontoClinicalBiochemistry:FoundationsandApplications

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**Abstract**

This chapter serves as an introduction to the field of clinical biochemistry, providing a comprehensive overview of its foundations and applications. It begins with a historical perspective, tracing the origins and evolution of clinical biochemistry, highlighting significant milestonesthathaveshapedthediscipline.Thechapterthenexploresthemajorbiomoleculesand their roles in cellular metabolism, elucidating how carbohydrates, lipids, proteins, and nucleic acids participate in key biochemical processes. Principles of laboratory medicine are introduced, emphasizingtheimportanceofqualitycontrol,accuracy, andreliabilityinlaboratoryresults.The conceptofreferenceintervalsandtheirinterpretationisdiscussed,emphasizingtheirsignificance inevaluatinglaboratoryresultswithintheclinicalcontext.Diagnostictechniquesandtechnologies commonly employed in clinical biochemistry, such as spectro-photometry, immunoassays, chromatography, and molecular diagnostics, are explored, showcasing their applications and limitations. The chapter also highlights the role of clinical biochemistry in disease management across various medical specialties, demonstrating how biochemical markers and tests aid in diagnosis, prognosis, and treatment decisions. Lastly, emerging trends and future directions in clinicalbiochemistryarediscussed,includingtheintegrationofomicstechnologiesandtheriseof personalizedmedicine.Overall,thisintroductorychapterprovidesreaderswithasolidfoundation to understand the principles and significance of clinical biochemistry in healthcare.

**Keywords:** clinical biochemistry, biomolecules, cellular metabolism, laboratory medicine, reference intervals, diagnostic techniques, disease management, medical specialties, emerging trends, personalized medicine.

## Introduction:

Clinical biochemistry is a vital discipline within the field of laboratory medicine that focuses on the study of biochemical processes in the human body and their relevance to health and disease. Thischapterservesasacomprehensiveintroductiontothefoundationsandapplicationsofclinical biochemistry, providing readers with a solid understanding of its fundamental principles and highlighting its significance in medical practice.

## Historical Perspective:

The chapter begins by exploring the historical background of clinical biochemistry, tracing its originsandevolution overtime. Fromearlydiscoveries inthe19thcenturyto thedevelopment of



ISBN:978-81-957858-1-0

sophisticated analytical techniques in the modern era, we delve into the milestones that have shaped the field and set the stage for its current prominence in healthcare.

**BiomoleculesandCellular Metabolism:**

Thissectionprovidesan overviewofthemajorbiomoleculesandtheirroles incellularmetabolism. It explores the structure and functions of carbohydrates, lipids, proteins, and nucleic acids, elucidating how they participate in key biochemical processes such as energy production, signal transduction, and genetic information transfer.

**PrinciplesofLaboratoryMedicine:**

Clinicalbiochemistryreliesheavilyonlaboratorytestingtoanalyzebodyfluidsandandtissuesfor diagnostic and monitoring purposes. Here, we introduce the essential principles of laboratory medicine, including sample collection, handling, and analysis. We discuss the importance of quality control, accuracy, precision, and reliability in laboratory results, emphasizing the significance of these factors in clinical decision-making.

**ReferenceIntervalsandClinicalInterpretation:**

Understanding reference intervals and their interpretation is crucial for evaluating laboratory results in the context of patient care. This section explores the concept of reference intervals, factors influencing their determination, and their clinical significance. We also delve into the interpretation of abnormal results, highlighting the importance of considering clinical context, patient characteristics, and potential interferences.

**DiagnosticTechniquesandTechnologies:**

Advancements in technology have revolutionized the field of clinical biochemistry, enabling the development of increasingly sophisticated diagnostic techniques. In this section, we discuss a range of laboratory methods and instrumentation commonly employed in clinical biochemistry, such as spectro-photometry, immunoassays, chromatography, and molecular diagnostics. We explore their principles, applications, and limitations, emphasizing their relevance in diagnosing and monitoring various diseases.

**RoleofClinical Biochemistryin DiseaseManagement:**

Clinical biochemistry plays a pivotal role in disease management, aiding in the diagnosis, prognosis, and treatment of a wide range of medical conditions. This section highlights the applications of clinical biochemistry in different medical specialties, such as endocrinology, cardiology,nephrology,andoncology.Weexplorespecificexampleswherebiochemicalmarkers and tests are instrumental in guiding clinical decisions and monitoring therapeutic interventions.



ISBN:978-81-957858-1-0

**EmergingTrendsandFuture Directions:**

To conclude the chapter, we discuss the emerging trends and future directions in clinicalbiochemistry. From the integration of omics technologies (e.g., genomics, proteomics) to the rise of personalized medicine, we explore how advancements in research and technology are shaping the field's landscape and paving the way for innovative diagnostic and therapeutic approaches.

**Conclusion:**

This introductory chapter provides readers with a comprehensive overview of clinical biochemistry, laying the foundations for understanding its principles and applications in healthcare. By exploring its historical background, key biomolecules, laboratory principles, diagnostictechniques,andclinicalrelevance,readerswillgainasolidfoundationfordelvinginto more specific topics within the field. As the subsequent chapters unfold, readers will be well- equipped to explore the intricacies of clinical biochemistry in the context of various disease processes and medical specialties.

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ISBN:978-81-957858-1-0

# BloodandHematology:InsightsintoCellularBiochemistry

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**Abstract**

This chapter provides a comprehensive exploration of blood and hematology, focusing on the cellular biochemistry underlying the composition and functions of blood components. It begins with an overview of blood as a specialized connective tissue and the role of hematopoiesis in its formation. The chapter delves into the cellular biochemistry of erythrocytes, leukocytes, and platelets, discussing their structure, metabolism, and key biochemical processes. The importance of cellular biochemistry in understanding blood disorders is emphasized, providing insights into thepathophysiologyofvarioushematologicalconditions.Additionally,thechapterhighlightsthe application of cellular biochemistry in diagnostic approaches and therapeutic interventions in hematology. This chapter serves as a valuable resource for researchers, clinicians, and students interested in unraveling the intricacies of blood and hematology from a cellular biochemistry perspective.

**Keywords:**Blood,hematology,Cellularbiochemistry,Erythrocytes,Leukocytes,Platelets,Blood disorders

## IntroductiontoBloodandHematology

### OverviewofBlood:Composition,Functions,andImportance

Blood is a vital fluid that circulates throughout the human body, delivering essential substances and providing numerous physiological functions necessary for life. It is a specialized connective tissue composed of cellular and non-cellular components suspended in a liquid matrix called plasma.Understandingthecompositionandfunctionsofbloodiscrucialinunravelingtheintricate mechanisms underlying hematological processes. The cellular components of blood include erythrocytes (red blood cells), leukocytes (white blood cells), and platelets (thrombocytes). Each cell type plays a unique role in maintaining homeostasis and responding to various physiological and pathological conditions. Erythrocytes are responsible for oxygen transport, leukocytes contribute to the immune response and defense against infections, and platelets are involved in blood clotting and wound healing. The non-cellular component of blood, plasma, is a complex mixture of water, electrolytes, proteins, hormones, and various other molecules. Plasma provides a medium for the transportation of nutrients, gases, waste products, and signaling molecules throughout the body. It also plays a critical role in maintaining osmotic balance, pH regulation, and temperature control.



ISBN:978-81-957858-1-0

**Hematopoiesis:BloodCellFormationand Regulation**

Hematopoiesis is the process by which blood cells are formed from hematopoietic stem cells in the bone marrow. It is a highly regulated and dynamic process that involves a series of developmentalstagesanddifferentiationpathways.Hematopoiesisoccursthroughoutthelifespan of an individual, ensuring the continuous production of all blood cell types to maintain homeostasis. The regulation of hematopoiesis is tightly controlled by various growth factors, cytokines,andtranscriptionfactorsthatinfluencetheproliferation,differentiation,andmaturation ofhematopoieticstemcells.Thesefactorsactinacoordinatedmannertodirectcellfatedecisions and ensure the production of the appropriate number and type of blood cells. Understanding the mechanisms underlying hematopoiesis is crucial for comprehending the pathogenesis of hematologicaldisorders,includinganemia,leukemia,andimmunedeficiencies.Disruptionsinthe regulation of hematopoiesis can lead to abnormal cell development, impaired immune function, and the onset of various blood diseases.

In this chapter, we will delve deeper into the cellular biochemistry underlying blood and hematology.Wewillexplorethestructure,metabolism,andfunctionsoferythrocytes,leukocytes, and platelets. Additionally, we will examine the role of cellular biochemistry in understanding blood disorders, diagnostic approaches, and therapeutic interventions in hematology. By gaining insights into the intricacies of blood and hematological processes at a cellular level, we can enhance our understanding of health and disease and pave the way for improved diagnostics and treatments in the field of hematology.

**CellularBiochemistryofErythrocytes:**

**StructureandFunctionofErythrocytes**

Erythrocytes,alsoknownasredblood cells,arehighlyspecializedcellsthatplayacrucialrolein oxygen transport throughout the body. Their unique structure and function are optimized to efficiently carry oxygen from the lungs to tissues and remove carbon dioxide, a waste product of cellularrespirationErythrocyteshaveabiconcavediscshape,whichmaximizestheirsurfacearea and facilitatesthediffusion ofgases. They lack a nucleusand most organelles, allowing formore space to accommodate hemoglobin, the oxygen-carrying protein. The flexible and deformable nature of erythrocytes enables them to squeeze through narrow capillaries and deliver oxygen to tissues in even the smallest blood vessels.

**Hemoglobin:Structure,OxygenBinding,and Transport**

Hemoglobin is the primary protein found in erythrocytes and is responsible for binding and transporting oxygen. It consists of four subunits, each containing a heme group that can bind to oxygen molecules. Hemoglobin exhibits cooperativity, meaning that the binding of one oxygen molecule facilitates the binding of subsequent molecules.



ISBN:978-81-957858-1-0

Inthelungs,whereoxygenlevelsarehigh,hemoglobinbindsoxygenandformsoxyhemoglobin. As erythrocytes circulate through the body, they encounter tissues with lower oxygen concentrations. The release of oxygen from oxyhemoglobin occurs, allowing oxygen to diffuse into tissues where it is needed. This oxygen unloading is facilitated by factors such as pH, temperature, and the concentration of carbon dioxide.

**Erythrocyte Metabolism: Glycolysis, Pentose Phosphate Pathway, and Energy Production**

Erythrocytes rely predominantly on anaerobic metabolism for energy production, as they lack mitochondria and cannot generate energy through oxidative phosphorylation. The primary pathwayinvolvedin energyproductioninerythrocytesisglycolysis,which convertsglucoseinto pyruvate and generates ATP as a source of cellular energy.

In addition to glycolysis, erythrocytes possess the pentose phosphate pathway (PPP), which provides reducing equivalents in the form of NADPH. NADPH is essential for maintaining the redox balance in erythrocytes and protecting them from oxidative damage. It also plays a critical role in maintaining the activity of glutathione, a crucial antioxidant molecule.

MembraneBiochemistry:LipidComposition,Transporters, andSignaling

Theerythrocytemembraneisacomplexstructurecomposedoflipids,proteins,andcarbohydrates. The lipid composition of the membrane, particularly its high content of phospholipids and cholesterol, contributes to its fluidity and stability. Various transporters and channels are embedded in the membrane, allowing for the movement of ions, nutrients, and waste products across the cell. The erythrocyte membrane also plays a role in cell signaling and antigen recognition.Glycoproteinsandglycolipidspresentonthemembranesurfaceparticipateinimmune recognitionprocessesanddeterminebloodtypes.Furthermore,themembraneundergoesdynamic changes in response to external stimuli, such as alterations in pH, temperature, and osmotic pressure.

Understandingthecellularbiochemistryoferythrocytesiscrucialforcomprehendingtheirrolein oxygen transport, energy production, and maintaining cellular homeostasis. By unraveling the intricacies of erythrocyte structure, hemoglobin function, metabolic pathways, and membrane biochemistry, we can gain valuable insights into normal erythrocyte physiology and the pathogenesis of erythrocyte-related disorders.

**Advancesin HematologyResearch:**

**OmicsApproaches:Genomics,Proteomics, and Metabolomicsin Hematology**

Inrecentyears,omicsapproacheshaverevolutionizedthefieldofhematologyresearch,providing valuableinsightsintothegenetic,proteomic,andmetabolicprofilesofhematologicaldisorders.



ISBN:978-81-957858-1-0

Genomics studies have identified genetic mutations and variants associated with various blood disorders, shedding light on disease pathogenesis, prognosis, and personalized treatment approaches. Whole-genome sequencing, single-cell sequencing, and genome-wide association studies have played a significant role in uncovering the genetic basis of hematological diseases.

Proteomics, on the other hand, focuses on the identification and characterization of proteins and theirmodificationsinhematologicaldisorders.Techniquessuchasmassspectrometryandprotein microarrays have enabled the identification of disease-specific protein biomarkers, facilitating early diagnosis, prognosis, and monitoring of therapeutic responses. Proteomic studies have also contributedtoabetterunderstandingofsignalingpathwaysandmolecularmechanismsunderlying hematological diseases. Metabolomics, the study of small molecule metabolites, offers a comprehensiveviewofcellularmetabolicpathwaysandalterationsassociatedwithhematological disorders. By analyzing metabolite profiles in blood or bone marrow samples, metabolomics can identify metabolic signatures and dysregulations that can serve as diagnostic or prognostic markers. Metabolic pathway analysis can also provide insights into disease mechanisms and potential therapeutic targets.

**NovelBiomarkersand DiagnosticToolsinHematological Diseases**

Advancements in hematology research have led to the discovery of novel biomarkers and the development of sophisticated diagnostic tools for hematological diseases. These biomarkers can helpintheearlydetection,accuratediagnosis,and monitoringofdiseaseprogression.Forexample, inleukemia,thedetectionoffusiongenesorminimalresidualdiseaseusingmoleculartechniques has become crucial for risk stratification and treatment decisions.

In addition to genetic biomarkers, circulating tumor cells, extracellular vesicles, and microRNAs have emerged as promising non-invasive biomarkers in hematological malignancies. These biomarkers can be detected in blood or other body fluids, allowing for less invasive and more frequent monitoring of disease status.

Furthermore, advances in imaging technologies, such as flow cytometry, fluorescence in situ hybridization, and next-generation sequencing-based assays, have significantly enhanced the diagnostic capabilities in hematological diseases. These tools enable the identification and characterization of specific cell populations, genetic abnormalities, and disease-associated biomarkers with high sensitivity and specificity.

**EmergingTherapeuticStrategiesTargeting Cellular Biochemistry**

Recent research in hematology has focused on developing innovative therapeutic strategies that targetcellularbiochemistryandmolecularpathwaysinvolvedinhematologicaldiseases.Targeted therapies,includingsmallmoleculeinhibitorsandmonoclonalantibodies,haverevolutionizedthe treatmentofhematologicalmalignancies.Forexample,tyrosinekinaseinhibitorshaveshown



ISBN:978-81-957858-1-0

remarkable success in treating chronic myeloid leukemia by selectively inhibiting the abnormal fusion protein BCR-ABL1.

Immunotherapies,suchaschimericantigenreceptor(CAR)T-celltherapyandimmunecheckpoint inhibitors, have demonstrated remarkable efficacy in hematological malignancies, including lymphomasand acutelymphoblasticleukemia. Thesetherapiesharness thepoweroftheimmune system to recognize and eliminate cancer cells.

Additionally, gene therapies, such as gene editing using CRISPR-Cas9 technology, hold promise for correcting genetic mutations underlying inherited hematological disorders, such as sickle cell disease and β-thalassemia. By precisely modifying the patient's own hematopoietic stem cells, gene therapies offer potential long-term solutions for these genetic diseases.

The advancements in hematology research, including omics approaches, novel biomarkers, and emerging therapeutic strategies, have significantly improved our understanding of hematological diseasesandtransformedpatientmanagement.Thesebreakthroughspavethewayforpersonalized and targeted therapies, leading to improved outcomes and quality of life for patients with hematological disorders.

**Conclusion:**

This chapter provides a comprehensive overview of the cellular biochemistry underlying blood andhematology.Byexploringthecellularbiochemistryoferythrocytes,leukocytes,andplatelets, readers gain insights into their structure, metabolism, and functions. The significance of cellular biochemistry in understanding blood disorders is emphasized, shedding light on the pathophysiology of various hematological conditions. Additionally, the chapter highlights the application of cellular biochemistry in diagnostic approaches and therapeutic interventions in hematology. With advances in omics technologies and the identification of novel biomarkers, researchersandcliniciansarepoisedtounravelfurtherthecomplexitiesof bloodandhematology from a cellular biochemistry perspective.

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ISBN:978-81-957858-1-0

## TheBiochemicalBasisofDisease:PathwaysandMechanisms

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**Abstract**

Theunderstandingofdiseasemechanismsatthebiochemicallevelisessentialforthedevelopment of effective diagnostic methods and therapeutic interventions. This chapter provides an in-depth exploration of the biochemical basis of disease, focusing on the pathways and mechanisms underlying various pathological conditions. It begins by discussing the fundamental concepts of cellularbiochemistryanditsroleinmaintaininghomeostasis.Subsequently,itdelvesintospecific biochemical pathways involved in disease development, including metabolic disorders, genetic diseases, and dysregulation of signaling pathways. The chapter highlights the importance of studying the biochemical basis of disease in elucidating disease etiology, identifying biomarkers, and designing targeted therapies. This comprehensive overview serves as a valuable resource for researchers,clinicians,andstudentsinterestedinunravelingtheintricatebiochemicalmechanisms underlying disease processes.

**Keywords:**Biochemicalbasis,Diseasemechanisms,Cellularbiochemistry,Metabolicdisorders, Genetic diseases, Signaling pathways, Etiology, Biomarkers, Targeted therapies.

### Introduction

Millions of people worldwide are impacted by disease, which presents substantial obstacles for global health. The complex molecular networks and mechanisms underlying diseased states are examined in the biochemical basis of disease. For the development of efficient diagnostic proceduresandtherapeuticapproaches,itisessentialtocomprehendthebiochemicalmechanisms that underlie illness onset and progression. The importance of identifying the biochemical causes ofdiseaseisemphasized inthischapter'ssummaryofcellularbiochemistryanditsrelationshipto illness.Understandingthecellularbiochemistryofdiseaseoffersunderstandingoftheunderlying molecular pathways. Researchers can better understand the etiology of disease, find prospective therapeutictargets,andcreatenewtreatmentapproachesbydecipheringthecomplexbiochemical processes and pathways linked to disease.

### TheValueof UnderstandingDisease's Biochemical Basis

Itiscrucialtocomprehendthebiochemicalcausesofdiseaseforanumberofreasons.Itfirstmakes it possible to pinpoint the cause of an illness. Researchers can learn more about the underlying causes and contributing factors of disease by understanding the metabolic mechanisms that are involved in itsdevelopment. This information is essential forcreating preventative strategies and focused interventions to lower disease risk.



ISBN:978-81-957858-1-0

**MetabolicDisorders:Dysregulationof CellularMetabolism**

Diabetesmellitusisametabolicdisordercharacterizedbyimpairedglucosehomeostasis,resulting inpersistenthyperglycemia.Theconditionarisesduetodefectsininsulinsecretion,insulinaction, orboth.Insulin,ahormoneproducedbythepancreaticbetacells,playsacriticalroleinregulating glucose levels in the blood. It promotes glucose uptake into cells, stimulates glycogen synthesis, andinhibitsglucoseproductionintheliver.Intype1diabetes,anautoimmuneprocessleadstothe destruction of pancreatic beta cells, resulting in an absolute deficiency of insulin. Without sufficientinsulin,glucosecannotentercellseffectively,leadingtoincreasedbloodglucoselevels. Type 1 diabetes usually develops early in life and requires lifelong insulin therapy. Type 2 diabetes, on the other hand, is characterized by insulin resistance and relative insulin deficiency. Insulin resistance refers to a reduced responsiveness of target tissues, such as muscle, liver, and adipose tissue, to the action of insulin. This resistance results in the pancreas compensating by producing moreinsulin. Overtime,thepancreatic betacells becomeexhaustedand failto secrete adequate insulin, leading to elevated blood glucose levels. Type 2 diabetes is strongly associated with obesity, physical inactivity, and genetic predisposition. Lifestyle modifications, including weight loss, exercise, and dietary changes, are often recommended as initial management strategies.Insomecases,oralmedicationsorinsulininjectionsmaybenecessarytocontrolblood glucose levels.

**2.2Dyslipidemia:AbnormalLipid Metabolism**

Dyslipidemiareferstoabnormallevelsoflipids,suchascholesterolandtriglycerides,intheblood. Lipids play crucial roles in cellular structure, energy storage, and signaling processes. However, disturbancesinlipidmetabolismcanleadtothedevelopmentofcardiovasculardiseases,including atherosclerosis, heart disease, and stroke. Several factors contribute to dyslipidemia, including dietary habits, genetics, and underlying medical conditions. Elevated levels of low-density lipoprotein cholesterol (LDL-C), often referred to as "bad cholesterol," increase the risk of atherosclerosis and cardiovascular events. Conversely, low levels of high-density lipoprotein cholesterol (HDL-C), known as "good cholesterol," are also associated with an increased risk of cardiovascular disease.

Treatment of dyslipidemia typically involves lifestyle modifications, including a heart-healthy diet, regular physical activity, and weight management. In cases where lifestyle changes are insufficient,medicationinterventions,suchasstatins,fibrates,orcholesterolabsorptioninhibitors, may be prescribed to lower LDL-C levels or increase HDL-C levels. Managing dyslipidemia is essential for reducing the risk of cardiovascular complications and maintaining overall cardiovascular health.



ISBN:978-81-957858-1-0

**2.3InbornErrorsofMetabolism:GeneticMetabolic Disorders**

Inborn errors of metabolism (IEMs) are a group of genetic disorders characterized by defects in specific enzymes or transporters involved in cellular metabolism. These disorders disrupt normal metabolic pathways, leading to the accumulation of toxic substances or deficiency of essential molecules. IEMs can affect various metabolic processes, including amino acid metabolism, carbohydrate metabolism, fatty acid metabolism, and organic acid metabolism.

EachIEMistypicallycausedbyaspecificgeneticmutationthatimpairsthefunctionofanenzyme or transporter involved in a particular metabolic pathway. Examples of IEMs include phenylketonuria (PKU), a disorder characterized by the inability to metabolize the amino acid phenylalanine,andmaplesyrupurinedisease(MSUD),whichaffectsthebreakdownofbranched- chain amino acids.

The clinical manifestations of IEMs can vary widely depending on the specific disorder and the extent of metabolicdisruption. Symptoms mayrangefrom mild to severe and can affect multiple organsystems,includingthecentralnervoussystem,liver,kidneys,andheart.Earlydetectionand interventionarecrucialformanagingIEMseffectively.Treatmentapproachesmayincludedietary modifications, enzyme replacement therapy, cofactor supplementation, or specific drug therapies aimed at addressing the underlying metabolic defect.

Understanding the biochemical basis of metabolic disorders provides valuable insights into the dysregulation of cellular metabolism and its impact on human health. By unraveling the intricate molecularmechanismsunderlyingthesedisorders,researcherscandeveloptargetedinterventions andtherapiestoalleviatesymptoms,improvepatientoutcomes,andadvanceourunderstandingof cellular metabolism as a whole.

**3. EtiologyandBiomarkers:InsightsfromBiochemicalStudies**

**UnravelingDiseaseEtiologythrough BiochemicalInvestigations**

Biochemical studies play a critical role in unraveling the etiology of various diseases. By examiningthebiochemicalprocessesunderlyingnormalcellularfunctionandcomparingthemto thealteredbiochemicalpathwaysobservedindiseasestates,researcherscangainvaluableinsights into the mechanisms driving disease development and progression. These investigations often involvetheuseofinvitroandinvivoexperimentalmodels,aswellashumanclinicalsamples.By analyzing changes in gene expression, protein levels, enzymatic activity, and metabolite concentrations, researchers can identify key molecular alterations associated with specific diseases. For example, studying the dysregulation of signaling pathways or the accumulation of abnormal metabolites can shed light on the pathogenesis of cancer, neurodegenerative disorders, or autoimmune diseases. Biochemical investigations also help identify potential therapeutic targets.Byunderstandingthespecificmolecularabnormalitiesunderlyingadisease,researchers



ISBN:978-81-957858-1-0

can design targeted therapies that aim to restore normal cellular function. For instance, the development of targeted therapies for cancer has been greatly influenced by the identification of specific genetic mutations or alterations in cellular signaling pathways through biochemical studies.

**Biomarkers:BiochemicalSignaturesofDisease**

Biomarkers are measurable indicators that provide information about the presence, severity, or progression of a disease. Biochemical biomarkers, in particular, offer valuable insights into the underlying pathophysiology of diseases and can be utilized for disease diagnosis, prognosis, and monitoring of therapeutic responses. Biochemical biomarkers can be diverse, ranging from small molecules, such as metabolites and hormones, to proteins, enzymes, or genetic markers. These biomarkers can be detected and quantified using various techniques, including immunoassays, mass spectrometry, and genotyping methods. The identification and validation of reliable biomarkers require extensive biochemical investigations. By comparing biomarker profiles betweenhealthyindividualsandpatientswithaparticulardisease,researcherscanidentifyunique biochemicalsignaturesassociatedwiththedisease.Biomarkerscanaidinearlydiseasedetection, facilitatepersonalizedtreatmentapproaches,andassesstreatmentresponseordiseaseprogression. Forexample, elevatedlevels ofprostate-specific antigen (PSA)in theblood serve as abiomarker forprostatecancerscreening,whilespecificgeneticmutationscanactasbiomarkersforhereditary diseases such as cystic fibrosis.

**Genomics,Proteomics,andMetabolomicsinBiomarker Discovery**

Advancements in genomics, proteomics, and metabolomics have revolutionized the field of biomarker discovery. These "-omics" approaches enable comprehensive profiling of genetic, protein, and metabolite alterations associated with diseases, providing a wealth of data for biomarker identification. Genomics focuses on the study of an individual's complete set of genes (the genome) and their variations. Through genome-wide association studies (GWAS) and next-generation sequencing technologies, researchers can identify genetic variants that predispose individuals to certain diseases or influence disease progression. These genetic markers can serve as biomarkers for disease risk assessment and personalized treatment strategies. Proteomics involves the large-scale study of proteins and their modifications within a cell or tissue. By analyzing changes in protein expression, post-translational modifications, or protein-protein interactions, researchers can identify proteins that are dysregulated in specific diseases. These proteins can be potential biomarkers for disease diagnosis or therapeutic targets. Metabolomics examines the global metabolite profiles within biological systems. By analyzing small molecule metabolites,researcherscangaininsightsintothemetabolicdysregulationassociatedwithvarious diseases. Metabolomic biomarkers can provide information about disease progression, treatment response,ormetabolicphenotypesassociatedwithspecificdiseases.Integrationofgenomics,



ISBN:978-81-957858-1-0

proteomics, and metabolomics data sets can enhance biomarker discovery by providing a more comprehensive understanding of disease mechanisms and identifying multi-dimensional biomarker signatures. These approaches hold great promise for precision medicine, where individualized treatment strategies can be tailored based on a patient's specificbiomarker profile.

## 4. TargetedTherapies:ExploitingBiochemicalPathways

### MolecularTargetingin Cancer Treatment

Cancerisacomplexdiseasecharacterizedbythedysregulationofmultiplebiochemicalpathways. Traditional cancer treatments, such as chemotherapy and radiation therapy, often target rapidly dividing cells without specifically addressing the underlying molecular abnormalities. However, targeted therapies aim to exploit specific biochemical pathways or molecules that are critical for cancer cellsurvival and proliferation. Molecular targetingin cancer treatmentinvolvestheuseof drugsorbiologicsthatselectivelyinterferewithspecificmoleculesorsignalingpathwaysinvolved intumorgrowth.Thesetargetedtherapiescanblocktheactivityofgrowthfactors,inhibitabnormal signaling pathways, or promote immune responses against cancer cells. For example, tyrosine kinase inhibitors (TKIs) selectively inhibit specific enzymes involved in aberrant signaling pathways in cancer cells, such as the epidermal growth factor receptor (EGFR) in non-small cell lung cancer. The development of targeted therapies heavily relies on understanding the specific biochemical alterations present in different cancer types. By identifying key driver mutations or overexpressed proteins, researchers can design drugs that selectively target cancer cells while minimizing damage to normal cells. Targeted therapies have shown remarkable success in improving patient outcomes and reducing side effects compared to conventional treatments.

### EnzymeReplacementTherapyforGenetic Disorders

Geneticdisordersoftenresultfromthedeficiencyormalfunctionofspecificenzymesinvolvedin critical biochemical pathways. Enzyme replacement therapy (ERT) is a targeted treatment approachthataimstorestoreenzymefunctioninindividualswithgeneticdisorders.ERTinvolves the administration of purified or recombinant forms of the deficient enzyme to replace or supplement the missing or dysfunctional enzyme in the body. These therapeutic enzymes can be delivered through intravenous infusion or other routes depending on the target tissue or organ. ERT has been successfully used in the treatment of various genetic disorders, such as Gaucher disease, Fabry disease, and Pompe disease. By replenishing the deficient enzyme, ERT can alleviate disease symptoms, prevent organ damage, and improve patients' quality of life.

### GeneTherapy:CorrectingGenetic Abnormalities

Genetherapyisarevolutionaryapproachthataimstocorrectgeneticabnormalitiesbyintroducing functional genes into affected cells. It holds great promise for the treatment of genetic disorders thatresultfrommutationsinspecificgenes.Thereareseveralapproachestogenetherapy,



ISBN:978-81-957858-1-0

includingthedeliveryoftherapeuticgenesusingviralvectorsornon-viralmethods.Viralvectors, suchasadeno-associatedviruses(AAV)orlentiviruses,aremodifiedtocarrythetherapeuticgene and deliver it to target cells. Non-viral methods, such as lipid nanoparticles or gene editing techniques like CRISPR-Cas9, offer alternative strategies for gene delivery.

Ingenetherapy,theintroducedgenescanproducefunctionalproteinsormodulategeneexpression to correct the underlying genetic defect. For example, in severe combined immunodeficiency (SCID),genetherapyhasbeensuccessfulinrestoringimmunefunctionbyintroducingafunctional copyofthedefectivegene.Althoughgenetherapyholdstremendouspotential,challengesremain in terms of ensuring long-term efficacy, targeting specific cell types, and addressing potential immune responses or off-target effects. Ongoing research and technological advancements continue to improve the safety and efficacy of gene therapy approaches.

**PharmacologicalIntervention:ModulatingBiochemical Pathways**

Pharmacological interventions play a vital role in modulating biochemical pathways involved in various diseases. Small molecule drugs or biologics can target specific enzymes, receptors, or signaling molecules to regulate or restore normal biochemical processes.

Pharmacological intervention aims to restore balance to dysregulated pathways, block abnormal signaling, or enhance therapeutic responses. For example, statins are commonly used drugs for dyslipidemia, which inhibit the enzyme HMG-CoA reductase involved in cholesterol synthesis. Byblockingthisenzyme,statinscanreducecholesterollevelsandlowertheriskofcardiovascular diseases. Other examples include inhibitors of specific kinases in targeted cancer therapies, immunosuppressants in autoimmune disorders, and antiretroviral drugs in HIV/AIDS treatment. These interventions are designed to specifically modulate biochemical pathways associated with the disease while minimizing adverse effects on normal physiological processes.

## Conclusion

Variousroutesandmechanismsareincludedinthefieldofthebiochemicalfoundationofdisease, whichisintricateandmultifaceted.Researcherscanlearnalotabout theonsetandprogressionof diseases by investigating the dysregulation of cellular metabolism, genetic anomalies, and disrupted signalling networks. The identification of illness aetiology, the finding of biomarkers, and the development of focused therapy approaches all depend on an understanding of the biochemical underpinnings of disease. Future research and innovation in the area of biochemical disease mechanisms have promising prospects thanks to developments in omics technologies, systems biology methods, and personalised medicine.



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# DiagnosticToolsinClinicalBiochemistry:FromLabtoPatient

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**Abstract**

The title focuses on diagnostic tools in clinical biochemistry and their application in improving patientcare.Thechapterbeginswithanintroductiontotheroleofclinicalbiochemistryindisease diagnosis,monitoring,andmanagement.Ithighlightsthediverserangeofdiagnostictoolsusedin clinical biochemistry and their importance in detecting diseases, assessing disease severity, and evaluating treatment efficacy. This explores laboratory testing as the foundation of clinical biochemistry diagnostics, covering basic techniques and instrumentation used in clinical laboratories. It discusses essential processes like sample collection, handling, and processing, alongwithanalyticaltechniquessuchasspectrophotometry,chromatography,immunoassays,and moleculardiagnostics.Biochemicalmarkersandpanelsplayacrucialroleinclinicalbiochemistry diagnostics,providinginsightsintonormalphysiologyanddiseaseprocesses.Thechapterfocuses oncommonbiochemicalmarkersrelatedtoorganfunction,metabolicdisorders,cardiacmarkers, andinflammationmarkers.Italsoemphasizestheutilityofbiochemicalpanelsinassessingoverall healthanddiagnosingspecificconditions.Lastly,thechapterdiscussesemergingtrendsandfuture directions in clinical biochemistry diagnostics. It explores novel diagnostic platforms like biosensors, microfluidics, and nanotechnology. Additionally, itexplores the potential ofartificial intelligenceandmachinelearninginenhancingdiagnosticaccuracyandefficiency.Understanding these emerging trends is vital for staying updated with the latest developments in clinical biochemistry diagnostics.

**Keywords:** Clinical biochemistry, Diagnostic tools, Laboratory testing, Biochemical markers, panels, Point-of-care testing, Molecular diagnostics

## IntroductiontoClinicalBiochemistryDiagnostics

Clinicalbiochemistryplaysacrucialroleinthediagnosis,monitoring,andmanagementofvarious diseases.Diagnostictoolsinclinicalbiochemistryencompassawiderangeoflaboratorytestsand techniquesthatprovidevaluableinformationaboutthebiochemicalstatusofpatients.Thesetools aid in the detection of diseases, assessment of disease severity, and evaluation of treatment efficacy.Thischapterexploresthediversediagnostictoolsusedinclinicalbiochemistryandtheir application in improving patient care.

## LaboratoryTesting:BasicTechniquesandInstrumentation

Laboratory testing forms the cornerstone of clinical biochemistry diagnostics. This section providesanoverviewofthebasictechniquesandinstrumentationusedinclinicallaboratories.It



ISBN:978-81-957858-1-0

covers essential laboratory processes such as sample collection, handling, and processing. Additionally, it explores common analytical techniques including spectrophotometry, chromatography, immunoassays, and molecular diagnostics. Understanding the principles and applications of these techniques is essential for accurate and reliable laboratory testing.

**CommonBiochemicalMarkersand Panels**

Biochemical markers are measurable substances present in the body that provide insights into normal physiology or disease processes. This section focuses on common biochemical markers usedinclinicalbiochemistrydiagnostics.Itdiscussesmarkersrelatedtoorganfunction(e.g.,liver enzymes, renal function markers), metabolic disorders (e.g., glucose, lipid profiles), cardiac markers (e.g., troponins, B-type natriuretic peptide), and inflammation markers (e.g., C-reactive protein, erythrocyte sedimentation rate). Additionally, it highlights the utility of biochemical panels in assessing overall health and diagnosing specific conditions.

**Point-of-CareTesting:RapidDiagnosticsatthe Bedside**

Point-of-care testing (POCT) refers to laboratory testing performed near the patient, providing real-time results without the need for sample transportation to a central laboratory. This section explores the advancements in POCT devices and their application in clinical biochemistry diagnostics. It covers portable analyzers for glucose monitoring, cardiac markers, coagulation tests, infectious disease diagnostics, and more. POCT enables prompt diagnosis, allows for immediate treatment decisions, and enhances patient management in various healthcare settings.

**MolecularDiagnostics:FromGeneticTestingtoPersonalizedMedicine**

Molecular diagnostics revolutionized clinical biochemistry by allowing the detection of genetic and molecular alterations associated with diseases. This section focuses on molecular diagnostic techniques, including polymerase chain reaction (PCR), DNA sequencing, and gene expression analysis. It explores the use of molecular diagnostics in genetic testing, infectious disease diagnosis,cancerprofiling,andpharmacogenomics.Moleculardiagnosticsnotonlyaidindisease diagnosis but also facilitate personalized medicine approaches by identifying specific genetic variants that influence treatment response.

**BioinformaticsandDataAnalysisin ClinicalBiochemistry**

Withtheadventofhigh-throughputtechnologies,clinicalbiochemistrygeneratesvastamountsof data that require advanced bioinformatics and data analysis tools. This section discusses the role of bioinformatics in clinical biochemistry diagnostics. It covers data management, analysis pipelines, interpretation of complex datasets, and integration of multiple data sources. Bioinformatics tools facilitate the identification of biomarkers, discovery of novel disease associations, and development of predictive models for disease diagnosis and prognosis.



ISBN:978-81-957858-1-0

**TranslatingLaboratoryFindingstoPatientCare**

Laboratory test results obtained from clinical biochemistry diagnostics must be effectively communicated to healthcare providers and integrated into patient care. This section emphasizes the importance of effective communication and collaboration between laboratory professionals andclinicians.Itexploresstrategiesforresult reporting,datainterpretation,andclinicaldecision-making based on laboratory findings. Furthermore, it highlights the role of clinical biochemistry in monitoring treatment responses and evaluating disease progression.

**EmergingTrendsandFuture Directions**

The field of clinical biochemistry diagnostics continues to evolve, driven by technological advancements and scientific discoveries. This section discusses emerging trends and future directions in the field. It explores novel diagnostic platforms, such as biosensors, microfluidics, andnanotechnology.Additionally,itdelvesintothepotentialofartificialintelligenceandmachine learninginenhancingdiagnosticaccuracyandefficiency.Understandingtheseemergingtrendsis crucial for staying abreast of the latest developments in clinical biochemistry diagnostics.

In conclusion, diagnostic tools in clinical biochemistry provide valuable insights into disease diagnosis, monitoring, and management. Laboratory testing, biochemical markers, point-of-care testing, molecular diagnostics, bioinformatics, and effective communication are all vital components of clinical biochemistry diagnostics. By leveraging these tools, healthcare professionalscanmakeinformeddecisions,personalizetreatmentapproaches,andimprovepatient outcomes. The ongoing advancements in the field hold promise for enhancing the accuracy, accessibility, and efficiency of diagnostic tools in clinical biochemistry, ultimately benefiting patient care.

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ISBN:978-81-957858-1-0

# MetabolicDisorders:UnderstandingBiochemicalImbalances

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**Abstract**

Metabolic disorders encompass a group of diseases characterized by disturbances in normal biochemical processes, resulting in imbalances in essential molecules, energy production, and cellularfunctions.Thischapterprovidesan in-depthexplorationof metabolicdisorders, focusing ontheunderlyingbiochemicalimbalancesandtheirimplications.Itbeginswithanintroductionto metabolic disorders and emphasizes the significance of comprehending their biochemical basis. The chapter then delves into key metabolic pathways, including carbohydrate metabolism, lipid metabolism, amino acid metabolism, and nucleotide metabolism, elucidating how imbalances in these pathways contribute to metabolic disorders. Specifically, it discusses the impact of carbohydrate metabolism disorders such as diabetes mellitus, glycogen storage diseases, and disorders of fructose and galactose metabolism. Furthermore, it explores lipid metabolism disorders like hyperlipidemia, hypercholesterolemia, and familial hyperlipidemias, emphasizing the link between lipid disorders and cardiovascular diseases. The chapter also covers amino acid andorganicacidmetabolismdisorders,includingphenylketonuria,maplesyrupurinedisease,and organic acidemias, elucidating the biochemical pathways affected and their consequences on neurological development and other organ systems. Additionally, it addresses mitochondrial disorders, highlighting the biochemical abnormalities underlying mitochondrial dysfunction and its diverse clinical manifestations. The chapter discusses the diagnostic approaches employed for inbornerrorsofmetabolism,suchasbiochemicaltesting,genetictesting,andmetabolicprofiling, underscoringtheimportanceofearlydetectionandthemultidisciplinarynatureofmanagingthese disorders.Itfurtherexploresvarioustreatmentstrategies,includingdietarymodifications,enzyme replacement therapy, and gene therapy. Finally, the chapter explores emerging research and therapeutic advances in the field of metabolic disorders, such as targeted therapies, gene editing technologies, and precision medicine approaches. Understanding the biochemical imbalances in metabolicdisordersis essentialforaccuratediagnosis,effectivemanagement, andthedevelopment of innovative therapeutic approaches.

**Keywords:** Metabolic disorders, Biochemical imbalances, Carbohydrate metabolism, Lipid metabolism, Amino acid metabolism

## IntroductiontoMetabolic Disorders

Metabolicdisordersareagroupofdiseasescharacterizedbythedisruptionofnormalbiochemical processes in the body. These disorders can affect various metabolic pathways, leading to imbalancesinessentialmolecules, energy production, andcellularfunctions. Thischapter provides



ISBN:978-81-957858-1-0

an overview of metabolic disorders and highlights the importance of understanding their underlying biochemical imbalances.

**MetabolicPathwaysandImbalances**

Metabolicpathwaysareintricatenetworksofchemicalreactionsthatoccurwithincellstoconvert nutrients into energy and essential molecules. This section delves into key metabolic pathways, including carbohydrate metabolism, lipid metabolism, amino acid metabolism, and nucleotide metabolism.Itexploreshowimbalancesinthesepathwayscanariseduetogeneticdefects,enzyme deficiencies, or environmental factors, leading to the development of metabolic disorders.

**CarbohydrateMetabolismDisorders**

Carbohydrate metabolism disorders involve dysregulation of glucose homeostasis and impaired utilizationorstorageofcarbohydrates.Thissectionfocusesondisorderssuchasdiabetesmellitus, glycogen storage diseases, and disorders of fructose and galactose metabolism. It discusses the underlying biochemical abnormalities, the impact on energy production and utilization, and the clinical manifestations associated with these disorders.

**LipidMetabolism Disorders**

Lipid metabolism disorders encompass a range of conditions characterized by abnormal lipid synthesis, transport, or breakdown. This section explores disorders such as hyperlipidemia, hypercholesterolemia, and familial hyperlipidemias. It discusses the biochemical basis of lipid imbalances, including abnormalities in lipoprotein metabolism, cholesterol synthesis, and triglyceride metabolism. The section also highlights the link between lipid disorders and cardiovascular diseases.

**AminoAcid andOrganicAcidMetabolismDisorders**

Aminoacidandorganicacidmetabolismdisordersresultfromdefectsintheprocessingofamino acids and organic acids in the body. This section focuses on conditions such as phenylketonuria, maplesyrupurinedisease,andorganicacidemias.Itdiscussesthebiochemicalpathwaysaffected by these disorders, the accumulation of toxic metabolites, and the impact on neurological development and other organ systems.

**MitochondrialDisorders**

Mitochondrialdisordersareagroupofgeneticdisordersthatprimarilyaffecttheenergy-producing structures within cells, known as mitochondria. This section explores the biochemical basis of mitochondrial dysfunction, including defects in oxidative phosphorylation, electron transport chain abnormalities, and impaired mitochondrial DNA replication. It discusses the wide range of clinicalmanifestationsassociatedwithmitochondrialdisordersandthechallengesindiagnosisand treatment.



ISBN:978-81-957858-1-0

## InbornErrorsofMetabolism:DiagnosisandTreatment

Diagnosing metabolic disorders requires a comprehensive understanding of the underlying biochemical imbalances. This section discusses the diagnostic approaches used, including biochemicaltesting,genetic testing,andmetabolicprofiling.Ithighlightstheimportanceofearly detection and emphasizes the multidisciplinary nature of managing these disorders, involving geneticists, metabolic specialists, and dieticians. The section also explores treatment strategies, including dietary modifications, enzyme replacement therapy, and gene therapy.

## EmergingResearchandTherapeuticAdvances

The field of metabolic disorders is continuously evolving, with ongoing research and therapeutic advancements.Thissectionexploresemergingareasofresearch,includingtargetedtherapies,gene editing technologies, and the development of novel small molecules. It discusses the potential of precision medicine approaches in the management of metabolic disorders and highlights the importance of collaborative efforts between researchers, clinicians, and industry stakeholders.

Inconclusion,metabolicdisordersarecomplexconditionsthatarisefrombiochemicalimbalances invariousmetabolicpathways.Understandingtheunderlyingbiochemicalabnormalitiesiscrucial for accurate diagnosis and effective management of these disorders. This chapter provides a comprehensive overview of metabolic disorders, exploring their impact on different metabolic pathways and highlighting the importance of ongoing research and therapeutic.

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ISBN:978-81-957858-1-0

# NutritionalBiochemistry:EssentialElementsforHealth

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**Abstract**

This chapter provides an overview of nutritional biochemistry and highlights the importance of essentialelementsinmaintainingoptimalhealth.Nutritionalbiochemistryexploreshowessential elementsandnutrientsinteractwithbiologicalsystems,influencinghumanhealthandwell-being. The chapter discusses the role of essential elements as building blocks for macromolecules, cofactors for enzymes, and regulators of physiological processes. It further delves into the biochemistry of macronutrients, including carbohydrates, proteins, and lipids, exploring their digestion, absorption, and utilization in the body. The biochemistry of micronutrients, such as vitaminsandminerals,isalsoexplored,emphasizingtheirrolesascofactorsandantioxidants.The chapter discusses the significance of antioxidants in combating oxidative stress, a key factor in various diseases and the aging process. Nutritional genomics, which investigates the interplay betweendiet,geneexpression,andhealthoutcomes,isexaminedinrelationtoessentialelements and personalized nutrition. The impact of nutritional biochemistry on disease prevention and management,particularlyincommonchronicdiseases,isexplored,alongwithitsroleintheaging process and potential interventions for healthy aging. The chapter concludes by highlighting emerging research areas and the future directions of nutritional biochemistry, including the gut microbiome,epigenetics,andpersonalizednutrition,andtheirpotentialinprecisionmedicineand dietary interventions.

**Keywords:** Nutritional biochemistry, Essential elements, Macronutrients, Micronutrients, Antioxidants.

## IntroductiontoNutritional Biochemistry

Nutritional biochemistry is the study of how essential elements and nutrients interact with biologicalsystems,impactinghumanhealthandwell-being.Thischapterprovidesanoverviewof nutritionalbiochemistry,emphasizingtheimportanceofessentialelementsinmaintainingoptimal health.Itexplorestheroleofessentialelementsasbuildingblocksformacromolecules,cofactors for enzymes, and regulators of physiological processes.

## Macronutrients:Carbohydrates,Proteins,and Lipids

Macronutrients, including carbohydrates, proteins, and lipids, are vital for energy production, growth, and tissue maintenance. This section examines the biochemistry ofthesemacronutrients, discussingtheirdigestion,absorption,andutilizationbythebody.Itexploresthemetabolic



ISBN:978-81-957858-1-0

pathways involved in carbohydrate metabolism, protein synthesis, and lipid metabolism, highlighting the role of essential elements in these processes.

**Micronutrients:Vitaminsand Minerals**

Micronutrients,suchasvitaminsandminerals,areessentialfornumerousphysiologicalfunctions, including enzymatic reactions, immune function, and cell signaling. This section delves into the biochemistry of vitamins and minerals, discussing their roles as cofactors and antioxidants. It explorestheimportanceofvitamins,suchasvitaminC,vitaminD,andtheBvitamins,aswellas minerals like iron, calcium, and zinc, in maintaining optimal health.

**AntioxidantsandOxidativeStress**

Oxidative stress, resulting from an imbalance between the production of reactive oxygen species (ROS) and antioxidant defense mechanisms, plays a significant role in various diseases and the aging process. This section explores the biochemistry of antioxidants, including enzymes (e.g., superoxide dismutase, catalase) and non-enzymatic antioxidants (e.g., vitamins C and E), in neutralizingROS.Itdiscussestheimpactofoxidativestressoncellularhealthandtheimportance of a balanced antioxidant defense system.

**NutritionalGenomics:InteractionsbetweenDietandGeneExpression**

Nutritionalgenomicsinvestigatestheintricateinterplaybetweendiet,geneexpression,andhealth outcomes. This section explores the field of nutrigenomics, which examines how nutrients and dietarycomponentscanmodulategeneexpressionandinfluencemetabolism.Itdiscussestherole of essential elements in gene regulation and the potential for personalized nutrition based on genetic variations.

**NutritionalBiochemistryandDiseasePrevention**

Nutritional biochemistryplays acrucial rolein diseaseprevention and management. This section explores the impact of nutrition on common chronic diseases, including cardiovascular disease, obesity,diabetes,andcancer.Itdiscussesthebiochemicalmechanismsunderlyingtheassociation between diet and disease risk, highlighting the role of essential elements and nutrients in maintaining optimal health and preventing the onset of these conditions.

**NutritionalBiochemistryandAging**

Aging is a complex process influenced by genetic, environmental, and lifestyle factors. This sectionexaminestheroleofnutritionalbiochemistryintheagingprocess,focusingontheimpact of essential elements, antioxidants, and caloric restriction on lifespan and age-related diseases. It discusses the biochemical pathways involved in aging and the potential for nutritional interventions to promote healthy aging.



ISBN:978-81-957858-1-0

**EmergingResearch andFuture Directions**

The field of nutritional biochemistry is continuously evolving, with ongoing research and advancements. This section explores emerging areas of research, such as the gut microbiome, epigenetics, and personalized nutrition. It discusses the potential for nutritional biochemistry to contribute to precision medicine approaches and the development of novel dietary interventions for disease prevention and management.

In conclusion, nutritional biochemistry is a multidisciplinary field that examines the interactions between essential elements,nutrients,and biologicalsystems.Understandingthebiochemistryof nutrition is crucial for maintaining optimal health, preventing disease, and promoting healthy aging. This chapter provides a comprehensive overview of the role of essential elements in nutritionalbiochemistry,exploringmacronutrients,micronutrients,antioxidants,andtheirimpact on disease prevention and aging. The ongoing research in this field holds promise for further unraveling the intricate relationship between nutrition and human health.

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ISBN:978-81-957858-1-0

# MolecularGeneticsandBiochemistry:Bridgingthe Gap

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## Abstract

Molecular genetics and biochemistry are two closely intertwined fields that provide a comprehensive understanding of the genetic and biochemical processes underlying biological systems. This chapter explores the interplay between molecular genetics and biochemistry, highlighting their collaborative nature in advancing our knowledge of cellular functions, disease mechanisms, and therapeutic interventions. It delves into the fundamental principles and techniques employed in molecular genetics and biochemistry and showcases their synergistic application in various research areas. The chapter also discusses the emerging trends and future prospects in bridging the gap between molecular genetics and biochemistry, emphasizing the potential for transformative discoveries and advancements.

**Keywords:** Molecular genetics, Biochemistry, DNA, RNA, Proteins, Gene expression, Genetic variations, Molecular mechanisms, Cellular functions.

## Introduction

Moleculargeneticsandbiochemistryaretwodistinctyetinterconnectedscientificdisciplinesthat contribute to our understanding of the fundamental principles of life. Molecular genetics focuses onthestudyofgenes,geneticvariation,andtheinheritanceoftraits,whilebiochemistryexplores the chemical processes and molecules that are vital for cellular functions. Together, they form a powerful alliance in unraveling the complexities of biological systems. By bridging the gap between molecular genetics and biochemistry, researchers can gain a deeper insight into the molecular mechanisms that govern genetic information flow, gene expression, and the regulation ofcellularprocesses.ThisintegrationenablesscientiststoexploretherelationshipsbetweenDNA, RNA, proteins, enzymes, and metabolic pathways, shedding light on the intricate molecular interactionsthatdrivebiologicalfunctions. Oneofthekeyareaswherethecollaborationbetween molecular genetics and biochemistry has had a significant impact is in disease research. Understanding the genetic basis of diseases and their biochemical consequences is crucial for developing targeted therapies and personalized medicine approaches. By combining molecular genetics techniques, such as genome sequencing and gene expression analysis, with biochemical assays and metabolomic profiling, researchers can identify disease-associated genetic variations, study their effects on protein function, and uncover novel therapeutic targets. Moreover, the integrationofmoleculargeneticsandbiochemistryhasrevolutionizedthefieldofdrugdiscovery. Biochemical studies provide valuable insights into the molecular targets of potential drugs and theirinteractionswithcellularcomponents.Geneticapproaches,ontheotherhand,allowforthe



ISBN:978-81-957858-1-0

identification of drug targets and the assessment of drug efficacy based on genetic variations in patient populations. This synergy between the two disciplines has paved the way for the development of more effective and personalized therapeutic interventions. The future prospects for bridging the gap between molecular genetics and biochemistry are promising. Advancements inhigh-throughputtechnologies,suchasnext-generationsequencingandproteomics,allowforthe simultaneous analysis of genetic, transcriptomic, and proteomic data, enabling a comprehensive understandingofbiologicalsystems.Integrativeapproaches,suchassystemsbiologyandnetwork analysis, are emerging to integrate complex datasets from molecular genetics and biochemistry, providing a holistic view of biological processes.

**Conclusion**

In conclusion, the collaboration between molecular genetics and biochemistry is essential for advancing our understanding of life processes. By combining their respective strengths, researcherscandeciphertheintricatemolecularmechanismsthatgoverngeneticinformationflow and cellular functions. This integration has profound implications for disease research, drug discovery, and personalized medicine. As we continue to bridge the gap between molecular genetics and biochemistry, we open doors to new discoveries and innovations that will shape the future of biological science.

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ISBN:978-81-957858-1-0

# BiochemicalMarkersinDisease:BiomarkersforDiagnosisandPrognosis

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**Abstract**

Biochemicalmarkers,alsoknownasbiomarkers,aremeasurablesubstancesormolecularchanges inthebodythatindicatethepresenceorprogressionofadisease.Thischapterexplorestheroleof biochemical markers in disease diagnosis and prognosis. It provides an overview of the different types of biomarkers, including proteins, enzymes, metabolites, genetic markers, and imaging biomarkers. The chapter highlights their significance in various diseases, such as cardiovascular disorders, cancer, neurodegenerative diseases, and infectious diseases. It discusses the principles and techniques involved in biomarkerdiscovery,validation, and clinical application. Thechapter alsoexploresthepotentialofemergingtechnologies,suchasomicsapproachesandliquidbiopsy, in expanding the repertoire of biomarkers for improved disease management and personalized medicine.

**Keywords:**Biochemical markers,Biomarkers,Diseasediagnosis,Diseaseprognosis, Proteins.

## Introduction

Biochemicalmarkers,alsoknownasbiomarkers,aremeasurablesubstancesormolecularchanges in the body that provide information about the presence or progression of a disease. They play a crucial role in disease management by aiding in the diagnosis, prognosis, and monitoring of variousmedicalconditions.Biochemicalmarkersarewidelyusedinclinicalpracticeandresearch settings due to their ability to provide valuable insights into the underlying biological processes associated with diseases.

## DefinitionandSignificanceofBiochemicalMarkers

Biochemicalmarkersarebiologicalsubstancesorcharacteristicsthatcanbeobjectivelymeasured and evaluated to indicate normal or pathological processes occurring in the body. These markers canincludeproteins,enzymes,metabolites,geneticvariations,orevenimagingfeatures.Theyare oftenfoundinbodyfluidssuchasblood,urine,cerebrospinalfluid,ortissues.Thesignificanceof biochemicalmarkersliesintheirabilitytoprovidevaluablediagnosticandprognosticinformation in a non-invasive or minimally invasive manner. They allow healthcare professionals to detect diseases at an early stage, monitor disease progression, assess treatment response, and predict outcomes.Byprovidingquantitativeandobjectivemeasurements,biochemicalmarkerscontribute to evidence-based decision-making and personalized patient care.

## TypesofBiochemicalMarkers



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Biochemical markers encompass a wide range of molecules and characteristics that can be categorizedintodifferenttypesbasedontheirnatureandrole.Somecommontypesofbiochemical markers include:

**Proteins:**Proteinsareoneofthemostextensivelystudiedbiomarkers.Theycanbemeasured in various forms, such as total protein levels, specific protein isoforms, or protein fragments. Protein biomarkers play crucial roles in various diseases, including cancer, cardiovascular disorders, and autoimmune diseases.

**Enzymes:** Enzymes are biological catalysts involved in numerous biochemical reactions. Changesinenzymelevelsoractivitycanindicateorgandamage,suchasliverorheartdysfunction. Enzymebiomarkers,suchas creatinekinaseandalanineaminotransferase, arecommonlyusedin diagnosing and monitoring certain diseases.

**Metabolites:** Metabolites are small molecules produced during metabolic processes in the body.Theyincludesubstanceslikeglucose,cholesterol,andvariousorganicacids.Alterationsin metabolite levels can provide insights into metabolic disorders, such as diabetes or inborn errors of metabolism.

**Genetic Markers**: Genetic markers refer to variations or mutations in the DNA sequence thatareassociatedwithdiseasesusceptibility,diagnosis,ortreatmentresponse.Thesemarkerscan be single nucleotide polymorphisms (SNPs), chromosomal rearrangements, or mutations in specific genes. Genetic markers play a crucial role in genetic disorders, cancer genetics, and pharmacogenomics.

**Imaging Biomarkers**: Imaging biomarkers involvethe useofmedical imaging techniques, such as X-rays, magnetic resonance imaging (MRI), or positron emission tomography (PET), to visualize and evaluate disease-related changes in tissues or organs. These biomarkers provide structural or functional information and are used in cardiovascular imaging, cancer imaging, and neuroimaging.

**RoleofBiochemicalMarkersin DiseaseManagement**

Biochemical markers play a vital role in disease management across various aspects, including diagnosis, prognosis, treatment monitoring, and therapeutic decision-making.

**Diagnosis:** Biochemical markers serve as valuable tools for disease diagnosis by providing objectiveevidenceofthepresenceorabsenceofaparticularcondition.Theycanhelpdifferentiate



ISBN:978-81-957858-1-0

betweendifferentdiseaseswithsimilarclinicalpresentationsandaidintheidentificationofdiseas e subtypes. For example, cardiac troponins are biomarkers used in the diagnosis of myocardial infarction, and prostate-specific antigen (PSA) is used in the diagnosis of prostate cancer.



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**Prognosis**: Biomarkers can provide valuable information about disease prognosis by assessing the likelihood of disease progression, recurrence, or response to treatment. They help clinicians estimate the risk of adverse outcomes and guide treatment decisions. For instance, certain genetic markers in breast cancer, such as HER2/neu and estrogen receptor status, provide important prognostic information for determining the course of treatment.

**TreatmentMonitoring:**Biochemicalmarkersenablethemonitoringofdiseaseprogression and treatment response. Changes in marker levels over time can indicate the effectiveness of therapeutic interventions or the need for treatment modifications. This is exemplified in diabetes management, where regular monitoring of blood glucose levels provides feedback on the effectiveness of glucose-lowering medications and lifestyle modifications.

**Therapeutic Decision-Making:** Biomarkers play a crucial role in guiding therapeutic decisions, especially in personalized medicine approaches. By identifying specific molecular targets orgeneticvariations, biomarkers help determinethe most appropriate treatment strategies andaidinpredictingresponsetospecificdrugs.Thisallowsfortheselectionoftargetedtherapies tailored to individual patients, resulting in improved treatment outcomes.

## ProteinBiomarkers

### OverviewofProteinBiomarkers

Proteins are essential molecules involved in various biological processes and serve as key biomarkers for numerous diseases. This section provides an overview of protein biomarkers, highlighting their significance in disease diagnosis, prognosis, and treatment monitoring. It discusses the characteristics of protein biomarkers, such as specificity, sensitivity, and stability, that make them valuable tools in clinical practice and research.

### ProteinBiomarkersinCardiovascular Disorders

Cardiovascular disorders, including heart disease and stroke, are major causes of morbidity and mortalityworldwide.Proteinbiomarkersplaya crucialroleinthediagnosis,riskassessment,and management of these conditions. This section explores prominent protein biomarkers used in cardiovascular disorders, such as troponins, B-type natriuretic peptide (BNP), and C-reactive protein (CRP). It discusses their association with cardiac injury, heart failure, and inflammation, highlightingtheirclinicalutilityinriskstratification,earlydetection,andmonitoringoftreatment response.

### ProteinBiomarkersinCancer

Cancer is a complex disease characterized by uncontrolled cell growth and proliferation. Protein



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biomarkershaverevolutionizedcancerdiagnosis,prognosis,andtreatmentdecision-making.This sectionfocusesonproteinbiomarkersusedinvarioustypesofcancer,includingbreast,prostate,



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lung, and ovarian cancer. Examples of cancer biomarkers discussed include carcinoembryonic antigen (CEA), prostate-specific antigen (PSA), and human epidermal growth factor receptor 2 (HER2). It explores their role in cancer screening, early detection, prediction of treatment response, and monitoring of disease recurrence.

### ProteinBiomarkersinNeurodegenerativeDiseases

Neurodegenerativediseases,suchasAlzheimer'sdiseaseandParkinson'sdisease,posesignificant challenges in diagnosis and treatment. Protein biomarkers have emerged as valuable tools for understanding disease mechanisms and improving diagnostic accuracy. This section examines protein biomarkers associated with neurodegenerative diseases, including amyloid-beta and tau proteins in Alzheimer's disease and alpha-synuclein in Parkinson's disease. It discusses their role in disease progression, differential diagnosis, and the development of targeted therapies.

### ProteinBiomarkersinInfectious Diseases

Infectiousdiseases,causedbybacteria,viruses,parasites,orfungi,presentaglobalhealthburden. Protein biomarkers play a critical role in the diagnosis, monitoring, and treatment of infectious diseases. This section explores protein biomarkers used in infectious diseases, such as C-reactive protein (CRP) in bacterial infections, viral antigen detection, and antibody-based assays for viral and bacterial pathogens. It discusses the significance of protein biomarkers in early detection, assessment of disease severity, and monitoring of treatment efficacy.

## MetaboliteBiomarkers

### Overviewof Metabolite Biomarkers

Metabolites are small molecules that are involved in various biochemical pathways and cellular processes within the body. They serve as valuable biomarkers for the detection, diagnosis, and monitoringofdiseases.Thissectionprovidesanoverviewofmetabolitebiomarkers,highlighting their importance in understanding disease mechanisms and evaluating metabolic dysregulations. It discusses the characteristics of metabolite biomarkers, such as stability, specificity, and detectability, that make them promising tools for disease biomarker discovery.

### MetaboliteBiomarkersinMetabolicDisorders

Metabolic disorders encompass a wide range of conditions characterized by abnormalities in metabolic pathways and homeostasis. Metabolite biomarkers play a crucial role in the identification and management of metabolic disorders, including diabetes, obesity, and inborn errors of metabolism. This section explores metabolite biomarkers associated with metabolic disorders,suchasglucose,insulin,andlipidmetabolites.Itdiscussestheircorrelationwithdisease progression,metabolicdysregulation,andthepotentialforpersonalizedtreatmentstrategiesbased on metabolomic profiling.



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### MetaboliteBiomarkersinCancer Metabolism

Cancer cells exhibit distinct metabolic alterations compared to normal cells, and metabolite biomarkers provide valuable insights into these metabolic changes. This section focuses on metabolite biomarkers used in cancer metabolism research, such as lactate, pyruvate, and amino acid metabolites. It discusses their role in cancer progression, tumor metabolism, and the development of targeted therapies. The section also explores the potential of metabolomics in cancer diagnosis, prediction of treatment response, and monitoring of disease recurrence.

### MetaboliteBiomarkersinNeurological Disorders

Neurologicaldisorders,includingAlzheimer'sdisease,Parkinson'sdisease,andmultiplesclerosis, involvecomplex molecularand metabolicchanges within the central nervous system. Metabolite biomarkers offer valuable information for understanding disease mechanisms, identifying diagnostic markers, and monitoring disease progression. This section examines metabolite biomarkers associated with neurological disorders, such as neurotransmitters, organic acids, and lipid metabolites. It discusses their relationship with disease pathology, neuroinflammation, and the potential for targeted therapeutic interventions based on metabolomic profiling.

## ClinicalApplication of Biomarkers

### DiagnosticBiomarkers

Diagnosticbiomarkersplayacrucialroleintheearlydetectionandaccuratediagnosisofdiseases. Theyprovidemeasurableindicatorsofdiseasepresenceorabsence,aidingintheidentificationof specific conditions. This section explores the use of diagnostic biomarkers in clinical practice, discussingtheirroleindifferentdiseasecontexts.Ithighlightsexamplesofdiagnosticbiomarkers, such as specific proteins, genetic markers, and metabolites, and discusses their sensitivity, specificity, and reliability in disease diagnosis. The section also emphasizes the importance of validated diagnostic biomarkers for improving patient outcomes through early intervention and targeted therapies.

### PrognosticBiomarkers

Prognosticbiomarkersareusedtoassessthelikelyoutcomeorcourseofadiseaseinanindividual patient.Theyprovidevaluableinformationaboutdiseaseprogression,severity,andthelikelihood of response to treatment. This section delves into the use of prognostic biomarkers in clinical settings, discussing their role in predicting disease outcomes and guiding treatment decisions. It explores examples of prognostic biomarkers, such as gene expression signatures, genetic mutations,andcirculatingtumormarkers,andtheircorrelationwithdiseaseprognosis.Thesection highlightstheimportanceofincorporatingprognosticbiomarkersintoclinicalpracticetooptimize patient management and improve long-term outcomes.



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### PredictiveBiomarkers

Predictive biomarkers are employed to identify patients who are likely to respond to a specific treatment or therapy. They aid in personalizing treatment decisions, maximizing therapeutic efficacy, and minimizing adverse effects. This section examines the use of predictive biomarkers in clinical applications,discussingtheirrolein predicting treatment response andguidingtreatment selection.Itexploresexamplesofpredictivebiomarkers,suchasgeneticmutations,expressionof specificproteins,andtumormolecularprofiles,andtheirassociationwithtreatmentoutcomes.The section emphasizes the significance of predictive biomarkers in precision medicine, facilitating tailored therapies for individual patients.

### Monitoring Biomarkers

Monitoring biomarkers are used to track disease progression, treatment response, and disease recurrence. They provide valuable insights into the effectiveness of therapeutic interventions and help clinicians make informed decisions regarding treatment adjustments. This section explores the application of monitoring biomarkers in clinical practice, discussing their role in disease monitoringandfollow-up.Itexaminesexamplesofmonitoringbiomarkers,suchasbloodmarkers, imaging agents, and molecular assays, and their correlation with disease status and treatment response. The section highlights the importance of incorporating monitoring biomarkers into clinical protocols to optimize patient care and ensure timely intervention.

### TherapeuticBiomarkers

Therapeutic biomarkers are utilized to guide the selection and monitoring of therapeutic interventions. They provide information about the likelihood of response to specific treatments, potential adverse effects, and optimal dosage adjustments. This section examines the use of therapeutic biomarkers in clinical practice, discussing their role in individualizing treatment regimens and optimizing patient outcomes. It explores examples of therapeutic biomarkers, such asgeneticvariants,pharmacokineticmarkers,andimmuneresponsemarkers,andtheirassociation with treatment efficacy. The section emphasizes the importance of integrating therapeutic biomarkersintoclinicaldecision-makingprocessestoimprovetreatmentoutcomes andminimize treatment-related risks.

## Conclusion

In conclusion, biochemical markers, or biomarkers, play a critical role in disease diagnosis, prognosis, and management. They provide valuable insights into the presence, progression, and response to treatment of various diseases. This chapter provides a comprehensive overview of differenttypesofbiochemicalmarkersandtheirapplicationsinarangeofdiseases.Itemphasizes the importance of biomarker discovery, validation, and clinical implementation for improved patientcare.Thechapteralsohighlightsemergingtechnologiesandfutureperspectivesthathold



ISBN:978-81-957858-1-0

promiseforadvancingthefieldofbiomarkerresearchandenhancingpersonalizedmedicine approaches.

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ISBN:978-81-957858-1-0

# TherapeuticApproachesinClinicalBiochemistry:FromBenchtoBedside

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## Abstract

Clinicalbiochemistryplaysacrucialroleintherapeuticsbyprovidinginsightsintothebiochemical mechanismsofdiseasesandtheirresponsetotreatment.Thischapterprovidesanoverviewofthe roleofclinicalbiochemistryintherapeuticsandhighlightstheimportanceoftranslationalresearch in advancing patient care. It discusses the role of clinical biochemistry in drug discovery and development,includingtargetidentificationandvalidation,drugscreeningandleadoptimization, preclinicalstudiesandanimalmodels,andclinicaltrialsandregulatoryapproval.Thechapteralso emphasizesthesignificanceoftherapeuticdrugmonitoringinoptimizingtreatmentoutcomesand explores the field of immunotherapy, including monoclonal antibodies, immune checkpoint inhibitors,and CAR-T cell therapy. Finally, it discussesfuture perspectives and emerging trends, such as the integration of clinical biochemistry in therapeutic strategies, advances in precision medicine and molecular therapeutics, and the importance of collaborative efforts and multidisciplinary approaches.

**Keywords:** Clinical biochemistry, therapeutics, translational research, drug discovery, target identification, drug screening, lead optimization, preclinical studies.

## Introduction

Clinical biochemistry plays a crucial role in the development and application of therapeutics, contributing to the understanding, diagnosis, treatment, and monitoring of various diseases. It encompassesthestudyofbiochemicalprocesses,biomarkers,andtherapeutictargets,bridgingthe gap between basic research conducted at the bench and its translation into clinical practice at the bedside.Thischapterprovidesanoverviewoftheroleofclinicalbiochemistryintherapeuticsand emphasizes the importance of translational research in advancing patient care.

## TheRoleofClinicalBiochemistryin Therapeutics

Clinicalbiochemistryplaysafundamentalroleintherapeuticinterventionsbyprovidingvaluable insights into the biochemical mechanisms underlying diseases and their response to treatment. It involves the measurement and analysis of biomarkers, metabolites, enzymes, and other biochemical parameters in patient samples, aiding in the diagnosis, prognosis, and monitoring of diseaseprogression.Intherapeutics,clinicalbiochemistryprovidesessentialinformationfordrug discovery and development. It aids in the identification and validation of therapeutic targets, guiding the design and optimization of drug candidates. By understanding the biochemical pathwaysinvolvedindiseases,researcherscandeveloptargetedtherapiesthatspecifically



ISBN:978-81-957858-1-0

modulate the underlying molecular processes. Clinical biochemistry also plays a critical role in personalized medicine and pharmacogenomics. Genetic variations among individuals can influence drug metabolism, efficacy, and adverse reactions. By analyzing genetic markers and biomarkers,clinicianscantailortreatmentstrategiestoindividualpatients,optimizingtherapeutic outcomes while minimizing side effects.

**TranslationalResearch:BridgingtheGap from Benchto Bedside**

Translational research serves as the bridge between basic scientific discoveries made at the laboratory bench and their practical application at the patient's bedside. It aims to transform scientific knowledge into clinical practices and interventions that improve patient care.

Inthecontextofclinicalbiochemistry,translationalresearchfocusesontranslatingfindingsfrom preclinical studies, such as in vitro experiments and animal models, into meaningful clinical applications. This involves the validation of biomarkers, evaluation of diagnostic assays, and the development of therapeutic interventions.

Translational research also facilitates the integration of new technologies and innovations into clinical practice. Advances in genomics, proteomics, metabolomics, and other fields of clinical biochemistry are rapidly expanding our understanding of diseases and their underlying mechanisms. Translating thesediscoveries into practical applications allows forthe development of novel diagnostic tools, targeted therapies, and personalized treatment strategies.

Collaboration and communication between researchers, clinicians, and industry stakeholders are crucialforsuccessfultranslationalresearchinclinicalbiochemistry.Byfosteringmultidisciplinary collaborations and creating synergies between academia, healthcare institutions, and pharmaceutical companies, the gap between bench and bedside can be effectively bridged, resulting in improved patient outcomes and the advancement of therapeutic approaches.

**DrugDiscoveryandDevelopment**

**TargetIdentificationand Validation**

Target identification and validation are critical steps in the drug discovery and development process.Itinvolvesidentifyingspecificmolecules,proteins,orgenetictargetsthatplayakeyrole in the disease process and can be modulated by therapeutic interventions. Clinical biochemistry plays a significant role in this stage by providing insights into the biochemical pathways and molecular mechanisms underlying diseases.

Through the use of various techniques, including genomics, proteomics, and metabolomics, researcherscanidentifypotentialtherapeutictargetsthatareaberrantlyexpressedordysregulated indiseasedtissues.Biochemicalassaysandhigh-throughputscreeningmethodscanfurther



ISBN:978-81-957858-1-0

validate these targets by assessing their activity and specificity. This information guides the selection of target molecules for drug development.

**DrugScreeningandLeadOptimization**

Oncepotentialtargetshavebeenidentifiedandvalidated,thenextstepisdrugscreeningandlead optimization. This stage involves the screening of large compound libraries or the design of specific molecules to identify compounds that interact with the target and exhibit therapeutic potential.Clinicalbiochemistrytechniques,suchasenzymaticassays,receptorbindingassays,and cell-based assays, are essential in assessing the efficacy, potency, and selectivity of drug candidates.

Biochemicalmarkersandbiomarkersplayacrucialroleindrugscreeningbyprovidingmeasurable indicators of drug activity and efficacy. They can be used to evaluate the drug's impact on the targetedbiochemicalpathwaysandtomonitoritseffectsondiseaseprogression.Biomarkersalso aid in the selection of lead compounds for further optimization.

Lead optimization involves modifying and optimizing the chemical structure of lead compounds to improve their efficacy, safety, and pharmacokinetic properties. Biochemical and pharmacokinetic studies help in assessing the compound's absorption, distribution, metabolism, and excretion (ADME) profiles. This information guides the refinement of lead compounds to enhance their therapeutic potential and minimize adverse effects.

**PreclinicalStudiesand AnimalModels**

Preclinical studies, including in vitro experiments and animal models, are conducted to evaluate thesafety,efficacy,andpharmacokineticsofdrugcandidatesbeforetheyprogresstoclinicaltrials. Clinical biochemistry techniques are employed to assess the compound's interaction with biological systems, its metabolic fate, and its impact on biochemical pathways.

In preclinical studies, biochemical markers and biomarkers are used to monitor the compound's efficacy, toxicity, and side effects. These markers provide valuable information on drug-target interactions, changes in biochemical parameters, and potential off-target effects. They contribute totheunderstandingofthecompound'smechanismofactionandguidetheselectionofappropriate doses for clinical trials.

**ClinicalTrialsandRegulatoryApproval**

Clinical trials are conducted to evaluate the safety and efficacy of drug candidates in human subjects. Clinical biochemistry plays a crucial role in these trials by monitoring biochemical markers and biomarkers to assess the drug's effects on disease progression, its impact on biochemicalpathways,anditssafetyprofile. Biochemicalmarkersareused toevaluatethedrug's efficacybymeasuringchangesinspecificbiochemicalparametersassociatedwiththetargeted



ISBN:978-81-957858-1-0

disease.Theycanindicatedisease remission,reductionintumorsize,normalizationofmetabolic markers,orimprovementinorganfunction.Biomarkersalsohelpidentifypotentialadverseeffects and monitor the drug's impact on normal physiological processes.

Thedatageneratedfromclinicaltrials,includingbiochemicalmarkers,pharmacokineticdata,and safety profiles, are submitted to regulatory authorities for approval. These authorities assess the clinical data to ensure the drug's safety, efficacy, and quality before it can be marketed and made available to patients.

## TherapeuticDrug Monitoring

### ImportanceofTherapeuticDrugMonitoring

Therapeutic drug monitoring (TDM) is a crucial aspect of clinical biochemistry that involves measuring drug levels in a patient's blood or other body fluids to ensure optimal therapeutic outcomes.Itplaysavitalroleinpersonalizedmedicine,helpinghealthcareprofessionalsdetermine the appropriate drug dosage, evaluate drug efficacy, minimize toxicity, and adjust treatment regimens as needed.

TheimportanceofTDMliesinthefactthatindividualsmayvaryintheirabilitytometabolizeand eliminate drugs due to factors such as genetics, age, underlying medical conditions, and drug interactions.Bymonitoringdruglevels,clinicianscanindividualizetreatmentplans,optimizedrug dosages, and prevent adverse effects or suboptimal responses.

### DrugLevelsandTherapeuticRange

Therapeuticdruglevelsrefertotheconcentrationofaduginthebodythatisassociatedwiththe desiredtherapeuticeffect.Thetherapeuticrangeis therangeofdrugconcentrationswithinwhich optimal therapeutic outcomes areexpected while minimizing the risk oftoxicity. The therapeutic rangeisdeterminedbasedonfactorssuchasthedrug'spharmacokinetics,pharmacodynamics,and clinical evidence.

Monitoring drug levels helps ensure that concentrations remain within the therapeutic range, allowing healthcare providers to make informed decisions about dose adjustments. If drug levels are too low, the desired therapeutic effect may not be achieved, leading to treatment failure. On theotherhand, excessively high druglevels mayincreasethe risk of toxicity and adverseeffects. Regular monitoring enables clinicians to maintain drug levels within the optimal range for each patient.

### RoleofClinicalBiochemistryin MonitoringDrugTherapy

Clinicalbiochemistryplaysapivotalroleinmonitoringdrugtherapythroughthemeasurementof drug levels in biological samples. Various analytical techniques, such as immunoassays, chromatography,andmassspectrometry,areemployedtoquantifydrugconcentrationsaccurately.



ISBN:978-81-957858-1-0

Clinical biochemistry laboratories provide valuable services in measuring drug levels and reportingtheresultsinatimelymanner.Thesemeasurementshelphealthcareprofessionalsmake informed decisions regarding drug dosing adjustments, treatment efficacy, and patient safety. Biochemical markers and biomarkers are also utilized to assess the response to therapy, evaluate drug effects on biochemical pathways, and detect any potential adverse effects.

In addition to drug level monitoring, clinical biochemistry can assess other relevant parameters, such as liver and kidney function, which can impact drug metabolism and clearance. By monitoringtheseparametersalongsidedruglevels,clinicianscanensurethesafeandeffectiveuse of medications.

Furthermore, clinical biochemistry plays a crucial role in therapeutic drug monitoring research, contributing to the development of new assays, technologies, and guidelines for optimizing drug therapy. These advancements enable healthcare providers to monitor a broader range of drugs, improve the accuracy and precision of measurements, and refine therapeutic ranges.

**Immunotherapy**

**OverviewofImmunotherapy**

Immunotherapyisarevolutionaryapproachtotreatingdiseasesthatharnessesthebody'simmune system to target and eliminate abnormal cells, including cancer cells and pathogens. Unlike traditional treatments such as chemotherapy and radiation therapy, which directly target the abnormal cells, immunotherapy works by enhancing or modulating the body's natural defense mechanisms to specifically recognize and destroy these cells.

Immunotherapy encompasses a diverse range of strategies, including the use of monoclonal antibodies,immunecheckpointinhibitors,adoptivecelltherapies,andtherapeuticvaccines.These approaches leverage the power of the immune system to enhance its ability to identify and eliminate disease-causing agents.

**MonoclonalAntibodiesandTargeted Therapies**

Monoclonal antibodies (mAbs) are laboratory-produced proteins that can mimic the immune system'sabilitytorecognizeandbindtospecifictargetsoncells.Inthecontextofimmunotherapy, mAbs are designed to selectively target molecules that are present on cancer cells or involved in disease processes. By binding to these targets, mAbs can block signaling pathways, deliver toxic substances directly to cancer cells, or engage the immune system to mount an immune response against the abnormal cells.

Targetedtherapiesareasubsetofimmunotherapythatfocusesoninhibitingspecificmoleculesor pathwaysthatarecriticalforthegrowthandsurvivalofcancercells.Thesetherapiescaninterfere withthesignalingprocessesthatpromotecellproliferation,angiogenesis,ormetastasis.By



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selectively targeting cancer cells while sparing normal cells, targeted therapies aim to improve treatment efficacy and reduce side effects.

### ImmuneCheckpointInhibitors

Immunecheckpointinhibitors(ICIs)areaclassofimmunotherapydrugsthatblocktheinhibitory signalsthatcancercellsusetoevadetheimmunesystem.Normally,immunecheckpointsserveas "brakes" to prevent the immune system from attacking healthy cells. However, cancer cells can exploit these checkpoints to avoid immune detection. ICIs work by blocking the interaction betweenimmunecheckpointproteins,suchasPD-1(programmedcelldeathprotein1)andCTLA- 4 (cytotoxic T-lymphocyte-associated protein 4), and their ligands. By doing so, ICIs release the brakes on the immune system, enabling it to mount a robust and sustained attack against cancer cells.

ICIs have revolutionized the treatment of various cancers, leading to durable responses and improved survival rates in patients with advanced or metastatic disease. However, their use can also lead to immune-related adverse events, as the unleashed immune system may attack healthy tissues.Closemonitoringofpatientsandmanagementofthesesideeffectsarecriticalinensuring the safe and effective use of ICIs.

### CAR-TCell Therapy

ChimericAntigenReceptorT-cell(CAR-T)therapyisaninnovativeformofimmunotherapythat involves modifying a patient's T cells to express a synthetic receptor called a CAR. The CAR is designed to recognize specific antigens present on the surface of cancer cells. Once the CAR-T cells are infused back into the patient, they can effectively seek out and destroy cancer cells that express the targeted antigen.

CAR-Tcelltherapyhasshownremarkablesuccessintreatingcertainhematologicalmalignancies, suchasacutelymphoblasticleukemiaand lymphomas. Ithasdemonstrated durable remissionsin patientswhohavenotrespondedtoothertreatments.However,CAR-Tcelltherapycan alsolead to serious side effects, including cytokine release syndrome and neurotoxicity. Close monitoring and management of these adverse events are essential for the safe administration of CAR-T cell therapy.

## FuturePerspectivesandEmerging Trends

### IntegrationofClinicalBiochemistryinTherapeuticStrategies

The integration of clinical biochemistry into therapeutic strategies is an exciting area of development.Asourunderstandingoftheunderlyingmolecularmechanismsofdiseasescontinues to advance, clinical biochemistry plays a crucial role in guiding therapeutic decisions. By analyzingbiochemicalmarkersandmolecularsignatures,clinicianscantailortreatmentplansto



ISBN:978-81-957858-1-0

individual patients, considering factors such as drug metabolism, drug interactions, and personalizeddosing.Theincorporationofclinicalbiochemistrydataintotreatmentalgorithmsand decision-making processes can lead to more precise and effective therapies.

**AdvancesinPrecisionMedicineandMolecularTherapeutics**

Precision medicine, which aims to customize medical treatment based on an individual's unique characteristics, holds tremendous potential for improving therapeutic outcomes. With the advent of high-throughput technologies and bioinformatics, molecular profiling has become more accessible, allowing for the identification of specific molecular targets and genetic variations associated with disease. This knowledge enables the development of targeted therapies that selectively act on disease-associated molecules, pathways, or genetic alterations. Clinical biochemistryplaysacriticalroleinidentifyingandvalidatingbiomarkersforpatientstratification and predicting treatment response. As precision medicine continues to advance, clinical biochemistry will become an indispensable tool in tailoring treatments to individual patients.

**CollaborativeEffortsandMultidisciplinaryApproaches**

The future of therapeutics lies in collaborative efforts and multidisciplinary approaches. Integrating knowledge from diverse fields, such as clinical biochemistry, molecular biology, genetics, pharmacology, and computational sciences, can lead to transformative breakthroughs. Collaboration between researchers, clinicians, bioinformaticians, and industrypartners can foster the development of innovative therapeutic strategies and accelerate the translation of scientific discoveries into clinical practice. By fostering these collaborations, we can overcome the challenges of complex diseases, optimize treatment regimens, and improve patient outcomes.

Furthermore, the integration of big data analytics, artificial intelligence, and machine learning approaches holds immense promise in identifying novel therapeutic targets, predicting treatment responses, andoptimizingtherapeuticstrategies. Thesetechnologiescan analyzevastamountsof clinicalandmoleculardatatouncoverpatterns,correlations,andpredictivemodelsthatcanguide therapeutic decision-making. Clinical biochemistry, with its wealth of data on biochemical markers and metabolic profiles, can contribute significantly to these data-driven approaches, leading to more precise and personalized therapies.

## Conclusion

### AchievementsandChallengesinClinicalBiochemistryTherapeutics

Clinicalbiochemistryhasmadesignificantachievementsinthefieldoftherapeutics,contributing to improved patient care and outcomes. The use of biochemical markers and molecular profiling has revolutionized the way we diagnose, monitor, and treat diseases. Biomarkers have enabled earlydetectionofdiseases,aidingintimelyinterventionsandimprovedprognosis.Theintegration



ISBN:978-81-957858-1-0

of clinical biochemistry into therapeutic strategies has led to personalized medicine approaches, optimizing treatment regimens and minimizing adverse effects.

The advancements in drug discovery and development have been remarkable, with clinical biochemistryplayingapivotalroleintargetidentification,drugscreening,andclinicaltrials.The development of targeted therapies, such as monoclonal antibodies and immune checkpoint inhibitors, has revolutionized cancer treatment, leading to improved response rates and survival outcomes.Therapeuticdrugmonitoringhasalsoemergedasavaluabletool,enablingcliniciansto adjustdrugdosesandensureoptimaltherapeuticlevelsforimprovedefficacyandreducedtoxicity.

Despite these achievements, there are still challenges to overcome. The identification of reliable andspecificbiomarkersremainsachallenge,particularlyforcomplexdiseaseswithmultifactorial etiologies. The integration of different -omics technologies, such as genomics, proteomics, and metabolomics, holds promise but requires further standardization and validation. The interpretationofcomplexdatasetsandtheintegrationofmultiplebiomarkersintoclinicalpractice also present challenges.

**FutureDirectionsand theImpact onPatient Care**

Looking ahead, the future of clinical biochemistry therapeutics is bright, with several exciting directions and opportunities. The integration of clinical biochemistry into precision medicine approaches will continue to expand, enabling tailored treatments based on individual patient characteristics. Advances in molecular therapeutics, such as gene and cell-based therapies, will further revolutionize the field, offering new treatment options for previously untreatable diseases.The impact on patient care will be profound. With more personalized and targeted therapies, patient outcomes will improve, leading to better quality of life and increased survival rates.Theabilitytomonitordruglevelsandoptimizetherapythroughtherapeuticdrugmonitoring will minimize adverse effects and enhance treatment efficacy. Collaborative efforts and multidisciplinary approaches will foster innovation, allowing for the development of novel therapeutic strategies and the translation of research findings into clinical practice.

To realize the full potential of clinical biochemistry in therapeutics, ongoing research and technological advancements are essential. Further understanding of disease mechanisms, biomarker discovery, and validation will be critical for the development of robust and reliable biomarkers. The integration of big data analytics and artificial intelligence will enhance data-driven approaches and improve patient stratification and treatment prediction.

In conclusion, clinical biochemistry has made remarkable achievements in therapeutics, transforming patient care through the use of biochemical markers, targeted therapies, and personalized medicine approaches. While challenges remain, the future holds great promise. Continuedadvancementsinclinicalbiochemistrywillhaveaprofoundimpactonpatientcare,



ISBN:978-81-957858-1-0

improving treatment outcomes, and paving the way for innovative and effective therapeutic strategies. By embracing these future directions and challenges, we can harness the full potential of clinical biochemistry in therapeutics and enhance the well-being of patients worldwide.

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ISBN:978-81-957858-1-0

# BiochemicalAnalysisofBodyFluids:CluesforDiagnosisandMonitoring

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## Abstract

Biochemicalanalysisofbodyfluidsplaysacrucialroleinclinicaldiagnostics,providingvaluableinsights into the physiological and pathological states of individuals. This chapter explores the significance of biochemical analysis in various body fluids for the diagnosis and monitoring of diseases. It highlights the diverse range of analytical techniques used to assess fluid composition and discusses the interpretation of keybiomarkersindifferentbodyfluids.Thechapteralsoemphasizesthepotentialofemergingtechnologies and future trends in biochemical analysis for enhancing diagnostic accuracy and improving patient care.

**Keywords:** biochemical analysis, body fluids, diagnosis, monitoring, biomarkers, analytical techniques, physiological states, pathological states, diagnostic accuracy, patient care.

## Introduction

Biochemical analysis of body fluids has revolutionized the field of clinical diagnostics by providing invaluable insights into the physiological and pathological states of individuals. Body fluids, such as blood, urine, cerebrospinal fluid (CSF), pleural fluid, ascitic fluid, and synovial fluid, serve as reservoirs of vital information that can aid in the detection, diagnosis, and monitoring of various diseases. By analyzing the composition of these fluids, healthcare professionals can uncover clues that help unravel the mysteries of a patient's health.

### ImportanceofBiochemicalAnalysisinClinicalDiagnostics

### Role of Body Fluids in Providing Diagnostic Information

Bodyfluidsactaswindowsintotheinnerworkingsofthehumanbody,reflectingitsoverallstate andprovidingimportantdiagnosticinformation.Thesefluidscontainadiversearrayofmolecules, includingelectrolytes,enzymes,proteins,metabolites,hormones,andgeneticmaterial,whichcan be analyzed to assess various physiological processes and identify pathological changes.

Blood, being the primary fluid that circulates throughout the body, is a rich source of diagnostic information.Itscellularcomponents,suchasredandwhitebloodcells,platelets,andplasma,can provideinsightsintohematologicaldisorders,infection,inflammation,andcoagulationdisorders. Bloodchemistryanalysisfurtherallowsfortheevaluationofelectrolytebalance,liverandkidney function, lipid profiles, and glucose levels, among others.

Urine, produced by the kidneys, is another valuable fluid for diagnostic purposes. Urinalysis can reveal important information about kidney function, metabolic abnormalities, urinary tract infections,andthepresenceofsubstancessuchasdrugsortoxins.Renalfunctiontests,basedon



ISBN:978-81-957858-1-0

urine analysis, help in the assessment of glomerular filtration rate, tubular function, and the presence of proteinuria or hematuria.

Cerebrospinal fluid (CSF), which bathes the brain and spinal cord, plays a crucial role in the diagnosis of neurological disorders. Analysis of CSF can provide valuable information about the presence of infectious agents, inflammation, tumors, and neurodegenerative diseases. CSF biomarkers, such as proteins, cells, and metabolites, aid in the identification and monitoring of conditions like meningitis, multiple sclerosis, and Alzheimer's disease.

Otherbody fluids, including pleural fluid, asciticfluid, and synovial fluid, havetheir ownunique diagnostic significance. Examination of pleural fluid helps in the diagnosis of respiratory disorders, such as pneumonia and lung cancer. Ascitic fluid analysis aids in the evaluation of abdominal conditions, such as liver disease or peritonitis. Synovial fluid analysis is essential for diagnosing and monitoring joint-related diseases, including arthritis.

### 1.1.2Significanceof BiochemicalAnalysis forDiseaseDetectionand Monitoring

Biochemical analysis of body fluids plays a vital role in disease detection, allowing for early identification and prompt intervention. By measuring specific biomarkers present in body fluids, healthcare professionals can detect deviations from normal ranges and identify the presence of diseasesevenbeforeclinicalsymptomsmanifest.Thisenablestimelytreatment,improvingpatient outcomes and prognosis.

Furthermore, biochemical analysis aids in the monitoring of disease progression and treatment efficacy. By regularly analyzing body fluids, healthcare providers can assess the response to therapy,adjusttreatmentplans,anddetectanycomplicationsorrelapses.Thisdynamicmonitoring allowsforpersonalizedmedicine,ensuringthatinterventionsaretailoredtoeachpatient'sspecific needs.

Inrecentyears,technologicaladvancementshaveexpandedthescopeandaccuracyofbiochemical analysis. Miniaturized and point-of-care testing devices have made analysis more accessible and efficient, particularly in resource-limited settings. Omics approaches, integrating genomics, proteomics, and metabolomics, have paved the way for the discovery of novel biomarkers and personalizeddiagnostics.Additionally,dataanalyticsandartificialintelligencehaveimprovedthe interpretation of complex data sets, aiding in diagnosis and treatment decision-making.

### AnalyticalTechniquesinBiochemicalAnalysis

Biochemical analysis of body fluids relies on a variety of analytical techniques that allow for the identification and quantification of specific molecules and biomarkers. These techniques provide crucialinformationaboutthebiochemicalcompositionoffluids,aidingindiseasediagnosisand



ISBN:978-81-957858-1-0

monitoring. This section provides an overview of some common analytical techniques used in fluidanalysisandhighlightsrecentadvancementsintechnologythathaverevolutionizedthefield.

### Overviewof CommonTechniquesUsedinFluid Analysis

**Spectrophotometry:**Spectrophotometryisawidelyusedtechniquethatmeasurestheabsorption or transmission of light by a sample. It is based on the principle that different molecules absorb lightatspecificwavelengths.Spectrophotometryallowsforthequantificationofvariousanalytes, including enzymes, metabolites, and proteins, by measuring the intensity of light absorbed or transmitted by the sample.

**Chromatography:** Chromatographic techniques separate and analyze mixtures of compounds based on their differential partitioning between a mobile phase and a stationary phase. High-Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC) are commonly employed in fluid analysis. HPLC is particularly useful for separating and quantifying small molecules, such as drugs, metabolites, and organic acids, while GC is often utilized for volatile compounds and gases.

**Electrophoresis:** Electrophoresis is a technique that separates charged molecules based on their migrationinanelectricfield.GelElectrophoresis,suchasSDS-PAGE(SodiumDodecylSulfate-Polyacrylamide Gel Electrophoresis), is used to separate proteins according to their size and charge. Capillary Electrophoresis (CE) is another powerful technique used for separation and quantification of small charged molecules, such as amino acids and nucleotides.

**MassSpectrometry:**Massspectrometry(MS)isahighlysensitivetechniqueusedtoidentifyand quantifymoleculesbasedontheirmass-to-chargeratio.Itprovidesdetailedinformationaboutthe chemical structure and composition of compounds. In fluid analysis, techniques such as Liquid Chromatography-Mass Spectrometry (LC-MS) and Gas Chromatography-Mass Spectrometry (GC-MS)arecommonlyemployedfortheidentificationandquantification ofmetabolites,drugs, and proteins.

**Immunoassays:** Immunoassays rely on the specific binding of antibodies to target molecules, enabling their detection and quantification. Enzyme-Linked Immunosorbent Assay (ELISA) and Immunofluorescence assays are widely used immunoassay techniques in fluid analysis. They allowforthedetectionofvariousanalytes,includinghormones,tumormarkers,infectiousagents, and autoimmune antibodies.

### AdvancementsinTechnologyandTheirImpact on Analysis

Technologicaladvancementshavesignificantlyenhancedthecapabilitiesofbiochemicalanalysis inrecentyears.Theseadvancementshaveledtoimprovedsensitivity,accuracy,speed,and



ISBN:978-81-957858-1-0

accessibilityofanalyticaltechniques,enablingmoreprecisediagnosesandefficientmonitoringof diseases.

**Miniaturized and Point-of-Care Devices:** The development of miniaturized and point-of-care devices has revolutionized fluid analysis. These portable devices allow for rapid and on-site testing,eliminatingtheneedforcentralizedlaboratoryfacilitiesandreducingturnaroundtimefor results. They have proven especially beneficial in resource-limited settings and emergency situations, enabling prompt diagnosis and treatment decisions.

**OmicsApproaches:**Omicsapproaches,includinggenomics,proteomics,andmetabolomics,have provided a comprehensive understanding of disease states by analyzing large-scale datasets. Genomic analysis helps in identifying genetic variations and mutations associated with diseases, while proteomic analysis allows for the identification and quantification of proteins, providing insights into disease mechanisms. Metabolomic analysis provides a snapshot of small molecules present in body fluids, enabling the identification of metabolic changes associated with diseases.

**High-Throughput Technologies:** High-throughput technologies have accelerated the pace of analysis by enabling the simultaneous analysis of multiple analytes in a single experiment. MicroarraysandNext-GenerationSequencing(NGS)technologieshaverevolutionizedgenomics and transcriptomics analysis, allowing for the rapid and cost-effective analysis of genetic variations and gene expression profiles. Similarly, multiplex immunoassay platforms enable the simultaneous measurement of multiple analytes in a single sample, saving time and resources.

**Mass Spectrometry Imaging:** Mass spectrometry imaging (MSI) combines mass spectrometry with spatial information, allowing for the visualization and mapping of molecules within tissues or fluid samples. MSI has emerged as a powerful tool in understanding disease pathology and identifying biomarkers associated with specific diseases. It enables the identification and localization of molecules, such as lipids, metabolites, and drugs, providing valuable insights into disease processes.

**BloodAnalysis**

Blood is a vital body fluid that provides valuable diagnostic information about a patient's health status.Theanalysisofbloodcomponentshelpsinthediagnosisandmonitoringofvariousdiseases. Thissectionfocusesonthreekeyaspectsofbloodanalysis:CompleteBloodCount(CBC),Blood Chemistry Analysis, and Coagulation Studies.

**CompleteBloodCount(CBC)**

The Complete Blood Count (CBC) is one of the most commonly performed blood tests and providesessentialinformationabout thecellularcomponentsofblood. It includesthemeasurement



ISBN:978-81-957858-1-0

of various hematological parameters, which can aid in the diagnosis and monitoring of a wide range of conditions.

**ThecomponentsofbloodanalyzedinaCBC include:**

**Red Blood Cells (RBCs):** RBCs carry oxygen to the body's tissues and remove carbon dioxide. The CBC measures parameters such as hemoglobin concentration, hematocrit, and red blood cell indices (mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration). Abnormalities in these parameters can indicate conditions such as anemia, polycythemia, or nutritional deficiencies.

**White Blood Cells (WBCs):** WBCs are responsible for the body's immune response and help in fighting infections. The CBC provides the total WBC count and differential count, which quantifies different types of WBCs, such as neutrophils, lymphocytes, monocytes, eosinophils, andbasophils.Alterationsinthesecountscanindicateinfections,inflammation,orhematological disorders.

**Platelets:** Platelets are essential for blood clotting. The CBC includes a platelet count, which assesses the number of platelets in the blood. Abnormal platelet counts can indicate bleeding disorders, thrombocytosis, or thrombocytopenia.

Interpreting the CBC results involves comparing the measured values with reference ranges specific to age, sex, and medical conditions. Deviations from the normal ranges can provide valuable clues for diagnosing and monitoring diseases.

**BloodChemistryAnalysis**

Blood chemistry analysis involves the measurement of various substances present in the blood, including electrolytes, enzymes, proteins, and metabolites. These measurements help evaluate organ function, identify imbalances, and detect abnormalities associated with diseases.

Somekeyanalytesanalyzedinbloodchemistryanalysisinclude:

**Electrolytes:** Electrolytes such as sodium, potassium, calcium, and chloride play crucial roles in maintainingfluidbalance,nerveconduction,andmusclefunction.Imbalancesinelectrolytelevels canoccurduetovariousconditionssuchasdehydration,kidneydisorders,orendocrinedisorders.

**Enzymes:**Enzymesareproteinsthatcatalyzebiochemicalreactionsinthebody.Bloodchemistry analysis includes the measurement of enzymes such as alanine transaminase (ALT), aspartate transaminase (AST), and alkaline phosphatase (ALP), which are associated with liver function, andcreatinekinase(CK),whichisrelatedtomuscledamage.Elevatedenzymelevelscanindicate organ damage or disease.



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**Proteins:** Blood chemistry analysis assesses the levels of proteins, including albumin, total protein, and specific proteins such as C-reactive protein (CRP) and immunoglobulins. Abnormal protein levels can indicate liver or kidney dysfunction, inflammation, or immune disorders.

**Metabolites:** Blood chemistry analysis also includes the measurement of metabolites such as glucose,cholesterol,triglycerides,andurea.Deviationsfromnormallevelscanindicatemetabolic disorders, diabetes, or kidney dysfunction.

Blood chemistry analysis provides valuable information for diagnosing and monitoring various diseases, assessing organ function, and evaluating treatment effectiveness.

### Coagulation Studies

Coagulation studies assess the blood's ability to form clots and detect abnormalities in clotting factors, which can lead to bleeding disorders or excessive clot formation. These studies include tests such as Prothrombin Time (PT), Activated Partial Thromboplastin Time (APTT), and International Normalized Ratio (INR).

PT measures the time it takes for blood to clot, primarily evaluating the extrinsic pathway of coagulation.AprolongedPTcanindicatedeficienciesinclottingfactors,suchasfactorsII,V,VII, or X, or the presence of anticoagulant medications.

APTT assesses the intrinsic pathway of coagulation and measures the time it takes for blood to clotwhentriggeredbyspecificreagents.ProlongedAPTTcanindicatedeficienciesinfactorsVIII, IX, XI, or XII, or the presence of inhibitors.

INR is a standardized ratio calculated based on the patient's PT and a control PT. It is primarily usedtomonitorpatientsreceivingoralanticoagulanttherapy,suchaswarfarin.INRvaluesoutside the therapeutic range can indicate an increased risk of bleeding or clotting.

Coagulation studies help diagnose conditions such as hemophilia, von Willebrand disease, liver disease,orthepresenceofanticoagulantmedications.Theyarealsocrucialinmonitoringpatients on anticoagulant therapy to ensure the appropriate dosage and prevent complications.

## Urine Analysis

Urine analysis, also known as urinalysis, is a crucial diagnostic tool used to evaluate various aspects of kidney function and detect abnormalities related to urinary tract health. This section focuses on two key aspects of urine analysis: Urinalysis and Renal Function Tests.

### Urinalysis

Urinalysisinvolvestheexaminationofthephysical,chemical,andmicroscopicpropertiesofurine. Itprovidesvaluableinsightsintoapatient'soverallhealthandaidsinthediagnosisofurinarytract infections, kidney diseases, metabolic disorders, and other systemic conditions.



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Physicalexaminationofurineinvolvesassessingitscolor,clarity,andodor.Abnormalitiesinthese characteristics can indicate the presence of certain diseases or the need for further investigation.

Chemical analysis of urine includes the measurement of various substances, such as glucose, protein, ketones, bilirubin, and nitrites. Elevated glucose levels may suggest diabetes, while the presence of protein can indicate kidney damage. Ketones in urine may indicate uncontrolled diabetes or fasting, and the presence of bilirubin may suggest liver dysfunction. Nitrites in urine can be indicative of a urinary tract infection.

Microscopic examination involves the analysis of urine sediment under a microscope. It helps identify the presence of red and white blood cells, casts, crystals, bacteria, and other cellular or non-cellular elements. The presence of red and white blood cells can indicate infection or kidney disease, while casts can suggest renal tubular damage. Crystals in urine may be associated with certain metabolic disorders or urinary stone formation.

**RenalFunctionTests**

Renalfunctiontestsassesstheoverallfunctionof thekidneysbyanalyzingvariousparametersin urine.Thesetestshelpinthedetectionandmonitoringofrenaldisorders,suchaskidneydamage, glomerular diseases, and renal failure.

One of the key aspects of renal function tests is the measurement of glomerular filtration rate (GFR), which estimates the kidney's ability to filter waste products from the blood. GFR can be calculated using formulas based on the levels of creatinine or cystatin C in the blood and urine.

Another important component of renal function tests is the assessment of urinary biomarkers. Biomarkers such as albumin, protein, and various enzymes are measured in urine to detect early signs of kidney damage or dysfunction. Elevated levels of albumin or protein in urine, known as albuminuria or proteinuria, respectively, may indicate glomerular dysfunction or renal damage.

In addition to albumin and protein, other urinary biomarkers such as N-acetyl-beta-D-glucosaminidase(NAG),kidneyinjurymolecule-1(KIM-1),andneutrophilgelatinase-associated lipocalin (NGAL) can provide insights into renal tubular injury and acute kidney injury (AKI).

Renalfunctiontestsareessentialindiagnosingandmonitoringvariousrenaldisorders.Theyhelp healthcare professionals assess the extent of kidney damage, guide treatment decisions, and monitor the response to therapy.

**CerebrospinalFluid(CSF) Analysis**

Cerebrospinal fluid (CSF) is a clear, colorless fluid that surrounds the brain and spinal cord, providingessentialsupportandprotectiontothecentralnervoussystem(CNS).CSFanalysisisa valuablediagnostictoolforevaluatingneurologicdisordersandassessingtheoverallhealthofthe



ISBN:978-81-957858-1-0

CNS. This section discusses the composition of CSF, methods of collection, and the analysis of CSF biomarkers.

**CSFComposition and Collection**

CSFisprimarilycomposedofwater,electrolytes,glucose,andproteins.Italsocontainscells,such aslymphocytesandmonocytes,aswellasvarious neurotransmittersandmetabolites.CSFserves several important functions, including cushioning the brain and spinal cord against mechanical trauma, removing waste products, delivering nutrients, and maintaining a stable environment for proper neuronal function.

Collecting CSF for analysis requires a lumbar puncture, also known as a spinal tap. During this procedure, a thin needle is inserted into the subarachnoid space of the spinal canal, usually in the lower back. CSF is then withdrawn and collected for analysis. Other methods of CSF collection include ventricular puncture or cisternal puncture, which are performed in specific clinical situations.

**AnalysisofCSF Biomarkers**

CSF analysis involves the evaluation of various biomarkers, including proteins, cells, and metabolites. These biomarkers provide valuable information for diagnosing and monitoring neurologic disorders.

Protein analysis in CSF plays a crucial role in detecting CNS diseases. One of the essential CSF protein markers is albumin, whose increased levels may indicate disruption of the blood-brain barrier.Otherproteins,suchasimmunoglobulinsandoligoclonalbands,areevaluatedtodiagnose conditions like multiple sclerosis.

Cellular analysis involves counting and examining the types of cells present in CSF. An elevated numberofwhitebloodcellscanindicateinfections,suchasmeningitisorencephalitis.Redblood cells in CSFmay suggest bleeding in the CNS or a traumatic tap during the collection procedure.

Metabolite analysis in CSF helps evaluate the metabolic state of the CNS. One of the critical metabolites analyzed is glucose, which is typically present at a level similar to that in blood. Decreased glucose levels in CSF may indicate bacterial or fungal infections, while low levels of specific amino acids can suggest metabolic disorders affecting the CNS.

CSFanalysisplaysavitalroleindiagnosingvariousneurologicdisorders.Ithelpsinthedetection of infections, such as bacterial, viral, or fungal meningitis, as well as neurodegenerative diseases like Alzheimer's and Parkinson's disease. CSF biomarkers are also used to identify certain types of brain tumors and monitor the response to treatment.



ISBN:978-81-957858-1-0

Furthermore,CSFanalysisisessentialinrulingoutotherpotentialcausesofneurologicsymptoms andguidingappropriatepatientmanagement.Itprovidesvaluablediagnosticcluesandaidsinthe selection of further diagnostic tests and treatment strategies.

**EmergingTechnologiesandFuture Trends**

Fluidanalysisinclinicaldiagnosticsisconstantlyevolving,drivenbyadvancementsintechnology and the quest for more accurate and efficient diagnostic methods. This section explores some emerging technologies and future trends that have the potential to revolutionize fluid analysis.

**MiniaturizedandPoint-of-CareTesting**

The development of miniaturized diagnostic devices and point-of-care testing has been a significant advancement in fluid analysis. These devices are portable, user-friendly, and provide rapid results at the patient's bedside or in resource-limited settings. They offer the advantage of real-time diagnosis, allowing for immediate intervention and treatment decisions.

Miniaturized devices, such as handheld analyzers and lab-on-a-chip systems, enable the analysis of small sample volumes with high sensitivity and specificity. They integrate multiple analytical functions,includingsamplepreparation,detection,anddataanalysis,intoasingleplatform.These advancements enhance the accessibility and efficiency of fluid analysis, particularly in remote or underserved areas where access to traditional laboratory facilities is limited.

Furthermore, point-of-care testing reduces the turnaround time for obtaining test results, facilitating prompt medical interventions and improving patient outcomes. It has the potential to revolutionize emergency medicine, primary care, and field-based healthcare, enabling timely diagnoses and effective disease management.

**OmicsApproachesinFluid Analysis**

Omics approaches, encompassing genomics, proteomics, and metabolomics, have gained prominence in fluid analysis. These technologies allow for the comprehensive profiling of biological molecules in body fluids, leading to the identification of novel biomarkers and personalized diagnostics.

Genomic analysis provides insights into an individual's genetic makeup and susceptibility to certain diseases. It aids in identifying genetic mutations, gene expression patterns, and genetic variations associated with specific conditions. Proteomics focuses on the study of proteins and theirmodifications,providingadeeperunderstandingofdiseasemechanismsandtheidentification of disease-specific protein markers. Metabolomics, on the other hand, examines the small- molecule metabolites in body fluids, offering insights into metabolic pathways and alterations associated with diseases.



ISBN:978-81-957858-1-0

The integration of omics data with traditional fluid analysis techniques enhances diagnostic accuracy and enables personalized medicine. It enables the identification of specific biomarkers for early disease detection, prediction of treatment response, and monitoring of disease progression. Omics approaches also contribute to the development of targeted therapies and precision medicine, tailoring treatment strategies to individual patients based on their unique molecular profiles.

**DataAnalyticsandArtificial Intelligence**

The increasing volume and complexity of data generated from fluid analysis necessitate the utilizationofdataanalyticsandartificialintelligence(AI)techniques.Data-drivenapproachescan help extract meaningful insights and patterns from large datasets, leading to improved diagnostic accuracy and decision-making.

Machine learning algorithms, a subset of AI, can analyze complex datasets and identify patterns thatmaynotbereadilyapparenttohumanobservers.Theycanrecognizedisease-specificpatterns, classify samples, and predict patient outcomes based on fluid analysis data. Machine learning algorithmsalsohavethepotentialtointegratedatafrommultiplesources,suchasclinicalrecords and imaging data, to provide a more comprehensive and holistic assessment of a patient's health status.

DataanalyticsandAItechniquesfacilitatethedevelopmentofpredictivemodels,decisionsupport systems, and risk stratification tools. They enhance the interpretation and integration of fluid analysis data, enabling more accurate diagnoses, prognoses, and treatment recommendations. Moreover, these technologies have the potential to improvelaboratory workflows, automate data analysis processes, and optimize resource allocation in clinical laboratories.

**Conclusion**

Biochemicalanalysisofbodyfluidsplaysacrucialroleindiagnosingandmonitoringdiseases.By examining the composition and properties of fluids such as blood, urine, and cerebrospinal fluid, healthcare professionals can gather valuable diagnostic information that aids in the detection, treatment,andmanagementofvariousconditions.Inthischapter,weexploredthesignificanceof biochemical analysis in clinical diagnostics, discussed the analytical techniques used, and highlighted the importance of fluid analysis in specific contexts.

The importance of biochemical analysis in clinical diagnostics cannot be overstated. Body fluids serve as a rich source of information, providing insights into the physiological and pathological processes occurring within the body. Through the analysis of fluid biomarkers, healthcare professionals can identify the presence of diseases, monitor disease progression, assess treatment efficacy, and even predict patient outcomes. Whether it is the complete blood count (CBC) to assessbloodcellcomponents,bloodchemistryanalysistoevaluateelectrolytesandmetabolites,



ISBN:978-81-957858-1-0

or urinalysis to detect urinary biomarkers, fluid analysis provides invaluable clues for diagnosis and monitoring.

Advancements in technology have significantly impacted fluid analysis. The development of miniaturized and point-of-care testing devices has increased the accessibility and efficiency of diagnostic procedures. These portable devices allow for rapid analysis at the patient's bedside, reducing the turnaround time for results and facilitating immediate medical interventions. Moreover,theintegrationofomicsapproaches,suchasgenomics,proteomics,andmetabolomics, has opened new avenues for identifying novel biomarkers and personalizing diagnostics. By analyzingthegenetic,protein,andmetabolicprofilesofbodyfluids,healthcareprofessionalscan gain a deeper understanding of disease mechanisms and develop tailored treatment strategies.

However, with these advancements come challenges. The implementation of emerging technologiesrequirescarefulvalidationandstandardizationtoensureaccurateandreliableresults. Quality control measures, proficiency testing, and adherence to regulatory guidelines are crucial to maintain the integrity of fluid analysis. Furthermore, the interpretation and integration of complex data generated by these technologies demand expertise in data analytics and AI techniques.Healthcareprofessionalsmustbeequippedwiththenecessaryknowledgeandskillsto navigate this evolving landscape.

Despite these challenges, the implications of improving patient care and diagnostic accuracy through fluid analysis are significant. Early detection of diseases allows for timely interventions, leading to improved treatment outcomes and potentially saving lives. Monitoring disease progression and treatment response through fluid analysis helps in adjusting treatment plans and optimizing patient management. Personalized diagnostics based on fluid biomarkers enable tailored therapies that address individual patient needs, improving treatment efficacy and minimizing side effects.

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ISBN:978-81-957858-1-0

# BiochemistryofAgingandAge-RelatedDiseases:MolecularPerspectives

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## Abstract

The chapter "Biochemistry of Aging and Age-Related Diseases: Molecular Perspectives" provides an overview of the cellular and molecular mechanisms underlying aging and age-related diseases. Aging is a complex biological process characterized by the progressive decline in physiological functions and increased susceptibility to age-related diseases. The chapter explores the biochemical basis of aging, including telomere shortening, oxidative stress, mitochondrial dysfunction, cellular senescence,and DNA damage. It also discusses the molecular insights into age-related diseases such as cardiovascular diseases, neurodegenerative diseases, cancer, and metabolic disorders. The role of inflammation, immune system dysregulation, hormonal changes, and epigenetic modifications in aging and age-related diseases is examined. Additionally, the chapter highlights interventions and therapies, including caloric restriction, pharmacological interventions, exercise, and emerging therapies, that hold promise for promoting healthy aging and delaying the onset of age-related diseases. Understanding the molecular perspectives of aging and age-related diseases provides valuable insights fordeveloping targetedinterventions and personalized therapeutic strategies to improve the quality of life and extend the health span of individuals.

**Keywords:**aging,age-relateddiseases,molecularperspectives,telomeres,oxidativestress,mitochondrial dysfunction, cellular senescence, DNA damage, cardiovascular diseases, neurodegenerative diseases, cancer, metabolic disorders, inflammation, immune system, hormonal changes, epigenetic modifications, interventions, therapies.

## Introduction

### TheProcessofAging

Aging is an inevitable biological process characterized by a progressive decline in physiological functions and increased vulnerability to age-related diseases. It is influenced by a complex interplay of genetic, environmental, and lifestyle factors. Understanding the underlying biochemicalmechanismsofagingiscrucialfordevelopinginterventionsthatcanpromotehealthy aging and mitigate age-related diseases.

### Age-RelatedDiseasesandtheirImpact

Age-related diseases, such as cardiovascular diseases, neurodegenerative diseases, cancer, and metabolic disorders, pose significant health challenges in aging populations. These diseases not onlyreducethequalityoflifebutalsoimposeasubstantialeconomicburdenonhealthcaresystems worldwide.Exploringthemolecularperspectivesofthesediseasesprovidesvaluableinsightsinto their pathogenesis and potential therapeutic targets.

### Cellularand MolecularMechanismsofAging



ISBN:978-81-957858-1-0

**TelomeresandTelomerase**

Telomeres, the protective caps at the ends of chromosomes, play a critical role in cellular aging. Witheachcelldivision,telomeresprogressivelyshorten,eventuallyleadingtocellularsenescence orapoptosis.Telomerase,anenzymethatcanelongatetelomeres,isinvolvedinregulatingcellular lifespan and has implications for aging and age-related diseases.

**OxidativeStressandReactiveOxygenSpecies (ROS)**

Oxidative stress, resulting from an imbalance between the production of reactive oxygen species (ROS) and the cellular antioxidant defense system, is a hallmark of aging. ROS can damage cellularcomponents,includingproteins,lipids,andDNA,contributingtocellulardysfunctionand the development of age-related diseases.

**MitochondrialDysfunction**

Mitochondria, the powerhouses of cells, play a crucial role in energy production and cellular homeostasis.Accumulatingevidencesuggeststhatmitochondrialdysfunction,includingimpaired energyproductionandincreasedproductionofROS,contributestoagingandage-relateddiseases.

**Cellular Senescence**

Cellular senescence is a state of irreversible growth arrest that occurs in response to various stressors, including DNA damage, telomere shortening, and oxidative stress. Senescent cells accumulate withageand secretepro-inflammatory factors, contributingtotissuedysfunctionand the development of age-related diseases.

**DNADamageand Repair**

Accumulated DNA damage over time and a decline in DNA repair mechanisms are associated with aging. Unrepaired DNA damage can lead to mutations, genomic instability, and cellular dysfunction, contributing to the development of age-related diseases, including cancer.

**Age-RelatedDiseases:MolecularInsights**

**Cardiovascular Diseases**

Cardiovasculardiseases,suchasatherosclerosis,hypertension,andheartfailure,areprevalentage-related diseases. Molecular processes, including chronic inflammation, oxidative stress, endothelial dysfunction, and vascular calcification, contribute to the pathogenesis of these diseases.

**NeurodegenerativeDiseases**

Neurodegenerativediseases,includingAlzheimer'sdisease,Parkinson'sdisease,andamyotrophic lateralsclerosis(ALS),arecharacterizedbytheprogressivelossofneuronsandassociated



ISBN:978-81-957858-1-0

cognitive and motor impairments. Abnormal protein aggregation, mitochondrial dysfunction, oxidativestress,andinflammationarecommonmolecularfeaturesimplicatedinthedevelopment of these diseases.

**Cancer**

The incidence of cancer increases with age, and the molecular mechanisms underlying cancer development are closely linked to aging processes. Accumulated DNA damage, genomic instability,impairedDNArepairmechanisms,anddysregulatedcellsignalingpathwayscontribute to the initiation and progression of age-related cancers.

**Metabolic Disorders**

Metabolic disorders, such as type 2 diabetes, obesity, and metabolic syndrome, are strongly associated with aging. Dysregulated metabolism, insulin resistance, chronic low-grade inflammation, and mitochondrial dysfunction play crucial roles in the pathogenesis of these disorders.

## InflammationandImmuneSystemin Aging

### ChronicLow-GradeInflammation (Inflammaging)

Aging is associated with a chronic low-grade inflammatory state known as inflammaging. Persistent activation of the immune system, accompanied by increased production of pro-inflammatorycytokines,contributestotissuedamageandthedevelopmentofage-relateddiseases.

**ImmuneSenescence**

Aging is also characterized by immune system dysregulation, known as immune senescence. Changes in the composition and function of immune cells, impaired immune responses, and decreased immune surveillance contribute to increased susceptibility to infections, decreased vaccine efficacy, and the development of age-related diseases.

**ImpactofInflammationonAge-RelatedDiseases**

Chronic inflammation plays a critical role in the pathogenesis of various age-related diseases, including cardiovascular diseases, neurodegenerative diseases, and metabolic disorders. Inflammatory mediators can directly damage tissues and exacerbate the underlying molecular processes involved in disease progression.

## HormonalChangesandAging

### EndocrineSystemand Aging



ISBN:978-81-957858-1-0

Agingisassociatedwithalterationsinhormonelevelsandhormonalsignalingpathways.Changes inhormoneproduction,suchasdecreasedgrowthhormone,sexhormones,andthyroidhormones, contribute to age-related physiological changes and increase the risk of age-related diseases.

### ImpactofHormonalChangesonAgingandAge-RelatedDiseases

Hormonesplayessentialrolesinregulatingmetabolism,cellularfunction,andtissuehomeostasis. Alterationsinhormonelevelscandisrupttheseprocesses,contributingtothedevelopmentofage- related diseases, including metabolic disorders, osteoporosis, and cognitive decline.

## EpigeneticModificationsin Aging

### DNAMethylation

Epigenetic modifications, such as DNA methylation, undergo dynamic changes during aging. DNA methylation patterns can influence gene expression and cellular function, contributing to age-related changes and disease susceptibility.

### Histone Modifications

Histone modifications, including acetylation, methylation, and phosphorylation, regulate chromatinstructureandgeneexpression.Alterationsinhistonemodificationswithagecanimpact gene expression patterns and contribute to age-related diseases.

### Non-codingRNAs

Non-coding RNAs, including microRNAs and long non-coding RNAs, play crucial roles in gene regulationandcellularprocesses.Dysregulationofnon-codingRNAswithagecandisruptcellular homeostasis and contribute to the development of age-related diseases.

### EpigeneticClocksandAging

Epigenetic clocks, based on DNA methylation patterns, have emerged as valuable tools for estimating biological age and predicting the risk of age-related diseases. These clocks provide insights into the molecular changes associated with aging and have potential applications in personalized medicine.

## InterventionsandTherapiesforAgingandAge-RelatedDiseases

### CaloricRestriction andDietaryInterventions

Caloricrestriction,withoutmalnutrition,hasbeenshowntoextendlifespananddelaytheonsetof age-related diseases in various organisms. Dietary interventions, such as intermittent fasting and specific nutrient supplementation, also show promise in promoting healthy aging.

### Pharmacological Interventions



ISBN:978-81-957858-1-0

Several pharmacological interventions, including rapamycin, metformin, and senolytics, have demonstrated potential in modulating aging processes and delaying the onset of age-related diseases. Targeting specific molecular pathways involved in aging holds promise for developing effective therapies.

**Exerciseand LifestyleModifications**

Regularexerciseandhealthylifestylehabitshavebeenassociatedwithimprovedhealthoutcomes and increased lifespan. Physical activity, along with a balanced diet, can mitigate age-related physiological decline and reduce the risk of age-related diseases.

**EmergingTherapiesandFuture Directions**

Emerging therapies, including stem cell-based therapies, genetherapies, and senescence-targeted interventions, are under investigation for their potential in reversing aging processes and treating age-relateddiseases.Continuedresearchandclinicaltrialsareneededtoestablishtheirsafetyand efficacy.

## Conclusion

**UnderstandingtheMolecularBasis ofAgingandAge-Related Diseases**

Advancesinmolecularbiologyandbiochemistryhaveprovidedvaluableinsightsintothecomplex processes of aging and age-related diseases. Unraveling the cellular and molecular mechanisms involvedinaging enablesthedevelopmentoftargetedinterventionsandpersonalizedtherapeutic strategies.

**ImplicationsforAgingResearchandTherapeuticStrategies**

Acomprehensiveunderstandingofthebiochemicalpathwaysandmolecularprocessesassociated withagingandage-relateddiseasesopensnewavenuesfortherapeuticinterventionsandstrategies to promote healthy aging. The translation of molecular perspectives into clinical practice has the potentialtoimprovethequalityoflifeandextendthehealthspanofindividualsacrossthelifespan.

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ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# Clinical Microbiology and Infectious Diseases: Diagnosis, Antimicrobial Resistance, Emerging Challenges, and Prevention Strategies

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**Abstract**

Infectious diseases continue to pose significant global health challenges. This chapter focuses on the field of clinical microbiology and infectious diseases, discussing diagnostic methods for infectious diseases, antimicrobial susceptibility testing, antibiotic resistance, emerging infectious diseases, and strategies for prevention through vaccination. The chapter aims to provide insights into the diagnostic approaches, challenges associated with emerging pathogens, and the importance of prevention strategies in combating infectious diseases.

**Keywords:** clinical microbiology, infectious diseases, diagnostics, antimicrobial susceptibility testing, antibiotic resistance, emerging infectious diseases, prevention, vaccination

**Introduction:**

Infectious diseases are a significant cause of morbidity and mortality worldwide, impacting individuals, communities, and global health systems. Effective diagnosis and management of infectious diseases are crucial for timely treatment, outbreak control, and prevention of further transmission. Clinical microbiology playsa pivotal rolein the diagnosis of infectious diseases by identifying the causative agents, understanding their characteristics, and determining appropriate treatmentstrategies.Thischapterprovidesanoverviewofthesignificanceofclinicalmicrobiology in infectious disease diagnosis and explores the impact of infectious diseases on global health.

**SignificanceofClinicalMicrobiologyin InfectiousDiseaseDiagnosis:**

Clinical microbiology is a specialized branch of laboratory medicine that focuses on the identification and characterization of microorganisms responsible for infectious diseases. It encompasses various laboratory techniques and methods to isolate, culture, and analyze microorganisms present in clinical samples. The accurate identification of pathogens is essential for determining appropriate treatment strategies, infection control measures, and surveillance activities. Clinical microbiologists work closely with healthcare providers to ensure prompt and accurate diagnosis, leading to improved patient outcomes.

**ImpactofInfectiousDiseasesonGlobal Health:**

Infectious diseases have a profound impact on global health, affecting populations across geographical boundaries. They contribute to substantial morbidity and mortality, particularly in resource-limitedsettings.Infectiousdiseasescanspreadrapidly,causingepidemicsandpandemics



ISBN:978-81-957858-1-0

with far-reaching consequences. These diseases pose challenges to healthcare systems, strain limited resources, and result in economic burdens. By understanding the epidemiology, etiology, and clinical manifestations of infectious diseases, clinical microbiologists play a vital role in disease surveillance, outbreak response, and the development of effective prevention and control strategies.

**DiagnosticMethodsforInfectiousDiseases:**

The accurate diagnosis of infectious diseases relies on a range of diagnostic methods and techniques. Clinical microbiology laboratories employ diverse approaches to identify and characterize the causative agents. This section explores the following diagnostic methods:

**Culture-BasedTechniques:**

Culture-based techniques involve the isolation and growth of microorganisms in appropriate laboratory media. Culturing enables the identification of bacteria, fungi, and parasites based on theirgrowthcharacteristics,colonymorphology,andbiochemicalreactions.Thesetechniquesare fundamental in establishing the etiology of infections, determining antimicrobial susceptibility, and guiding treatment decisions.

**MolecularDiagnostic Techniques:**

Moleculardiagnostictechniqueshaverevolutionizedthefieldofclinicalmicrobiologybyenabling rapid and accurate identification of pathogens. Polymerase chain reaction (PCR), nucleic acid amplification tests (NAATs), and DNA sequencing are among the molecular methods used to detect and characterize microbial nucleic acids. These techniques offer high sensitivity and specificity and can detect viral, bacterial, and fungal pathogens directly from clinical samples.

**SerologicalMethods:**

Serological methods involve the detection of antibodies produced by the host in response to an infection. Serological tests, such as enzyme-linked immunosorbent assays (ELISAs) and immunofluorescence assays (IFAs), help identify past or current infections, determine immune status,andassesstheeffectivenessofvaccination.Serologyplaysacrucialroleindiagnosingviral infections, detecting specific antibodies, and monitoring immune responses.

**AdvancementsinDiagnostic Technologies:**

Advancementsindiagnostictechnologieshavefurtherenhancedthefieldofclinicalmicrobiology. Automated systems, mass spectrometry, next-generation sequencing (NGS), and point-of-care testing (POCT) have improved the speed, accuracy, and accessibility of infectious disease diagnosis.Thesetechnologiesenablerapididentificationofpathogens,detectionofantimicrobial resistance genes, and real-time monitoring of outbreaks.



ISBN:978-81-957858-1-0

## AntimicrobialSusceptibilityTestingandAntibiotic Resistance:

### PrinciplesofAntimicrobialSusceptibilityTesting:

Antimicrobial susceptibility testing (AST) is a critical component of clinical microbiology that determines the effectiveness of antimicrobial agents against specific pathogens. AST provides valuableinformationforguidingappropriateantibiotictherapyandpreventingtheemergenceand spreadofantibioticresistance.ThissectionexploresttheprinciplesofAST,includingtheselection ofantimicrobialagents,interpretationoftestresults,andmethodsusedfortesting,suchasthedisk diffusion method, broth dilution, and automated systems.

### MechanismsofAntibioticResistance:

Antibiotic resistance is a growing global health concern that poses a significant threat to the effective treatment of infectious diseases. These mechanisms include genetic mutations, acquisition of resistance genes through horizontal gene transfer, and the formation of biofilms. Understanding the molecular basis of antibiotic resistance is crucial for the development of strategiestocombatresistance,such asthediscoveryofnovelantibioticsandtheimplementation of antimicrobial stewardship programs.

### ChallengesinAntibioticStewardshipandResistanceManagement:

Antibiotic stewardship programs aim to optimize antibiotic use, promote appropriate prescribing practices, andreducetheemergenceandspreadof antibioticresistance.Thesechallengesinclude limiteddiagnosticcapabilities,suboptimalprescribingpractices,patientandpublicawareness,and the need for global collaboration to address the complex issue of antibiotic resistance.

## EmergingInfectiousDiseasesandDiagnostic Challenges:

### DefinitionandFactorsContributingtoEmergingInfectiousDiseases:

Emerging infectious diseases (EIDs) are diseases that have recently appeared in a population or haveexistedbutarerapidlyincreasinginincidenceorgeographicrange.Thissectionprovidesan overviewofthefactorscontributingtotheemergenceofinfectiousdiseases,includingecological changes, globalization, climate change, antimicrobial resistance, and zoonotic spillover events. Understandingthesefactorsiscrucialforearlydetection,surveillance,andeffectivemanagement of emerging pathogens.

### DiagnosticChallengesPosedbyEmerging Pathogens:

Emergingpathogensoftenpresentuniquediagnosticchallengesduetotheirnovelnature,atypical clinical manifestations, and limited knowledge about their biology. This section explores the diagnosticchallengesposedbyemergingpathogens,includingtheneedforspecializeddiagnostic



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tests, limited availability of reference materials, and the requirement for rapid response and coordination between clinicians and diagnostic laboratories. The role of advanced molecular techniques, syndromic panels, and metagenomic sequencing in overcoming these challenges is also discussed.

**SurveillanceandEarlyDetectionofEmergingPathogens:**

Surveillanceandearlydetectionareessentialfortimelyresponse,outbreakcontrol,andprevention of the spread of emerging pathogens. This section highlights the importance of surveillance systems, both at the local and global levels, in monitoring infectious diseases and detecting emerging pathogens. It explores the role of laboratory networks, real-time data sharing, and the integration of molecular epidemiology and genomics in enhancing surveillance capabilities. The developmentofrapiddiagnostictestsandpoint-of-caretechnologiesisalsodiscussedasvaluable tools for early detection and containment of emerging pathogens.

**VaccinesandPrevention Strategies:**

**ImportanceofVaccinationin InfectiousDiseasePrevention:**

Vaccinationisoneofthemosteffectivestrategiesforpreventinginfectiousdiseasesandreducing theirburdenonpublichealth.Thissectionemphasizestheimportanceofvaccinationinpreventing the spread of infectious diseases and achieving herd immunity. It discusses the principles of vaccination,includingtheconceptofimmunization,typesofvaccines(liveattenuated,inactivated, subunit, etc.), and the role of vaccination in reducing morbidity, mortality, and disease transmission.

**VaccineDevelopment andApproval Process:**

The development and approval of vaccines involve a rigorous scientific process to ensure their safety, efficacy, and quality. This section provides an overview of the vaccine development process,includingpreclinicaltesting,clinicaltrials(phasesI,II,andIII),regulatoryapproval,and post-marketing surveillance. It also highlights the role of regulatory agencies, such as the Food and Drug Administration (FDA) and the World Health Organization (WHO), in assessing and monitoring vaccine safety and effectiveness.

**VaccineStrategies forHigh-Risk Populations:**

Certain populations, such as infants, the elderly, pregnant women, and immunocompromised individuals, are more susceptible to severe complications from infectious diseases. This section explores specific vaccine strategies targeted at high-risk populations, including maternal immunization,catch-upimmunization,andimmunizationofhealthcareworkers. Italsodiscusses the challenges and considerations in implementing vaccination programs for these populations, such as vaccine safety in pregnancy and overcoming vaccine hesitancy.



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**PublicHealthMeasuresforInfectiousDiseasePrevention:**

Vaccinationaloneisnotalwayssufficienttocontrolthespreadofinfectiousdiseases.Thissection highlights the importance of comprehensive public health measures in conjunction with vaccination. It explores strategies such as disease surveillance, outbreak investigations, infection control practices, hygiene measures, and public health education campaigns. The role of government agencies, healthcare providers, and community engagement in implementing and promoting these preventive measures is also discussed.

**FutureDirectionsand Challenges:**

**AdvancementsinDiagnosticTechnologiesandPoint-of-Care Testing:**

Thefield ofclinical microbiology is continually evolving, with rapid advancements in diagnostic technologies. This explores the future directions of diagnostic methods for infectious diseases, includingthedevelopmentofnovelmoleculartechniques,biosensors,andpoint-of-caretesting.It discusses the potential of emerging technologies, such as next-generation sequencing, microfluidics, and nanotechnology, in improving the speed, accuracy, and accessibility of infectious disease diagnostics. The challenges and considerations associated with implementing these technologies in clinical practice are also addressed.

**AddressingAntimicrobial Resistance:**

Antimicrobial resistance has become a major global health concern, rendering many antibiotics ineffectiveandthreateningourabilitytotreatinfectiousdiseases.Thissectionfocusesonthefuture challenges and strategies in combating antimicrobial resistance. It explores the development of novel antimicrobial agents, such as phage therapy, antimicrobial peptides, and combination therapies. It also highlights the importance of antimicrobial stewardship programs, surveillance systems, and infection prevention and control practices in reducing the spread of antimicrobial resistance. The role of research, policy interventions, and global collaborations in addressing this critical issue is discussed.

**PreparednessforEmergingPathogensandPandemics:**

Theemergenceofnovel pathogensandthepotentialforpandemicsposesignificantchallengesto global health security. This section explores the future directions and challenges in preparedness foremergingpathogens.Itdiscussestheimportanceofearlydetectionandrapidresponsesystems, strengtheninglaboratorycapacity,andestablishingglobalsurveillancenetworks.Italsoaddresses theneedforcollaborativeresearch,riskassessment,anddevelopmentofvaccinesandtherapeutics toeffectivelyrespondtoemerginginfectiousdiseasesandmitigatetheirimpact.Theroleof



ISBN:978-81-957858-1-0

internationalorganizations,governments,andpublichealthagenciesinpandemicpreparednessis highlighted.

**Conclusion:**

**ImportanceofClinicalMicrobiologyandInfectiousDiseaseControl:**

Clinical microbiology plays a crucial role in the diagnosis, management, and prevention of infectious diseases. The accurate and timely identification of pathogens, determination of antimicrobial susceptibility, and monitoring of resistance patterns are essential for guiding appropriatetreatmentdecisionsandcontrollingthespreadofinfections.Byemployingarangeof diagnostic methods, including culture-based techniques, molecular diagnostics, and serological assays, healthcare professionals can accurately identify infectious agents and tailor treatment regimens accordingly. Additionally, understanding the mechanisms of antibiotic resistance and implementingeffectiveantimicrobialstewardshipprogramsarevitalforpreservingtheefficacyof available treatments and combating the global challenge of antimicrobial resistance.

**CollaborativeEfforts forEffectiveDisease Diagnosis and Prevention:**

Effective control and prevention of infectious diseases require collaborative efforts from various stakeholders. Healthcare professionals, clinical microbiologists, researchers, public health agencies, policymakers, and the community must work together to address the challenges posed by infectious diseases. This includes promoting awareness and education on disease prevention, ensuring access to diagnostic technologies, fostering international collaborations for surveillance and response systems, and implementing effective infection control measures. By sharing knowledge, resources, and expertise, we can enhance our ability to detect, manage, and prevent infectious diseases on a global scale.

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ISBN:978-81-957858-1-0

# Point-of-CareTestinginClinicalBiochemistry

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**Abstract**

This chapter provides an in-depth exploration of point-of-care testing (POCT) in clinicalbiochemistry, focusing on its principles, technologies, applications, challenges, and emergingtrends. POCT refers to diagnostic tests performed outside of the traditional laboratory setting,delivering rapid results that can guide immediate clinical decision-making. The advantages ofPOCT include faster turnaround time, enhanced patient convenience, and timely interventions.Various analytical techniques, such as immunoassays, biosensors, handheld spectrophotometry,and molecular diagnostics, are utilized in POCT for clinical biochemistry. Portable devices,including handheld analyzers, portable spectrophotometers, smartphone-connected devices, andlab-on-a-chip devices, enable testing at the point of care. POCT finds applications in glucosemonitoring, lipid profile testing, coagulation testing, cardiac marker analysis, and infectiousdisease testing. However, challenges related to quality assurance, regulatory considerations,training,competency,anddatamanagementmustbeaddressed.EmergingtrendsinPOCTincludebiosensors and wearable devices, smartphone applications, point-of-care molecular diagnostics,andtheintegrationofartificialintelligenceandmachinelearning.Thesetrendsofferopportunitiesfor continuous biomarker monitoring, improved accessibility, rapid nucleic acid amplificationtesting, and enhanced accuracy and interpretation of results. Despite challenges, the evolvingtechnologies and emerging trends in POCT hold great promise for advancing diagnostics at thepoint of care.

**Keywords**: point-of-care testing, clinical biochemistry, analytical techniques, portable devices,glucose monitoring, lipid profile testing, coagulation testing, cardiac markers, infectious diseasetesting, biosensors, wearable devices, smartphone applications, molecular diagnostics, artificialintelligence, machine learning

## Introduction

Point-of-caretesting (POCT) refers to diagnostic tests performed at ornear the patient's location,providing rapid results that can guide immediate clinical decision-making. This chapter exploresthe application of POCT in clinical biochemistry, highlighting its advantages, challenges, andemerging trends.

## PrinciplesandTechnologiesofPoint-of-CareTesting

### Overview of POCT:



ISBN:978-81-957858-1-0

Point-of-caretesting(POCT)referstodiagnostictestingthatisperformedoutsideofthetraditional laboratory setting, often at or near the patient's location. It aims to provide rapid, real-time diagnostic information to healthcare providers, enabling immediate clinical decision-making and improving patient outcomes. POCT offers several advantages, including faster turnaround time, enhanced patient convenience, and the potential for more timely interventions and treatments.

**Analytical Techniques:**

POCT utilizes various analytical techniques to measure and detect biomarkers of interest. These techniques are designed to be portable, user-friendly, and capable of delivering reliable results in a timely manner. Some common analytical techniques used in POCT for clinical biochemistry include:

**Immunoassays:** Immunoassays are widely employed in POCT due to their high sensitivity and specificity.Theyinvolvetheuseofspecificantibodiesthatbindtotargetanalytes,suchasproteins or hormones, to generate a measurable signal. Immunoassays can be designed as lateral flow assays, immunochromatographic tests, or enzyme-linked immunosorbent assays (ELISAs).

**Biosensors:**Biosensorscombinebiologicalrecognitionelements,suchasenzymesorantibodies, withtransducersto converttheinteractionbetween theanalyteandtherecognitionelementinto a measurable signal. They are commonly used in POCT due to their miniaturization and ability to provide real-time, quantitative results. Biosensors can be based on various principles, including electrochemical, optical, or piezoelectric detection.

**Handheld Spectrophotometry:** Handheld spectrophotometers utilize the principles of absorbance or fluorescence spectroscopy to measure the concentration or activity of specific analytes.Thesedevicesarecompact,portable,andcapableofmeasuringawiderangeofanalytes, such as metabolites, enzymes, or biomarkers of diseases.

**Molecular Diagnostics:** Molecular diagnostic techniques, such as polymerase chain reaction (PCR) or nucleic acid amplification, are increasingly being integrated into POCT devices. These techniques allow for the detection and identification of specific nucleic acid sequences, such as DNAorRNA,providingrapidandaccuratediagnosesforinfectiousdiseases orgeneticconditions.

**PortableDevices:**

POCT devices are designed to be portable, user-friendly, and capable of providing real-time results. These devices have undergone significant advancements in miniaturization and technological innovation, enabling the analysis of various biomarkers at the point of care. Some commonly used portable devices in POCT include:

**Handheld Analyzers:** These compact devices incorporate analytical techniques, such as immunoassaysorbiosensors,intoahandheldformat.Theyoftenhaveuser-friendlyinterfacesand



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provide on-screen results within minutes. Examples include handheld blood glucose meters, pregnancy test kits, or handheld cardiac marker analyzers.

**Portable Spectrophotometers**: These devices utilize spectrophotometric principles to measure analytes in various sample types. They are often battery-powered, compact, and capable of measuring multiple wavelengths to assess different analytes. Portable spectrophotometers find applications in measuring blood gases, hemoglobin levels, or bilirubin concentrations.

**Smartphone-Connected Devices:**Withtheubiquityofsmartphones,thereisanincreasingtrend to integrate POCT with mobile technology. Smartphone-connected devices can leverage the processingpowerandconnectivityofsmartphonestoperformdiagnostictests.Thesedevicesoften utilize miniaturized sensors or cartridges that connect to the smartphone's audio or USB port.

**Lab-on-a-Chip Devices**: Lab-on-a-chip devices, also known as microfluidic devices, integrate multipleanalyticalfunctionsontoasinglechiporcartridge.Theyenabletheautomationofsample preparation,mixing,andanalysisinaminiaturizedformat.Lab-on-a-chipdevicesfindapplications in various areas, including infectious disease diagnostics, molecular diagnostics, or point-of-care hematology.

**ApplicationsofPoint-of-CareTestingin ClinicalBiochemistry**

**Glucose Monitoring:**

POCTdevicesplayacrucialroleinthemonitoringofbloodglucoselevelsinpatientswithdiabetes mellitus. Glucose meters are widely used by individuals for self-monitoring of blood glucose at homeorinnon-laboratorysettings.Thesehandhelddevicesutilizeasmallbloodsampleobtained through finger pricking. Glucose meters provide rapid results, allowing patients to make immediateadjustmentstotheirdiet,medication,orinsulindoses.Continuousglucosemonitoring (CGM) systems are another advancement in glucose monitoring, providing real-time glucose readings throughout the day via a sensor placed under the skin. CGM systems enable individuals to monitor glucose trends, identify hypoglycemic or hyperglycemic episodes, and optimize diabetes management.

**Lipid ProfileTesting:**

POCTdevicescanrapidlyassesslipid profiles,including total cholesterol,high-densitylipoprotein (HDL), low-density lipoprotein (LDL), and triglycerides. These devices often utilize enzymatic reactions or biosensor technology to measure specific lipid components in blood samples. Lipid profile testing at the point of care enables healthcare providers to promptly evaluate a patient's cardiovascular risk. Results from POCT lipid testing can guide treatment decisions, such as lifestyle modifications, initiation of lipid-lowering medications, or monitoring lipid levels during therapy.



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**Coagulation Testing**:

POCT is valuable in coagulation monitoring, particularly for patients on anticoagulant therapy. The international normalized ratio (INR) is a widely used measure of the blood's coagulation ability and is crucial in monitoring patients taking anticoagulant medications, such as warfarin. POCTdevicesoffer rapid INRtesting,allowinghealthcareproviderstomaketimelyadjustments toanticoagulantdosages.Thisensuresthatpatientsmaintaintheirtherapeuticrangeandminimizes the risk of bleeding or clotting complications.

**Cardiac Markers:**

POCT plays a significant role in the rapid diagnosis and management of cardiac conditions. Cardiac markers, such as troponin, creatine kinase-MB (CK-MB), and brain natriuretic peptide (BNP), are used to assess cardiac injury, myocardial infarction, and heart failure. POCT devices enable the measurement of these markers within minutes, providing critical information for immediate clinical decision-making. Rapid diagnosis and risk stratification facilitate appropriate interventions, such as timely reperfusion therapy or initiation of heart failure management.

**InfectiousDiseaseTesting:**

POCT has revolutionized the rapid detection of infectious diseases, contributing to infection control and early treatment initiation. POCT devices are available for a wide range of infectious diseases, including respiratory infections (e.g., influenza, respiratory syncytial virus), sexually transmitted infections (e.g., HIV, syphilis), and blood-borne pathogens (e.g., hepatitis B and C). Thesedevicesemployvarioustechniques,suchasimmunoassaysornucleicacidamplification,to detectspecificpathogensortheirmarkersinpatientsamples.Rapidandaccuratediagnosisenables immediate treatment initiation, appropriate infection control measures, and prevention of disease transmission.

**ChallengesandConsiderationsinPoint-of-Care Testing**

**QualityAssurance:**

Quality assurance is a critical aspect of point-of-care testing (POCT) to ensure the accuracy and reliability of test results. In decentralized testing settings, maintaining consistent quality can be challenging. Key considerations include:

**CalibrationandVerification**:POCTdevicesrequireregularcalibrationandverificationtoensure accuratemeasurements.Thisinvolvestheuseoftraceablereferencematerialsandperiodicchecks against known standards. The challenge lies in performing these procedures reliably and consistently in non-laboratory settings.

**Proficiency Testing:** Participation in proficiency testing programs is essential for evaluating the performanceofPOCTdevicesandensuringcomparabilityacrossdifferenttestingsites.However,



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implementing proficiency testing in decentralized settings can be logistically complex and may require coordination with external proficiency testing providers.

**External Quality Assessment:** External quality assessment (EQA) programs assess the overall quality of POCT by comparing the results obtained by different testing sites. However, implementing EQA in decentralized settings poses challenges in terms of logistics, result reporting, and data analysis.

**RegulatoryConsiderations:**

RegulatoryrequirementsplayacrucialroleinensuringthereliabilityandsafetyofPOCTdevices. Key considerations include:

**Certification and Approval:** POCT devices must meet specific regulatory requirements and obtain appropriate certifications or approvals before being marketed or used in patient care. Regulatory bodies evaluate the performance, safety, and accuracy of these devices through rigorous evaluation processes.

**Quality Control:** Regulatory guidelines often mandate the implementation of quality control processes for POCT devices. This includes establishing and maintaining quality control procedures, monitoring the performance of devices, and documenting corrective actions.

**Standards Compliance**:POCT devices need to adhereto relevant standards, such as ISO 15189 orCLSIPOCTguidelines,toensureconsistencyindeviceperformance,resultinterpretation,and quality management practices.

**Trainingand Competency:**

Adequatetrainingandcompetencyassessmentofhealthcareprofessionalsinvolvedinperforming POCT are essential to ensure accurate and reliable results. Considerations include:

**TrainingPrograms:**Healthcareprofessionalsmustreceivecomprehensivetrainingontheproper use of POCT devices, including sample collection, device operation, result interpretation, and troubleshooting.Trainingprogramsshouldbetailoredtospecificdevicesandregularlyupdatedto keep pace with technological advancements.

**Competency Assessment**: Ongoing competency assessment is crucial to ensure healthcare professionals maintain the necessary skills and knowledge for performing POCT accurately. Competency assessment may involve practical assessments, proficiency testing, or periodic retraining.

**ManufacturerInstructions:**Followingmanufacturerinstructionsiscriticalforobtainingreliable results.Healthcareprofessionalsshouldbeeducatedabouttheimportanceofadheringto



ISBN:978-81-957858-1-0

manufacturer recommendations, including proper sample handling, device maintenance, and quality control procedures.

**DataManagementandConnectivity:**

DatamanagementandconnectivityposechallengesinPOCT,buttheyalsoofferopportunitiesfor improved patient care. Considerations include:

**Result Interpretation:** POCT devices generate data that require accurate interpretation to guide clinicaldecision-making.Standardizedresultinterpretationguidelinesandreferencerangesshould be established to ensure consistent and meaningful interpretation across different settings.

**Integration with Electronic Health Record**: Integration of POCT results into the electronic health record (EHR) is crucial for comprehensive patient care. Challenges include data entry errors, interoperability issues between POCT devices and EHR systems, and standardization of data formats.

**ConnectivityandDataExchange:**EstablishingconnectivitybetweenPOCTdevices,laboratory informationsystems,andEHRsallowsforseamlessdataexchangeandreal-timeaccesstopatient information.Thisfacilitatesremotemonitoring,qualitycontrol,andimprovedcoordinationamong healthcare providers.

**Data Security and Privacy:** Protecting patient data and ensuring compliance with data security and privacy regulations (e.g., HIPAA) is of paramount importance when implementing connectivity and data exchange in POCT.

**EmergingTrendsinPoint-of-Care Testing**

**BiosensorsandWearable Devices:**

Biosensorsandwearabledevicesarerevolutionizingpoint-of-caretestingbyenablingcontinuous monitoringofbiomarkersandreal-timehealthdata.Thesedevicesincorporatesensortechnologies that can detect and measure specific analytes in bodily fluids. They are designed to be non- invasive, user-friendly, and capableof transmitting datawirelessly to a mobiledeviceora cloud- based platform. Biosensors and wearable devices have applications in areas such as glucose monitoring, cardiac biomarker detection, electrolyte analysis, and monitoring of vital signs. The ability to track biomarkers continuously offers new opportunities for personalized medicine, remote patient monitoring, and early disease detection.

**SmartphoneApplications:**

Integration of smartphone applications with point-of-care testing devices has expanded the accessibility and functionality of POCT. With the proliferation of smartphones worldwide, these devicescannowserveasaplatformforperformingdiagnostictestsandinterpretingresults.



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Smartphone applications can guide users through the testing process, capture and analyze test results, provide educational resources, and facilitate data sharing with healthcare professionals. ThecombinationofsmartphonetechnologyandPOCTdevicesenhancesconvenience,portability, and user engagement, making healthcare more accessible and empowering individuals to take an active role in their health management.

**Point-of-CareMolecular Diagnostics:**

Advancements in molecular diagnostics have led to the development of rapid nucleic acid amplificationtests(NAATs)thatcanbeperformedatthepointofcare.Thesetestsenabletherapid detection of infectious agents, such as viruses and bacteria, directly from patient samples. POCT molecular diagnostics have applications in infectious disease testing, including respiratory infections, sexually transmitted infections, and emerging pathogens. The availability of portable and user-friendly molecular diagnostic devices allows for rapid and accurate identification of pathogens, enabling timely treatment decisions, infection control measures, and disease surveillance.

**ArtificialIntelligenceandMachine Learning:**

Artificial intelligence (AI) and machine learning (ML) have the potential to transform point-of-caretestingbyenhancingtheaccuracyandinterpretationoftestresults.AIalgorithmscananalyze large volumes of data generated by POCT devices, identify patterns, and provide insights for diagnostic decision-making. ML models can learn from previous test results and patient data, improvingdiagnosticaccuracyandpredictivecapabilities.AIandMLtechniquescanaidinresult interpretation, risk stratification, and clinical decision support. Furthermore, these technologies enable the integration of POCT data with electronic health records and support population health management initiatives.

## Conclusion:

Point-of-care testing in clinical biochemistry offers the advantage of rapid results, allowing for immediateclinical decision-makingandimprovedpatient care.Despitethechallengesassociated with quality assurance and data management, the evolving technologies and emerging trends in POCT hold great promise for advancing diagnostics at the point of care.

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ISBN:978-81-957858-1-0

# QualityAssuranceandLaboratoryManagementinClinicalBiochemistry

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**Abstract**

Quality assurance and laboratory management play a vital role in ensuring accurate and reliable testresults,patientsafety,andoveralllaboratoryperformanceinclinicalbiochemistry.Thisarticle highlights key considerations in quality assurance and laboratory management, including accreditation and compliance, quality control and assurance programs, standard operating procedures, equipment and instrumentation, competency assessment and training, risk management, data management and information systems, and continuous quality improvement. Byprioritizingtheseaspects,clinicalbiochemistrylaboratoriescanmeetregulatoryrequirements, achieve accreditation, and deliver high-quality services.

**Keywords:** quality assurance, laboratory management, clinical biochemistry, accreditation, compliance, quality control, quality assurance programs, standard operating procedures, equipment and instrumentation, competency assessment, training, risk management, data management, information systems, continuous quality improvement.

## Introduction

Qualityassuranceandeffectivelaboratorymanagementarecrucialaspectsofclinicalbiochemistry that ensure accurate and reliable test results, patient safety, and overall laboratory performance. Adhering to rigorous quality standards and implementing robust management practices are essential for delivering high-quality clinical biochemistry services. Here are some key considerations in quality assurance and laboratory management in clinical biochemistry:

### AccreditationandCompliance:

Laboratoriesperformingclinicalbiochemistrytestsshouldstriveforaccreditationfromrecognized accrediting bodies such as the College of American Pathologists (CAP) or the International Organization for Standardization (ISO). Accreditation ensures that the laboratory meets established quality standards and follows standardized procedures. Compliance with regulatory requirements,suchasClinicalLaboratoryImprovementAmendments(CLIA)intheUnitedStates, is also essential to maintain the quality and integrity of laboratory testing.

### QualityControlandQualityAssurance Programs:

Quality control (QC) procedures are critical to monitor the accuracy and precision of test results. Theseproceduresinvolvetheregularanalysisofcontrolsampleswithknownvaluestoensurethe reliabilityandconsistencyoftestmeasurements.Qualityassurance(QA)programsencompassa



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broader set of activities aimed at ensuring overall laboratory quality. QA programs may include proficiencytesting,inter-laboratorycomparisons,internalaudits,andcontinuousstafftrainingand education.

**StandardOperatingProcedures (SOPs):**

Laboratories should develop and implement comprehensive SOPs for all aspects of laboratory operations,includingspecimenhandling,instrumentcalibrationandmaintenance,resultreporting, andqualitycontrolprocedures.SOPsprovideclearinstructionsandguidelinesforlaboratorystaff tofollow,ensuringstandardizedand consistentpractices.RegularreviewandupdateofSOPsare necessarytoincorporatenewtechnologies,bestpractices,andchangesinregulationsorguidelines.

**Equipmentand Instrumentation:**

Investinginmodernandreliablelaboratoryequipmentandinstrumentationiscrucialforaccurate and efficient clinical biochemistry testing. Regular maintenance, calibration, and verification of instruments are essential to ensure their proper functioning and to minimize the risk of errors. Laboratories should establish a preventive maintenance schedule and maintain proper records of equipment maintenance and service.

**CompetencyAssessmentandTraining:**

Laboratory staff should undergo regular competency assessments to ensure their proficiency in performing clinical biochemistry tests. Competency assessments may include written exams, practical demonstrations, and performance evaluations. Adequate training and continuing education programs should be in place to keep laboratory personnel updated with the latest techniques, technologies, and regulatory requirements.

**Risk Management:**

Laboratoriesshouldimplementasystematicapproachtoidentifyandmitigaterisksassociatedwith clinical biochemistry testing. This involves conducting risk assessments, establishing risk management protocols, and implementing appropriate preventive and corrective actions. Identifying and addressing potential risks in the pre-analytical, analytical, and post-analytical phases of testing are crucial for patient safety and accurate test results.

**DataManagementandInformationSystems:**

Efficient data management systems and information technology infrastructure are vital for laboratory operations and data integrity. Laboratories should implement secure and reliable systemsfordataentry,storage,retrieval,andresultreporting.Databackupprocedures,data



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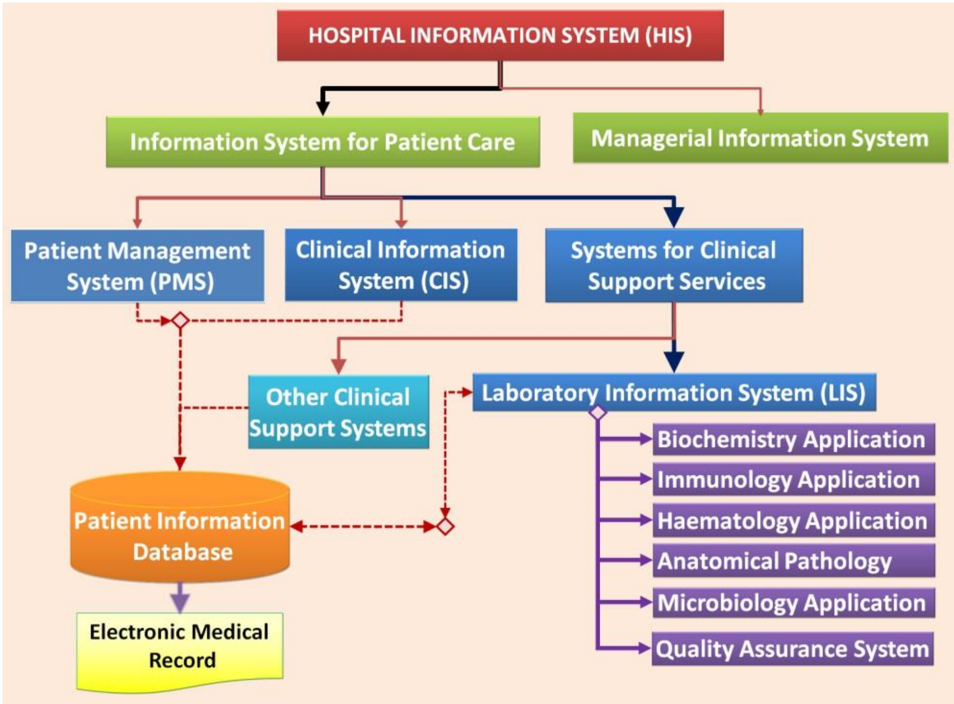
security measures, and contingency plans should be in place to ensure the availability and confidentiality of patient data.




**ContinuousQualityImprovement:**

Laboratoriesshouldembraceacultureofcontinuousqualityimprovement(CQI)todriveongoing enhancements in laboratory processes and services. This involves regularly monitoring key performance indicators, analyzing quality metrics, and implementing improvement initiatives. Feedback mechanisms, such as customer satisfaction surveys and complaint handling processes, can provide valuable insights for CQI efforts.

By prioritizing quality assurance and implementing effective laboratory management practices, clinical biochemistry laboratories can deliver accurate and reliable test results, ensure patient safety,andmaintainhighstandardsofservice.Thesepracticesareessentialformeetingregulatory requirements, achieving accreditation, and providing optimal patient care.

**Conclusion:**

Inconclusion,qualityassuranceandlaboratorymanagementarecriticalforthesuccessofclinical biochemistry laboratories. Adhering to accreditation standards, implementing quality control and assuranceprograms,anddevelopingcomprehensivestandardoperatingproceduresensure



ISBN:978-81-957858-1-0

accurate and reliable test results. Investing in modern equipment, providing competency assessmentandtrainingtostaff,andimplementingriskmanagementstrategiescontributetopatient safety and minimize errors. Efficient data management systems and continuous quality improvement efforts further enhance laboratory performance. By prioritizing these aspects, clinical biochemistry laboratories can meet regulatory requirements, achieve accreditation, and deliver high-quality services, ultimately benefiting patient care.

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ISBN:978-81-957858-1-0

# UnderstandingSpectrophotometry:AVersatileAnalyticalTechnique

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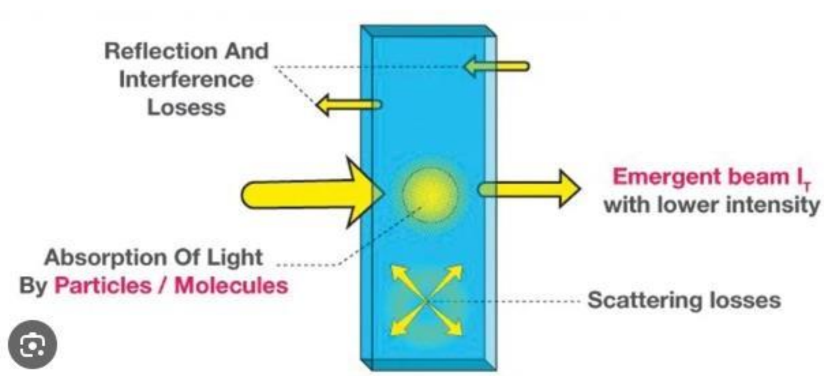
**Abstract**

Spectrophotometry is a widely used analytical technique in the field of biochemistry and other scientific disciplines. It involves the measurement of the absorption or transmission of light by a substance across a range of wavelengths. Spectrophotometry is valuable for quantifying the concentrationofvariousanalytesinasample,aswellasforstudyingtheinteractionofsubstances with light.

**Principle:**

The principle behind spectrophotometry is based on the Beer-Lambert Law, which states that the amount of light absorbed by a substance is directly proportional to its concentration and the path lengthofthelightthroughthesample.Theinstrumentusedforspectrophotometricmeasurements is called a spectrophotometer.




**Instrumentation:**

The basic components of a spectrophotometer include a light source, a monochromator or wavelength selector, a sample holder or cuvette, and a detector. The light source emits a broad spectrum of light, typically including ultraviolet (UV), visible, and near-infrared (NIR) wavelengths. The monochromator allows the selection of specific wavelengths for analysis, ensuring accurate measurement of the absorption characteristics of the analyte.



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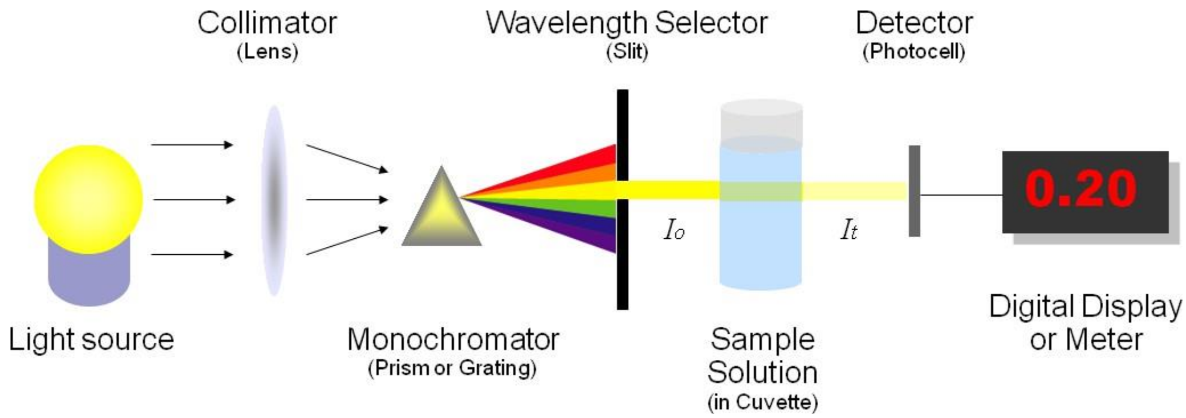


In atypicalspectrophotometricmeasurement,asamplesolutionisplacedin atransparentcuvette with parallel sides. The cuvette is then inserted into the spectrophotometer, and light passes through the sample. The detector measures the intensity of light that passes through the sample (transmittance) or the amount of light absorbed by the sample. The measurement is usually recorded as absorbance, which is the logarithm of the ratio of incident light to transmitted light.

**Applications:**

Spectrophotometryfindsnumerousapplicationsinclinicalbiochemistry,pharmaceuticalanalysis, environmental monitoring, food analysis, and many otherfields. Herearesome key applications:

**QuantificationofAnalytes:**Spectrophotometryallowsthequantificationofvariousanalytesina sample. By measuring the absorbance of a sample at a specific wavelength, the concentration of the analyte can be determined using a calibration curve or mathematical equations derived from the Beer-Lambert Law. Common analytes measured using spectrophotometry include proteins, enzymes, nucleic acids, vitamins, and metabolites.

**Enzyme Kinetics:** Spectrophotometry is widely used in enzyme kinetics studies. Enzyme reactions often involve the conversion of a substrate to a product accompanied by changes in absorbance.Bymonitoringthechangeinabsorbanceovertime,therateoftheenzymaticreaction can be determined, and parameters such as enzyme activity and kinetics can be characterized.

**DNA and RNA Quantification:** Spectrophotometry is employed to quantify DNA and RNA concentrations in molecular biology research. Nucleic acids absorb UV light at specific wavelengths,allowingtheirquantificationbasedontheirabsorbancevalues.Thisinformationis



ISBN:978-81-957858-1-0

crucial for various applications, including gene expression analysis, DNA sequencing, and PCR experiments.

**ProteinAnalysis:**Spectrophotometryisusedtomeasuretheconcentrationofproteinsinasample, oftenbasedontheabsorbanceofspecificaminoacidresidues,suchastryptophanortyrosine,that exhibit characteristic absorption properties. Protein concentration determination is essential for proteinpurification,protein-proteininteractionstudies,andproteinquantificationinbiochemistry and biotechnology research.

**Drug Assays:** Spectrophotometry plays a significant role in pharmaceutical analysis, including drugassaysanddrugreleasestudies.Itenablesthequantificationofdrugsinvariousdosageforms and biological samples, such as blood or urine, based on their unique absorption properties. Spectrophotometric methods are widely employed in quality control laboratories to ensure the potency and purity of pharmaceutical products.

**EnvironmentalAnalysis:**Spectrophotometryisutilizedinenvironmentalmonitoringtomeasure various parameters, including water quality indicators such as dissolved oxygen, nitrate, phosphate,andheavymetalions.Byanalyzingtheabsorbanceofspecificwavelengthsassociated with these parameters, spectrophotometry provides valuable information for assessing environmental contamination and water safety.

**Colorimetric Assays:** Many colorimetric assays rely on spectrophotometry to measure the intensity of color produced in a chemical reaction. By correlating the intensity of the color with the concentration of the analyte, these assays enable the quantification of a wide range of substances, such as glucose, cholesterol, hormones, and drugs.

Spectrophotometry offers several advantages, including its simplicity, versatility, and non-destructive nature. It allows for rapid and accurate analysis of samples, often requiring minimal sample preparation. However, some limitations should be considered, such as potential interference from impurities or sample matrix, as well as limitations in sensitivity and dynamic range for highly concentrated or dilute samples.

**Conclusion**



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In conclusion, spectrophotometry is a powerful analytical technique widely used in clinical biochemistry and otherscientificdisciplines. It enables the quantification ofvarious analytes and facilitates the study of light-matter interactions. With its broad applications and ease of use, spectrophotometry continues to be an invaluable tool in scientific research, quality control, and diagnostic laboratories.

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ISBN:978-81-957858-1-0

# EthicalandLegalConsiderationsinClinicalBiochemistry

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**Abstract**

Ethical and legal considerations play a critical role in the practice of clinical biochemistry. As healthcare professionals involved in laboratory testing and the interpretation of results, clinical biochemists must adhere to ethical principles, respect patient autonomy, ensure patient confidentiality, and comply with legal requirements. This article explores the ethical and legal considerations relevant to clinical biochemistry, including ethical issues, patient confidentiality, informed consent, and legal aspects.

**Keywords**:Biochemistry,Laboratory,Ethical, Patients

## Introduction

**Privacy and Confidentiality:** Clinical biochemists must prioritize patient privacy and maintain strict confidentiality regarding patient information and laboratory results. They should follow establishedprotocolstoensurethatpatientdataissecurelystoredandaccessibleonlytoauthorized individuals.

**PatientAutonomy:**Clinicalbiochemistsshouldrespecttheautonomyofpatients,whichincludes respecting their right to make informed decisions regarding their healthcare. This may involve discussing the purpose, benefits, risks, and limitations of laboratory tests with patients and obtaining their informed consent.

**Conflict of Interest:** Clinical biochemists should manage and disclose any potential conflicts of interest that may compromise their objectivity and professional judgment. They should avoid situations where personal, financial, or professional interests could influence the accuracy or interpretation of laboratory results.

**PatientConfidentiality:**

**Privacy Protection:** Clinical biochemists should implement measures to protect patient privacy, such as secure storage of electronic health records, encryption of data during transmission, and restricted access to patient information.

**Confidentiality Agreements:** Clinical biochemists should ensure that all laboratory staff, includingtechnicians,researchers,andstudents,signconfidentialityagreementsandareawareof the importance of maintaining patient confidentiality.



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**DataSharingandTransfer:**Whensharingpatientdataortransferringlaboratoryresultstoother healthcareprovidersorinstitutions,clinicalbiochemistsshouldusesecureandauthorizedchannels to maintain the confidentiality of patient information.

**Informed Consent:**

**ExplanationofTests:**Clinicalbiochemistsshouldprovidepatientswithclearandunderstandable information about the purpose, risks, benefits, and potential alternatives of laboratory tests. Patients should have the opportunity to ask questions and make informed decisions about their participation in testing.

**VoluntaryParticipation:**Patientsshouldhavetherighttogiveorwithholdconsentforlaboratory testing. Clinical biochemists should respect patients' decisions and ensure that their consent is obtained voluntarily without any coercion.

**CapacityandCompetency:**Clinicalbiochemistsshouldassesspatients'capacityandcompetency to provide informed consent. In cases where patients are unable to provide informed consent, appropriate legal guardians or authorized representatives should be involved.

**LegalAspects:**

Regulatory Compliance: Clinical biochemists must comply with relevant laws and regulations governing laboratory testing, including licensure, accreditation, and quality assurance requirements.

**ReportingObligations:**Clinicalbiochemistshavealegalresponsibilitytoreportcertainfindings or results to public health authorities, such as notifiable diseases or cases of suspected abuse or neglect.

**Liability and Malpractice:** Clinical biochemists may be held liable for professional negligence or malpractice if their actions or decisions result in harm to patients. It is essential to adhere to professional standards, maintain accurate records, and communicate effectively with healthcare providers.

**Conclusion:**

Ethical and legal considerations are integral to the practice of clinical biochemistry. Clinical biochemists must uphold ethical principles, protect patient confidentiality, obtain informed consent, and comply with legal requirements. By prioritizing these considerations, clinical biochemists can ensure patient trust, maintain professional integrity, and contribute to the provision of high-quality healthcare services.



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

## PCR:AmplifyingDNAforScientificAdvancements

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**PolymeraseChainReaction(PCR) Abstract**

Polymerase Chain Reaction (PCR) is a powerful molecular biology technique used to amplify specific DNA sequences. It revolutionized the field of molecular biology and has become a cornerstoneofnumerousapplicationsinresearch,diagnostics,forensics,andbiotechnology.This article provides an overview of PCR, its principles, steps involved, and its applications.

### Introduction

PCR is based on the enzymatic amplification of DNA using a heat-stable DNA polymerase, typically Taq polymerase. The process involves repeated cycles of DNA denaturation, primer annealing, and DNA extension. These cycles exponentially amplify the targeted DNA region, allowing for the detection and analysis of specific sequences.

### Stepsin PCR:

**Denaturation**: The PCR reaction begins with heating the DNA sample to a high temperature (typically 94-98°C) to denature the double-stranded DNA, separating it into two single strands.

**Primer Annealing**: The reaction temperature is then lowered (typically 50-65°C) to allow the specificDNAprimerstoannealtocomplementarysequencesonthesingle-strandedDNA.Primers are short DNA sequences that flank the target region and provide a starting point for DNA synthesis.

**Extension:** The reaction temperature is increased (typically 72°C) to activate the DNA polymerase, which synthesizes a new DNA strand complementary to each template strand. The polymerase adds nucleotides to the primers, extending the DNA sequence.

**Cycling:** Steps 1 to 3 are repeated for multiple cycles, typically ranging from 20 to 40 cycles, depending on the application. Each cycle doubles the amount of DNA, resulting in exponential amplification of the target sequence.

### Applicationsof PCR:

**Gene Amplification**: PCR is widely used to amplify specific genes or DNA regions for various purposes, such as cloning, gene expression analysis, and mutation detection. It enables the generation of sufficient quantities of DNA for downstream applications.



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**Disease Diagnosis:** PCR plays a crucial role in clinical diagnostics for the detection and identification of pathogens, including viruses, bacteria, and fungi. It allows for the rapid and sensitive detection of infectious agents, aiding in the diagnosis of diseases.

**ForensicAnalysis:**PCRisutilizedinforensicsciencetoanalyzeDNAsamplesfromcrimescenes andidentifyindividuals.ItenablestheamplificationofminuteamountsofDNA,facilitatingDNA profiling and matching with suspects or victims.

**Genetic Testing**: PCR-based techniques, such as allele-specific PCR and quantitative PCR (qPCR), are employed for genetic testing and screening. These techniques allow the detection of specific genetic variations associated with inherited diseases or genetic predispositions.

**EnvironmentalMonitoring:**PCRisusedinenvironmentalresearchandmonitoringtodetectand quantifymicrobialcommunities,pathogens,orgeneticallymodifiedorganisms(GMOs)invarious environmental samples, including soil, water, and air.

**DNASequencing:**PCRisacrucialstepinDNAsequencingmethods,suchasSangersequencing andNext-GenerationSequencing(NGS).ItallowstheamplificationoftargetDNAregionsbefore sequencing, enabling the analysis of genetic information.

**Conclusion:**

PCR is a versatile and indispensable tool in molecular biology and various fields of research and diagnostics. Its ability to amplify specific DNA sequences rapidly and exponentially has revolutionized the way scientists study genes, identify pathogens, diagnose diseases, and analyze genetic variations. The widespread use of PCR has significantly advanced our understanding of geneticsandhasnumerousapplicationsinmedicine,forensics,biotechnology,andenvironmental sciences.

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ISBN:978-81-957858-1-0

## FromOriginstoTermination:ExploringEukaryoticDNAReplication

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**Abstract**

DNAreplicationisafundamentalprocessthatensurestheaccurateduplicationofgeneticmaterial in eukaryotic cells. Eukaryotic DNA replication is a highly regulated and complex process involving multiple proteins and enzymatic activities. Understanding the intricacies of DNA replication in eukaryotes is essential for unraveling the mechanisms behind genetic stability, cell proliferation, and the maintenance of genetic information.

**Keywords:**Termination, Eukaryotes,Replication,Genetics,DNA,RNA

### Introduction

**TheprocessofDNA replicationineukaryotescanbebroadlydividedintoseveralstages:**

**Initiation:**DNAreplicationbeginsatspecificsiteswithinthegenomecalledoriginsofreplication. These origins are recognized by initiator proteins, which recruit other replication factors to form thepre-replicationcomplex(pre-RC).Thepre-RCservesasthestartingpointforDNAreplication and ensures that each region of the genome is replicated exactly once during each cell cycle.

**Unwinding and Strand Separation:** Once the pre-RC is formed, it undergoes a series of biochemical changes to activate the helicase enzyme. Helicase unwinds the DNA double helix, separatingthetwostrandsandgeneratingareplicationfork.Theunwindingprocesscreatestension and introduces positive supercoiling ahead of the replication fork.

**PrimerSynthesisandDNAPolymerization:**DNApolymerasesarethekeyenzymesresponsible for synthesizing new DNA strands during replication. Primase synthesizes short RNA primers at the replication fork, providing a starting point for DNA polymerases to initiate DNA synthesis. DNApolymerasesthenaddnucleotidestothegrowingDNAstrandsinacomplementarymanner, following the rules of base pairing (A-T and G-C). Leading and lagging strands are synthesized differently due to the antiparallel nature of the DNA double helix, leading to the formation of Okazaki fragments on the lagging strand.

**Proofreading and Repair:** DNA polymerases have built-in proofreading activity, which allows them to detect and correct errors that may occur during DNA synthesis. Mismatch repair mechanisms further enhance the fidelity of DNA replication by identifying and excising incorrectly incorporated nucleotides and replacing them with the correct ones.

**Termination:** Replication of the entire genome is completed when the replication forks from adjacentoriginsmeetorwhentheyreachspecificterminationsites.Theterminationprocess



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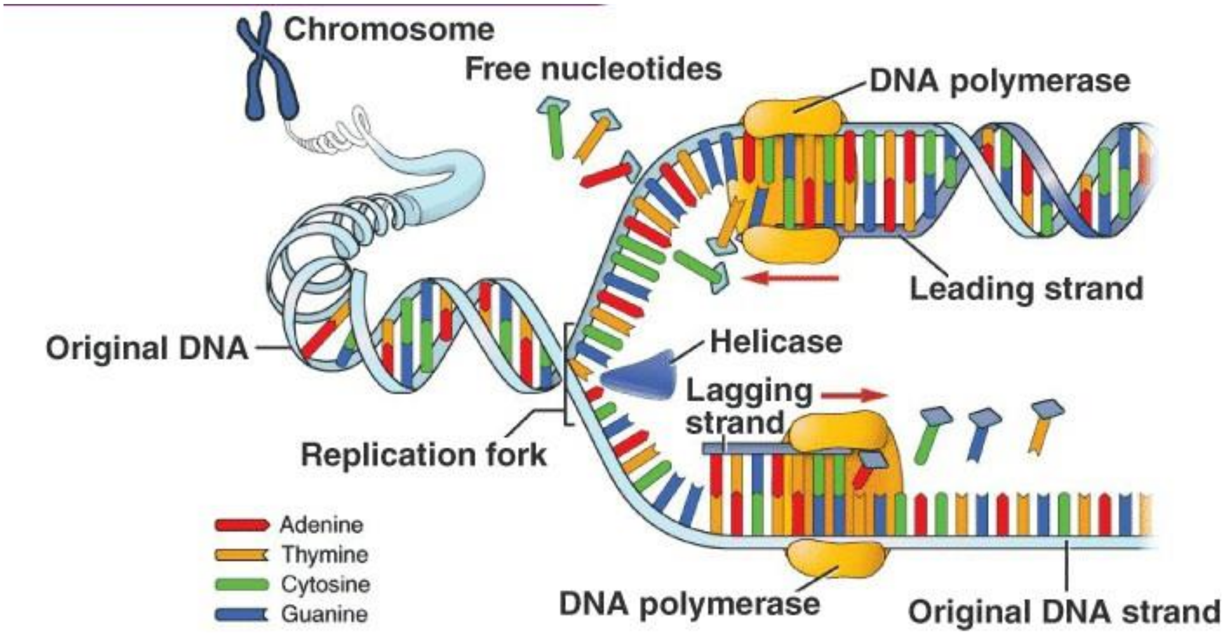
involvestheresolutionofDNAstructuresandtheremovalofreplicationmachineryfromtheDNA strands.




Throughout the process of DNA replication, various regulatory mechanisms ensure the accuracy and efficiency of replication. Cell cycle checkpoints monitor the progression of replication and coordinateitwithothercellularevents.ChromatinremodelingfactorsfacilitateaccesstotheDNA template,whileDNArepairmechanismspromptlyaddressanyDNAdamageencounteredduring replication.

Understanding the intricacies of DNA replication in eukaryotes is not only important for basic researchbutalsofor clinicalapplications.DysregulationofDNAreplicationcanleadtogenomic instability and contribute to the development of diseases, including cancer. Furthermore, knowledge of the replication process has practical implications for techniques such as DNA sequencing, genetic engineering, and diagnostic testing.

In conclusion, DNA replication in eukaryotes is a complex and highly regulated process that ensures the faithful transmission of genetic information from one generation to the next. Investigating the molecular mechanisms underlying DNA replication provides insights into fundamental biological processes and contributes to our understanding of genetic diseases and cellular proliferation.



ISBN:978-81-957858-1-0

## FromGenestoRNA:TheJourneyofDNATranscriptioninEukaryotes

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**Abstract**

DNAtranscription is a fundamental process in which thegeneticinformation encoded in DNA is used to synthesize RNA molecules. In eukaryotes, DNA transcription is a complex and highly regulatedprocessthatoccursinthenucleusofthe cell. Itinvolvesmultiplestepsandrequiresthe coordinated action of various protein complexes.

**Keywords:**PCR,Eukaryotes,Transcription,DNA,Polymerases,RNA,Genetics

**Introduction**

**Initiation:**

The process of transcription begins with the binding of transcription factors to specific DNA sequencesknownaspromoters.ThesetranscriptionfactorsrecruitRNApolymeraseII,theenzyme responsible for synthesizing RNA from DNA templates. Together, the transcription factors and RNA polymerase II form a pre-initiation complex, which marks the start site for transcription.

**Elongation:**

Once the pre-initiation complex is formed, RNA polymerase II unwinds the DNA double helix and begins synthesizing RNA in the 5' to 3' direction. As the RNA polymerase moves along the DNA template strand, it adds complementary RNA nucleotides, following the base pairing rules (A-U and G-C). The newly synthesized RNA molecule elongates, and the DNA helix reforms behind the RNA polymerase.

**Processing:**

AftertheRNAmoleculeissynthesized,itundergoesseveralprocessingstepstoproduceamature messenger RNA (mRNA) molecule. These steps include capping, splicing, and polyadenylation. Capping involves the addition of a modified nucleotide (cap) to the 5' end of the RNA molecule, which protects it from degradation and assists in its export from the nucleus. Splicing is the removal of introns, non-coding regions, from the pre-mRNA molecule, leaving only the protein-coding exons. Polyadenylation is the addition of a poly-A tail, a string of adenine nucleotides, to the 3' end of the mRNA molecule, which also aids in mRNA stability and export.

**Termination:**

The termination of transcription occurs when RNA polymerase II reaches a specific termination sequenceintheDNAtemplate.ThissequencesignalsthedetachmentoftheRNApolymerase



ISBN:978-81-957858-1-0

fromtheDNAtemplateandthereleaseofthenewlysynthesizedRNAmolecule.Thetermination process is complex and can involve various mechanisms depending on the gene and the specific regulatory elements involved.

**Regulation:**

Transcription in eukaryotes is tightly regulated to ensure proper gene expression and cellular function. Transcription factors play a crucial role in controlling gene expression by binding to specificDNAsequencesandeitherpromotingorinhibitingtranscription.Additionally,epigenetic modifications, such as DNA methylation and histonemodifications, can influencetranscriptional activity by modulating chromatin structure and accessibility.

In conclusion, DNA transcription in eukaryotes is a highly regulated process that involves initiation, elongation, processing, and termination. It requires the coordinated action of transcriptionfactorsandRNApolymeraseIItosynthesizeRNAmolecules fromDNAtemplates. UnderstandingthemechanismsofDNAtranscriptionineukaryotesisessentialforunravelingthe complexities of gene expression and cellular function.



ISBN:978-81-957858-1-0

# Antibiotics

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## Abstract

antibiotic, chemical substance produced by a living organism, generally a microorganism, that is detrimental to other microorganisms. Antibiotics commonly are produced by soil microorganisms and probablyrepresentameansbywhichorganismsinacomplexenvironment,suchassoil,controlthegrowth of competing microorganisms. Microorganisms that produce antibiotics useful in preventing or treating disease include the bacteria and the fungi. Antibiotics came into worldwide prominence with the introductionofpenicillinin1941.Sincethen,theyhaverevolutionizedthetreatmentofbacterialinfections in humans and other animals. They are, however, ineffective against viruses.

Keywords:Antibiotics,Penicillin,Quinolones,Chloramphenicol,Garamycin

## Introduction

Antibiotics are medicines that fight bacterial infections in people and animals. They work by killing the bacteria or by making it hard for the bacteria to grow and multiply. Antibiotics can be taken in different ways: Orally (by mouth). This could be pills, capsules, or liquids.

### Thefirstantibiotics

In 1928 Scottish bacteriologist Alexander Fleming noticed that colonies of bacteria growing on a culture platehadbeenunfavourablyaffectedbyamold,Penicilliumnotatum,whichhadcontaminatedtheculture. A decade later British biochemist Ernst Chain, Australian pathologist Howard Florey, and others isolated theingredientresponsible,penicillin,andshowedthatitwashighlyeffectiveagainstmanyseriousbacterial infections. Toward the end of the 1950s scientists experimented with the addition of various chemical groupstothecoreofthepenicillinmoleculetogeneratesemisyntheticversions.Arangeofpenicillin’sthus became available to treat diseases caused by different types of bacteria, including staphylococci, streptococci, pneumococci, gonococci, and the spirochaetes of syphilis. Conspicuously unaffected by penicillin was the tubercle bacillus (Mycobacterium tuberculosis). This organism, however, turned out to be highly sensitive to streptomycin, an antibiotic that was isolated from Streptomyces griseus in 1943. As wellasbeingdramaticallyeffectiveagainsttuberculosis,streptomycindemonstratedactivityagainstmany other kinds of bacteria, including the typhoid fever bacillus. Two other early discoveries were gramicidin and tyrocidine, which are produced by bacteria of thegenus Bacillus. Discovered in 1939 by French-born American microbiologist René Dubos, they were valuable in treating superficial infections but were too toxic for internal use. In the 1950s researchers discovered the cephalosporins, which are related to penicillin’s but are produced by the mold Cephalosporium acremonium. The following decade scientists discovered a class of antibiotics known as quinolones. Quinolones interrupt the replication of DNA—a crucialstepinbacterialreproduction—andhaveprovenusefulintreatingurinarytractinfections,infectious diarrhea, and various other infections involving elements such as bones and white blood cells.



ISBN:978-81-957858-1-0

## Useand administrationof antibiotics

The principle governing the use of antibiotics is to ensure that the patient receives one to which the target bacterium is sensitive, at a high enough concentration to be effective but not cause side effects, and for a sufficient length oftime toensure that theinfection is totally eradicated. Antibiotics vary in their range of action.Somearehighlyspecific.Others,suchasthetetracyclines,actagainstabroadspectrumofdifferent bacteria. Theseareparticularlyuseful incombating mixed infectionsandintreating infections when there isnotimetoconductsensitivitytests.Whilesomeantibiotics,suchasthesemisyntheticpenicillinsandthe quinolones, can be taken orally, others must be given by intramuscular or intravenous injection.

## Categoriesofantibiotics

Antibioticscanbecategorizedbytheirspectrumofactivity—namely,whethertheyarenarrow-,broad-,or extended-spectrum agents. Narrow-spectrum agents (e.g., penicillin G) affect primarily gram-positive bacteria.Broad-spectrumantibiotics,suchastetracyclinesandchloramphenicol,affectbothgram-positive and some gram-negative bacteria. An extended-spectrum antibiotic is one that, as a result of chemical modification, affects additional types of bacteria, usually those that are gram-negative. (The terms gram-positive and gram-negative are used to distinguish between bacteria that have cell walls consisting of a thick meshwork of peptidoglycan [a peptide-sugar polymer] and bacteria that have cell walls with only a thin peptidoglycan layer, respectively.)

## Common antibiotics

Somecommonantibioticsarelisted

gentamicinGaramycininfectionsoftherespiratoryandurinarytracts,blood,abdominalcavity;pelvic inflammatory disease.

tobramycinAKTob,Nebcininfectionsoftherespiratoryandurinarytracts,blood,abdominalcavity;pelvic inflammatory disease.

cefaclorCeclorinfectionsoftherespiratoryandurinarytractsandskin;otitismedia

cefamandole,Mandolinfectionsoftherespiratoryandurinarytracts,skin,boneandjoints,andblood; peritonitis.

cefazolinAncef,Kefzolinfections of the respiratory and genitourinary tracts, skin, bone and joints, andblood; endocarditis.

ceftriaxone and Rocephin infections of the respiratory and urinary tracts, skin, blood, abdominal cavity, and bone and joints; pelvic inflammatory disease; gonorrhea; meningitis

cefuroximeCeftin,Kefuroxinfectionsoftherespiratoryandurinarytracts,skin,boneandjoints,andblood

cephalexinBiocef,Keflexinfectionsoftherespiratoryandurinarytracts,skin,andbone;otitismedia.

chloramphenicol,Chloromycetininfectionsoftheeyes,ears,andskin;cysticfibrosis;preventionof infection in minor wounds

ciprofloxacin,Ciproinfectionsoftherespiratoryandurinarytracts,skin,eyes,abdominalcavity,andbone



ISBN:978-81-957858-1-0

andjoints;diarrhea;gonorrhea;sinusitis;pneumonia;prostatitis;anthrax.

norfloxacin,Chibroxin,Noroxinurinarytractinfections,STDscausedbyNeisseriagonorrhoeae,eye infections, prostatitis.

clindamycin,Cleocininfectionsoftherespiratorytract,skin,andabdominalcavity;acne;pelvic inflammatory disease.

azithromycin,Zithromaxinfectionsoftherespiratorytractandskin;STDs;otitismedia;chronicobstructive pulmonary disease; pneumonia.

clarithromycinBiaxininfectionsoftherespiratorytractandskin;otitismedia

erythromycin, E.E.S., E-Mycin, Eryc infections of the respiratory tract, skin, and eyes; STDs; pertussis; diphtheria; intestinal amebiasis; otitis media; acne; Legionnaire disease; prevention of infection in minor wounds.

nitrofurantoinFuradantin,Macrobidurinarytract infections.

amoxicillin,Amoxil,Trimoxvariousstreptococcalandstaphylococcalinfections.

ampicillin,Marcillin,Omnipen infections of the respiratory and urinary tract and blood; meningitis; gonococcal infections; endocarditis.

penicillinG,Bicillin,Pen-GPot,Wycillinstreptococcalandstaphylococcalinfections.

piperacillin,Pipracilinfectionsoftherespiratoryandgenitourinarytracts,skin,abdominalcavity,boneand joints, and blood.

ticarcillin,Ticarinfectionsoftherespiratoryandgastrointestinaltracts;streptococcalandpseudomonas infections; gonorrhea; tonsillitis; Lyme disease; impetigo; otitis media; meningitis.

## Mechanismsof action

Antibiotics produce their effects through a variety of mechanisms of action. A large number work by inhibiting bacterial cell wall synthesis; these agents are referred to generally as β-lactam antibiotics. Production of the bacterial cell wall involves the partial assembly of wall components inside the cell, transport of these structures through the cell membrane to the growing wall, assembly into the wall, and finally cross-linking of the strands of wall material. Antibiotics that inhibit the synthesis of the cell wall have a specific effect on one or another phase. The result is an alteration in the cell wall and shape of the organism and eventually the death of the bacterium.

Other antibiotics, such as the aminoglycosides, chloramphenicol, erythromycin, and clindamycin, inhibit protein synthesis in bacteria. The basic process by which bacteria and animal cells synthesize proteins is similar, but the proteins involved are different. Those antibiotics that are selectively toxic utilize these differences to bind to or inhibit the function of the proteins of the bacterium, thereby preventing the synthesis of new proteins and new bacterial cells.

AntibioticssuchaspolymyxinBandpolymyxinE(colistin)bindtophospholipidsinthecellmembraneof the bacterium and interferewithits functionasa selective barrier;thisallowsessentialmacromolecules in



ISBN:978-81-957858-1-0

thecelltoleakout,resultinginthedeathofthecell.Becauseothercells,includinghumancells,havesimilar or identical phospholipids, these antibiotics are somewhat toxic.

Someantibiotics,suchasthesulfonamides,arecompetitiveinhibitorsofthesynthesisoffolicacid(folate), which is an essential preliminary step in the synthesis of nucleic acids. Sulfonamides are able to inhibit folicacidsynthesisbecausetheyaresimilartoanintermediatecompound(para-aminobenzoicacid)thatis converted by an enzyme to folic acid. The similarity in structure between these compounds results in competition between para-aminobenzoic acid and the sulfonamide for the enzyme responsible for convertingtheintermediatetofolicacid.Thisreactionisreversiblebyremovingthechemical,whichresults in the inhibition but not the death of the microorganisms. One antibiotic, rifampin, interferes with ribonucleic acid (RNA) synthesis in bacteria by binding to a subunit on the bacterial enzyme responsible for duplication of RNA. Since the affinity of rifampin is much stronger for the bacterial enzyme than for the human enzyme, the human cells are unaffected at therapeutic doses.

## Antibioticresistance

A problem that has plagued antibiotic therapy from the earliest days is the resistance that bacteria can develop to the drugs. An antibiotic may kill virtually all the bacteria causing a disease in a patient, but a few bacteria that are genetically less vulnerable to the effects of the drug may survive. These go on to reproduceortotransfertheirresistancetoothersoftheirspeciesthroughprocessesofgeneexchange.With their more vulnerable competitors wiped out or reduced in numbers by antibiotics, these resistant strains proliferate. The end result is bacterial infections in humans that are untreatable by one or even several of the antibiotics customarily effective in such cases. The indiscriminate and inexact use of antibiotics encourages the spread of such bacterial resistance.Researchers are continually working to discover new antibioticsasameansofovercomingantibioticresistance.Somepotentiallyeffectivecompoundsthathave beendiscoveredincludecertainbacterialtoxinsandantimicrobialpeptides.Noveltreatmentstrategies,such as combiningsynergisticantibioticsto boostthekillingofbacteria, arealso underinvestigation.Itmay be possible to introduce compounds into bacterial populations that effectively resensitize the bacteria to existing antibiotic drugs.

## Majorantibiotics

Eachtypeofantibiotichasaspecificapplicationinmedicineandcanserveasausefulmodelforexploring the various mechanisms by which antibiotics exert their effects. The following sections focus on the penicillins and cephalosporins, imipenem, the antituberculosis antibiotics, and the agents aztreonam, bacitracin,andvancomycin.Theseagentsandgroupsofagentsfurtherillustratethechemicalandfunctional diversity found among the antibiotics.

## Penicillins

The penicillins have a unique structure, a β-lactam ring, that is responsible for their antibacterial activity. The β-lactam ring interactswith proteinsin the bacterial cell responsible forthe final step in the assembly ofthecellwall.thepenicillinscanbedividedintotwogroups:thenaturallyoccurringpenicillins(penicillin G, penicillin V, and benzathine penicillin)andthe semisynthetic penicillins. Thesemisynthetic penicillins areproducedbygrowingthemoldPenicilliumunderconditionswherebyonlythebasicmolecule(6-



ISBN:978-81-957858-1-0

aminopenicillanicacid)is produced. By addingcertainchemical groups tothismolecule, several different semisyntheticpenicillinsareproducedthatvaryinresistancetodegradationbyβ-lactamase(penicillinase), an enzyme that specifically breaks the β-lactam ring, thereby inactivating the antibiotic. In addition, the antibacterialspectrumofactivityand pharmacologicalpropertiesof thenatural penicillins can bechanged andimprovedbythesechemicalmodifications.Theadditionofaβ-lactamaseinhibitor,suchasclavulanic acid, to a penicillin dramatically improves the effectiveness of the antibiotic. Several naturally occurring inhibitors have been isolated, and others have been chemically synthesized. The naturally occurring penicillinsremain the drugs of choice fortreatingstreptococcal sorethroat,tonsillitis, endocarditis caused by some streptococci, syphilis, and meningococcal infections. Several bacteria, most notably Staphylococcus, developedresistancetothenaturallyoccurring penicillins,whichledtothe productionof the penicillinase-resistant penicillins (methicillin, oxacillin, nafcillin, cloxacillin, and dicloxacillin). The use of several of these agents, however, has been severely limited by resistance; methicillin is no longer used, because of the emergence of methicillin-resistant Staphylococcus aureus (MRSA). To extend the usefulnessofthepenicillinstothetreatmentofinfectionscausedbygram-negativerods,thebroad-spectrum penicillins (ampicillin, amoxicillin, carbenicillin, and ticarcillin) were developed. These penicillins are sensitive to penicillinase, but they are useful in treating urinary tract infections caused by gram-negative rods as well as in treating typhoid and enteric fevers. The extended-spectrum agents (mezlocillin and piperacillin) are unique in that they have greater activity against gram-negative bacteria, including Pseudomonasaeruginosa,abacteriumthatoftencausesseriousinfectioninpeoplewhoseimmunesystems have been weakened. They have decreased activity, however, against penicillinase-producing Staphylococcus aureus, a common bacterial agent in food poisoning. the penicillins are the safest of all antibiotics.Themajoradversereactionassociatedwiththeiruseishypersensitivity,withreactionsranging from a rash to bronchospasm and anaphylaxis. The more serious reactions are uncommon.

## Cephalosporins

The cephalosporins have a mechanism of action identical to that of the penicillins. However, the basic chemical structure of the penicillins and cephalosporins differs in other respects, resulting in some difference in the spectrum of antibacterial activity. Modification of the basic molecule (7-aminocephalosporanic acid) produced by Cephalosporium acremonium resulted in four generations of cephalosporins. The first-generation cephalosporins (cefazolin, cephalothin, and cephalexin) have a range of antibacterial activity similar to the broad-spectrum penicillins described above. For instance, they are effective against most staphylococci and streptococci as well as penicillin-resistant pneumococci.

The second-generation cephalosporins (cefamandole, cefaclor, cefotetan, cefoxitin, and cefuroxime) have anextendedantibacterialspectrumthatincludesgreateractivityagainstadditionalspeciesofgram-negative rods. Thus, these drugs are active against Escherichia coli and Klebsiella and Proteus species (though several strains of these organisms have developed resistance). Cefamandole is active against many strains of Haemophilus influenzae and Enterobacter, while cefoxitin is particularly active against most strains of Bacteroides fragilis. Second-generation cephalosporins have decreased activity, however, against gram-positive bacteria. The third-generation cephalosporins (ceftriaxone, cefixime, and ceftazidime) have increasedactivityagainstthegram-negativeorganismscomparedwiththesecond-generationagents.Most



ISBN:978-81-957858-1-0

Enterobacter species are susceptible to these drugs, as are H. influenzae and various species of Neisseria. The antibacterial spectrum of the fourth-generation compounds (cefepime) is similar to that of the third-generation drugs, but the fourth-generation drugs have more resistance to β-lactamases.

Likethepenicillins,thecephalosporinsarerelativelynontoxic.Becausethestructureofthecephalosporins is similar to that of penicillin, hypersensitivity reactions can occur in penicillin-hypersensitive patients.

## Imipenem

Imipenemisaβ-lactamantibioticthatworksbyinterferingwithcellwallsynthesis.Itishighlyresistantto hydrolysis by most β-lactamases. This drug must be given by intramuscular injection or intravenous infusion because it is not absorbed from the gastrointestinal tract. Imipenem is hydrolyzed by an enzyme presentin the renal tubule;therefore,itis always administered with cilastatin, aninhibitor ofthis enzyme. Neurotoxicity and seizures have limited the use of imipenem.

## Antituberculosis antibiotics

Isoniazid,ethambutol,pyrazinamide,andethionamidearesyntheticchemicalsusedintreatingtuberculosis. Isoniazid, ethionamide, and pyrazinamide are similar in structure to nicotinamide adenine dinucleotide (NAD), a coenzyme essential for several physiological processes. Ethambutol prevents the synthesis of mycolicacid,alipidfoundinthetuberculebacillus.All thesedrugsareabsorbedfromthegastrointestinal tract and penetrate tissues and cells. An isoniazid-induced hepatitis can occur, particularly in patients 35 yearsofageorolder.Cycloserine,anantibioticproducedbyStreptomycesorchidaceus,isalsousedinthe treatment of tuberculosis. A structural analog of the amino acid D-alanine, it interferes with enzymes necessary for incorporation of D-alanine into the bacterial cell wall. It is rapidly absorbed from the gastrointestinal tract and penetrates most tissues quite well; high levels are found in urine. Rifampin, a semisyntheticagent,isabsorbedfromthegastrointestinaltract,penetratestissuewell(includingthelung), andisusedinthetreatmentoftuberculosis.Rifampinadministrationisassociatedwithseveralsideeffects, mostly gastrointestinal in nature. The drug can turn urine, feces, saliva, sweat, and tears red-orange in colour.

## Aztreonam,bacitracin,andvancomycin

Aztreonamisa synthetic antibioticthat worksbyinhibitingcellwall synthesis,anditis naturallyresistant tosomeβ-lactamases.Aztreonamhasalowincidenceoftoxicity,butitmustbeadministeredparenterally. Bacitracinisproducedbyaspecialstrainof Bacillussubtilis.Becauseofitsseveretoxicitytokidneycells, its use is limited to the topical treatment of skin infections caused by Streptococcus and Staphylococcus and for eye and ear infections.

Vancomycin, an antibiotic produced by Streptomyces orientalis, is poorly absorbed from the gastrointestinal tract and is usually given by intravenous injection. It is used for the treatment of serious staphylococcalinfectionscausedbystrainsresistanttothevariouspenicillins.ItsuseagainstMRSAledto the emergence of vancomycin-resistant Staphylococcus aureus (VRSA).



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# GoodLaboratoryPractice(GLP)RegulationsandAccreditation

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**Abstract**

The quality control department of a company oversees good laboratory practice. However, it is ultimatelytheresponsibilityofeverymemberofstaffinvolvedwithlaboratorytesting. Intheearly 70's FDA (United States Food and Drug administration) have realized cases of poor laboratory practice throughout the United States. FDA decided to check over 40 toxicology labs in-depth. They revealed lot dishonest activities and a lot of poor lab practices. Examples of some of these poor lab practices found were equipment not been calibrated to standard form, therefore giving wrongmeasurements,incorrectorinaccurateaccountsoftheactuallabstudyandincompetenttest systems.Althoughtheterm"goodlaboratorypractice"mighthavebeenusedinformalalreadyfor sometimeinmanylaboratoriesaroundtheworldGLPoriginatedintheUnitedStatesandithada power-full effect worldwide.

**Keywords:**GLP,Qualityassurance,FDA,Chemicals,Acceptance.

## Introduction

History of Good Laboratory Practice (GLP) GLP is an official regulation that was created by the FDAin1978.TheOECD(OrganisationforEconomicCo-operationandDevelopment)Principles of Good Laboratory Practice were first created by an Expert Group on GLP set up in 1978 under the Special Programme on the Control of Chemicals. The GLP regulations that are accepted as international standards for non-clinical laboratory studies published by the US Food and Drug Administrationin1976suppliedthebasisfortheworkoftheExpertGroup,whichwasguidedby theUnitedStatesandconsistedexpertsfromthefollowingcountriesandorganisations:Australia, Austria, Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, the UnitedStates,theCommissionoftheEuropeanCommunities,theWorldHealthOrganisationand the International Organisation for Standardisation. Eventually after United States other countries startedmakingGLPregulationsintheirhomecountries.(Lorietal.,2009)2.1ThosePrinciplesof GLP were officially suggested for use in member countries by the OECD Council in 1981. They were set about as an essential part of the Council Decision on Mutual Acceptance of Data in the Assessment of Chemicals, which expresses that "data denoted in the testing of chemicals in an OECDmembercountryinaccordancewithOECDTestGuidelinesandOECDPrinciplesofGood Laboratory Practice shall be accepted in other member countries for the aims of assessment and other uses relating to the protection of man and the environment"



ISBN:978-81-957858-1-0

DefinitionofGLPThequalityisthecapabilitytosystematicallyproducethesameproducttomeet the same specifications time after time. GLP was altered to protect the integrity and quality of laboratorydatausedtobackupaproductapplication.Thedefinitionoftheterm“GoodLaboratory Practice”itself, whichidentifiesGLPas“aqualitysystemrelatedwiththe organisationalprocess and the conditions under which non-clinical health and environmental safety studies areplanned, performed, monitored, recorded, archived and reported.” can be considered as an example of a briefandaccuratedefinition.GLPdescribesgoodpracticesfornon-clinicallabstudiesthatsupport research or marketing approvals for FDA-regulated products (Seiler, 2005).

Purpose of GLP Everyone makes mistakes that’s why GLP is needed. GLP principles are a good ideaevenifyouarenotrequiredtofollowthestandards.Therearesomesimplerulessuchas:Say What You Do (with written standard operating procedures), do what you say (follow the procedures), be able to prove it (with good record keeping) (Jean Cobb, 2007).

The principles of good laboratory practice (GLP) is to support the development of quality and validity of test data used for determining the safety of chemicals and chemicals product (Clasby, 2005).

The principles of good laboratory practice Good Laboratory Practice is based on four principles: The Management; The Quality Assurance; The Study Director; and The National Compliance Monitoring Authority. All of them serve important functions in the concordance of performing andmonitoringsafetystudies,anditshouldbekeptinmindthatallofthemarerequiredforGLP toachievequalitydata.2.2.1AlthoughGLPdiffersfromotherqualitysystemsinaspectsthatare important not only for the traceability of data but especially for the full reconstruct ability of the study, there are certain co-occurrences between GLP and other quality systems like accreditation schemes. (Seiler, 2005).

The aim of this chapter will be to give enough information about the GLP in details with the test facility organisation and personal, the facilities of quality assurance programme, test system, archive and waste disposal, apparatus, material, and reagents, physical, chemical, biological test systems, receipt, handling, sampling and storage and characterisation of the test and reference items,standardoperatingprocedures,performanceofthestudy,reportingofstudyresults,storage and retention of records and materials.

Theconcerns ofthechaptermay besummarized as follows:

1. Testfacility management
2. Qualityassurance programme
3. Meetingtherequirementsofthetest facility
4. Equipment



ISBN:978-81-957858-1-0

5. Receipt,handling,samplingandstorage

6. Standardoperating procedures.

7. Performanceofthestudy.

8. Reportingof study results

9. Storageandretentionofrecordsandmaterials.

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ISBN:978-81-957858-1-0

## ClassificationofMicroorganisms

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### Abstract

classification,alsoknownastaxonomy,whichisthearrangementoforganismsintorelatedgroups.Inthis lesson, we will explain the categories into which microorganisms can be placed - bacteria, algae, fungi, protozoa, and viruses.In addition, we will briefly consider a few larger organisms such as rotifers and worms.But before we consider the different types of microorganisms, you need to understand how scientists classify all living organisms.

**Keywords:**Microorganisms,Viruses,Prokaryotes,Mammalia,Eukaryotes,Protozoa

### Introduction

kingdomisthemostgeneralcategoryusedtodescribeanorganism.AcatisinthekingdomAnimalia,also knownastheanimalkingdom.Avarietyofotherorganismssuchasworms,insects,andsnailsarealsoin the animal kingdom.By saying that cats and snails are in the same kingdom, we are saying that they are more closely related to each other than either is related to, for example, a fern in the plant kingdom. Each category below kingdom narrows down the types of characteristics which an organism has.The phylum Chordata,forexample,includesonlyanimalswithbackbones,whiletheclassMammaliacontainsanimals with backbones which also have hair and feed their young with milk. The narrowest category is species, whichisagroupoforganismsthathavesimilartraitsandcaninterbreed.Scientistsusuallyrefertoacertain species of organism using its scientific name, which consists of both its genus and species names with the genus name capitalized and with both names italicized.For example, the scientific name of the domestic catisFeliscactus,thescientificnameofhumansisHomosapiens,andthescientificnameoftheorganism which causes giardiasis is Giardia lamblia.

### Microorganism Classification

The three most general groups into which the organisms are placed are prokaryotes, eukaryotes, and non-living organisms.We will explain what each of these categories mean in a later section.For now, you should just be aware that prokaryotes are more primitive organisms than eukaryotes.Only bacteria are prokaryotes; the rest of the organisms considered in this course are either eukaryotes or viruses.

### Prokaryotes

Bacteria are prokaryotes. Prokaryotes are organisms which do not contain nuclei or membrane-bound organelles.(Nuclei and organelles are both cell parts which we will define in a later section.)All prokaryotes are unicellular, which means that each organism is made up of only one cell. Another trait common to all prokaryotes is their small size - a typical cell is only about 2 um long.A micrometer, abbreviated as um and sometimes known as a micron, is equal to one millionth of a meter.It would take about 13,000 prokaryotes lying end to end to stretch the length of one inch.Under a light microscope, bacteriaaresosmallthattheyareusuallyvisibleonlyastinydots.Althoughthereartwokingdomswhich



ISBN:978-81-957858-1-0

containprokaryotes(EubacteriaandArchaebacteria),allprokaryotesarecommonlyknownasbacteria.In the past, some prokaryotes have been called blue-green algae, but these organisms are now known as cyanobacteria. Bacteria are present in large numbers in raw wastewater, in biological treatment plants, in plant effluent, in natural waters, and throughout our environment.In the wastewater treatment plant, they form part of the slime on trickling filters and on the discs of rotating biological contactors.They are also present in activated sludge.

## Cell Structure

A cell is the fundamental unit of all life.In the case of unicellular organisms, a cell is the body of the organism.Inthecaseofmulticellularorganisms(organismswhichconsist ofmorethanonecell),thecell is the building block from which the organism's bodyis made. Inside the membrane, the cell isfilled with a fluid known as cytoplasm.Floating in the cytoplasm are various organelles (subcellular structures with specific functions.)We have only illustrated a few of the most important organelles.Notice that the the DNA,whichcontainsthegeneticmaterialofthecell,isfloatingfreelyinamasswithinthecell.Inaddition to the main mass of DNA, the bacterial cell contains plasmids, which are small loops of DNA which can be transferred to other bacteria, or in some cases into other organisms.Ribosomes are the sites of protein synthesis.Outsidethemembrane,mostbacteriaaresurroundedbytwootherlayers.Thefirstofthese,the cellwall,isarigidlayermadeupofproteins,polysaccharides,andlipids.Thecellwallgivesthebacterium a set shape.Outside the cell wall is the capsule, a gelatinous slime layer which allows the bacterium to attachtosurfacesandalsoprotectsthebacterium.Inthetreatmentplant,bacterialcapsulesareresponsible for clumping the organisms into flocs, or aggregations, which can settle out of water.In order for disinfecting agents such as chlorine to be effective, they must penetrate this protective slime layer.The bacteriumcanalsohavevariousappendages.Piliarehollow,hair-likestructureswhichallowthebacterium toattachtoothercells.Flagellaarelongerprojectionswhichcanmoveandpushthebacteriumfromplace to place.

## Endospore

Some bacteria are able to survive in harsh environments by forming endospores.Endospores are small spores which develop asexually inside the bacterial cell.An endospore consists of the bacterium's DNA surrounded by a protective cell wall.Once the endospore has formed, the parent cell bursts open and releases the endospore. An endospore is able to survive in very harsh environments because it is in a dormant stateand does not attempt to eat, grow, andreproduce.Bacteriatypicallyform endospores when they encounter an undesirable pH, electrolyte content, amount of food, or amount of oxygen in the environment.Once the environmental conditions improve, the endospore is able to germinate and turn back into a growing bacterial cell.

## Classification

There are thousands of species of bacteria on earth, many of which have not yet been identified.When attemptingtoclassifyabacterium,avarietyofcharacteristicsareused,includingvisualcharacteristicsand laboratory tests. Some bacteria can be identified through a simple visual perusal.First, the operator considers the appearance ofthe bacterial colony (a group of the same kind ofbacteria growing together,



ISBN:978-81-957858-1-0

often on a petri dish.)The operator also views individual bacteria under a microscope, considering their shape, groupings, and features such as the number and location of flagella. A variety of laboratory techniquescanbeusedtonarrowdowntheidentityofabacterialspeciesifavisualsurveyisnotsufficient. Theoperatorcanstainthebacteriausingagramstainoranacid-faststain.Thebacteriacanbeculturedon aspecificmediumwhichpromotesthegrowthofcertainspecies,asinthemembranefiltermethodoftesting for coliform bacteria.Other tests can detect bacterial by-products, while yet more advanced tests actually analyze the DNA of the bacteria.

**Bacterial Shapes** Themostbasicmethodusedforidentifyingbacteriais basedonthebacterium's shape and cell arrangement.This section will explain the three morphological categories which all bacteria fall into - cocci, bacilli, and spirilla.You should keep in mind that these categories are merely a way of describing the bacteria and do not necessarily refer to a taxonomic relationship.

**Cocci:** Cocci (or coccus for a single cell) are round cells, sometimes slightly flattened when they are adjacent to one another.Cocci bacteria can exist singly, in pairs (as diplococci), in groups of four (as tetrads), in chains (as streptococci), in clusters (as stapylococci), or in cubes consisting of eight cells (as sarcinae.)

Bacilli:Bacilli(orbacillusforasinglecell)arerod-shapedbacteria.Sincethelengthofacellvariesunder theinfluenceofageorenvironmentalconditions,youshouldnotusecelllengthasamethodofclassification for bacillus bacteria.Like coccus bacteria, bacilli can occur singly, in pairs, or in chains.Examples of bacillusbacteriaincludecoliformbacteria,whichareusedasanindicatorofwastewaterpollutioninwater, as well as the bacteria responsible for typhoid fever.

Spirilla: Spirilla (or spirillum for a single cell) are curved bacteria which can range from a gently curved shape to a corkscrew-like spiral.Many spirilla are rigid and capable of movement.A special group of spirilla known as spirochetes are long, slender, and flexible.

## Eukaryotes

except for bacteria and viruses, all other organisms considered in this course are eukaryotes.Eukaryotes are unicellular or multicellular organisms which contain a nucleus and membrane-bound organelles.A nucleusisamembranesacwithinthecellwhichholdsallofthecell'sDNA.Membrane-boundorganelles withinthecellcanincludechloroplasts,mitochondria,andseveralotherorganelletypeswhichwewillnot discusshere.Liketheprokaryoticcell,theeukaryoticcellisfilledwithcytoplasm.Ribosomesandvarious otherorganellescanbefoundfloatinginthecytoplasm.Thetwoadditionalorganellesshowninthediagram above are membrane-bound and are found only in eukaryotic cells.Mitochondria (mitochondrion when referring to a single organelle) are present in nearly all eukaryotic cells and produce the cell's energy by breaking down food.Chloroplasts, in contrast, are present only in plants and algae and are used in photosynthesis, the process through which the organism uses energy from the sun to build sugars.

**Fungi:** Fungi are organisms which typically cannot move, which cannot make their own food (heterotrophic),andwhichcontainachemicalknownaschitinintheircellwalls.Theycanbemulticellular orunicellular,withtheunicellularorganismshavingrelativelylargecells.Althoughsomefungiliveinsalt orfreshwater,mostfungiareterrestrial.Manyspeciesaresaprophytic,feedingondeadorganicmatter.



ISBN:978-81-957858-1-0

Othersareparasiteswhichliveinsideoronhostanimals,primarilyfeedingonplantsthoughafewalsolive on animals.The aquatic fungi are important in treating wastewater.

**Typesoffungi:**Classificationoffungiisbasedprimarilyonreproductivestructures,withalloftheaquatic fungibeingfoundintheMastigomycotagroup.Weuseseveralcommonnamestorefertogroupsoffungi, butthesegroupingsreferonlytomorphologyandnottoanyrelationshiporscientificclassification.Yeast aresingle-celledfungi,moldsarefilamentousfungiconsistingofmultiplecellsinthreadsknownashyphae, and mushrooms are the fruiting bodies of filamentous fungi.

**Algae**:Commonnamesusedtorefertoalgaeinclude"seaweed"and"pondscum."Algaearedistinguished fromanimals,fungi,andprotozoansbytheirabilitytomaketheirownfoodthroughphotosynthesisandare distinguished from plants by their relative simplicity of structure.All algae contain the green pigment chlorophyll and the organelles chloroplasts, both of which are essential for photosynthesis. Algae may be either unicellular (in which case they are known as phytoplankton) or multicellular.The algae which are important to water treatment are generally unicellular.All algae contain a rigid cell wall and some also have sheaths (or thin gelatinous coatings) outside the cell wall.Algae may be non-motile, but many are able to move using a flagella, in which case they are known as flagellates (a term based on morphology rather than taxonomy.)

## Algaebloom.

Algae can be problematic in nutrient-rich waters, especially those containing phosphorus, in which case they often reproduce rapidly and produce colored water and mats of algae known as algae blooms.In natural waters or treatment plants, algae blooms are problematic because they can change many water characteristics. One of the primary factors which algae blooms influence is the dissolved oxygen content of the water.During the day, the masses of algae produce so much oxygen that the water becomes supersaturated.Then,atnight,thealgaeactuallyuseupoxygeninthewaterandcancausesuchextremely low dissolved oxygen levels that fish kills may result. Algae blooms can also cause elevated pH levels in thewater.TheymayraisethepHlevelsashighas9.5,whichwillinfluencemanyof thenaturalprocesses occurringinthewater.Insomecases,analgaebloomwillconsumeitself.Asthealgaegrowandreproduce, they use upnutrients inthewater.Eventually, the nutrient levels will dropso low that the algae will have no nutrients and will die back.In this case, the dead algae bodies will often promote a bacterial bloom as the bacteria respond to the abundance of food.This overabundance of bacteria can cause yet more problems,depletingthedissolvedoxygenlevelsinthewaterandcausingthesystem tobecomeanaerobic.

## Protozoa

Protozoaareunicellularorganismswhichareheterotrophicandaremobileatsomestageintheirlife.They donothaveacellwall,althoughtheirmembraneisoftensurroundedbyapellicle(athin,flexible,protective coating).A few protozoa give their cells rigidity by producing shells made out of calcium carbonate or silicon. Protozoa are important in both water and wastewater treatment.They are responsible for several ofthewater-bornediseases.Inaddition,protozoa helpbreakdownwasteinaerobic wastewatertreatment plants.Protozoa are divided into four groups based on their method of locomotion.Scientists initially believedthatthesegroupsactuallyrepresentedtaxonomicrelationships,butnowmanyscientistssuspect



ISBN:978-81-957858-1-0

that the taxonomy of protozoa is much more complicated.For the sake of simplicity, we will use the old method of classification here, based on mode of locomotion.

**Amoebae** Amoebae, like those shown above, are protozoans which move by extending finger-like protrusions of their cells called pseudopodia.An amoeba can also use its pseudopodia to engulf a food particleinaprocessknownasendocytosis,bringingthefoodinsidethecellwhereitcanbedigested.You canseeseveralengulfedfoodparticlesascircleswithineachamoebacellabove.Althoughmostamoebae are free-living, one species is the cause of amoebic dysentery.

**Giardia** Flagellates are protozoa which move using flagella.This is a very diverse group which is considered by somescientiststo include the euglenoidalgae.An example of aflagellate is Giardia which isfoundinmanynatural watersandcausesgiardiasiswheningested.Asyoucanseeinthepictureabove, Giardia contains two nuclei, a trait shared by several other protozoa.

**Paramecium**

Ciliates are protozoa which use the motion of tiny hairs, called cilia, to propel them through the water. Ciliatesareusuallyfoundinlargenumbersinnaturalwatersandinsewagewheretheyactaspredators and scavengers, ingesting food through "mouths."A few species are parasitic, living inside hosts.The image above is an example of a Paramecium, which is a typical ciliate protozoan.Notice that the Paramecium has both a large and a small nucleus, a trait typical of ciliates.

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ISBN:978-81-957858-1-0

# MetalPoisoning:Arsenic

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**Abstract**

Metal poisoning is primarily caused by human activities, leading to increased metal levels in theenvironment and potential health risks. Metals have various uses in industry, agriculture, andmedicine, increasing exposure to both occupational workers and consumers. Understanding thecommon toxicological features of metals is crucial as they must enter cells to exert their toxicity.Metal poisoning can result from acute or chronic exposure, and proper timing of specimencollectionisimportantforaccurateanalysisandinterpretationofpoisoningcases.Thewideran ge of metallic or anionic poisons that might be involved in any case of suspected poisoning means that great care is required in the collection of appropriate specimens and the selection of toxicological and other tests.

**Keywords:**Heavymetals,Non-poisonous,Metalpoisoning,Toxicological,Poisons

**Arsenic**

Metallic arsenic, which is black in color, is commonly known to be non-poisonous, primarily because it is not easily absorbed by the alimentary canal when ingested. However, it is important to note that when subjected to heat, metallic arsenic can undergo a chemical transformation. The heatcausesthearsenictoreactwithoxygen,resultingintheformationofarsenictrioxide,ahighly poisonous vapor.

Arsenic, in its metallic form, is relatively stable and has limited reactivity in the body. When ingested orally, it passes through the digestive system without being significantly absorbed into the bloodstream. This characteristic has led to the belief that metallic arsenic is not poisonous.

However, caution must be exercised when handling metallic arsenic, as it can be hazardous if volatilized. When exposed to high temperatures, such as duringheating or burningprocesses,the metallicarsenicreactswithatmosphericoxygen,convertingintoarsenictrioxide.Arsenictrioxide is a toxic compound that can readily evaporate into the air as a vapor.

Inhalation of arsenic trioxide vapor poses significant health risks. It can be absorbed by the respiratory system and subsequently enter the bloodstream, leading to various adverse effects on the body. Prolonged or excessive exposure to arsenic trioxide vapor can cause serious health problems, including respiratory issues, cardiovascular complications, and damage to organs such as the liver and kidneys.Therefore, while metallic arsenic itself may not be poisonous when ingested,thetransformationofmetallicarsenicintoarsenictrioxidevaporthroughheating



ISBN:978-81-957858-1-0

processes can result in a highly toxic substance. It is crucial to handle and dispose of metallic arsenic safely to prevent the generation and release of poisonous arsenic trioxide vapor.

Chronic arsenic poisoning from arsenic oxide is characterized by a complex array of signs and symptoms. These may include weight loss, general discomfort, skin hyperpigmentation, white linesonthenails,liverdamage,bloodabnormalities,peripheralneuropathy,andanincreasedrisk of skin and liver cancer. Acute poisoning manifests as bloody diarrhea, vomiting, excruciating abdominal pain, circulatory collapse, and coma. Chronic exposure to arsenic is also associated with skin and respiratory cancers.

Hair and nail analysis have been employed in the diagnosis and assessment of chronic arsenic poisoning, particularly in suspected homicides. However, distinguishing between external contamination and ingested arsenic can pose challenges. Normal values for arsenic in blood and urinearetypicallybelow10μg/L,butelevatedlevelscanbeobservedafterconsumingseafoodor in cases of occupational exposure. It is essential to consider the possibility of elevated arsenic levels from these sources when interpreting measured concentrations. In acute inorganic arsenic poisoning, concentrations above 500 μg/L may be detected in blood and urine.

**Action**

Arsenic exerts its action by disrupting cellular respiration. It achieves this by binding to the sulfhydryl groups present in mitochondrial enzymes, particularly pyruvate oxidase and specific phosphatases. By interfering with these enzymes, arsenic hinders the normal functioning of cellular respiration. Additionally, it primarily targets the vascular endothelium, leading to increased permeability, tissue edema, and hemorrhage, particularly within the intestinal canal.

Locally,arseniccausesirritationofthemucousmembranes,whileitseffectsonthenervoussystem are observed at a distance from the site of exposure. Arsenate, another form of arsenic, induces toxicity by uncoupling mitochondrial oxidative phosphorylation, a crucial process in energy production. By disrupting this process, arsenate impairs the efficient utilization of energy within cells. Furthermore, arsenic interferes with glycolysis, the metabolic pathway responsible for breaking down glucose to generate energy.

Thecombinationoftheseactionsleadstoarangeofadverseeffectsonthebody.Theinterference withcellularrespirationresultsincompromisedenergyproduction,impactingvarioustissuesand organ systems. The disruption of mitochondrial enzymes and oxidative phosphorylation affects the functioning of vital cellular processes. The specific targeting of the vascular endothelium causes increased permeability, leading to tissue edema and hemorrhage, particularly in the intestinalcanal.Thelocalirritationofmucousmembranescontributestodiscomfortandpotential damageatthesiteofexposure.Arsenic'seffectsonthenervoussystemcanmanifestasdepression, impacting mood, cognition, and overall neurological function.



ISBN:978-81-957858-1-0

Understanding the mechanisms of arsenic toxicity is essential for comprehending its harmful effects on the body. By interfering with cellular respiration, disrupting mitochondrial enzymes, and uncoupling oxidative phosphorylation, arsenic disrupts vital metabolic processes and compromises the functioning of various tissues and systems. The vascular endothelium is a primarytarget, resulting in increased permeability, tissue edema, and hemorrhage, particularly in theintestinalcanal.Additionally,arsenic'slocalirritationanddistanteffectsonthenervoussystem contribute to its overall toxic impact.

**ColourtestforArsenic**

**Reinsch's Test**

About 20 ml. of concentrated Hydrochloric Acid and 100 ml. of water are taken in a porcelain basininwhichabrightCopperfoil,ofabout3x1/4inch,isplacedwithoneofitsendsbeingfixed ontheedgeofthebasinintheformaloop. ItisboiledforabouthalfanhourtoseeiftheCopper, basinandtheacidarefreefromthemetaltobetested(hereitisArsenic)Ifastainon Copperfoil appears, the blank experiment is to be carried out again with fresh materials. If the blank is negative, the suspected material is added and boiled for about an hour or more with random addition of water and acid to make up for the loss due to evaporation. A shining steel grain stain appearsinafewminuteswhichbecomethickslowly.ThestainedCopperstripobtainedbyReinsch test is washed cautiously with water followed by alcohol and finally with Ether to remove the adheringfat,ifthematricesarebiologicalmaterials.Thestripisdriedbykeepingitbetweenfilter paper sheets, cut in small pieces of 0.2 mm x 0.2 mm size and taken into Reinsch tube. The tube isheatedslowly ontheflameofspiritlamp.Theblackdepositon theCopperstripvolatilizes and gets deposited on the cooler part of the tube. The tube is cooled and viewed under microscope. CharacteristicoctahedralcrystalsofArseniousOxideareseen.OrganicArsenicalsdonotrespond if organic matter is not destroyed. Some organic sulphur compounds produce black stains of Copper sulphide, which may be removed by oxidation. The concentration of Hydrochloric Acid should not be too low or too high. This test is generally used for rapid screening of Arsenic, Antimony and Mercury.

**GutzeitTest**

ThesolutionobtainedfromtheWetDigestionprocessistestedbythismethod.1ml.ofthesolution is taken into a Gutzeit apparatus, 2 pellets of pure Zinc metal are put into it. 5 ml. of dilute Sulphuric Acid is poured over the contents. The evolved gas is purified by passing over Lead Acetate paper (to absorb Hydrogen Sulphide gas) and is reacted finally with Mercuric Chloride test paper. A yellow stain on the paper indicates the presence of Arsenic.



ISBN:978-81-957858-1-0

**Marsh'sTest**

Electrolytic Marsh Berzelius test is done over conventional Zinc-Sulphuric Acid method for the evolution of nascent hydrogen as these reagents are often contaminated with Arsenic etc. Scanty materials like burnt bones, hair and nail peelings containing minute traces of Arsenic and for testing the feeble traces of Arsenic present as a natural constituent in tissues, the Marsh's test appears to be the only reliable technique available. The test is performed in the solution obtained fromthewetdigestionprocess.ThesolutioncontainingArsenicinthepentavalentstateisreduced to trivalent state by boiling with pyrogallol solution and sulphurated water. One ml of the test solutionistakenintoaporcelainbasin,mixedwith2to3dropsof0.5%pyrogallolsolutionand 1.0ml ofsaturated sulphuratedwater (watersaturatedwith SO2)and boiledfor30 minutes.

**Conclusion**

In forensic science, arsenic testing plays a crucial role in determining the presence andconcentration of arsenic in various samples. The advantages of arsenic testing lie in its ability toprovideevidenceincasesofsuspectedarsenicpoisoningorhomicides.Ithelpsestablishthecauseof death, supports the investigation process, and aids in determining the source of arsenic.However,arsenictestingalsohasitslimitations.Theinterpretationofresultscanbecomplex,and distinguishing between external contamination and ingested arsenic can be challenging.Additionally, arsenic levels in the body can vary, making it important to consider factors likedietary intake and occupational exposure during analysis.

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ISBN:978-81-957858-1-0

## NarcoticsDrugs:Marijuana/Cannabis

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### Abstract

Narcoticsdrugsrefertosubstancesthathavethepotentialforabuseandcanproducemind-altering effects. Marijuana, also knownas cannabis, is one such narcotics drugthat has gained significant attentionduetoitswidespreaduseandcontroversiallegalstatusinmanyjurisdictions.Thechapter delves into the key aspects related to marijuana, including its botanical characteristics, psychoactive compounds, modes of consumption & identification colour test. It explores the historical context of marijuana use, from its ancient origins to its current legal and social status. Furthermore,theabstracthighlightsthephysiologicalandpsychologicaleffectsofmarijuanause, including the short-term and long-term consequences on cognitive functions, mental health, and overallwell-being.Thepotentialrisksassociatedwithmarijuanause,suchasaddiction,impaired driving,andthegatewayhypothesis,arealsodiscussed.Inaddition,theabstracttouchesuponthe legallandscapesurroundingmarijuana,providinginsightsintothevaryingdegreesoflegalization andregulationacrossdifferentcountriesandstates.Ithighlightstheongoingdebatesandresearch concerningthepotentialbenefitsandrisksofmarijuanause,aswellasthechallengesfacedbylaw enforcement agencies in controlling its illicit production, distribution, and consumption.

**Keywords:**Narcotics,drugs,Cannabis,Marijuana,cannabidiol,Therapeutics

### Introduction

Cannabis,alsoknownasmarijuana,isaplantthathasbeenusedforvariouspurposesforcenturies. Itisacomplexplantcontainingnumerouschemicalcompounds,withthemost well-knownbeing delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Cannabis has gained significant attention in recent years due to its medicinal properties, recreational use, and ongoing debates surrounding its legal status. Historically, cannabis has been used for its therapeutic effects in differentculturesaroundtheworld.Ithasbeenutilizedtoalleviatepain,reduceinflammation,and treatvariousmedicalconditions.However,itsrecreationaluseforitspsychoactivepropertieshas also been prevalent throughout history. In terms of its legal status, cannabis has faced varying degrees of regulation and prohibition globally. Some countries and states have decriminalized or legalized its use for medicinal and/or recreational purposes, while others strictly prohibit its possession and consumption. The cultivation, production, and distribution of cannabis have also evolved with advancements in technology and changing societal attitudes. From traditional cultivation methods to indoor hydroponic systems, the methods used to grow cannabis have become increasingly sophisticated.



ISBN:978-81-957858-1-0

CannabissativaisaplantthatisfoundgrowingalloverIndia,althoughitscultivationisrestrictedby the government. It is a dioecious plant, meaning that it has separate male and female plants.The female cannabis plant tends to be taller, reaching heights of about 4 to 6 meters, and itpossessesmoreluxuriousfoliagecomparedtoitsmalecounterpart.Thevisualdifferencesbetweenthes exesareevidentintheirphysicalcharacteristicsOnesignificantsyntheticcannabinoidderivedfrom cannabis is Nabilone, which exhibits antiemetic properties. It has been proven to beparticularlyusefulinpatientsundergoingcancerchemotherapy,providingrelieffromnausea andvomiting associated with the treatment. This synthetic compound offers a potential therapeuticoptionformanagingthesechemotherapy-induced sideeffects effectively.VariouspreparationsofCannabis sativa are used for different purposes.:-

1. Bhang,alsoknownassidhi,patti,orsabji,isonesuchpreparationmadefromdriedleavesof the cannabis plant, which are then pressed into cakes.
2. Ganja,ontheotherhand,isderivedfromtheflowering topsofthecannabisplant.
3. AnotherpreparationisCharas, alsoreferredto as hashishorhash, whichis obtainedfromtheresinousexudatesof thecannabisplant.Majun isasweetpreparationthatincorporatesany of the above cannabis preparations, creating a unique blend.

Active Principle: Cannabis contains various compounds, including cannabidiol (CBD) and several isomers of tetrahydrocannabinol (THC). Among these isomers, l-Δ9-tetrahydrocannabinol (Δ9-THC) is responsible for most of the characteristic effects associated with cannabis.

Itisimportanttonotethatcannabiscanbetoxicifconsumedinexcessiveamounts.Thefataldose differs depending on the preparation. For charas, a concentrated resinous form of cannabis, the fataldoseisestimatedtobearound2gramsperkilogramofbodyweight.Ganja,whichrefersto the flowering tops of the cannabis plant, has a higher estimated fatal dose of approximately 8 grams per kilogram of body weight. Bhang, a preparation made from dried cannabis leaves, has an even higher estimated fatal dose of about 10 grams per kilogram of body weight.

**IdentificationtestforMarijuana:**

**1.** FASTBLUEBSALTTEST:Smallamountofsuspectedmaterialistakeninatesttube;avery small amount of the solid reagent and 1 ml of solution 1 is added to it. Shake well for one minute and add 1 ml of solution 2. Shake the test tube for two minutes, and allow this test tubetostandfor2minutes.Apurpleredcolourinthelowerlayerofchloroformindicatesthe positive result of the presence of cannabis product.

**2.** DUQUENOIS-LEVINETEST:Smallamountofsuspectedmaterialistakeninatesttubeand shakenwith2mlreagentfor1minute,add2mlofconc.HClandshakeitwell.Alloweditto stand for 10 minutes and then add 2 ml of chloroform. Appearance of violet colour in chloroform layer (lower layer) indicates the presence of cannabis.


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3. ALTERNATETEST:Thesampleisextractedwithpetroleumether.Filteredandevaporatedto dryness. Added 2 ml. of Duquenois reagent to dissolve the residue add 2ml. Conc. HCl. Shaken and kept for 10min.Transferred the solution into a test tube add 2ml. of Chloroform and shaken. Purple colour in the chloroform layer indicates the Tetrahydrocannabinol.
4. TESTFORDIFFERENTIATIONBETWEENBHANG,GANJAANDCHARAS:The suspectedmaterialofcannabisisextractedinethanol.Adropofextractistakeninacavityof a spot tile or in a micro tube, and 2 drops of chromogenic Reagent 1 is added and mixed thoroughly followed by addition of 2 drops of Reagent 2. : Bhang gives green colour; Ganja gives blue colour while Charas gives violet colour.

**Conclusion:**cannabisisaversatileplantwithvariouscompounds.accurateidentificationand differentiation of cannabis samples can help determine if a substance seized during a drug bustisindeedcannabisoranotherillicitsubstance,aidingintheclassificationofdrug-related offenses.Potencyanalysiscanprovidecrucialinformationincasesinvolvingimpaireddriving ordeterminingtheintenttodistribute.Adulterationdetectionensuresthesafetyofindividuals whomayunknowinglyconsumecontaminatedcannabisproducts,preventingpotentialharm. Sourcetrackingcanaidindismantlingillicitcultivationoperationsandtracingthedistribution networks of illegal cannabis. Overall, cannabis testing plays a significant role in gathering evidence and building strong cases against individuals involved in cannabis-related crimes.

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ISBN:978-81-957858-1-0

## PetroleumProduct&ForensicScience

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**Abstract**

Petroleum, a fossil fuel derived from the incomplete decay of ancient organisms, has shapedhuman history and played a significant role in various aspects of society.

Petroleum products comprise a complex mixture of hydrocarbons, which are compounds composed ofcarbonand hydrogen atoms. Thespecificcomposition ofpetroleum products varies depending on the refining process and the source of the crude oil. However, some common components found in petroleum products include:

1. Gasoline:Gasolineisprimarilycomposedofhydrocarbonswith8to12carbonatoms,suchas octane and heptane. It also contains small amounts of additives and detergents.
2. Diesel:Dieselfuelconsistsofheavierhydrocarbonswithlongercarbonchains,typically ranging from 12 to 16 carbon atoms. It has a higher energy density compared to gasoline.
3. Jet Fuel: Jet fuel, specifically jet A and jet A-1, is similar to kerosene and contains a mix ofhydrocarbons with carbon chains ranging from 10 to 16 carbon atoms.
4. HeatingOil:Heatingoil,alsoknownasfueloil,isadistillatefuelusedforheatingpurposes.It contains a mix of hydrocarbons similar to diesel but with a higher viscosity.
5. Lubricants: Lubricating oils are made up of base oils, which are refined petroleum fractions, along with additives to enhance their lubricating properties.
6. Petrochemicals: Petroleumserves as a feedstockfortheproductionofvariouspetrochemicals, including plastics, solvents, detergents, synthetic fibers, and rubber.

**Keywords:**Petrochemicals,Solvents,Fuels,Gasoline,Diesel,Lubricants

### Introduction

Theproductionofpetroleumproductsinvolvesseveralkeyprocesses.Firstly,crudeoilisextractedfromundergroundreservoirsthroughdrilling.Itisthentransportedtorefineriesforprocessing.Atthe refinery, the crude oil undergoes distillation, where it is heated to separate it into variousfractionsbased ontheirboilingpoints.Thesefractionsincludegasoline, diesel,jetfuel,andotherproducts.Additionalrefiningprocesses,suchascrackingandreforming,areemployedtoconvertheavier fractions into lighter, more valuable products. Finally, additives may be blended into theproducts to enhance their performance and meet specific requirements. Petroleum products havesignificantforensicimportanceduetotheirpresenceandcharacteristicsinvariouscrimescenes



ISBN:978-81-957858-1-0

and investigations. They can serve as valuable physical evidence in cases involving arson,explosions,vehicleaccidents,andfuel-relatedcrimes.Theanalysisofpetroleumproducts,suchasgasoline,diesel,andlubricants,canhelpdeterminetheorigin,composition,andpotentialsourcesofignitionorcontamination.Forensicscientistsutilizetechniqueslikegaschromatography,massspectrometry, and spectroscopy to identify and compare petroleum samples, aiding in theidentification of suspects, understanding the circumstances surrounding a crime, and supportinglegal proceedings. The forensic examination of petroleum products plays a crucial role in linkingevidence, reconstructing events, and providing scientific support in criminal investigations.

**Adulterants:** Adulteration of fuel is very booming, due to different price of product with similar concentrations. The dealers of fuel do this adulteration in order to make extreme profit from productignoringthedamagestovehiclesandharmfuleffectstolifeofhumans.Forexamplewhen adulteration of kerosene takes place with petrol it can be very hazardous as it can be highly inflammable.Themaineffectoffueladulterationisonvehiclethatusessuchadulteratedfuel.This causes increase cases of tailpipe emission and hence cause engine knock. The frequent blending of lubricant into kerosene, kerosene into petrol/ diesel and lubricant into diesel are very common type of petroleum adulteration.

**Sampling** The samples shall be taken in clean glass or aluminum vessels. One liter of sample is required for analysis, the vessel containing the sample must be sign and seal by authorized/competent authority.

ForensicExamination(Preliminary)ofPetroleumProductsforadulterationarebasedonthefollowingtype of characteristics:

| Sl. No | Property | Petrol | Diesel | Kerosene |
|---|---|---|---|---|
| 1 | Density | 710-770kg/m3at 15 degree C | 820-870kg/m3at 15 degree C | .78-.82kg/m3 at 15 degree C |
| 2 | Colour | Orange dye (Phenyl azo 2-naphthol) | Yellow | Colourless (Regular Blue dyed (Di-alkyl amino anthraquinone) Kerosene for Public Distribution Supply) {PDS} |
| 3 | Flash Point | <-21°C | 35°Cto40°C | 37°Cto65°C |



ISBN:978-81-957858-1-0

| | | | | |
|---|---|---|---|---|
| 4 | BoilingPoint | 25to75℃ | 250 to350 ℃ | 190 to250 ℃ |
| 5 | Thin Layer Chromatographic Solvent System (Hexane:Toluene: Acetic Acid[50:50:2]) | PinkorOrange colourRfValue 0.49 &0.51 | Violet | Bluecolourspot at Rf around 0.4 |
| 6 | Filter Paper Test (Place two drops of Petrol on a filter paper) | Vanish without leaving any trace behind | Leave Patches | Leave Patches |
| 7 | Cetane Number | 5-20 | 40-55 | NA |
| 8 | OctaneNumber | 90-92 | 15-25 | NA |

ForensicExamination(Confirmatory)ofPetroleumProductsforAdulterationaredonebyfollowing Instruments:

- HPLC
- Gas Chromatography

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ISBN:978-81-957858-1-0

# PhysicalEvidences

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**Abstract**

Marking Evidence and container -If an object can be marked, by all means mark it; and when its size permits, mark it in such a way that it becomes unique to the particular case. As an example, yourinitials,serialnumberandaDRnumbercaneasilybewrittenonahand-rolledcigarettewith a fiber or ball point pen. Remember, if in court ayear or more later, you cannot relate the exhibit to this particular offense being tried; it will not be admitted into evidence. Evidence tags and adhesive labels may also be used to mark evidence when appropriate to use. Items whose very nature or size precludes their being marked should be placed in a small vial or envelope, sealed, and the vial or envelope marked accordingly. convert it into 50 words.

**Keywords:**Physical,Evidence,Photography,Sketches,Contamination,Markings

## Introduction

Thecollectionandpreservationofphysicalevidenceisacriticalprocessinforensicinvestigations.Proper handlingandpreservationtechniquesensurethatevidenceremainsintact,uncontaminated,andadmissibleincourt.Theprocedurebeginsbysecuringthecrimescenetopreventunauthorizedaccess and contamination. Forensic experts meticulously document the scene through notes,photography, and sketches. They then carefully collect and package physical evidence usingappropriate tools and containers, ensuring each item is properly labeled and sealed. Preservationmethods vary depending on the nature of the evidence, with considerations for temperature,humidity, and light exposure. Chain of custody documentation tracks the movement of evidenceto maintain its integrity. Adhering to strict protocols in evidence collection and preservation isessential for maintaining the evidentiary value and reliability of physical evidence in forensicinvestigations.

## Evidences

Therearelegaldistinctionsamongdifferenttypesorcategoriesofevidencesthathelptodetermine itsadmissibilityincourtoflaw.Evidencehavebeencategorizeddifferentlybydifferentscientist, but the most convenient categorization which cover most type of evidences are as follows:

1. **PhysicalEvidences**:Theseevidences,knownasrealevidences,belongtothecategoryofindirect evidence.Theyincludetangibleitemslikehairs,fibers,latentfingerandfootprints,aswellasotherbiologicalandchemicalmaterials.Thesephysicalobjectsserveasvaluableevidence in investigations and can provide crucial information in solving crimes



ISBN:978-81-957858-1-0

2. **Testimonial or Personal Evidence**: Testimonial or personal evidence belongs to thecategory of direct evidence and can take various forms. It includes statements ortestimonies given by individuals present at the crime scene or those with relevantknowledge. However, this type of evidence can be subjective and influenced by personalattitudes orbiases. Eyewitness accounts, confessions, and hearsay (which is generally notadmissible in court) also fall under this category. While testimonial evidence can providevaluable insights and leads in investigations, its reliability and credibility are subject toscrutiny and corroboration through other sources of evidence.
3. **Miscellaneous evidence**: Miscellaneous evidence includes subjective or objective itemsthatmaynotfitintoothercategoriesandmaynotalwaysbeadmissibleincourt.Examplesincludepolygraph tests (not always admissible), voiceanalysis (admissibility varies), andpsychological examinations (potentially admissible in court).
4. **Corpusdelictievidence**:Corpusdelictievidenceconsistsofevidencethatestablishestheoccurrenceofacrime.Beforeaninvestigationcanbegin,theremustbeadequateevidenceto demonstrate that a crime has occurred. Examples of corpus delicti evidence include adeadbody,abrokenwindowindicatingapointofentry,stolenordamageditemssuchasasafe, and other physical evidence that directly connects to the commission of the crime.Thistypeofevidenceservesasafoundationforfurtherinvestigationandcanhelpestablisht he elements necessary to prove the criminal act. It provides initial confirmation that acrime has taken place and prompts the need for a thorough investigation.

**CommonTypesofPhysicalEvidence:**

The following Indirect types of evidences which can be scientifically examined in the laboratory can be divided in to two following category:

- **Non-Living**

1. Paint evidence, such as smears, chips, or dry particles, can be transferred betweenobjects during the commission of a crime. It is often found in hit-and-run cases. Bycomparingasuspectedsamplewithacontrolsample,paintcanbematchedtoavehiclewith almost complete certainty
2. Glass pieces, including fragments from windows or ventilator panes, can providesubstantialevidenceconnectingsuspectsorobjectstoacrimescene.Brokenglassmaycontainfingerprintsorblood,anditspatterncanhelpdeterminethecauseanddirectionof breakage.
3. Soilsandnaturalresourcesfoundonclothingorfootwearcanlinkindividualsorobjectsto specific locations.
4. Marks: Marks such as tool, foot, and tire marks are crucial in forensic investigations.Theseimpressions,includingtoolmarks,shoeprints,andtiretracks,provide valuable



ISBN:978-81-957858-1-0

evidence for crime analysis.. These areas play significant roles in solving crimes andenforcing drug laws.

5. Drugs:theillicitdrugtradeposeschallengesduetotechnologicaladvancements,making drug manufacturing easier and apprehending suspects more difficult

• **Living**

LivingPhysicalEvidences:HumanBodyMaterials

- Fingerprints
- Blood,Organs,andotherPhysiological Fluids
- HairandFibers etc.

**Conclusion:** In forensic sciences, the importance of physical evidence cannot be overstated. Atany crime scene, the range of human activity is so diverse that almost anything present can beconsideredaspotentialphysicalevidence.Theroleofaforensicscientistbeginsatthecrimescene,where they recognize and recover physical evidence. Once these evidences reach the forensiclaboratory,theyundergovariousanalysesbasedontherequirementsspecifiedbytheinvestigatingofficer for each item. Paint evidence, for example, is often encountered in hit-and-run cases.Furthermore, blood, body fluids, such as semen and saliva, undergo biochemical and otheranalysestodetermineidentity,origin,andindividuality.Theseprocessesarecrucialinthefieldofforensicsciences,astheyaidinsolvingcrimesandprovidingaccurateevidenceforinvestigations.

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ISBN:978-81-957858-1-0

# PrincipleofForensicScience

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**Abstract**

The principle of forensic science revolves around the application of scientific methods and techniques to investigate and solve criminal cases. It involves the systematic and objective examination of physical evidence to establish facts, identify perpetrators, and support legal proceedings. Key principles in forensic science include:

## Locard'sPrinciple

Locard'sPrincipleofMutualExchange,formulatedbyFrenchscientistEdmondLocard,statesthat everycontactleavesatrace.Whentwosurfacescomeintocontact,therewillbeamutualexchange of matter between them. This principle forms the basis of forensic science, asserting that it is virtuallyimpossibleforacriminaltocommitacrimewithoutleavingevidencebehindandcarrying away traces from the scene. These trace evidences, such as fingerprints, footprints, hair, bodily fluids, and clothing, can establish a decisive link between the suspect and the crime scene.

AlthoughLocarddidnotexplicitlymentiontheprincipleinhiswritings,hestronglybelievedthat criminals always leave something behind at the crime scene and take something with them. This belief was supported by his investigations, including the case of Marie Latelle's murder. By examiningthebodyandcollectingtraceevidencefromthesuspect,EmileGourbin,Locardfound a pink dust that matched the makeup worn by the victim. This evidence confirmed Gourbin's involvement in the strangulation.

Theprincipleemphasizestheimportanceofidentifyingthepointsofcontactbetweenthecriminal, theirtools,andthecrimescene.Thesepoints,suchasthepointofentry,thecrimesceneitself,and the point of exit, provide crucial investigatory leads. Detectives can discover footprints, fingerprints,marksfrombreakingwindowsordoors,andtracesleftduringthecommissionofthe crime.Byanalyzingthesetraceevidences,investigatorscaneffectivelyconnectthecrimeandthe criminals.Theprincipleofmutualexchangehighlightsthesignificanceofeventhesmallesttraces in forensic investigations.

## Law of individuality

'Everyobject,naturalorman-made,hasanindividualitywhichisnotduplicatedinanyotherobject orinotherwordsNotwothingsinthisuniversearealikeevenwhentheyaremanufacturedinthe same machine one after the other.



ISBN:978-81-957858-1-0

Although objects may appear identical at first glance, they possess individual characteristics thatdistinguish them from one another. Even in seemingly identical items like sand grains, seeds,coins, or currency notes, there are minute flaws or variations that can be used for identification.Extensiveresearchonfingerprintshasshownthatnotwofingerprints,evenfromthesameperson,are ever identical. Similarly, experiments on superimposition techniques have demonstrated thatevenimprintsfromthesamefingercannotbeperfectly superimposed.The lawofindividualityisof utmost importance in forensic identification, as it establishes a link between the crime and theindividual by recognizing their unique characteristics.

**LawofProgressiveChange**

Another important principle which affect the quality of analysis and their results in the lab or otherwiseisthelawofprogressivechange.Accordingtothisprinciple'Everythingchangeswith the passage of time'

Therateofchangehasa significantimpactonforensicscienceinvestigations.Criminalsundergo progressive changes over time, making them unrecognizable except through permanent characteristics like fingerprints or bone fractures, which may not always be available. The scene ofthecrimealsoundergoesrapidchangesduetoweather,vegetationgrowth,andhumanactivity, making it unrecognizable over time. Additionally, the evidences involved in the crime may be affected by external conditions and gradually change, potentially losing their practical identity. Therefore, prompt action is essential in criminal investigations to prevent the loss of crucial evidence.

**Principleof Comparison**

Thisprincipleisveryimportantparticularlyinthelaboratoryinvestigationi.e.thetypeofspecimen or sample required for comparison in the lab. It states that'Only the likes can be compared'

The principle emphasizes the need to provide samples of similar nature for comparison withquestioned items. For accurate analysis, a bullet fired from a high velocity firearm should not becompared with shotguns or pistols. Likewise, hair from different races would not be useful whendeterminingtheoriginofhairfromaspecificrace.Providingappropriatespecimensensuresproper comparison in forensic examinations.

**Principleof Analysis**

Thisprinciplehavegreatsignificanceinthelaboratoryinvestigationofthecluematerials.Itstates that"The analysis can-be no better than the sample analyzed"

In rape cases, the investigating officer collects the victim's clothes with blood and semen stains, ensuring the affected areas do not touch each other or the container walls. They send the clothes to the forensic laboratory to determine the presence of semen and the blood group.



ISBN:978-81-957858-1-0

## Conclusion

Forensicscienceisguidedbyseveralfundamentalprinciples.Thelawofindividualityrecognizesthat every object, whether natural or manmade, possesses unique characteristics that cannot bereplicated elsewhere. The law of progressive change acknowledges that all objects undergomodificationsovertime.Additionally,EdmondLocard'sPrincipleofMutualExchangehighlig htsthetransferoftraceevidenceduringcontact,affirmingthateveryinteractionleavesbehindatrace.The se principles emphasize the importance of individualizing evidence, considering the dynamicnature of objects and the potential for trace evidence to provide valuable insights in forensicinvestigations. By recognizing these principles, forensic scientists can effectively analyze andinterpretevidencetoestablishconnections,identifyperpetrators,andsupportthepursuitofjustice.

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ISBN:978-81-957858-1-0

## StagesinCrimeSceneInvestigation:SearchingandCollectionofEvidences

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**Abstract**

As we all are aware that crime scene is a place where actually any unlawful act has taken place and is always unique. So, there can't be any single right way to process every crime scene. Each scenehastobeevaluatedindividually.Therearenohard-and-fastrulesforsuccessfulcrime-scene processing. There is a need to have flexible approach to crime scene processing. Nothing can substitute for experience. Crime scene investigation (CSI) refers to the process of collecting,analyzing,andpreservingevidenceatacrimescene.Itisacrucialaspectofcriminalinvestigationsandplaysavitalroleindeterminingwhathappened,identifyingpotentialsuspects,andsupportinglegal proceedings.

**Keywords:**Crimescene, Investigation, Analysis,Evidence, Collection.

## Introduction

The aim of scientific investigation in crime scene analysis is to apply rigorous scientific methodsandtechniquestouncoverandinterpret evidenceinordertoreconstructtheeventsof acrime.Byemploying scientific principles, forensic experts meticulously collect and analyze physicalevidence, such as fingerprints, DNA, fibers, ballistics, and trace substances, to establish a linkbetween the crime and potential suspects. The objective is to provide unbiased and reliablescientific evidence that can support legal proceedings, identify the perpetrator, and contribute tothepursuitofjustice.Throughsystematicexamination,analysis,andinterpretationoftheevidence,scientificinvestigationincrimesceneanalysisaimstoprovideobjectiveinsightsandconclusionsthat can withstand scrutiny in the legal system and contribute to the resolution of criminal cases. The collected physical evidences packaged properly at the scene and sent to the forensic science laboratory along with the list of requirements for scientific analyses in the laboratory. These scientificopinionsnotonlyhelpusinreducingourdependenceonwitnessestominimum,butalso link the suspect and victim with each other and with the scene of crime. Analysis of physical evidences can be divided into two major stages. The first stage is Crime Scene Investigation i.e., the investigation start from the crime scene, which is a meeting place of the persons involved in the commission of crime and where the exchange of traces takes place. The physical evidences originatedfromcrimescenerequiredtoberecognized,documented,collectedandpackaged.After that the second stage started which is a 'Laboratory investigation', where all the evidences collected from crime scene are sent to be analysed scientifically according to the requirement of theinvestigatingofficerandreportisprepared.Finally,thatreportispresentedbeforethecourtof law to



ISBN:978-81-957858-1-0

take final decision in that particular case based on the scientific outcome.



ISBN:978-81-957858-1-0

So for conducting a successful crime investigation, whole process can be divided into following series of stages:

**Crimescene protection**

Toensuretheprotectionofacrimescene,thefirststepistopromptlydispatchpolicepersonneltothe location and establish strict access control. This prevents unauthorized individuals fromentering the scene and helps preserve its integrity. Simultaneously, it is crucial to inform seniorofficers, including the forensic science team, about the crime to ensure their involvement andexpertiseintheinvestigationprocess.theprimarydutiesofthepolicewhenreceivinginformation about a crime are to promptly protect thecrimescene and informseniorofficers. Mistakes at this stage can compromise the investigation, prosecution, and defendant's rights. It is vital for investigators to learn from past mistakes and strive for improvement. The first officer's responsibility is to secure the scene, document details, and prevent unauthorized entry. The body shouldremainundisturbed,andonlyessentialpersonnelshouldbeallowed. Carefulprotectionof the crime scene is crucial for conclusive results and excluding suspects.

**Recognitionofevidence**

Recognition of evidence is a crucial duty for the scientific team when they arrive at the crimescene. There are no set rules or procedures for this complex task, as it requires the investigator'strainingandexperience.Differentiatingbetweensignificantandirrelevantevidenceischa llenging,as each case is unique. The investigator's knowledge and expertise, along with carefulobservations, play a vital role in conducting a successful investigation. Sufficient time should bedevoted to this duty without rushing, as mental reconstructions aid in recognizing relationshipsbetween evidence and the crime. Effective communication between field and laboratoryinvestigators is essential for identifying and collecting important evidence. Comprehensivedocumentationtechniquesfacilitateconveyingcasedetailstoscientistsunabletobepres entatthecrime scene.

**Searchingofevidence**

Thesearchandcollectionofevidenceatacrimescenearevitaltoanycriminalinvestigation.Theprimary goal is to find associative evidence that links the suspect, victim, and crime scene,answeringcrucialquestionsaboutthewho,how,why,andcircumstancesofthecrime.Sometimes, certain evidence may be initially unrecognized, but mental reconstruction and availableinformation can prompt the search for missing items. Broken glass fragments and other physicalmatchingitemsarealsoimportanttoexamineonthespot.Itiscrucialtogiveclearinstructionstoa uxiliarysearchersandutilizeappropriatesearchpatternstoeffectivelyandthoroughlysearchforevidenc e at the crime scene. Searching methods are following



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**Strip Search**: Also called Line search method, which is used by one or two investigators by walking in straight lines across the crime scene.

**Grid Search**: In this method search is conducted by two or more people overlapping separate line searches forming a grid

**Quadrant/zone Search**:Another search method in which the crime scene can be divided into smaller zones or quadrants according to the convenience and team members are assigned to search each section

**Documentationofcrimesceneand evidences**

Documentationofacrimesceneisacriticalstepinpreservingandpresentingevidence.Severalmethods areemployed to ensureacomprehensive record.Photography captures overall scenes,close-ups,andindividualitems.Detailednotesaretaken,includingobservations,measurements,anddescriptionsofthescene,objects,andtheirlocations.Sketchesordiagramsprovideavisualrepresentation of the crime scene layout. Video recordings can capture the scene in real-time.

**CollectionofEvidence&PackagingofEvidence**

Whencollectingevidenceatacrimescene,itiscrucialtothoroughlydocumentandphotographthe scene before handling any items. Different types of evidence require specific collectionprocedures. Precautions must be taken to prevent contamination and preserve the integrity oftheevidence.Specializedequipmentsuchasscalpels,forceps,andcontainersarenecessary.Asecondary survey is conducted as a quality control step to ensure thoroughness. To maintain the integrity of collected evidence, it must be securely packaged to prevent escape or contamination. Different types of evidence require specific packaging methods. Volatile evidenceshouldbehermeticallysealed,whilewetbloodstainedgarmentsshouldbedriedand sealedinairtightcontainers.Itemsshouldbepackagedseparatelytoavoidtransferofevidence. Paper bags and wrappings are suitable for moisture-containing evidence. After packaging evidences are send to the lab.

## Conclusion:

The proper collection and packaging of evidence is crucial in crime scene investigations. Eachcaserequiresatailoredapproachbasedonthecircumstancesandlocationofthecrime.Thoroughdocumentation, including photographs and notes, should precede any handling of evidence.Specialprecautionsmustbetakentoprotectfragileorstableevidenceandpreventcontamination.Controlsamplesmaybenecessaryforcertaintypesofevidence.Theconditionsatthesceneshouldbeevaluated, and measures should betaken to manageand preservethe integrity of theevidence.



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ISBN:978-81-957858-1-0

# ConceptandtypesofBioremediations

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**Abstract**

Toxic inorganic and organic chemicals are major contributors to environment contamination and posea severehealth risk to thehuman population. Prevention offuture contamination from these compounds presents an immense technical challenge. Unlike organic compounds that can be mineralized,theremediationofinorganicsrequiresremovalorconversionintoabiologicallyinert form (Ow, 1996). Bioremediation is a natural process, which relies on bacteria, fungi, and plants to remove, reduce, degrade, or immobilize environmental pollutants from soil and water, thus restoring contaminated sites to a relatively clean nontoxic environment. Metabolic processes of these organisms are capable of using chemical contaminants as an energy source, rendering the contaminants harmless or less toxic products in most cases. Therefore, bioremediation is often consideredacost-effectiveandenvironmentallyfriendlymethodandisgraduallymakinginroads for environmental clean-up applications (Ashraf et al., 2019). Considering the need to increase knowledge about sustainable techniques for the remediation of contaminated environments through biological organisms and plants, because they can absorb and/or convert inorganic contaminants,inthischapter,weelucidatetheconceptofbioremediationanddescribethepossible mechanismsofdifferentbioremediationstrategiestobeappliedincontaminatedsitesbyinorganic pollutants. Furthermore, an attempt has been made to review the challenges and opportunities of the bioremediation for remediating toxic metals and inorganic pollutants from contaminated media.

Keywords:

## Introduction

Bioremediation has been defined as "Use of living organisms to clean up or remove pollutants from soil, water, or wastewater; use of organisms such as nonharmful insects to remove agricultural pests or counteract diseases of trees, plants, and garden soil," as reported by US EPA, United States Environmental Protection Agency.Thisactivitycanbecarriedoutbygreen plants that are able to remove pollutants from the soil or waterby absorption through the roots and next accumulation into the leaves. It also can make use of microorganisms to detoxify or remove inorganic pollutants from the environments (Khalid et al., 2017). Bioremediation also offers a permanent in situ remediation rather than simply translocating the problem. This technique can be used for remediationofheavymetals,metalloids, orotherinorganicpollutants fromsoilorwater(Alietal.,2013;Ashrafetal.,2019).Itisprovedcost-effective,efficient,novel, eco-friendly,andsolar-driventechnologywithgoodpublicacceptanceascomparedwith



ISBN:978-81-957858-1-0

engineering techniques like excavation, soil incineration, soil washing, flushing, and solidification(Alietal.,2013;Sarwaretal.,2017).Theefficiencyofbioremediationonremoving inorganic pollutants usually de- pendson numerous plant,microbes, and soil/water factors such as thephysicochemicalproperties ofthesoil/water, microbial,andplantexudatesandthecapacity oflivingorganismstouptake,accumulate,sequester,translocate,anddetoxify pollutants (Khalid et al., 2017).

Typesofbioremediation

The term bioremediation includes plant-/microbe-based remediation (defined as phytoremediation and micro- organism remediation, respectively), which differ greatly in the process/mechanism by which plants/microbes can immobilize, remove, or degrade pollutants (Khalid et al., 2017). It includes phytoremediation and microorganism remediation.

Phytoextraction

Phytoextraction (also known as phytoaccumulation, phytoabsorption, or phytosequestration) is the removal of pollutants from soil or water by plant roots and their translocation and accumulationin abovegroundbiomass,thatis,shoots,whicharesubsequentlyharvested(Ghosh and Singh, 2005; Muthusaravanan et al., 2018). Pollutant trans-location to shoots is a crucial biochemical process desirable for an effective phytoextraction, because the harvest of root biomass is generally not feasible (Halim et al., 2003; McIntyre, 2003). Continuous phytoextractioncanuseplantsthataccumulatehighlevelsof pollutantsovertheirentirelifetime (Sarwaretal.,2017).Generally,phytoextractionprocessinvolvesthefivemajorsteps:pollutant mobilization in rhizosphere, pollutant uptake by plant roots, trans- location toward aerial plant parts, and pollutant sequestration in plant tissues (Memon and Schröder, 2009;Ali et al.,2013). Ideally a hyperaccumulator plant should possess the following characteristics: (i) high growth rate, (ii) more aboveground biomass, (iii) tolerance to a high concentrations of inorganic pollutants, (iv) widely distributed and highly branched root system, (v) adaptation to the local environmentalconditions,(vi)translocationoftheaccumu-lated pollutantsfromrootstoshoots, (vii)resistanttopathogensandpests,(viii)easycultivationandharvest,and

(ix)moreaccumulationofthetargetpollutants(Alietal.,2013;Maharetal.,2016;Khalidetal., 2017; Sarwar et al., 2017). Among these, pollutant tolerance is a prerequisite for phytoremediation process, as strong tolerance of plant tissues could be accompanied by minimum adverseeffects on plant health. Generally the mechanisms ofcell wall metalbinding, activetransportofmetalionintothevacuoles,chelationofmetalionswithproteinsandpeptides, andcomplex formation contribute to pollutant tolerance potential of a plant (Memon and Schröder, 2009).

Theeffectivenessofphytoextractionisoftenassociatedwiththedepthavailableforplantroot



ISBN:978-81-957858-1-0

growth,theseasonalweather, and climatic conditions (Bhargava et al., 2012). The efficiency of phytoextraction can be improved by the application of mobilizing agents like citric acid, ethylenediaminetetraacetic acid, nitrilotriacetic acid, aminopolycar- boxylic acids, and ethylenediaminedisuccinic acid (Mahar et al., 2016). Recently, phytoextraction is primarily beingusedfortheremovalofinorganicpollutantsfrompollutedmedia,becausethistechnology displaystheadvantagesofhighlyeconomical,lessdisruptivetothesoilandenvironment,noneed of disposal sites, high public acceptance,and no excavation or transport of contaminated media, etc.(Sheoranetal.,2016;Maharetal.,2016).However,itisnotwithoutitsfaults.Forexample, it depends on the growing conditions essential for plants and plant tolerance to pollutants,and relatively longtime period to completely remediate the sites is required (Khalid et al., 2017). Thereforeits application should depend on the specific case study.

Phytofiltration

Phytofiltration is also termed as rhizofiltration that involves adsorption or precipitation of pollutants from solu- tion onto plant roots or absorption into the roots encompassing the root zone(Khanetal.,2019).Itsmechanismisrelatedwiththesynthesisofcertainchemicalswithin the roots, which cause the adsorption of pollutants, because some plants may contain several phytochelatinstoincreasebindingcapacityofpollutantslikemetalions(SinghandSantal,2015). Rhizofiltration can be straightforwardly connected to effluents, contaminated waterways, or ground- water frameworks. The success of rhizofiltration requires a full understanding of the contaminant speciation and interactions of all contaminants and nutrients. An ideal plant for rhizofiltration should have rapidly growing roots with the ability to remove contaminants from solutions over extended periods of time (Dhanam, 2017). Therefore use of terrestrial plants is often preferred owing to the extensive root architecture and fibrous roots that help them todraw out contaminants from the ground water and rhizospheric zone (Pilon-Smits, 2005; Ali et al., 2013; Khan et al.,2019).

Phytostabilization

Phytostabilization or phytoimmobilization is the process of using plants with the ability to decrease the mobilityor/and bioavailability of pollutants either to prevent its leaching to ground wateroritsentryinto foodchainby cer-tainmechanismsincludingadsorptionbyrootsorbythe formation of insoluble compounds in the root zone (Sarwaret al., 2017; Khan et al., 2019). Phytostabilization may be characterized as (1) restriction of a pollutant in the contami-nated mediainthecourseofassimilationandaggregationbyroots,adsorptionontoroots,orprecipitation within theroot region of plants and (2) the deployment of plants and plant roots to avoid contaminantmovementthroughwindandwater,draining,anddispersionofsoil(USEPA,1999). Theultimateaimofphytostabilizationisstabilizationofpollutantsratherthantheirremoval,thus diminishingtheirhazardtohumanwell-beingandnaturewiththeinten-tionthattheplantsplay



ISBN:978-81-957858-1-0

a similar roles with soil amendments (Prasad and Freitas, 2003). Unfortunately, phytostabilizationisnotapermanentsolutiontocontamination,becausephytostabilizationdoesnotreduce the concentrationof pollutants but reduces the contamination of nearby media/area (Bolan et al., 2011; Khalid et al., 2017). However, phytostabilization does show an advantage over other phytoremediation techniques, since the need to treat the aerialparts is reduced, as the process mostly retains contaminants in the roots, with low translocation to the shoots. It canbe a very effective strategy when rapid immobilization is needed to preserve ground and surface waters (Jadia and Fulekar, 2009; Gomes et al., 2016). Therefore, phytostabilization has been regarded as one of the most experimental forms of phytoremediation and has potential applicability for manymetals,especiallylead,chromium,andmercurythatarestabilizedinthesoil(Cunningham andOw,1996) andreducetheinteractionofthese contaminantswith associatedbiota(Mahar et al., 2016).

Phytovolatilization

Another phytoremediation strategy, phytovolatilization, employs the plant-mediated uptake of contaminants, thentransforms them into volatile compounds, and subsequently releases these compoundsintheatmosphereassameorinanalteredformduetoitsmetabolicandtranspiration pull (Kumar et al., 2017; Khan et al., 2019). Transpirationinvolves the evaporation of water vapors from the leaf surfaces through stomata into the atmosphere. Certain plantspecies with extensive rooting system often have the ability to uptake and degrade the contaminants through production of some specific enzymes or genes (Newman and Reynolds, 2004; Pilon-Smits, 2005;Muthusaravanan et al.,2018). During phytovolatilization, pollutants aretaken up from the soil/water and converted into less toxic vapors, which are then released into the atmosphere throughtranspirationprocessoftheplants(Khalidetal.,2017).Thetechniquecanbeappliedfor organicpollutantsandsomeheavymetals,thatis,As,Se,andHg,whichexistasgaseousspecies intheenvironment(Pajevićetal.,2016).Thereareverylessnumberofnaturallyoccurringplants capable of converting metals into volatilize forms. Phytovolatilization technique therefore generallymakesuseofgenetically modified plants to enhance the ability of plants to volatilize metals (Khalid et al., 2017). However, itsuse is restricted by the fact that the process does not completelyremovethepollutantsfromtheenvironment,asthecontaminantissimplytransferred from one environmental compartment (soil/water) to the other (atmosphere), from which it is likely to precipitate with rainfall and then return to the ecosystem (Ali et al., 2013). Moreover, phytovolatilization involves little erosion and no disposal of contaminated plant biomass with negligiblesitedisturbance(Rughetal.,2000;Khalidetal.,2017).Thismakesphytovolatilization the most controversial phytoremediation tech-nologies (Padmavathiamma and Li, 2007; Gomes et al., 2016).



ISBN:978-81-957858-1-0

## Phytodegradation

Phytodegradation, also called phytotransformation, refers to the capture of contaminants and nutrients from the water, sediment, or soil and the following chemical modification of contaminantsasadirectresultofplantme-tabolism,oftenresultingincontaminantinactivation, degradation, or immobilization both in plant roots and/or shoots (Bulak et al., 2014; Gomes et al.,2016).Someplantscandegradetheabsorbedcontaminantsintolesstoxiccompounds,either by plant's metabolic process or enzymes (Muthusaravanan et al., 2018). Thus phytodegradation is a metabolic strategy of plants in detoxification and degradation of contaminants within the plant tissues (Pajević et al., 2016; Mahar et al., 2016).

## Microorganismremediation

Theprincipalmechanismofmicrobialremediationofpollutedmediaistoimmobilizeandreduce bioavailabilityof pollutants. Inorganic pollutants like heavy metals cannot be degraded by microorganisms, but can be converted toanotherformduetotheiralteredphysicalandchemical properties (Ashraf et al., 2019). For example, in environmental

bioremediationapplications,microorganismscanbesupportedonsolidagrowastetoprovidethe requiredmacro-andmicronutrientsforbiofilmformation,whichfurtherenhancesthemetabolic activities of the microorganisms for solubilization and biodegradation of hydrocarbon contaminants (Mahdi and Aziz, 2017). Similarly the interactionofmicrobesandmetalionscan occur by various mechanisms, which could be classified based on involvement of metabolism, like active and passive uptake of metal ions (Gupta and Diwan, 2017). Extracellular complexation, in- tracellular accumulation, oxidation-reduction reactions, and precipitation are the main microbial remediation mech-anisms (Yang et al., 2018; Ashraf et al., 2019). Among these modes, bioaccumulation and biosorption hold significant importance, by which the microorganisms, or biomass, bind to and concentrate contaminants from the environ- ments. Both biosorption and bioaccumulation function in different manners. Bioaccumulation is a double-stage, slow, partially reversible, active metabolic transport in living biomass. The first process is the quick sorption, identi-cal with biosorption by microbial biomass and by-products of microbes, and the second is slower and includes phys-iological transport of sorbate into the insides of cells by the metabolically active transport system (Martín-Gonzálezet al., 2006; Chojnacka,2010).Bioaccumulation organismsshouldhaveamechanismof intracellularbinding, suchasspecialproteinsrichinthiolgroups—phytochelatins(PCs)andmetallothioneins(MTs)— which are synthesized as the response to the presence of toxic metal ions in their living environment; the complex with those pollutants can be thus excluded from normal metabolic processes (Chojnacka, 2010). Differently biosorption works passively in a metabolism independent manner, where live and dead biomass can act the remediation role through several phys-iochemicalmechanisms(Philippisetal.,2007;GuptaandDiwan,2017).Generally,



ISBN:978-81-957858-1-0

pollutants can be adsorbed on thepolysaccharide slime layers of microbes through functional groups such as carboxyl, amino, phosphate, and sulfategroups.Besides,extracellularpolymeric substances (EPS) constituted by nucleic acids, proteins, lipids, and complexcarbohydrates also play an important role in the adsorption of pollutants. The chitin-chitosan complex, glucuronic acid, phosphate, and polysaccharides in/on cells of microbes can involve in heavy metal adsorptionthroughionex-changeandcoordination(GuptaandDiwan,2017).Differenttypesof ionizablesitesandvariousfunctionalgroupsofmicrobesinfluencetheadsorptioncapabilityand specificity of strains to heavy metal ions. Microorganisms can also remove heavy metals from environment through enzymatic or nonenzymatic processes (Ashraf et al., 2019). Efficiency of microbial remediation depends on the type of pollutants and microorganisms.

It is important to note that the microbial activities in the root/rhizosphere soils could enhance theeffectivenessofphytoremediationprocessesincontaminatedenvironments.Microbe-assisted phytoremediation couples plants (usually contaminant-tolerant species) with rhizospheric or endophyticmicroorganismsthatenhanceremediationofinorganics(Festeretal.,2014;Gerhardt et al., 2017). The efficient remediation is achieved by two complementaryways: (i) direct promotion of phytoremediation in which plant associated microbes enhance pollutant translocation(facilitate phytoextraction) or reduce the mobility/availability of contaminants in therhizosphere(phytostabiliza-tion) and (ii) indirect promotion of phytoremediation in which the microbes confer plant pollutant tolerance and/or enhance the plant biomass production to remove/arrest the pollutants (Gerhardt et al., 2017). Various features of rhizospheric microorganismshavebeenindicatedasfollows:(i)Theycommunicatecooperativelywithroots to improve the capability of metal take-up, (ii) they discharge compounds to increase pollutant bioavailability,(iii)theyencourageingestionofnutrientsplusnonessentialmetalsbyroots,and (iv)theyspecificallyaffectpollutantdissolv-abilitybychangingtheirsyntheticproperties(Doty, 2008;Khalidetal.,2017).Microorganismsthatshowpromiseinthelaboratory/greenhousemust be tested in the field, where environmental variables can lead to different results (Burges et al., 2016). Proper application of inoculants is also essential for the success of microbe-assisted phytoreme-diation(Gerhardtetal.,2017).Theycanbeintroducedtocontaminatedfieldsoilsin various ways, including seed treatment, foliar sprays, and direct inoculation of soils (Bashan et al., 2014; Prasad et al., 2018).

### Challengesforbioremediation

Although bioremediation is a promising approach for remediation of inorganic pollutant-contaminated media, italso has some challenges (Chojnacka, 2010; Mukhopadhyay and Maiti, 2010;RamamurthyandMemarian,2012;Alietal.,2013;Gomesetal.,2016;Maharetal.,2016; Gerhardt et al., 2017; Ashraf et al., 2019):

- Bioremediationrequireslongtimeforclean-up.



ISBN:978-81-957858-1-0

- Phytoextractionefficacyofmosthyperaccumulatorplantsisgenerallyrestrictedbytheir low biomass and slowgrowth rate.
- Environmentalconditionsareagreatdeterminant ofthe efficiencyof phytoremediation and may not always beadequate for most species.
- Contaminationbymultiplepollutantsrequiretheuseofspecificspecies,well adapted or tolerant to theenvironmental conditions and contamination present.
- Correctdisposalofthepollutedbiomass(asdangerouswaste)isneededfollowing phytoextraction.
- Itis hardtomobilizemore tightlyboundfraction ofmetal ions from soil,thatis, limited bioavailability of thecontaminants in the soil.
- The introduction of invasive plant species as hyperaccumulator, which may affect theindigenous floraldiversity must be avoided.
- Bioremediationisanapplicableapproachforsites,whichhavelowtomoderatelevels of pollution due tounsustainable plant/microbe growth in highly contaminated media.
- Exogenous application of microorganisms could disturb the stability of biological treatment systems.

## Conclusionandfutureprospects

Bioremediation is becoming more popular as a method of remediating inorganic pollutant contamination, as it hasmany advantageous features that make it an appropriate and successful technology. In this chapter, various strate- gies of bioremediation techniques and the correspondingmechanismshavebeendiscussedforthrivingnewideasforremovingofpollutants from the contaminated sites. Bioremediation is a relatively recent technology and is mostly in research stage. Its research is highly interdisciplinary in nature and requires background knowledge in soil/waterchemistry, plant biology, ecology and soil/water microbiology, and environmental engineering. Additional studies should be conducted to better understand plant physiology, biochemistry and uptake of these contaminants, and proper evaluation of possible synergistic effects of multiple contamination. Nowadays, biotechnology is a powerfultool used in bioremediation to improve the pollutant removal efficiencies, but it is limited to the lab conditions orat averysmallscale.Moreovertheapplicationoftransgenictechnologyandplant-microbeinteractionsarefeasiblestrategiesfortheimprovementofplantsforpollutanttolerance.
Hence, it is better to create or find an appropriate plant/microbe system for environmental cleanup.



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

## Nanomaterials:Scope,Applications,andChallengesinAgriculture

*Amit Vashishth, Himani Punia and Avni Vij*

*ChandigarhSchoolofBusiness,CGC,Jhanjeri* **Abstract**

Nanotechnologyhadbeenattractedmanyscientistsforitsuniquephysical,chemicalandbiological characteristics that differ from those in a large-scale model for the same material. Nanomaterials weredevelopedformanyapplicationsinmanyfieldssuchasmedicine,drugdelivery,electronics, fuel cells, solar cells, food, space and etc. Among these application nanomaterials had proved many important benefits for agricultural purpose. Nanotechnology proved to have the ability to detectandtreatmentofplantdiseases,enhancementofphotosyntheticrateandnutrientsabsorption byplants,deliveryofactiveingredientstospecificsitesandwatertreatmentprocessesusingmany kinds of nanomaterials. The potential of nanotechnology in agriculture and how its effect on the plan is huge, and tbut a few issues only will be discussed in this chapter.

**Keywords:** Nanotechnology. Plant germination. Pesticides detection., Nonfertilizer. Environmental reclamation.

### Introduction

Nanotechnology has many definitions explain the properties of nanomaterials, while the main subject that defines nanomaterials is “These materials that measure between 1 and 100 nm (NNI, 2005).However,materialclassificationsimplyonsizedoesnotgivesatisfactorydefinitionofthe nanotechnology.Manynanosizedstructures(e.g.,weatheredmineralspresentintheenvironment naturally.Whilethesematerialsdoesnotfallintothecategoryofnanotechnology.Theremaining requirements for classification as nanotechnology include the model that materials must have uniquephysical,chemical,and/orbiologicalcharacteristics,differentfromthosefoundonalarge scaleinthesamematerial(NNI,2005).Compoundsalsomustbeformedontheprincipleofatomic scale control of the assembly and structure. The National Nanotechnology Initiative (NNI) similarly analysis the definition of nanomaterials into three requirements, of which any “nanotechnology” must involve all three: “1.) Research and technology improvement at the atomic, molecular, or macromolecular levels, in the length scale of approximately 1 - 100 nanometers,2.)Creatingandusingstructures,devices,andsystemsthathavenovelpropertiesand functions because of their small and/or intermediate sizes, and 3.) Ability to be controlled or manipulated on the atomic scale.” (NNI, 2005). The main idea in nanotechnology is mainly the recent findings that matter change properties and behavior in the nanoscale status. For example, nanoscale status observed size and structure dependent. Consequently, optical, electrical, interfacial and tensional properties are changes.



ISBN:978-81-957858-1-0

In addition to, the reactivity, for example the catalytic activity of nanomaterials is often greater thantheirlargerstatus.Byenhancingphysicalandchemicalpropertiesofnanomaterials,thiswas led to manufacture novel functional materials that can have enormous beneficial influences on solving some of the grand challenges of the society, e.g. energy production and storage, water treatment, lighter and stronger vehicles, better health care, efficient computers, etc.

The huge investments innanotechnology will produce many kinds of nanoparticles that are currentlymovedfromlabstomassmarkets.Nanoparticleswillbecomemoreconsiderableinwork environments, consumer products and the environment.

Therearesomereasonsforworryingofthehazardpotentialofnanoparticles,i.e.thehighreactivity maycauseadversebiologicaleffects,nanoparticlesarecomparableinsizetosomeofthestructures in cells, small enough to be mobile and a few example of penetration of biological barriers and most nanomaterials are persistent.Therefore in order to encourage a sustainable development of nanotechnologies and safeguard the human health and eco-systems it is necessary to assess the risks side-by-side with the nanotechnology research and development. Otherwise there is a risk that there will be a public opinion counteracting all kinds of nanomaterials and thus society will lose the beneficial ones.

Nanomaterials were developed for many applications in many fields such as Medicine, drug delivery, electronics, fuel cells, solar cells, food and space andetc. these application could be nominalized as follows: 1) Nanomaterials are developed to have many beneficial impacts in medicineaccordingtothesizeofmoleculesthatcandeliverdrugsdirectlytodiseasedcellsinyour body.Whenit'sperfected,thismethodshouldsignificantlydecreasethedamagetreatmentsuchas chemotherapy does to a patient's healthy cells. 2) Nanotechnology holds some answers for how we enhance the capabilities of electronics strategies while we reduce their weight and power consumption.3)Nanotechnology has many beneficial impacts on several aspects offoodscience, from how food is grown to how it is packaged. Nanomaterials developed will make a difference not only in the food taste, but also in food safety, and the health benefits that food provides. 4)Nanomaterials havea hugecatalyst reactivity that reducethecost of catalysts used in fuel cells toproducehydrogenionsfromfuelsuchasmethanolandtoimprovetheefficiencyofmembranes usedinfuelcellstoisolatehydrogenionsfromothergasessuchasoxygen.5)Developednanotech solarcellsarelowercostthanconventionalsolarcells.Currently,researchersdevelopingbatteries using nanomaterials. One such battery will be a noble as new after storage for decades. Also batteries manufactured from nanomaterials could be recharged significantly faster than conventionalbatteries.6)Nanotechnologymayholdthekeytomakingspace-flightmorepractical. Innovations in nanomaterials make lightweight spacecraft and a cable for the space elevator promising. By significantly reducing the amount of rocket fuel required, these advances could lowerthecostofreachingorbitandtravelinginspace.7)Nanotechnologyhasmanybenefitsto



ISBN:978-81-957858-1-0

solve the shortage of fossil fuels such as diesel and gasoline by making the production of fuels from low grade raw materials economical, increasing the mileage of engines, and making the production of fuels from common raw materials more effective. 8) Nanotechnology can increase the powerful of catalysts used to transform vapors released from cars or industrial plants into beneficialgasses.Thiswasattributedtohighsurfaceareaofcatalystsmadefromnanoparticlesto interact with the reacting chemicals than catalysts made from larger particles. The larger surface areaallowsmorechemicalstoreactwiththecatalystprogressively,whichmakesthecatalystmore efficient.9)Nanotechnologyhasmanyapplicationstosolvemanyproblemsinwaterpurification. Oneoftheseproblems is theremoval ofindustrial wastes, such as acleaning solvent called TCE, from groundwater. Nanoparticles have the ability for biodegradation of these chemicals and converted it to harmless components. Studies have shown that this method is more efficient and lower costs in ground water treatment than methods which require pumping the water out of the groundfortreatment.10)Nanotechnologycanbeusedassensorstodetectverysmallamountsof chemicalvapors.Varioustypesofnanomaterials,suchascarbonnanotubes,zincoxidenanowires or palladium nanoparticles can be used as sensors. Because of the small size of nanotubes, nanowires,ornanoparticles,afewgasmoleculesareenoughtochangetheelectricalpropertiesof the sensing elements. This allows detecting a very low concentration of chemical vapors. 11) Nanomaterialsalsousedtoproducemanysportinggoods.Currentnanotechnologyapplicationsin the sports arena include enhancing the power of tennis racquets, filling any defectiveness in club shaft materials and decreasing the rate of air resistance from tennis balls. 12) Making composite fabric with nano-sized particles or fibers allows improvement of fabric properties without a significantincreaseinweight,thickness,orstiffnessasmighthavebeenthecasewithpreviously-usedtechniques.Amongtheseapplicationsnanotechnologyhadprovedtohavemanybenefitsfor agricultural applications. Nanotechnology is a new technology could be applied to agricultural production to solve many problems in the interest of yield production. The application of nanomaterialsinagricultureaimsinparticulartoreduceapplicationsofplantprotectionproducts, minimize nutrient losses in fertilization, and increase yields through optimized nutrient management.Nanotechnologyprovedtohavetheabilitytodetectandtreatmentofplantdiseases, enhancement of nutrients absorption by plants, delivery of active ingredients to specific sites and water treatment processes using many kinds of nanomaterials such as, Nano capsules, nanoparticles and even viral capsids. The use of target-specific nanoparticles can decrease the destructiontonon-targetplanttissuesandtheamountofchemicalsreleasedintotheenvironment. AlsoNanotechnologycouldbeappliedinplantbreedingandgenetictransformation.Thepotential ofnanotechnologyinagricultureishuge,butafewissuesmustbediscussed,suchasgrowingthe scale of production processes and minimizing costs, as well as risk assessment issues. Therefore, nanoparticlesfabricatedfrombiopolymerssuchasproteinsandcarbohydratesaremoreattractive since it has low impact on human health and the environment.



ISBN:978-81-957858-1-0

In the field of bio-sensors nanomaterials and nanostructures with unique chemical, physical, and mechanicalproperties(e.g.electrochemicallyactivecarbonnanotubes,nanofibersandfullerenes) havebeenrecentlysettledandappliedforhighlysensitivebio-chemicalsensors.Thesenanosensors have also related application in agriculture, in particular for soil analysis, easy bio-chemical sensingandcontrol,wateranalysis,pesticideandnutrientdetermination.Nanotechnologyhasalso a very important role inthe treatment of agricultural waste products, during production of nanocompositematerialsfromtraditionallyharvestedmaterials.Forexample,itispossibletouse chemical-mechanical processes to obtain nanofibers with enhanced thermal properties for the productionofthermoplasticcomposites,startingfromwheatstrawandsoyhulls.Andhereissome applications of nanomaterials in agricultural with deep details.

**1. Nanotechnologyapplicationsin agriculture.**

**Plantgerminationandgrowth**

Theeffectsofnanomaterialsonplantgerminationandgrowthwiththegoaltopromoteitsusefor agricultural applications have been studied during recent years. Zheng et al.(2005)studied the application of nano and traditional $TiO_2$on the yield of naturally-aged spinach seeds. The results revealedthatseedstreatedwithnano$TiO_2$ increaseddryweight(73%),Photosyntheticrate(three times) and chlorophyll-A formation (45%) than control over germination period of 30 days. Nanomaterial was achieved better growth rate of spinach seeds than traditional $TiO_2$ indicating thatnanomaterialshavebeneficialpropertiesforplantgermination.Thismightbeattributedtothe photo-sterilizationandphoto-generationof“activeoxygenlikesuperoxideandhydroxideanions” bynano-$TiO_2$thatcanenhancetheseedstressresistanceandsupportcapsulepenetrationforwater absorption and oxygen for fast germination. The authors harmonized that the $TiO_2$nanoparticles might have improved the absorption of inorganic nutrients, enhanced the degradation of organic substances, and also caused reducing of oxygen free radicals formed during the photosynthetic process, hence enhancing the photosynthetic rate.

The main reason make germination fast is the penetration of nanomaterials into the seed. Khodakovskaya et al. (2009)concluded that MWCNTs can penetrate tomato seeds and improve the germination rate by increasing the seed water absorption. The MWCNTs increased the seed germination,upto90%(comparedto71%incontrol)in20days,andtheplantbiomass.Shahand Belozerova(2009)showed that nanoparticles (Pd, Au at low concentrations; Si, Cu at higher concentrations,andcombinationofAuandCu)hadapositiveeffectonseedgermination,enhance shoot to root ratio and seedling growth. The influence of nanoparticles on plants can be positive or negative (Monica and Cremonini, 2009). One of the most important points in application of nanomaterials for seed germination is their phytotoxicity. The level of phytotoxicity may rely on the kind of nanomaterial and its prospective application. For example, the applicability of fluoresceinisothiocyanate(FTIC)-labeledsilicananoparticlesandphotostableCadmium-Selenide



ISBN:978-81-957858-1-0

(CdSe) quantum dots were tested for improving seed germination. They concluded that FTIC-labeledsilicananoparticlesenhanceseedgerminationinrice,whileCdSequantumdotsprevented the germination (Nair et al., 2011).Lin and Xing (2007)assessed phytotoxicity of nanomaterials (MWCNTs,Aluminumoxide-$Al_2O_3$,ZnO,AlandZn)anditseffectongerminationratesinradish, rapecanola,ryegrass,lettuce,corn,andcucumber.Theyconcludedthatthehigherconcentrations (2000 mg/L) of nano-sized Zn (35 nm) and ZnO (~20 nm) prevented the germination in ryegrass andcorn,respectively.Rootlengthofstudiedspecieswasalsoinfluencedbyusing200mg/Lnano-ZnandZnO.Phytotoxicityofnano-AlandAl$_2$O$_3$significantlyenhancedrootstretchingofryegrass and corn, respectively; whereas, nano-Al supported the radish and rape root growth.

EPA had been agreed for using Nano silver in agriculture(Bergeson, 2010a ; 2010b), so there are more than 100 kinds of pesticides contain Nano Ag due to its anti-microbial characteristics. However,its impact on theecosystem and human health is a major concern. Luet al. (2010)have concluded that the citrate-coated colloidal Ag nanoparticles were not genotoxic (genetic), cytotoxic (cell), and phototoxic (toxicity through photo-degradation) to humans, butsame materialweretoxicinpowderform.Thiswasattributedtothe"chemicalchangeofsphericalsilver nanoparticle in the powder to form silver oxides or ions." Interestingly, the photoxicity of the powdered Ag nanoparticles was inhibited by coating them with biocompatible polyvinylpyrrole (Lu et al. 2010). Oancea et al. (2009)assumed that controlled release of active plant growth stimulators and other chemicals encapsulated in nanocomposites made of layered double hydroxides(anionicclays)couldbeanotherpossibleopportunityfororganicagriculture.However, important food organic certifiers (e.g. UK soil association, Biological farmers of Australia) inhibited using nanomaterials for organic agricultural(Scrinis and Lyons, 2010). Recently, German-based organizations such as Naturland and the International Federation of Organic Agriculture Movements (IFOAM) considered food products grown with artificial nanomaterials as non-organic food(Naturland, 2011 and IFOAM, 2011).

**Plantprotectionandproduction**

Nanopesticides could be summarized as very small particles of pesticidal active components or other small engineered structures with useful pesticidal characteristics(Bergeson, 2010b). Nanopesticides can enhance the dispersion and wettability of agricultural formulations (i.e., decrease in organic solvent runoff), and harmful pesticide movement (Bergeson, 2010a). Nanomaterials and biocomposites show useful characteristics such as stiffness, permeability, crystallinity, thermal stability, solubility, and biodegradability (Bouwmeester et al., 2009 and Bordes et al., 2009)important for formulating nanopesticides. Nanopesticides also have large specific surface area which increased affinity to the target (Jianhui et al., 2005). There are kinds of nanopesticides such as nanoemulsions, nanoencapsulates, nanocontainers and nanocages have beenrecentlydiscussed(Bergeson,2010b;Bouwmeesteretal.,2009andLyonsandScrinis,2009)



ISBN:978-81-957858-1-0

forplantprotection. Table1reportsthesekindsof nanomaterialsandtheir application.Basically, nanomaterialsshoulddegradefasterinthesoilthanplantswithresiduelevelsbelowtheregulatory criteria in foodstuffs. Jianhui et al. (2005)reported the advance of such sodium dodecyl sulfate (SDS) modified photocatalytic $TiO_2$/Ag nanomaterial joint with dimethomorph (DMM), commonly used pesticide in agricultural production. Modified formulation, 96 nm average granularity, improved dispersivity and breakdown of the pesticide in soil while enhancing its impact in vegetable seedling (of cabbage and cucumber) studies. The modification of the nanomaterials using SDS significantly improved the absorption of the DMM. Guan et al. (2010)fabricated encapsulatednano-imidacloprid with abovepropertiesto beusedforpests control for vegetable production. The SDS modified Ag/$TiO_2$imidacloprid nanoformulation was developed by a microencapsulation way that used chitosan and alginate. It was applicated on soybean plants that were transplanted to soil with 3.1% dry matter content and pH of 6.2. The formulation residues in soil and the plants degraded faster during the first eight days, and were minimaltoundetectableafter20days.TheSDSintheaboveapplicationswasusedtoenhancethe photo-degradation of the nanoparticles in soil. Alternatively, Mohamed and Khairou (2011)developed highly photo-degradable Ag/$TiO_2$particles (5-7 nm), manufactured using polyoxyethylene laurel ether (POL) and SDS and was applicated for 2,4-D herbicide degradation undervisibleandUVradiation.TheresultsrevealedthatPOLmanufacturednanoparticlesphoto-degraded faster during the same exposure period. Toxicity or biosafety of pesticides is a major concerninagriculturalproduction.WiththeapplicationsofNanopesticides,theuncertaintyonthe long-term impacts of pesticides on the human health and environment rises. Xu et al. (2010)concluded that with better kinetic stability, smaller size, low viscosity and optical transparency, nanoemulsions can potentially be better pesticide delivery medium. The micro or nanoemulsion as a carrier for pesticide delivery can increase the solubility and bioavailability of nanopesticides.However,thereisaneedtoevaluatethepossibleuptakeofnanopesticidesthatcan agricultural workers exposure by inhalation.Shi et al. (2010)studied the toxicity of chlorfenapyr (nanopesticide)onmice.Itwasconcludedthatthechlorfenapyrnanoformulationfrom4.84mg/kg to 19.36 mg/kg was less toxic to mice than the common formulation. Thus, nano pesticides may decreaseadverseenvironmentalandhumanimpactsascomparedtocommonpesticideapplication. Formulation stability is an important issue at the nano level. Liu et al. (2008)successfully fabricated stable nanopesticide (bifenthrin) using polymer stabilizers such as Poly (acrylic acid)-b-poly (butylacrylate) (PAA-b-PBA), Polyvinylpyrrolidone (PVP), and Polyvinyl alcohol (PVOH). A flash nano-precipitation technique was used to prepare 60-200 nm bifenthrin nanoparticles.Anotherimportantpointofresearchcouldbethedevelopmentofnanomaterialsthat can be used as a protective layer to allow slow release of traditional pesticides and fertilizers.For example,Corradinietal.(2010)discoveredthepossibilityofusingchitosannanoparticles,ahighly degradableantibacterialmaterialforslowreleaseofNPKfertilizer.Liuetal.(2006)fabricated



ISBN:978-81-957858-1-0

kaolin clay-based nanolayers to be used as cementing and coating material for slow release of fertilizers. Primarily, nano-clay materials have interactive surfaces with high aspect ratio for encapsulating "agrochemicals such as fertilizers, plant growth promoters, and pesticides" (Ghormade et al., 2010).

**Pesticideresidue detection**

Food and Drug Administration(FDA, 2005) reported about 1045 chemicals as pesticide residues. Nanomaterials based nanosensors can be used to detect manypesticide residues instead of traditional gas or liquid chromatography (GC/LC) -mass spectroscopy (-MS) techniques (Stan andLinkerhägner, 1996; Sicbaldi et al., 1997 and Balinova et al., 2007). While traditional techniquesinvolvemanystepsincludingsampling,solid-phaseextractioninlaboratory,analyzing thesample, and definetheobtained spectral peaks to determinethepesticideresidues. Now,U.S. DepartmentofAgriculture(USDA)developedasingle-andmulti-residuemethodsbasedGC/LC-MStoevaluate"organophosphates,organochlorines,carbamates,triazines,triazoles,pyrethroids, neonicotinyls, strobilurins" residues in 85 agricultural commodities (USDA, 2010). Nanosensors for pesticide residue detection offer, "high sensitivity, low detection limits, super selectivity, fast responses, and small sizes" (Liu et al. 2008). Table 2 reports some of the nanosensors aimed to detectthepesticideresiduessuchasmethylparathion(Kangetal., 2010andParhamandRahbar, 2010), parathion (Li et al., 2006 and Wang and Li, 2008), fenitrothion (Kumaravel and Chandrasekaran, 2011), pirimicarb (Sun and Fung, 2006), and dichlorvos and paraoxon (Vamvakaki and Chaniotakis, 2007). Additionally, Dyk and Pletschke (2011)have reviewed enzymebased biosensors for organochlorines, organophosphates, and carbamates residue detection. Some of these biosensors used C, Au, hybrid Titanium (Ti), Au-Platinum (Pt), and nanostructuredleaddioxide(PbO2)/$TiO_2$/Titoimmobilizetheenzymesonsensorsubstrateandto increase the sensor sensitivity. Application of nanomaterials as biosensors for pesticide residue detectionisvast,neverthelesssomeissuessuchas:1)availabilityofthenanomaterialssensitiveto much pesticide residues, 2) simplicity of sensor manufacture techniques and instrumentation, 3) desired dependability and repeatability in tracelevel detection, 4)cost, and 5)concernsrelated to nanomaterialexposuretothesurroundingenvironmentneedstobeconsidered.Also,largenumber ofpesticidesusedinagricultureproductionmightminimizeusingnanomaterialsbasedsensorsfor pesticide residue detection (Liu et al. 2008 and Dyk and Pletschke,2011). Moreover, Liu et al. (2008) reported thatthe development in the selective and stable nanomaterial sensing and techniques to participate biomolecules (enzymes, antibodies, etc.) with nanomaterials is needed. As a starting point, nanosensors can be to detect major residuals that are extremely harmful to humanhealth. Smart nanomaterials also can beused as sensorsforpesticidedetection. Thesmart nanomaterials and nanopesticides (Bergeson, 2010b) that act as a source of pesticide as well as indicativesensormakenoneedofsensorsfordetectingpesticideresiduesinsoil.Thenanomaterial thathaveslowtargetedreleaseofthematerialandalsoindicatedeficiency(e.g.colorchange)of



ISBN:978-81-957858-1-0

thenutrients in soil could work as an advanced alertsystem forfarmersto adopt upon thedosage rate and frequency.

**Plant pathogen detection**

Bergeson, (2010a) reported that application of pesticides and fertilizers come after detection, locate,andreportonpathogenspriortotheonsetofsymptoms.Consequently,nanomaterialscould beusedforstatebacterial,viralandfungalplantpathogens(Boonhametal.,2008;Yaoetal.,2009 and Chartuprayoon et al., 2010) in agriculture as a rapid analytical tool. Nanoparticles showed highaccuracyfordetectingviralpathogensinplant(Baacet al., 2006).Nanoparticlesalsocanbe modified to be used as a diagnostic tool to detect compounds revealing to a diseased condition. Nano-chipsarekindsofmicroarrayswhichcontainfluorescentoligocaptureprobesthroughwhich the hybridization can be detected (López et al., 2009). These nano-chips are known in detecting singlenucleotidechangesofbacteria andviruses duetotheirsensitivityandspecificity(López et al., 2009). Yao et al. (2009)developed afluorescencesilicananoparticles uploaded with antibody to detect Xanthomonas axonopodis pv. Vesicatoria which causes bacterial spot disease in Solanaceae plants, showing that nanoparticle can be applied successfully for disease detection. Singh et al. (2010)used nano-gold based immune sensors by using surface plasmon resonance (SPR) that could detect Karnal bunt (Tilletia indica) disease in wheat. Particularly, they try to detect the disease using SPR sensor in wheat plots for seed certification and to form plant quarantines. Application of nanomaterials for detecting pathogen using nanosensors infield application is highly valuable for quick diagnosis and disease executive. Plants affected by different stress disorders through physiological changes. For example, the induction of systemic defense, that regulated by plant hormones: jasmonic acid, methyl jasmonate and salicylic acid. Wang et al. (2010) joined this indirect stimulus to develop a sensitive electrochemical sensor, by using modified gold electrode with copper nanoparticles, to monitor salicylic acid levels in oil seeds for fungi detection (Sclerotinia sclerotiorum). More work for developing nanosensors to detect pathogens, their byproducts, or monitor physiological changes in plants is needed.

**NanomaterialsforSoilReclamationandEnvironmentalRemediation**

Nanotechnology is a promising approach for reclamation of mine soils involves removing soil contaminants and enhancing soil quality and fertility. Two advantages of nanomaterials over the traditional amendments for soil reclamation include the higher reactivity due to smaller particle size and higher specific surface area and the easier delivery of the small-sized particles into the porous media (soils). High reactivity leads to a high efficiency and high rate of soil reclamation, while easy delivery is advantageous for in situ application. These nanomaterials with large potentials for mine soil reclamation include zeolites, zero-valent iron nanoparticles, iron oxides nanoparticles, phosphate-based nanoparticles, iron sulfide nanoparticles, and carbon nanotubes. Withemphasisontheirfunctionsinsoilqualityimprovements,Transportandmobilityofthose



ISBN:978-81-957858-1-0

nanoparticlesintheenvironmentaswellastheirpossibleecotoxicologicaleffectsarealsobriefly introduced in this section.

**SoilConditioner-Zeolites.**

Zeolitesarecrystalline,hydratedaluminosilicatesofalkali(Na+,orK+)andalkalineearthcations ($Ca^{2+}$ or $Mg^{2+}$) characterized by an ability to hydrate/dehydrate reversibly and to exchange some of their constituent cations with aqueous solutions, without a major change in structure (Pabalan and Bertetti, 2001). Their unique feature is that the zeolites possess an open, three-dimensional cage-like structure and a vast network of open channels extending throughout. The channels and pores, typically 0.3 to 0.7 nanometers in diameter, impart the mineral large specific area (about 105 $m^2$ $g^{-1}$)forion exchangeand forselectivecaptureofspecificmolecules (e.g., $H_2O$). Because of these structural features, zeolites generally have low density compared with that of other minerals. Nearly 50 natural species of zeolites have been recognized, and more than 100 species have been synthesized in the laboratory (Mumpton, 1985). Clinoptilolite is the most abundant zeolite species in the sedimentary deposits on the earth and also the most mined zeolite minerals in the world (Boettinger and Ming, 2002). Zeolites can occur in soils but with only less than 5% (by weight) in content, and again clinoptilolite is the major zeolite species in soils [64]. Because of their ion exchange, adsorption, and molecular sieve properties, as well as their geographically widespreadabundance,zeolitemineralshavegeneratedworldwideinterestforuseinabroadrange ofapplications.Inagriculturalindustries,zeoliteshavebeenusedassoilconditioners,slow-release fertilizers, and remediation agents for contaminated soils (Ming and Allen, 2001). As a soil conditioner, literatures showed that zeolite nano materials can improve the mine soil quality by increasingthewaterholdingcapacity,increasingtheclay-siltfractions,improvingnutrientlevels, and removing toxins(Ming and Allen, 2001).



ISBN:978-81-957858-1-0

Table1Nanomaterialsinagriculturalplantprotectionandproduction.

| Purpose | Material | Findings | Reference |
|---|---|---|---|
| Smart agrochemical delivery system via plant roots of sunflower, tomato, pea and wheat | Magnetic carbon coated nanoparticlesNanoparticles | Nanoparticles moved through plant xylemand phloem within 24 h | Cifuentes et al., (2010) |
| Controlled release herbicide delivery system for atrazine Polyhydroxybutyrate-co-hydroxyvalerate | Polyhydroxybutyrate-co-hydroxyvalerate microspheres with atrazine (w13 nm) | Goodaffinityofherbicidewithpolymer,decreased genotoxicity and increased biodegradability | Grilloetal., (2010) |
| Nanocomposite based controlled release of herbicide, 2,4-dichlorophenoxyacetate (2,4-D) | norganic ZneAl layered double hydroxide (ZAL)asreleaseagent | Initialburstof2,4-Dfollowedbysustainedrelease that depended on type of anions and their concentrations in release medium | Husseinetal., (2005) |
| Controlleddelivery system for water-soluble pesticide (validamycin) | Porous hollow silica nanoparticles (PHSNs) | PesticidewasloadedintoPHSNs(36wt%loading capacity) and the release was in two stages: initial burst followed by sustained release | Liu et al., (2006) |



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| | | | |
|---|---|---|---|
| Reduce the bean rust disease severity | CNT conjugated with INF24 oligonucleotides | Treatment reduced the rust severity | Corrêaetal., (2010) |
| Controloflentilpathogen and wilting | Silver nanoparticles-AgNPs (0.5-1000 ppm) | Fasterplantgrowthcomparedtocontrol; AgNPs did not reduce the plant wilting | Ashrafi et al., (2010) |
| Physical and biological changes of Brassica oleracea in presence of nanomaterials | $TiO_2$(5-8nm)0.05-2mLof $TiO_2$in 500 mL ofHoaglandsolution | Higher concentrations had negative impact onshootlengthwhereaspositiveimpactonrootlength | Singhetal., (2010) |
| Effect of carbon nanostructures on tomato germination | MWCNTs | SeedgerminationwasnotrelatedtoMWNCTs (observed up to 7 days) | Limaetal., (2010) |
| Treatment of fungal pathogens in vitro and in chickpeaandwheatplants | AmphotericinBnanodisks (AMB-NDs) 0.1-2mg/mL(invitro),0.1-10 mg/L (plants) | AMB-NDsinhibitedfungiat0.1mg/mL(invitro); effective chickpea fusarium wilt control (preventive dosage of 0.1 mg/L), wheat leaf rust control by foliar treatment | Perez-de-Luqueetal., (2010) |

Table2Nanomaterialsforpesticideresidue detection.

| Pesticide/herbicide detection | Sensing material | Detection limit | Sensortype | Reference |
|---|---|---|---|---|



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| | | | | |
|---|---|---|---|---|
| 2,4,5-trichlorophenoxy acetic acid | Poly-o-toluidineZirconium(IV) phosphatenanocomposite | 1 mM | Electrochemical | KhanandAkhtar, (2011) |
| Fenitrothioninwater | Nano$TiO_2$/nafion composite | 0.13 mM | Electrochemical | Kumaraveland Chandrasekaran, (2011) |
| Melamine in milk | 18-crown-6 ether functionalized Au nanoparticles | 6 ppb | Optical | Kuangetal.,(2011) |
| Organochlorine and organophosphorus pesticidesincabbage | Amino-functionalizednanocomposite with tetraethylenepentamine | 0.29 mg/kg | Chromatography | Zhaoetal.,(2011) |
| Methylparathioninwater | Nano-$ZrO_2$/graphite/Paraffin | 2 ng/mL | Electrochemical | ParhamandRahbar, (2010) |
| Methylparathioninvegetables (cabbage, spinach, lettuce) | Nano-Au/Nafioncomposite | $10^{-7}$M | Electrochemical | Kangetal.,(2010) |
| Methylparathion, chlorpyrifos | Nano size polyaniline matrix with SWCNT, single stranded DNA and enzyme | 1 pM | Electrochemical biosensor | Viswanathanetal., (2009) |
| Fenamithionandacetamipridin water | Cd-Telluriumquantumdotswith p-sulfonatocalix[4]arene | 0.12 and 0.34 nM | Luminescence | Quetal., (2009) |



ISBN:978-81-957858-1-0

| | | | | |
|---|---|---|---|---|
| Parathioninwater | Nano-$ZrO_2$/Aucomposite | 3 ng/mL | Electrochemical | Wang and Li, (2008) |
| Dichlorvosandparaoxonin drinking water | Acetyl cholinesterase and Pyranine immobilized on nano-sized liposomes | $10^{-10}$M | Optical Nano-biosensor | Vamvakaki and Chaniotakis,(2007) |
| Parathioninvegetables | Nano-$TiO_2$onglassycarbonelectrode | $10^{-8}$M | Electrochemical | Liet al., (2006) |
| Pirimicarbinvegetables | Molecularimprintednano-polymers (methacrylic acid with carboxyl functional groups) | 8 ×$10^{-6}$M | Piezoelectric | Sun and Fung, (2006) |



ISBN:978-81-957858-1-0

***ReducingSoilBulkDensityandImprovingSoilWaterHoldingCapacity.***

Natural zeolites have several unique physical properties that make them attractive as additives to improvesoilphysicalproperties.Forexample,bulkdensityofzeolitemineralscanbeaslowas 0.8Mgm$^{-3}$duetotheporousnature(MingandAllen,2001).Forexample,minesoilshavemany problems such as coarse texture which make soil have higher water infiltration rate, lower water holding capacity and higher bulk density (hindering root growth). Therefore, application of fine- grained zeolites (<0.05 mm) might increase the effective silt and clay fractions, enhance water- holding capacity, and decrease the bulk density which improve crop growth. Githinji et al. (2011)studiedtheeffectofzeolite(0.55–0.6mm)atarateof15%(vv$^{-1}$)tosand(0.31mm)media, they reported thatthe bulk density was decreased from 1.67 to 1.56 Mg m$^{-3}$ and available water contentwasincreasedby 2times.Wehtjeet al.(2003)alsoreportedthatBermudagrass (Cynodon dactylon) performance was increased using zeolite soil mixtures due to increased water holding capacity relative to control (un amended soils), and they exclude that chemical properties of the amendments could be affect. Particle size distribution of zeolite minerals and the application rate are important factors in improving soil physical properties. Petrovic (1990)reported that the optimumparticlesizeofclinoptiloliteaddedtogolfcoursesandwasbetween0.1to1mminorder to improving water infiltration, water availability, and aeration in soil. Huang and Petrovic (1990)reportedthatclinoptiloliteparticlessizeandtheamendmentdosagearethemainparameters enhance the water available to plants in a sand medium. They reported that available water for plantinsandamendedwith5and10%(gg$^{-1}$)clinoptilolitewithaparticlesizeof>1mmwasnear 6gkg$^{-1}$;whereasavailablewatertoplantsinthesamesoilamendedwithsameamountsof <0.047mm clinoptilolite was approximately 10 and 17 g kg$^{-1}$, respectively. Huang and Petrovic (1995)alsoreportedthatshoot-growthrateincreasingby26–60%atsand-basedputtinggreenturf using 10% clinoptilolite amendment.Lopez et al. (2008) proposed a method to solve the drought problem by application ofzeoliteto thesoil and acting as awicking (capillary)material to attract thewaterfromashallowgroundwatertabletoplant’srootzone,thusreducingthedependenceon precipitation or irrigation. They reported that the grass planted in the zeolites-packed core structuresweresurvived,whilethegrassplantedincontrolarea(Nozeolitetreatment)inthesame site planted died. These findings concluded that zeolites could be used as an effective soil amendment to improve water availability in mine soils. Also zeolite showed a high benefit for survivalofthevegetationatpoorstructuresoils,whichhavehighbulkdensity,lowwaterholding capacity, and the available water mainly depends on precipitation.

***2.5.1.2.ImprovingSoilpHandCationExchangeCapacity.***

Mine soils are usually acidic and infertile with low cation exchange capacity (CEC), resulting in poor nutrient status for plant growth. In contrast, pure zeolite materials usually have high CEC rangingfrom220to570cmolckg$^{-1}$(BoettingerandMing,2002).Addingzeolitestoasoilcan



ISBN:978-81-957858-1-0

increasethesoil'soverallCECandpHinmostcases(MingandAllen,2001),whichimprovesoil's nutrient holding capacity. For example, Huang and Petrovic (1995) reported that application of 10%(gg$^{-1}$)zeolitetoasandysoil,hadbeenincreasedtheCECfrom0.08to15.59cmolckg$^{-1}$and the pH from 5.4 to 6.6. Other studies reported that application of clinoptilolite to two kinds of materials(glacialtillandmarineclay)atarateof25%and50%(gg$^{-1}$),CECofthemixtureswas increased 2.6∼3.3 times and pH was also increased from 4.2 to 6.5(Katz et al., 1996), reflecting the prominent effect of zeolites on raising soil CEC. It was also reported that adding 0.2∼2% zeolitestosoilswasbeneficialtocropseedgerminationandcropproductions(Khanetal.,2009). Zeolites could increase the pH of acidic solution or soils due to alkaline properties. The acid neutralizationpropertymightincreasefromthehighCECbywhichzeolitesexchangethesolution proton($H^+$)with$Ca^{2+}$ion.Buttheacidneutralizationcapacityofzeolitesislimitedcomparedwith agricultural liming materials. Previous studies reported that application of zeolites at 10% (g g$^{-1}$) rate to mine soils increased the pH by 0.5–1 unit, while using the liming materials, pH was increasedby2to3units(LiuandLal,2012).Itisnotknownwhetherzeolitescandestroytheacid production in mine soils resulting from the oxidation of sulfide minerals. But application of fine zeolitesmayblocktheporesinthecoarse-texturedminesoilsanddecreasetheoxygendispersion totheunderlyingsulfidematerials.Moreover,zeoliteshavetheabilitytoadsorbgaseousmolecules such as $H_2S$ and $SO_2$and decrease its harmless to vegetation.

***NanoenhancedFertilizers***

***Zeolites-EnhancedFertilizers.***

Mine soils usually lack nitrogen (N) and phosphorus (P), and fertilizers are needed to ensure successful vegetation establishment (Burger and Zipper, 2011). However, applying conventional Nfertilizersoftenpromotesthegrowthofnoxiousweeds,suppressingthegrowthofcropsandtree seedlings(Burger and Zipper, 2011). Moreover, Excessive extravagance of mineral fertilizersresulted in excessive nitrates leaching to the ground water, which resulted in ground/surfacewatercontaminationsduetothecoarsetextureoftheminesoilsandtheaccelerated soil erosion. Therefore, using zeolites loaded with nitrogen to provide a slow release of the nutrients to meet the need ofcropsresulted inminimizing theleaching loss ofthe fertilizer(Ming andAllen,2001). Inadditionto,improvingthefertilizerefficacyanddecreasingthevolatilization of gaseous N (e.g., as $NH_3$or $N_2$), especially when $NH_4^+$fertilizers are exchanged onto zeolite exchangesitessothatthe$NH_4^+$ionisunavailableforconversionintogaseousphaseviamicrobial processes (Ming and Allen,2001).

ClinoptiloliteishighlyselectiveforK$^+$and$NH_4^+$relativetosodium($Na^+$)ordivalentcationssuch as$Ca^{2+}$and$Mg^{2+}$duetothelocationanddensityofnegativechargeinthestructureanddimensions ofinteriorchannels(MingandAllen,2001).Hence,$NH_4^+$and$K^+$loadedzeolitesaretypicallyused asslowreleasefertilizers.Forexample,Perrinetal.(1998)loadedclinoptilolitewith$NH_4^+$by



ISBN:978-81-957858-1-0

soakingthevarioussizefractionsin1M$(NH_4)_2SO_4$for10days(d),changingthesoakingsolution every2to3d,thenappliedthesolidto4-litercontainersseededwithsweetcorn(Zeamays).Perrin et al. (1998) observed that the soil fertilized with $(NH_4)_2SO_4$leached 10 to 73% of the added N (depending on applying N rate) whereas mere <5% of the added N leached from the $(NH_4)_2SO_4$-zeolite amended soil regardless of the N application rate and zeolite particle size. Nitrogen use efficiency(NUE)rangedfrom72.0to95.2%using$NH_4^+$clinoptilolite-amendedsoilsafter42dof plant growth, while it decreased to 29.7 to 76.3% in soils fertilized with $(NH_4)_2SO_4$only. Moreover, Lewis et al. (1984)reported that $NH_4$-loaded clinoptilolite amendment could prevent injury by urea to radish (Raphanus sativus) plantsbeside it was an efficient slow-release N-fertilizer.BarbarickandPirela(1984)alsoconcludedthatzeoliteshavebenefitstovegetationsuch as; prevent leaching losses of ammonium fertilizers, reduce ammonia toxicity to plants and increase crop yields. Zeolites loaded with potassium have also been used as a slow-release K- fertilizer (Williams and Nelson, 1997; Carlino et al., 1998). Phosphorus (P) is also an important nutrient indispensable for vegetation establishment and reforestation in the reclaimed mining areas.Rockphosphatessuchasapatites(e.g.,$Ca_{10}(PO_4)6(OH)_2$)arecommonlyusedsourcesofP inminesoilrehabilitation(JacintheandLal,2007).Buttheavailabilityofthephosphorusfromthe rocksdependsontheapatitedissolutioninthesoil.AlkalinesoilpHoftenimpedesthedissolution and decreases the soluble P amount. For example, Jacinthe and Lal (2007) reported that rock phosphate has no effect on the tree growth in a reclaimed mine land, this was attributed to the relatively high pH of the soil ranging from 6.5 to 8.0. Zeolites have also been used to solve this problem:someresearchershaveusedacombinationbetweenzeoliteandgroundapatitetoenhance thedissolutionofapatitetodelivermoreavailablePevenathighsoilpH.Thiswasdonetocreate exchange sites for $Ca^{2+}$in zeolites which decrease $Ca^{2+}$ions in the soil solution by this process supports further apatite dissolution and phosphate release(Lai and Eberl, 1986; Eberl et al., 1995 and He et al., 1999)). Lai and Eberl (1986)combined a rock phosphate with untreated and treated ($NH_4^+$, $Na^+$, and $H^+$) zeolite at a ratio of 1: 5 and reported that the mixture contained 5–70 times highersolublePthancontainedinrockphosphate-onlycontrol.Usingbatchexperiments,Allenet al.(1993)reportedthatmorezeolitetoProckratio,morePwasreleasedfromthemixturestothe solution, further confirming the role of zeolites in P rock dissolution. These results reported that zeolites could enhance the effectiveness of rock phosphate used as P fertilizer in mine soil reclamation.

***OtherNanoenhanced Fertilizers.***

Except for zeolites superior fertilizers, there are otherresearches on other type of nanomaterial-combined fertilizers. Which achieved 30– 50% efficiency of the conventional fertilizers and no other management practices to increase the rate, Derosa et al. (2010)advised to apply nanotechnology to fertilizer developments. Lal (2008) also suggested that applying nanotechnologyinagriculture(includingfertilizerdevelopment)isoneofthebestoptionsto



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increase the crop production and supply the world's increasing population with food. The suggestions that C nanotubes and zinc oxide nanoparticles are capable of penetrate tomato (*Lycopersicon esculentum*) plant root or seed tissues indicate proved that new nutrient delivery systems can be developed through using the nanoscale porous domains on plant surfaces (2010). Liu and Zhao (2007) and Liu (2011) discussed nanosized vivianite ($Fe_3(PO_4)_2 \cdot 8H_2O$) particles (~10 nm) and apatite ($Ca_5(PO_4)_3Cl$) particles (<200 nm) for heavy metal remediation. These phosphate-basednanoparticleshavepotentialstobeusedasPnanofertilizersforagriculturaluses.

***Nanomaterials for Remediating the Mine Soils Contaminated with Heavy Metals and Other Toxins***

***Zeolites.***

Natural and synthesized zeolites can immobilize heavy metals and radioactive nuclides in contaminated soils and sediments, thus minimizing the risks of those toxic substances being released to neighboring water bodies or taken up by plants/animals is necessary. For example, Edwards et al. (1999)proved that treated mine soils polluted by Zn, Pb, Cu, and Cd using synthesized zeolites at rates of 0.5–5% by weight has a significant reductions (42%–72%) of the labile and easily-available fractions of the heavy metals after the treatments. In addition to adsorption, zeolites also raise soil pH which played a role in the metal immobilization (Edwards etal.1999).Otherscientistshavegotsimilarresults(Linetal.,1998;ShanablehandKharabsheh, 1996 and Moirou et al., 2001)that use other leaching solutions such as 0.01M $CaCl_2$or dilute acetate solution to evaluate the stability of the heavy metals in the soil phase. The leachable fraction of the metals by these solutions was significantly reduced after the contaminated soils were amended with 0.5 to 16% zeolites by weight (Lin et al., 1998; Shanableh and Kharabsheh, 1996 and Moirou et al., 2001). Plants were also used as indicators to evaluate the metal toxicity and bioavailability inthe zeolites-amended soils. Using ryegrass (*Loliumperenne L.*) and alfalfa (*Medicago sativa L.*) as indicator plants, Haidouti(1997)reported that application of zeolite at 1–5%($g g^{-1}$)ratesminimizeHguptakebyplantfromacontaminatedsoilby upto58%and86%in theroots and shoots, respectively. Chlopeckaand Adriano(1996)found that adding 1.5%($g g^{-1}$) zeolite to a Zn-spike soil was able to amend the harmful effect of the metal and to increase the growth and yields of maize and barley (*Hordeum vulgare*). The Zn concentration in plant tissues wasalsominimizedbytheamendment.Knoxetal.(2003)reportedthatapplying2.5–5%zeolites to a metal-laden soil near a Zn-Pb smelter significantlyincreased the growth of maize and oat (*Avena sativa*) and decreased the Cd, Pb, and Zn accumulations in the plant tissues. In contrast, neither plant could grow in the unamended soil. Mahmoodabadi (2010)reported that application of natural zeolites increased the shoot dry weight, the number and dry weight of the root nodule and decreased the Pb toxicity to the soybean (*Glycine max*). However, there are also quite a few reportswhichindicatedthatapplicationofzeolitesreducedthegrowthofsomecropsand



ISBN:978-81-957858-1-0

vegetables (Geebelen et al., 2002; Coppola et al., 2003 andStead,2002). It is generally believed that use of Na-type zeolites resulted in release of Na+ to the soil solution and negatively affected the plant growth even though the adverse effects of the heavy metals were alleviated. Therefore, using Ca-type zeolites for heavy metal remediation is preferred at the sites where revegetation is planned. Additionally, possessing unique selectivity for $Cs^{+}$ and $Sr^{2+}$, zeolites are also good remediationagentsfortrappingradioactive139Csand90Srfromcontaminatedsoilsduetonuclear fallout, contact with water from reactor cooling reservoirs, or radioactive waste spills (Ming and Allen,2001).Similartoheavymetalremediation,theprimary purposeofusingnaturalzeolitesis toimmobilizeradionuclidesinthesoilandtoreduceorpreventtheuptakeofthosebyplants(Ming and Allen, 2001).

***Iron OxidesNanoparticles (nFeOs).***

As an important constituent of soil and anecessary nutrient to plants and animals, iron (Fe) is classifiedasthe4thmostabundantelementintheearth.TheFeoxidesexistinsoilsandsediments usually occur as Nano-crystals (5–100 nm in diameter) with reactive surfaces can adsorb a wide range of both inorganic and organic substances through mechanisms such as surface complexation/surface precipitation (Bigham et al., 2002). Because of their noticeable absorption capacity for toxic substances and their environmentally friendly characteristics, many kinds of engineered iron oxide nanoparticles have been synthesized and applied to in situwater/soil remediation processes. For example, nano- Fe oxides (nFeOs) solution can be pumped/spread directly to polluted sites at low cost with insignificant risks of secondary contamination. The intensively studied nFeOsfor heavy metals removal from water/wastewater include goethite ($\alpha$- FeOOH, needle-like, 200nm × 50nm), hematite ($\alpha$-$Fe_2O_3$, granular, 75 nm), amorphous hydrous Fe oxides (particles, 3.8 nm), maghemite ($\gamma$-$Fe_2O_3$, particle, 10nm),and magnetite ($Fe_3O_4$, particles, around 10nm) (Hua et al., 2012). Those nFeOs have been widely researched for heavy metal removal form aqueous phase through adsorption. The target contaminants included $Cu^{2+}$, $Cr^{6+}$, $Ni^{2+}$, $Pb^{2+}$, $Cr^{3+}$, $Zn^{2+}$, $As^{+5}$, and $As^{+3}$(Hua et al., 2012). However, the use of nFeOs for polluted soil reclamation has not been widely studied. But many researchers reported that the capacity of the nanoparticles for removal of heavy metals from aqueous phase can sequester the labile fractions of heavy metals from the soil solution by adsorption and thus decrease the availability and mobility of those toxins in the soils. Moreover, application of industrial wastes rich in iron oxides to contaminated soils resulted in highimmobilization of heavy metals(Xenidis etal.,2010;Kumpieneet al., 2008andUSEPA,2007),suggestingthatapplicationofnFeOswith theminesoilscouldsignificantlyimmobilizethesoil-boundtoxicsubstances.Shipleyetal.(2011) reportedthatusingacolumnpackedwithsoilmixedwith15%($g g^{-1}$)Nanomagnetitehadshowed negligible As concentrations in the effluent for up to 132 days as the influent containing 100 $\mu$g $L^{-1}$,andobservedthatAssolutioninjectedthroughthecolumnatarateof0.3$mL h^{-1}$.Only20% ofthecontaminantwasleachedoutafter208daysascomparedwithsoilalonethathadno



ISBN:978-81-957858-1-0

adsorptionofAs.Shipleyetal.(2011)alsoreportedthatanother12heavy metals(V,Cr.Co,Mn, Se, Mo, Cd, Pb, Sb, Tl, Th, and U) could be simultaneously removed by the nFeOs in the soil. After 35 hours of the leaching test, only Cr, Mo, Sb, and Co leaching reached more than 20% of the influent levels, revealing the fairly strong and high adsorption capacity of the nFeOs nanoparticlesevenformultipletoxins.Nano-hematitehassimilaradsorptioncapacitytotheNano-magnetiteShipley et al. (2011). Besides the chemical compositions, remediation efficacy and deliverability of the nanoparticles are mainly controlled by their stability and transport behaviors inthemedia(water,soil, oraquifer). Stabilityand transportofnFeOsdependontheparticlesize, particle concentration, particle magnetism, the solution chemistry, and the medium property. For a given nanoparticle suspension, the particle stability is largely governed by the electrostatic repulsion between particles (O'Carroll et al., 2013). The force is caused by the particle surface charge and surface "zeta potential" is used to quantify the magnitude of the charge or the electrostatic repulsion. Whenever zeta potential washigher, the repulsion forcebetween particles was stronger, thus the nanosolution is more stable. Charged ions (e.g., $H^+$, $OH^-$, $Na^+$, or $Cl^-$) in thebackgroundsolutioncanaffectthesuspensionstabilitybychangingtheparticlessurfacecharge (zeta potential). A pH value where the net surface charge becomes zero is called "point of zero charge" (PZC), and the solution is smallest stable and greatest prone to form aggregates at pH closetothePZC.Therefore,nanoparticlesstabilityinfluencedbysolutionpHdependsontowhich extendsolution pH close to the particle PZC. For example, the PZC is at pH 7.1 for magnetite nanoparticles. The suspension won't be stable at pH from 6 to 8 because the net particle surface chargedecreasedtoaroundzeroandfastaggregationtookplaceduetotheminimumrepulsion.In contrast, the nanoparticles solutions stayed stable at pH from 3 to 5 or from 9 to 10, which were farfromthePZCofmagnetitenanoparticles(Hu etal., 2010).Inthesecases,theaverageparticle sizeremainedsimilartotheoriginalsize(60nm)(Huetal.,2010).Nanoparticlesinaconcentrated solutionismorelikelycollidewitheachotherwhichmakethemlessstablethaninadilutesolution whereasitformaggregatesandprecipitates(Heetal.,2008andBaalousha,2009).Heetal.(2008) reported that aggregation rates were higher for smaller hematite nanoparticles due to changes of the surface properties with particles size changes. In addition to,attractive force of magnetism amongtheparticlesofnFeOsincreasestheprobabilityofaggregation.Hongetal.(2009)observed thatthestabilityandtransportofmagneticnanoparticlesareadverselyinfluencedbyacombination of electrostatic and magnetic interactions. Hong et al. (2009) reported during a column test with sand media that the less-magnetic nanoparticles removed from the columns more than the more-magneticparticles.AndthenonmagneticnFeOswerehighlytransported.Themajorityofparticles were retained at the column inlet for all transport experiments, the magnetic nanoparticles were thegreatestretained.Indicatingthatmagneticallyconvincedaggregationandsubsequentstraining cause a greater retention in the column. Magnetic particles include maghemite ($\gamma$-$Fe_2O_3$), magnetite($Fe_3O_4$),andzerovalentiron($Fe^0$),whileahematite($\alpha$-Fe2O3)nanoparticleis



ISBN:978-81-957858-1-0

nonmagnetic.Ontheotherhand,transportofthosemagneticnanoparticlesmightbecontrolledby themagnificentofanexternalmagneticfieldtothesystem.Naturalorganicmattercanmodifythe nanoparticlessurfaceand changetheparticlePZCwhenabsorbedbythenanoparticle.Therefore, changes of nanoparticle suspension stability by humic acids (HA) weredue to the acids effect on the particle PZC. Adsorption of HA often cause a decrease of magnetite PZC towards the more acidic pH values, and lower PZC got with the more HA addition. For example, Hu et al. (2010) reported PZCofmagnetitenanoparticlesdecreasedfrom7.1 (withoutHA)to5.8at2mg $L^{-1}$HA and to 3.77 at 3 mg $L^{-1}$ HA. When the HA concentration was high enough (e.g., 10 mg $L^{-1}$), the PZCwasdecreasedtopHvaluesoutoftherange(pH3–10)thatiscommonlyencounteredbythe natural environment. In this case, the suspension shows the highest stability under normal conditions (Hu et al. 2010). Similar results were got by other scientists(He et al.,2008; Baalousha,2009;Hongetal.,2009;Baalousha,2008).Inaddition,anincreaseofthesolutionionic strength generally improves the aggregation of the nanoparticles (Hu et al. 2010). Iron oxides nanoparticlesaregenerallyassumedtohavesmallornotoxicitytothelivingorganismsaccording tolimitedrelatedreports.Forexample,Karlssonetal.(2009)assessedtheabilityofthenFeOswith varyingsizesoncelldeath,mitochondrialdamage,DNAdamageandoxidativeDNAlesionsafter exposure of the human cell line A549. They reported that the iron oxide ($Fe_2O_3$) nanoparticles revealed low toxicity and no clear difference between the different particle sizes. Auffan et al. (2006) believed the organic coating on maghemite nanoparticles served as a barrier for a direct contact between particles and the cells (human fibroblasts), further reducing the possible toxic effects.TheyfoundthatthecoatednFeOsproducedweakcytotoxicandnogenotoxiceffects.One main mechanism behind the toxicity of manufactured metal nanoparticles is their ability to result in an oxidative stress in cells by creating reactive oxygen species (ROS). ROS can damage proteins,lipidsandDNAinadditiontogiverisetonecrosisandapoptosis(Karlssonetal.,2009).
However, Limbach et al. (2007)thought that the chemical composition rather than the nanoscale size is a most significant factor determining the formation of ROS in exposed cells. Moreover, they observed that dissolved iron ions promote a 20 times higher ROS production than exposure to the same amount of iron in the form of $Fe_2O_3$nanoparticles, indicating that nano-sized iron particles do not cause more toxicity than the soluble iron or solid irons with larger particle sizes. As a matter of fact, Sadeghiani et al. (2005)reported that poly aspartic-acid-coated magnetite nanoparticles may be considered as a potential precursor of anticancer drugs.

***NanoscaleZero-ValentIron Particles (nZVI).***

Nanoscale zero-valent iron (nZVI) technology developed in 1990s was fabricated to degrade the toxichalogenatedhydrocarboncompoundsandotherpetroleum-relatedproductswhichpollutethe ground water environment through gas tank leakage, organic solvent spills, etc. (Zhang, 2003). Themetallicironparticles arehighly effectivereducing agents and ableto degrademany organic contaminantstobenigncompoundsbyreductionreactions.Thesecontaminantsinclude



ISBN:978-81-957858-1-0

chlorinatedmethane,chlorinatedbenzene,pesticides,polychlorinatedbiphenyls(PCBs),andnitro aromaticcompounds(Zhang,2003).Inadditionto,thehighdegradationefficiency,thistechnology considered an eco-friendly material for the environment and being easily delivered to the subsurface environment due to the smallparticle size. This technology is also used totreat heavy metals in water and soil. Zero valent iron is a strong reductant with a reduction potential (*E*0, $Fe^{2+}/Fe^{0}$) of −0.44V (O'Carroll et al., 2013). Theoretically, some metals with E0 much more positivethan−0.44Vcouldbereductivelyimmobilizedby nZVI.Typicalexamplesofsuchmetals withenvironmentalimportanceinclude$CrO_4^{2-}/Cr^{3+}$(*E*0=+1.56V),$Cr_2O_7^{2-}/Cr^{3+}$(*E*0=+1.36 V),and$UO_2^{2+}/U^{4+}$(*E*0=+0.27V)(O'Carrolletal.,2013).Thehigh-valentspecies($CrO_4^{2-}$, $Cr_2O_7^{2-}$,and$UO_2^{2+}$)ofthosemetalsareusuallymoresolubleandmoretoxicthantheirlowvalent counterparts ($Cr^{3+}$ and $U^{4+}$) in the natural environment. nZVI is able to convert the former to the latterthroughreductionreactions,thusreducingthesolubility/mobilityandtoxicityofthosemetals (the whole process is called reductive immobilization). For example, uranium (U) is the most common radionuclide pollutant found at many nuclear waste sites. It is mainly detected in contaminatedgroundwaterashighlysolubleandmobile$U^{6+}$intheformof$UO_2^{2+}$(Caoetal.,2010). Fe oxy hydroxides can adsorb $UO_2^{2+}$in soils and in uranium mining tailings (Abdelouas, 2006). However,acidminedrainagecandissolveandreleasetheadsorbeduraniumtothenearby ecosystem. These risks can be solved by converted it to insoluble $U^{4+}$ oxides using nZVI. Many reports concluded that, compared to the other reductants (metal iron filing, galena (PbS) and iron sulfide)nZVIismoreefficienttoreductivelyimmobilize$U^{6+}$fromaqueousphase,whichcouldbe attributedtoitsnanosize,highreactivity,largesurfacearea,andreactiveFe(II)producedbynZVI (Yanetal.,2010;Fiedoretal.,1998;Craneetal.,2011;DickinsonandScott,2010andRibaetal., 2008). This literature confirmed that$U^{6+}$ was predominantly removed by nZVI via reductive precipitationof$UO_2^{2+}$($U^{4+}$)withminorprecipitationof$UO_3{\cdot}2H_2O$($U^{6+}$)asconfirmedbytheXray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD) analyses. Oxygen level, solution pH, and presences of bicarbonates and calcium ions all affect the reductive immobilization processes (Yan et al., 2010;Fiedor et al., 1998). It has also been reported that nZVI was able to convert higher valent $Cr^{+6}$ to low valent $Cr^{+3}$ in aqueous solutions or soil media. Franco et al. (2009) reported that 97.5% of $Cr^{+6}$ in a polluted soil could be converted to $Cr^{+3}$ by nZVI, which significantly decreased the chromium toxicity in the spoil. Similar results were got in soils using nZVI (Xu and Zhao, 2007 and Ponder et al., 2000). Selenium (Se) is an important nutrient in animal systems, but high concentrations could be harmful for biological systems when human activities, such as mining into shale for oil and phosphorus or irrigating arid and semiarid lands, produce seleniferous soils (Lemly, 1997). Plants can accumulate Se from the impacted soils (Mackowiak and Amacher,2008). Plant accumulation and soil ingestion lead to Se bioaccumulation and Se poison in livestock and wildlife (Witte and Will,1993 andThomas et al., 2005).Similartouraniumandchromium,highvalentseleniumspecies($SeO_4^{-2}$or$Se^{6+}$and$SeO_3^{-2}$



ISBN:978-81-957858-1-0

or$Se^{4+}$)aremoresolubleandmobileinthenaturalenvironmentandmoretoxicthanthelow-valent speciessuchas$Se^0$and$Se^{-2}$.nZVIhasbeenappliedtoremovetheseleniumfromthesolutionand reduce the high-valent species to the low valent ones thus the toxicity and solubility of Se are greatly lowered (O'Carroll et al., 2013). Olegario et al., (2010) reported that nZVI had high adsorption capacity for elimination of dissolved $Se^{6+}$ up to 0.1 mole Se/mole Fe. Using X-ray absorption near edge structure (XANES) spectroscopy and X-ray absorption fine structure (EXAFS) spectroscopy, they identified FeSe compound in the solid phase as the reduced $Se^{2-}$species transformed from $S^{6+}$. They concluded that nZVI has the capability for reduction of soluble Se oxyanions to insoluble $Se^{-2}$. nZVI is also able to treat some other toxic elements in water or soil such as $Hg^{+2}$, $Ni^{+2}$, $Ag^{+1}$, $Cd^{+2}$, $As^{+3}$, and $As^{+5}$(Li and Zhang, 2006; Li and Zhang,2007;Kaneletal.,2006andKaneletal.,2005).Thedecontaminationmechanismsinclude reduction of metal ions to zero valent metals on the nZVI surfaces and/or adsorption of the ions on the nZVI particle shells which consist of a layer of iron oxidation products (iron oxides) (O'Carroll et al., 2013). For example, Watanabe et al. (2009) reported that application of 0.01% nZVI (g $g^{-1}$) to a Cd-spiked soil considerablydecreased the Cd accumulations in rice (*Oryza sativa*)seedsandleavesby10%and20%respectivelythancontrol.Theenvironmentalrelocation of bare nZVI has been estimated to be within a few centimeters under subsurface environment (Salehetal.,2008andTratnyekandJohnson,2006)duetoquicknanoparticlesaccumulationand interactionswithsurfacesoftheambientporous media.Substantialeffortsweremadetoenhance thestabilityandmobilityofnZVI(e.g.,usingnanoparticlestabilizers),hopingthatnZVIdiffuses the entire contaminated aquifer and degrades the pollutants in situ as soon as being injected undergroundthroughoneormoreinjectionwells.Supportedbythelaboratorycolumntestresults, quiteafewreportshaveclaimedsuccessfulsynthesisofnZVIwithimprovedstabilityandmobility as well as reactivity (He and Zhao, 2005; He and Zhao, 2007; Phenrat et al., 2008 andSakulchaicharoen et al., 2010). But there is no solid evidence on significantly increased mobility of such products in the field (O'Carroll et al., 2013). Stabilized nZVI has been visually confirmed to travel merely 1m from an injection well, and evidence suggests that the maximum travel distance of up to 2-3m may be achieved in high permeability formations (O'Carroll et al., 2013).Thedifferences between thelabworkand thefield experiments resulted from thefact that lab work use lower Fe concentrations (<0.25 g $L^{-1}$), higher flow velocities (15–30 m $day^{-1}$), and simplified subsurface simulations by sand-packed columns. While field experiment use much higher Fe application rates (1–30 g $L^{-1}$), lower groundwater flow rates (0.1 to 10 m $day^{-1}$), and much more complicated aquifer formations (O'Carroll et al., 2013), which produce much aggregation and precipitation of nZVI. In addition, oxidizing nZVI faster by dissolved oxygen,creating maghemite and magnetite precipitates (Reinsch et al., 2010). These reports suggested that risks of nZVIspread in the environment and subsequent exposure of organisms to the nZVIdoesn'tseriouslytookplaceonthecurrentstageofnZVItechnology.There are nofield



ISBN:978-81-957858-1-0

experimentsonusingnanoparticlesforsoilremediation.However,therearesomedifferencesfrom groundwater remediation. For mine soil recovery and vegetation establishment purposes, a thin soil surface layer (e.g., 50 cm deep) for plant root growth is usually involved. In a way similar to the surface irrigation, nanoparticle suspension would be applied to all over the targeted land surfaces. By employing the nanoparticle size, the particles would be ideally engaged within the polluted surface layer only after the whole targeted soil column was saturated and treated by the particles,thusdecreasingtherisksofnanomaterialsspreadandevadingsecondarycontaminations totheneighboringwaterbodies.Fromthisapproach,nZVIandothernanoparticleswithextremely highmobilityarenotrequiredforsurfacesoilremediationpurpose.Therearealimitednumberof reportsand researcherspertainingtothetoxicologicalandecotoxicological effectsofnZVIusing in the environment (Grieger et al. 2010). Grieger et al. (2010)reported the possible effects of exposure to nZVI as follows: (a) lowserious toxicity to aquatic organisms, as sublethal effects at minor concentrations (<1mg $L^{-1}$); (b) nZVI can cause histological changes and morphological changesinsomespeciesduringattachtoorganismsandcells;(c)somecoatingsdecreasetoxicity by reduced adherence; (d) release of Fe(II) from nZVI lead to ROS production as well as distraction of cell membranes causing cell death and lysis and possible improvement of biocidal effectsofFe(II);(e)theagingofnZVIunderaerobicconditionsdecreasesnZVItoxicity,whereby $Fe^0$ is speedily oxidized Other metal-based nanoparticles for environmental remediation include nanoscalemanganeseoxidesandhydroxides,aluminumoxides,titaniumoxides,zincoxides,and magnesiumoxides.Allthesenanoparticlescouldadsorbheavymetalfromsolutiononsurface;iron oxides also have the same mechanism for heavy metal removal (Bigham et al., 2002). Among those metal oxides nanoparticles, iron and manganese nanoparticles are sensitive to the compact environment such as those in a waterlogged soils or wetlands. Those particles may be reduced to the lower valent states and miss the adsorption capacity. For manganese, zinc, and aluminum-based nanoparticles, phytotoxicity might be useful for acidic soils. Moreover, Limbach et al. (2007) reported that cobalt and manganese oxides ($Co_3O_4$and $Mn_3O_4$) nanoparticles produced more ROS (indicating more toxicity) than their respective salt solutions while titanium oxide ($TiO_2$) and iron oxide ($Fe_2O_3$) nanoparticles were relatively inert.

***Phosphate-BasedNanoparticles.***

Many kinds of nFeOs or nZVI, phosphate-based nanoparticles used for removal of heavy metals from contaminated soils by creating highly insoluble and stable phosphate compounds. Same example is treatment of the lead-laden soils. The solubility of common lead compounds in soils such as anglesite ($PbSO_4$), cerussite ($PbCO_3$), galena (PbS), and litharge (PbO) have been determined as $10^{-7.7}$, $10^{-12.8}$, $10^{-27.5}$, and $10^{+12.9}$, respectively (Ruby et al., 1994). In comparison, leadphosphatecompoundssuchaspyromorphites(($Pb_5(PO_4)_3X$,X=$F^-$,$Cl^-$,$Br^-$,and$OH^-$)have solubility products fewer than $10^{-71}$(Ruby et al., 1994). This fact shows that lead phosphates are significantlyfewersolublethanotherPbproductsexistinsoils.AnalterationofthelessstablePb



ISBN:978-81-957858-1-0

products to more stable species by phosphate amendments is a thermodynamically preferred process which minimizes the leachability and availability of the lead in the solid phase. Some phosphate amendments are more effective method for *in situ* lead precipitation and have been intensively studied (Ruby et al., 1994). Other metals having been investigated and reported effectiveincludeCu$^{2+}$,Zn$^{2+}$,Cd$^{2+}$,Co$^{2+}$,Cr$^{3+}$,Ba$^{2+}$,U$^{6+}$,andEu$^{3+}$(Maetal.,1995;Raicevicetal., 2005; Raicevic et al., 2006 and Basta and McGowen, 2004). Generally, soluble phosphate salts andparticulatephosphatemineralsarecommonlyutilizedformsofthephosphatesforthispurpose. The former includes phosphoric acid (Eighmy et al., 1997), $NaH_2PO_4$(Stanforth and Qiu, 2001), and $(NH_4)_2HPO_4$(Basta and McGowen, 2004), the latter involves various forms of apatite includingsyntheticapatites(Peldetal.,2004),naturalrockphosphates(Maetal.,1995;Raicevic et al., 2005; Raicevic et al., 2006 and Basta and McGowen, 2004), and biogenic apatites such as fishbone (Knox et al., 2006). Although both are extremely effective for in situ accumulation of heavy metals at the laboratory scale, the problems of these materials in the field still exist. Forexample, although soluble phosphates aregreatly mobile in the subsurface and thus more effective in heavy metal stabilization, may resulted in the harmful effects of eutrophication. Furthermore, excessive amounts of phosphoric acids and ammonium phosphates may cause acidifyingthesoils (Bastaand McGowen, 2004). Amendment dosageof3%$PO_4$(or1%as P)by weightforsoilshasbeenstudiedbyUSEPAandotherscientists(USEPA,2001),suggestinghigher risk of the phosphate spill to water bodies and soil acidification following the heavy metal remediation.Yet,solidphosphateapplicationishinderedbythelargesizeparticles,whichrestrict thephosphatemobilityanddeliveryandinhibitsphosphatefromreachingandreactingwithheavy metalsinsubsurfacelayersofsoil.Alsothefinelygroundsolidphosphateparticlesarenotmobile insoils,soitneedsformechanicalmixinginthefieldfortreatmentprocesses.Consideringofthese problemsofphosphateapplication,LiuandZhao[86]fabricatednanosizedironphosphateparticles for heavy metal accumulation as the commonly used phosphates while overcoming the delivery problem and secondary contamination risks related with the latter. For example, the nanoparticle suspension, which has the same mobility as aqueous solution due to the nanoscaled particle size, iseasilytransported tothecontaminationsitewith conventionalengineeringmethods(e.g.,spray orwell-injection).Thenanoparticlesarealsoreportedfriendlyenvironmentbecausethephosphate in solid form is much less bioavailable to the algae than those in soluble forms (Reynolds and Davies,2001). Algae-bioavailable P and N are primarily responsible for eutrophication in surface waters. Liu and Zhao (2007)synthesized and applied a new class of iron phosphate (vivianite) nanoparticles for *in situ* adsorption of Pb$^{2+}$ in soils. Batch experiment results revealed that the nanoparticlessignificantlyreducetheleachabilityandbioaccessibilityofPb$^{2+}$inthreestudiedsoils (calcareous, neutral, and acidic), evaluated by the toxicity characteristic leaching procedure (TCLP) and physiologically based extraction test (PBET), respectively. When the soils were treatedfor56dataraterangingfrom0.61to3.0mgg$^{-1}$-soilas$PO_4^{-3}$,theTCLPleachablePb$^{2+}$



ISBN:978-81-957858-1-0

wasdecreasedby85–95%,andthebioaccessiblefractionwasdecreasedby31–47%.Resultsfrom asequentialextractiontechniqueobserveda33–93%decreaseinexchangeable$Pb^{2+}$andcarbonate-bound fractions, and an increase in residual- $Pb^{2+}$ fraction when $Pb^{2+}$-spiked soils were amended with the nanoparticles. Additions of chloride in the treatment further lower the TCLP-leachable $Pb^{2+}$ in soils, proposing the formation of chloropyromorphite minerals. Compared to soluble phosphateapplicationfor*insitu*metalimmobilization,usingironphosphatenanoparticlesresulted in around 50% decrease in phosphate leaching into the environment. Liu (2011) concluded an effective remediation of a lead-laden soil from a shoot range using manufactured apatite nanoparticles. Results revealed that the apatite nanoparticles solution could effectively decrease the TCLP-leachable Pb fraction in the Pb-contaminated soil from 66.43% to 9.56% after one-month amendment at aratio of2mL solution to 1 g soil and the resulting Pb content in the TCLP solution was decreased to 12.15 mg L−1 from 94.33 mg L−1.When the amendment ratio was raised by 5 times, the leachable Pb was decreased to 3.75 mg $L^{-1}$ with only about 3% of the soil Pbleachable.Theoriginalsoilsamplecontainedanaverageof2647.9mgPbkg$^{-1}$soil(Liu,2011). These phosphate-based nanoparticles also could be used as P nano-fertilizers. In addition to supplying nutrient P to the plants, these nanoparticles also have benefits of easy delivery (by spraying to the soil surface) with minimum P leaching to the neighboring water bodies.

***IronSulfideNanoparticles***

Similar to the mechanisms of phosphate based nanoparticles application for heavy metal immobilization, sulfide-based nanoparticles have been studiedfor removal of mercury (Hg) and arsenic (As) in water and soil/sediment by providing sulfide ($S^{-2}$) ligands and/or management surfaces.Asamatteroffact,reducedsulfur($S^{-2}$)hasbeenconsideredasastabilizer/sinkofheavy metals in the reduced environment such as in the sediments or water-logged soils by forming highlyinsolublemetalsulfides(Mooreetal., 1988).Ithasbeenestimatedthatasedimentsample wouldbeconsideredsafeornontoxictotheaquaticorganismswhenmolarratiooftheacidvolatile sulfide (AVS) to the total heavy metal concentrations (e.g., Cu + Ni + Zn) was greater than 1 (Ankley et al., 1996). In this case, ideally, the heavy metals are all bound in the insoluble metal- sulfide phases and thus the soluble (bioavailable) metals in the pore water are decreased(Ankley et al., 1996). Moreover, sulfide ($S^{-2}$) has been widely supposed as greatly important inorganic ligandtoremovetheHgfromthewatercolumnanddestroytheformationofthenotorious-methyl-mercury($CH_3Hg$)inthenaturalenvironment.Methyl-mercuryhasbeensupposedtobeoneofthe most toxic Hg species which can easily bioaccumulate and concentrate in fish and other aquatic organisms and become biomagnified through food chain. Consumption of fish and shellfish contaminated with $CH_3Hg$ is the primary route of human exposure to mercury (Ankley et al., 1996). Dissolved, neutral mercury complexes (primarily HS0 and $Hg(HS)_2$rather than $Hg^{2+}$ or total dissolved Hg are considered the main Hg(II) species controlling the extent of mercury methylationinthecontaminatedsediments(Liuetal.2009andBenoitetal.,1999).Ironsulfide



ISBN:978-81-957858-1-0

amendments can effectively decrease the concentrations of the neutral mercury complexes by formationofchargedHg(II)-polysulfides(e.g.,$HgS_2^{2-}$,HgSH+,HgS2H−)(Liuetal.2009;Benoit et al., 1999; Drott et al., 2007 and Xiong et al., 2009)). In addition, formation of the insoluble mercuric sulfide complexes also reduces conversion of the ionic Hg to volatile metal Hg in soil (Revis et al., 1989). Liu et al. (2009) reported that synthesized mackinawite (FeS) was able to remove the aqueous Hg around 0.75mol $Hg^{2+}$/mole FeS. They believed that 77% of Hg removed was through precipitation by forming in soluble HgS species and the residual 23% was removed by adsorption on the FeS surface. Meanwhile, under anoxic environments, iron sulfides has the ability to reduce the mobility and availability of toxic element As by adsorption and/or precipitation processes,depending on thesolution pHand ironsulfidetype and oxidation stateof As(Renocketal.,2009;Wolthersetal.,2005;Gallegosetal.,2007andGallegosetal.,2008).For example, Wolthers et al. (2005)concluded that the maximum As(V) adsorption by FeS happened at pH 7.4 with an adsorption capacity of 0.044 mol As/mol FeS while the capacity was 0.012 As/molFeStoAs(III)butlesspHdependent.Furthermore,thereductioncapacityofironsulfides isalsopracticaltoreductiveimmobilizationof$Tc^{+6}$(Liuetal.,2008),Cr+6(Pattersonetal.,1997), and $U^{+6}$(Hua and Deng, 2008), and reductive degradation of trichloroethylene (TCE) and tetrachloroethylene (PCE)(Butler and Hayes,1998; Butler and Hayes,1999 and Butler and Hayes,2001). Again, sulfide ion ($S^{2-}$) plays major role in those reduction reactions, and the decontamination mechanisms are similar to those of zero-valent iron nanoparticles as discussed before. Mackinawite is a widely reported iron sulfide synthesized for those environmental remediation studies in the laboratory. This compound is prepared by simply mixing $Fe^{2+}$-containing and $S^{2-}$-containing salts together under anaerobic condition. This method produces black-colored micrometer-sized particles (Liu et al., 2008; Ankley et al., 1996 and Xiong et al., 2009), which aggregate and precipitate in a few minutes (Xiong et al., 2009) By carboxy methyl cellulose (CMC) as nanoparticle stabilizer, Xiong et al. (2009)fabricated stable FeS spherical nanoparticlesuspensionwhichstayedsuspendedforatleast3monthswithaparticlesizeof31.4±4 nmdiameter.Shietal.(2006)synthesisFeSnanoparticlesusingsamestabilizer,creatingspherical-shaped particles with an average size of 4– 6 nm. Xiong et al.(2009)reported that the CMC stabilized nanoparticles were found to enhance the adsorption of Hg in a sediment sample. For example,whentheFeSsphericalnanoparticletoHg(sediment-bound)withmolarratioupto26.5, theHgconcentrationinthesedimentporewaterwasdecreasedby97%andtheTCLPleachability of the sediment-bound Hg was decreased by 99%, indicating that the FeS nanoparticles amendmentsignificantlydecreasedthelabileHgportioninthesample.Inadditionto,significantly decreasedthe availability of Hg species ($HgS^0$ + Hg $(HS)_2{}^0$) by up to three orders of magnitude. Most essentially, the FeS spherical nanoparticle suspension was highly mobile in a clay loam sedimentcolumn,indicatingtheessentialpropertiesofthenanoparticlesandthehighmobilityfor soil/sedimentremediation.Theyobservedthatcompletebreakthroughofthenanoparticles



ISBN:978-81-957858-1-0

happened at around 18 pore volumes (PVs), compared to 3 PVs for the inert tracer ($Br^-$). In contrast, when FeS spherical nanoparticleswere applied in thesame tests, themajority (>99.7%) 0fparticleswerecapturedontopofthesedimentcolumn(Xiongetal.,2009).Xiongetal.'swork is probably the only one using real FeS nanoparticles to remediate the soil-bound contaminants (Hg).Otherearlierresearchessuggestthat FeSnanoparticleswerehighlyimmobilizedotherheavy metals (especially As) and some organic contaminatesexist in soils or in sediments. However, cautions must be taken when using it in a mine soil reclamation plan: firstly, most of the iron sulfide ($S^-$) solids could be oxidized to soluble sulfate species ($SO_4^{2-}$) by the air due to their instabilityundertheaerobicenvironments(Liuetal.,2008andAnkleyetal.,1996),therebytheir adsorption capacity is lost and the contaminants already retained on the FeS solid surface would be rereleased to the pore water and become remobilized (Ankley et al., 1996). Processes such as drainingapondorawater-loggedlandanddredgingthesedimentsareafewexamplesofexposing thesedimentstotheair.Practically,itishardtokeepasoil/sedimentunderanaerobicenvironment for long period, and a change of the redox potential might resulted in a secondary contamination problem related to FeS amendments. Secondly, acid mine drainage (AMD) is a very important environmental issue at most of the abandoned mining sites. Many works had been done on investigation, inhibition, management, and remediation of AMD and acidic mine soils for many years(Blodau,2006).Infact,theacidityinthedrainageandinthesoilsestablishedfromoxidation oftheironsulfideminerals(mostlypyrite, $FeS_2$)byoxygen ($O_2$)aftertheseburiedmineralswere exposedtotheairthroughtheminingprocess(Blodau,2006).Therefore,simplyapplicationofFeS minerals to the soils might exacerbate the AMD and soil acidity problems at a mining site. More stable adsorption materials such as iron oxide nanoparticles (for As) or phosphate-based nanoparticles (for heavy metals) could be better options.

***CarbonNanotubes.***

TheCnanotubes(CNTs)areCmacromoleculesconsistingofsheetsofCatomscovalentlybonded inhexagonallatticesthatseamlesslytollintoahollow,cylindricalshapewithbothendsnormally caped by fullerene-like tips (Niu and Cai, 2012). According to their structures, CNTs could be categorizedinto:single-walledCnanotubes(SWCNT)andmulti-walledCnanotubes(MWCNT). ThediameterofCNTscanvariedfromhundredsnanometersandmicrometersto0.2and2nmfor SWCNT, and from 2 to 100 nm for coaxial MWCNT. CNTs a promising adsorbent material for nonpolar organic contaminants such as trihalomethanes, polycyclic aromatic hydrocarbons, or naphthalene, dioxin, herbicides, DDT and its metabolites, because of their large surface area, tubular structure and nonpolar property (Niu and Cai, 2012; Theron et al., 2008 and Mauter and Elimelech,2008).ComparedtoanactivatedC,thepurifiedCNTspossesstwotothreetimeshigher adsorption capacities for organic contaminants (Theron et al., 2008). CNTs has nonpolar characteristics, this was led to very low sorption of the polar metal ions while the sorption was increasedaftermodificationoftheCNTssurfacebycreatingalargeamountofoxygen-containing



ISBN:978-81-957858-1-0

polarfunctionalgroups(–COOH,–OH,or–C=O).Thesefunctionalgroupsresultedinincreasing negative charge on CNTs surface, and the oxygen atoms in functional groups provide single pair ofelectronstometalions,whichraisethecationsadsorptioncapacityofCNTs(Raoetal., 2007). For example, MWCNTs, pretreated with nitric acid, showed high adsorption for many kinds of heavy metal ions, including Pb(II) (97.08 mg $g^{-1}$), Cu(II) (24.49 mg $g^{-1}$), and Cd(II) (10.86 mg $g^{-1}$) from an aqueous solution. In addition, SWCNTs and MWCNTs after their oxidation with NaClOprovedtohavebetterNi(II)sorptionproperties.Thesetreatmentsincreasepolarityofthe CNT surface, and led to be more hydrophilic and, therefore, able to adsorb more charged metal ions from the aqueous solution (Li et al., 2003 and Lu and Liu, 2006). Although CNTs proved to be efficient adsorbents for many kinds of pollutants in both drinking and environmental waters, theirpracticalapplicationmaybehinderedbytheirhighcost(Theronetal.,2008).However,CNTs couldbeappliedatsmallscalewithsludgeortoothersolidwastestoremoveseveralcontaminants whichmakethesewastessafelyland-appliedtoimprovesoilqualityandreducethewaste-disposal expenses. Thepristine CNTs are proneto aggregation and precipitation in the aqueous phase due totheirextremehydrophobicity(Hyungetal.,2007andJaisiandElimelech.2009).Dispersionof CNTs in the aqueous phase can be achieved either by modifying the surface structure and introducing hydrophilic (polar) functional groups (Jaisi and Elimelech. 2009and Jaisi et al., 2008)or by improving the interactions on the nanotubes/water interface through addition of surfactants(Jiangetal.,2003),polymers(O'Connelletal.,2001),andnaturalorganicmatter(Jaisi et al., 2008; Jiang et al., 2003 and Zhou et al., 2012). The former method directly enhances the hydrophility of the CNTS, while the latter options not only create a thermodynamically suitable surface in water but also provide steric or electrostatic repulsion among dispersed CNTs, thus preventingaggregation(Hyungetal.,2007).Naturalorganicmattermayplayseriousrolesinfate and transport of nanotubes in the environment due to its ubiquitous presence. Hyung et al. (2007)stated that the water samples taken from the Suwannee River, USA, presented a similar MWCNT stabilizing capacity as compared to fabricated solutions containing the model natural organic matter (SR-NOM). For the same initial MWCNT concentrations, the concentrations of suspended MWCNTs in SR-NOM solutions and the Suwannee River water samples were even significantlygreaterthanthatinasolutionof1%sodiumdodecylsulfate(surfactantusedtostabilize CNTs in the aqueous phase). During studying the transport of carboxyl-functionalized SWCNTs inquartz-sandpackedcolumns,JaisiandElimelech(2009)andJaisietal.(2008)reportedthatthe performances of the nanotubes were generally similar to those traditionally got with colloidal particles and bacterial cells. For instance, ionic strength of the solution was increaseddue to increasedSWCNTdepositioninthecolumnanddivalentcations(e.g.,$Ca^{2+}$)decreasetheSWCNT stability higher than monovalent cations (e.g., $Na^{+}$) at the same ionic strength. However, at very lowionicstrengthseveninDIwater,SWCNTnatureinthesandmediachangedslightly,reflecting thatthesimplyphysicalconstrains(straining)alsoplayedrolesinnanotubemobilitybesidesthe



ISBN:978-81-957858-1-0

complicated physicochemical interactions between particle and the medium surfaces. Jaisi and Elimelech(2009)reportedthatstraininghaveseriousrolesonnanotubemobilityinthesoilmedia. They compared themobility oflinearnanotubesand spherical fullerenenanoparticlesin columns packedwiththesamesoils.Itwasfoundthatthefullereneremovalrateswerefewerthanthoseof SWCNTs at the same ionic strength. Moreover, fullerene nanoparticles were more affected by changes in ionic strength as compared with SWCNTs. Scientists suggested that linear shape and structure, particularly the very large aspect ratio and its highly bundled (aggregated) found in aqueoussolutions,werethemainreasonfornanotuberetaininginthesoil columns.Furthermore, theporesizedistributionandporegeometryaswellasheterogeneityinsoilparticlesize,porosity, and permeability also participating in to straining in flow through the soil media by nanotubes. Thus,SWCNTmobilityinsoilswouldbelimited(Jaisietal.,2008).MWCNTsalsoreportedsame results(Xueyingetal.,2009).Ontheotherhand,naturalsoilenvironmentsaremoreheterogeneous and normally contain open soil structures (e.g., cracks, fissures, worm trails, and other open features)thatcanencouragemobilityofSWNTsinsoil.Moreover,soilporewaterisnormallyrich in dissolved organic molecules (e.g., humic and fulvic acids) that can improve the colloidal stability of nanomaterials (Jaisi et al.,2008). Due to limited work studying the nanoparticles mobility in the soil media, the discussions above reported significant suggestions on transport of alltypesofnanoparticlesinthesoilenvironmentOnonehand,nanoparticlesmayreducemobility andgreaterretentionrateinsoilmediathanwhatwerereportedusingsand-packedcolumnstudies in the laboratory due to the more complicated pore structures and pore distributions in soils. On the other hand, existence of the preferential flow and natural organic matter in soil media would increasethenanoparticlestransportthroughthesoilcolumnsandenhancetherisksofgroundwater pollution.OtherworksreportedthatCNTsarebiologicallyactiveasdemonstratedbyapulmonary response via induction of pulmonary granulomas (Warheit et al., 2004 and Lam et al., 2004) at a higherinstancethanquartz(1–3$\mu$mcrystallinesilica),whichisaconsideredchronicoccupational healthhazard(viainhalationroutes).BothSWCNTsandMWCNTswerealsorecognizedtocause loss of phagocytic ability and ultrastructure damage to alveola macrophages (Jia et al., 2005). Additionally,CNTshaveencouragedobservabletoxicresponsesinothercellcultures(Magrezet al., 2006).

***UsingNanoenhancedMaterialsasSolidWasteStabilizers/Conditioners.***

Solid wastes have mostly different environmental contaminants (detrimental impurities, pathogens, and sometimes nauseous odors). Thus, to make these wastes have benefits for landfill soil reclamation, secondary environmental contaminations should be eliminated. Nano-enhanced materials had proved toenhance the environmental safety and public acceptance for landfill application of these wastes in mine or agricultural remediation. For instance, Li et al. (2007)reported that a small amount of nZVI (0.1% by weight) significantlyeliminate nauseous odors(causedbyorganicsulfurcompounds),heavymetals,andorganiccontaminantsinthebio-



ISBN:978-81-957858-1-0

solids,indicatingthatnZVIcoulddecreasethecontaminationofbiosolidsandincreasebeneficial usesofthesewastes.Turan(2008)concludedthatco-compostofpoultrylittermixingwith5%and 10% (g $g^{-1}$) natural zeolites had removed 66% and 89% of the end product salinity, respectively. Using 25%–30% (g $g^{-1}$) zeolitesfor biosolids remediation can remove many kinds of heavy metals (100% of Cd, 28– 45% of Cu, 10–15% of Cr, 50–55% of Ni and Pb, and 40– 46% of Zn) anddecrease the leaching of these metals (Zorpas et al., 2000). Zeolites also used at lower rates (0.5% and 1.0%) for significantly removal of labile Zn duringexperimental horticultural compost derivedfromsewagesludge(Nissenetal., 2000).Subsequentplantgrowthtrialsmeasuring transfer ofZnandCutoryegrassinsuccessiveharvestsdemonstratedthat1.0%zeolitecausedsignificant reduction in total metaltransferfrom soil to plantovera116 d growth period.Theuseofzeolites isacost-effectiveamendmentforcomposttosignificantlyreducepotentialforsoilmetalmobility andsoiltoplanttransfer(Villase˜noretal.2011).Villase˜noretal.(2011)addedthreecommercial naturalzeolitestoapilot-scalerotarydrumcompostingreactor,wherethedomesticsewagesludge andbarleystrawswereco-composted.Theyobservedthatallthreetypesofzeolitesremoved100% of Ni, Cr, Pb, and significant amounts (more than 60%) of Cu, Zn, and Hg originated from the sludge(Villase˜noretal. 2011).ItisalsoreportedthattheclinoptilolitesreducedB50%oftheNH$_3$emissionfromthecompost(Villase˜noretal.2011),avoidingNlossandunpleasantodorfromthe compost. Villase˜nor et al. (2011) claimed that addition of 10% zeolites produced composts compliantwithSpanishregulationsregardingheavymetalcontamination.Accordingtothem,the zeolite-amended compost could either be applied directly to soil, or the metal-polluted zeolites couldbeseparatedfromthecompostpriortoapplicationtoensuretheenvironmentalsafety.Using zeolites as heavy metal absorbents in compost is also verified by other researchers (Zorpas and Loizidou, 2008; Zorpas et al., 2002 and Zorpas et al., 1999). Gadepalle et al. (2007) applied compostcontaining5%zeolitetoanAs-contaminatedsoilandobservedthatzeolitesadditioncan effectively reduce the As uptake by rye grass and that less than 0.01% of the total As content in the soil may be absorbed by the plants. Literature above showed that amending the solid wastes with relatively small amounts of nanomaterials could effectively reduce or eliminate the risk of secondary contamination associated with land applications of these wastes. This practice could expand the industrial or municipal waste lists which are safe for land application, thus saving the cost of waste disposal and ameliorating the adverse environmental impacts. In addition, agricultural soils and drastically disturbed lands (e.g., mine soils) could benefit from these most cost-effective waste materials (soil amendments). Moreover, application of the nanomaterials to stabilize or condition the conventional soil amendment materials (e.g., composts, biosolids, coal combustion by-products) could be a potential aspect of utilization of nanotechnology in the agriculture at low cost. Zeolites, nFeOs, phosphate-based nanoparticles, and sulfide-based nanoparticlesareefficientinimmobilizinginorganiccontaminantsinthesolids,whileCnanotubes haveahighabsorptioncapacityfororganicpollutantsandnZVIcandestroytheOWCspresentin



ISBN:978-81-957858-1-0

thewastesbyreductionreactions.Finally,incubationofthenanomaterialswithsolidwastescould inturnstabilizetheformerandreducetherisksofnanomaterialsspillandcontaminationsresulting from direct application of the nanoparticles to the environment.

***UsingNanoenhanced MaterialstoControlSoil Erosion.***

Soil erosion affected by rainfall or wind in a closed mining site, can result in loss of good soil, exposuretheburiedsulfideminerals,andtransportationofthesedimentsandpollutantstosurface water bodies besides. Therefore, soil erosion management is a high importance in a mine soil reclamation plan. Nanoenhanced materials have benefits to use for combat the harmful of soil erosion. Andry et al. (2009)reported thatthe surface runoff and soil loss can be significantly decreased by zeolite application at rate of 10% of a Ca type zeolite material when applied at an acidic soil under simulated rainfall. This was attributed to an enhancement of wet aggregate stability and the large particle size of the sediment due to the amendments. Andry et al. (2009)suggested that zeolites can be more effective than lime in soil erosion management. Yamamotoetal.(2004)alsoappliedCatypeofartificialzeoliteatratesof5–25%insodicsoilsto controltherunoffrateandsoilloss.TheyreportedthattheexchangeofCa$^{2+}$onzeoliteswithNa$^{+}$ inthesodicsoilreducedtheclaydispersion,resultinginincreasedsoilhydraulicconductivityand soil aggregation, which decrease the runoff rate and soil loss. Zheng (2011)reported that using polyacrylamide (PAM, a polyelectrolyte used for soil erosion management) and magnetite nanoparticles to an As-spiked soil subject tothe simulated rainfall could effectively decrease soil erosion while the nanoparticles could reduce As leaching. Wang et al. (2007)reported that using alumina nanoparticles ($Al_2O_3$, 140–330 nm) in conditioning a wastewater treatment sludge result inlargerflocksandbetterdewateringeffectsthanthesingleconditioningbypolyelectrolyteonly. The valuable effects are more evident when finer nanoparticles (140 nm) wereused. Wang et al., (2007)suggested that the nanoparticles can increase the stretch of the chain-like structures of the polyelectrolyte,resultinginmoreeffectivebridgingeffectsandbetterflocculation.Asamatterof fact,thePE(polyelectrolyte)—NP(nanoparticles) flocculationsystemshavebeen widelyusedin effectively eliminating solid particles from the solution (Ovenden and Xiao, 2002 and Yan and Deng,2000).Theflocculationinsuchasystemisinducedbythesequentialadditionofapositively charged polyelectrolyte followed by negatively charged nanoparticles, such as bentonite and colloidal silica. The systems produce a better flocculation and drainage (dewatering) than conventionalpolymer-onlyflocculationsystems(OvendenandXiao,2002).Theseresultssuggest that double application of polyelectrolyte and nanoparticles could increase flocculation and improve soil particle size and particle stability and thus effectively manage soil erosions caused by wind or rain.



ISBN:978-81-957858-1-0

## Conclusion

Nanotechnology had been attracted many researchers for its unique physical, chemical and biological characteristics in nano size that differ from those in a large scale model for the same material. Nanomaterials were developed for many applications in many fields such as Medicine, drug delivery, electronics, fuel cells, solar cells, food, space and etc. Among these application nanomaterialshadprovedmanybenefitsforagriculturalpurpose.Nanotechnologyprovedtohave manybenefitsforplantgerminationandgrowth. $TiO_2$ Nanoparticlesincreaseddryweight(73%), Photosynthetic rate (three times) and chlorophyll-A formation (45%) than control over germination period of 30 days. Nanomaterial was achieved better growth rate of spinach seeds thantraditional$TiO_2$indicatingthatnanomaterialshavebeneficialpropertiesforplantgermination. Also other nanoparticles showed positive effects on seeds germination and plant growth such as Pd,Auatlowconcentrations;Si,Cuathigherconcentrations,andcombinationofAuandCu.Also nanomaterials were used todetect and treatment of plant diseases. Since nanomaterials could be usedforstatebacterial,viralandfungalplantpathogens.Nano-chipsareknownindetectingsingle nucleotide changes of bacteria and viruses due to their sensitivity and specificity, also a fluorescence silica nanoparticles uploaded with antibody to detect Xanthomonas axonopodis pv. Vesicatoria which causes bacterial spot disease in Solanaceae plants, showing that nanoparticle canbeappliedsuccessfullyfordiseasedetection.Nanomaterialsbasednanosensorscanbeusedto detectmanypesticideresiduesinsteadoftraditionalgasorliquidchromatography(GC/LC)-mass spectroscopy (-MS) techniques. Some of these biosensors used C, Au, hybrid Titanium (Ti), Au-Platinum (Pt), and nanostructured lead dioxide (PbO2)/$TiO_2$/Ti to immobilize the enzymes on sensorsubstrateandtoincreasethesensorsensitivity.Nanomaterialsalsousedforplantprotection instead of manufactured pesticides. Nanopesticides can enhance the dispersion and wettability of agricultural formulations (i.e., decrease in organic solvent runoff), and harmful pesticide movement. Nanomaterials and biocomposites show useful characteristics such as stiffness, permeability, crystallinity, thermal stability, solubility, and biodegradability important for formulating nanopesticides. Nanopesticides also havelargespecificsurface areawhich increased affinity to the target. There are many kinds of nanopesticides such as nanoemulsions, nanoencapsulates, nanocontainers and nanocages have been recently used for plant protection. Nanomaterials also applied for enhancement of nutrients absorption by plants, delivery of active ingredientstospecificsitesandwatertreatmentprocessesusingmanykindsofnanomaterials.The potential of nanotechnology in agriculture is huge, and need more work to state all benefits of nanomaterials for agricultural section.

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ISBN:978-81-957858-1-0

## AnOverViewinDietandNutrientsofBreastCancer

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**Abstract**

Breastcancerisanuncontrolledgrowthofbreastcells.Usuallybreastcancereitherbeginsinthe cells of the lobules, which are the milk-producing glands, or the ducts, the passages that drain milk from the lobules to the nipple. The cruciferous vegetables (broccoli, cauliflower, cabbage, kale,Brusselssprouts,bokchoy,collardgreens,radish,watercress),inparticular,areassociated with a reduced risk of breast cancer. Consumption of cruciferous vegetables, particularly broccoli, was inversely, though not statistically significantly associated with breast cancer risk in women. Diet and nutritionare controversial factors. Dietary fat has received a great deal of attention as a possible risk factor for breast cancer because of the high correlation between national per capita fat consumption and the incidence of the disease. In addition, a number of experimentsinlaboratoryanimalshavesuggestedalinkbetweentheamountandtypeofdietary lipids and the growth of mammary. The evaluated of over view all the staging of breast cancer, treatment, diet, nutrition and healthy breast cancer.

**Keywords:**Breastcancer,Vegetables,DietandNutrition

### Introduction

Breastcancerisanuncontrolledgrowthofbreastcells.Usuallybreastcancereitherbeginsinthe cells of the lobules, which are the milk-producing glands, or the ducts, the passages that drain milk from the lobules to the nipple. Less commonly, breast cancer can begin in the stromal tissues, whichinclude the fatty and fibrous connective tissues of the breast (Sariego J., 2004). Usually breast cancer either begins in the cells of the lobules, which arethemilk-producing glands,ortheducts,thepassagesthatdrainmilkfrom the lobules to the nipple. Less commonly, breast cancer can begin inthe stromal tissues, which include the fatty and fibrous connective tissues of the breast (Yager JD., 2006). Over time, cancer cells can invade nearby healthybreasttissueandmaketheirwayintotheunderarmlymphnodes small organs that filter out foreign substances in the body. If cancer cells getintothelymphnodes,theythenhave a pathway into other parts of the body.

### Epidemiology

Worldwide, breast cancer is the most common invasive cancerin women Breast cancer comprises 22.9% of invasive cancers in women (Sueoka E *et al*., 1999) and 16% of all female cancers (American Cancer Society., 2007). In 2008, breast cancer caused 458,503 deaths worldwide(13.7%ofcancerdeathsinwomenand6.0%ofallcancerdeathsformenand



ISBN:978-81-957858-1-0

women together (World Cancer Report., 2011). The incidence of breast cancer varies greatly around the world. It is lowest in less-developed countries and greatest in the more-developed countries.

Breastcanceristhemostcommoncanceramongwomenandtheleadingcauseofdeathinwomen aged 40 to 55 years. About 2,240 new cases of invasive breast cancer were expected to be diagnosedinmenin2013(Cuzick,J*etal*.,2013andRobbC*etal*.,2007).Aman'slifetimerisk of breast cancer is about 1 in 1,000.About 39,620 women in the U.S. were expected to die in 2013frombreastcancer,thoughdeathrateshavebeendecreasingsince1989.InNorthAmerica, thelifetimeoddsofdevelopingbreastcancerforwomenareoneineight(YuYHandLiangC*et al*., 2010).

I. Riskfactorsofbreastcancer

**Weight:**Beingoverweightisassociatedwithincreasedriskofbreastcancer,especiallyfor women after menopause.

**Diet:**Dietisasuspectedriskfactorformanytypesofcancer,including breastcancer.Red meat and other animal fats (including dairy fat in cheese, milk, and ice cream), because they may contain hormones, other growth factors, antibiotics, and pesticides increase the risk of breastcancer.Alow-fatdietrichinfruitsandvegetablesisgenerallyrecommended(Santoro, E *etal*., 2009).

**Exercise:**Evidence is growing that exercise can reduce breast cancer

risk.

**Exposuretoestrogen:**Becausethefemalehormoneestrogenstimulates

breast cell growth, exposure to estrogen over long periods of time, without any breaks, can increase the risk of breast cancer.

**Stress and anxiety:** There is no clear proof that stress and anxiety can increase breast cancerrisk.However,anythingyoucandotoreduceyour stressandtoenhanceyourcomfort, joy, and satisfaction can have a major effect on your quality of life. So-called "mindful measures" (such as meditation, yoga, visualization exercises, and prayer) may be valuable additions to your daily or weekly routine. Some research suggests that these practices can strengthen the immune system (Goncalves, V *et al*., 2013).

**Gender:**Beingawomanisthemost significantriskfactorfordeveloping breast cancer.

**Age:**Simplygrowing olderisthesecondbiggestrisk factorforbreastcancer.

**Family history of breast cancer:** If you have a first-degree relative (mother, daughter, sister)whohashadbreastcancer,oryouhavemultiplerelativesaffectedbybreastorovarian



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cancer (especially before they turned age 50), you could be at higher risk of getting breast cancer (Marc Lacroix 2011)

**Personalhistoryofbreastcancer:**Ifyouhavealreadybeendiagnosedwithbreastcancer, your risk of developing it again, either in the same breast or the other breast, is higher than if you never had the disease (Olson and James., 2002).White women are slightly more likely to develop breast cancer than are African American women. Asian, Hispanic, and Native American women have a lower risk of developing and dying from breast cancer (Leopold, Ellen., 1999).

### Radiationtherapytothechest

Havingradiationtherapytothechestareaasachildoryoungadultastreatmentforanother cancersignificantlyincreasesbreastcancerrisk.Theincreaseinriskseemstobehighestifthe radiation was given while the breasts were still developing (during the teen years) (Buchholz TA., 2009)

**Breast cellular changes:** Unusual changes in breast cells found during abreast biopsy (removal of suspicious tissue for examination under a microscope) can be a risk factor for developing breast cancer. These changesinclude overgrowth of cells (called hyperplasia) or abnormal (atypical) appearance.

**Exposuretoestrogen:**Becausethefemalehormoneestrogenstimulatesbreastcellgrowth, exposure to estrogen over long periods of time, without any breaks, can increase the risk of breast cancer.

**Pregnancyandbreastfeeding:**Pregnancyandbreastfeedingreducetheoverall number of menstrual cycles in a woman's lifetime, and this appearsto reduce future breast cancer risk. Womenwhohavenever hadafull-term pregnancy, orhadtheirfirst full-termpregnancyafter age 30, have an increased risk of breast cancer. For women who do have children, breastfeeding may slightly lower their breast cancer risk, especially if theycontinue breastfeeding for 1 1/2 to 2 years.

### Signs and Symptoms

Breast cancermay cause any of the following signs and symptoms.

Check with your doctor if you have any of the following problems:

- Alump orthickening inor nearthebreastorintheunderarmarea
- Achangeinthesizeor shapeofthebreast
- Adimpleor puckeringin theskinofthebreast
- Anippleturned inwardinto thebreast



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- Fluid,other than breastmilk,fromthenipple,especiallyifit'sbloody
- Scaly, red, or swollen skin on the breast, nipple, or areola(the darkareaofskin that is around the nipple)
- Dimples in the breast that look like the skin ofanorange,calledpeaud'orange

## Diagnosis

Most types of breast cancer are easy to diagnose bymicroscopic analysis of a sample or biopsy of the affected area of the breast. The two most commonly used screening methods, physical examination of the breastsby a healthcare provider and mammography, can offer an approximatelikelihood thatalump iscancer, and mayalsodetectsomeotherlesions,suchas a simple cyst (Leopold, Ellen.,1999).Very often the results of physical examination by a healthcare provider, mammography, and additional tests that may be performed in special circumstances (such as imaging by ultrasound or MRI) are sufficient to warrant excisional biopsy as the definitive diagnostic and primary treatment method.

## Breastcancerstaging

Thebreastcancer'sstagereferstohowfarthecancercellshavespreadbeyondtheoriginal tumour (Table 1).

**Table1:**Breastcancer staging

| **Stage** | **Definition** |
|---|---|
| Stage 0 | Cancercellsremaininsidethebreastduct,withoutinvasion into normaladjacent breast tissue. |
| Stage IA | The tumor measures up to 2 cm AND the cancer has notspread outside thebreast; no lymph nodes are involved |



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| | |
|---|---|
| tage IB | There is no tumor in the breast; instead, small groups of cancer cells-larger than 0.2 millimeter but not larger than 2 millimeters-are found in the lymph nodes OR there is a tumorinthebreastthatisnolargerthan2centimeters,andthereare smallgroupsofcancer cells-larger than 0.2 millimeter but not larger than 2 millimeters-in the lymph nodes. |
| tage IIA | Notumorcanbefoundinthebreast,butcancercellsarefoundintheaxillarylymphnodes (the lymph nodes under the arm) OR the tumor measures 2centimeters or smaller and has spread to the axillary lymph nodes OR the tumor is larger than 2 but no larger than 5 centimeters and has not spread to the axillary lymph nodes. |
| tage IIB | The tumor is larger than 2 but no larger than 5 centimeters and has spread to the axillary lymph nodes OR the tumor is larger than 5 centimeters but has notspread to the axillary lymph nodes. |
| Stag e IIIA | No tumor is found in the breast. Cancer is found in axillary lymph nodes that are sticking togetherortootherstructures,orcancermaybefoundinlymph nodesnearthebreastbone ORthetumorisanysize.Cancerhasspreadtotheaxillarylymphnodes,whicharesticking togetherortootherstructures,orcancermaybefoundinlymphnodesnearthebreastbone. |
| Stag e IIIB | Thetumormaybeany sizeand has spread to thechest wall and/orskin ofthe breast AND may have spread to axillary lymph nodes that are clumped together or sticking to other structures, or cancer may have spread to lymph nodes near the breastbone. Inflammatorybreast cancer is considered at least stage IIIB. |
| Stag e IIIC | There may either be no sign of cancer in the breast or a tumor may be any sizeand may have spread to the chest wall and/or the skin of the breast AND the cancerhasspreadto lymphnodeseitheraboveorbelowthecollarbone AND the cancer may have spread to axillary lymph nodes or to lymph nodes near the breastbone. |
| tage IV | Thecancerhasspread ormetastasizedtoother partsofthebody. |

Treatment

**Surgery:** Surgery involves the physical removal of the tumor, typically along with some of thesurroundingtissue.Oneormorelymphnodesmaybebiopsiedduringthesurgery;increasingly the lymph node sampling is performed by a sentinel lymph node biopsy

**Chemotherapy:**Chemotherapyispredominantlyusedforcasesof breastcancerinstages2-



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**Radiation and Radiotherapy:** Radiotherapy is given after surgery tothe region ofthe tumor bed and regional lymph nodes, todestroy microscopic tumor cells that may have escaped surgery.Itmayalsohaveabeneficialeffectontumormicroenvironment. Radiationtherapycan bedeliveredasexternalbeamradiotherapyorasbrachytherapy(internalradiotherapy)(Buchnolz TA., 2009).

**Diet and Breast cancer:** Eating and drinking are an important part of our lives and breast cancer she may become even more aware of what she eatand drink (Table 2 to 6).

**Table2:**Eatingand drinking

| S.No. | Eatavarietyofdifferent foods |
|---|---|
| 1. | Eattherightamount tobeahealthyweight |
| 2. | Eatplenty offoodsrich in fibre |
| 3. | Eatatleastfiveportionsoffruitandvegetablesaday |
| 4. | Limitfoodsthatcontainalot offat,especiallyanimal(saturated)fat |
| 5. | Limitsugaryfoodanddrinks |
| 6. | Loweryoursalt intake |
| 7. | Moderateyouralcohol intake |
| 8. | Drinkaroundtwolitresoffluidsaday(suchaswater,herbaltea,coffeeorlowcalorie drinks) |
| 9. | Enjoy thefood |

Thereare manyconflictingideasandtheoriesaboutdietandnutritionandthiscanbeconfusing.

**Table3:**Dietand Nutrition

| Dietandhealthybreastcancer | |
|---|---|
| 1. | Eat8to10colorfulfruit andvegetableservings daily |
| | • Twotothreepiecesof fruit |
| | • Onecupor moreofvegetableswith lunch and dinner |
| | • 8flozvegetablejuice |
| 2. | Consume25to35gramsoffiber daily |
| | • Youwilllikelymeet yourfibergoalif youeat8to 10<br>• Servingsoffruits andvegetablesplus oneservingof<br>• Beans/legumes oratleasttwo servingsofwholegrainsdaily. |
| 3. | Avoidprocessedandrefinedgrains/flours/sugars |
| | • KeepWHITEoffyourplate:bread,pasta,rice,creamsauces,<br>• Cakes,andmore. |



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**Table4:**HighFiber Sources

| Food | Servingsize | FiberGrams/Serving |
|---|---|---|
| Apple | 1 medium | 3.7 |
| Banana | 1 medium | 2.8 |
| Blackberries | 1/2 cup | 1.9 |
| Blueberries | 1 cup | 1.3 |
| Cantaloupe | ½ cup | 6.0 |
| Figs(dried) | ¼ cup | 6.0 |
| Grapefruit | 1 medium | 3.4 |
| Grapes | 1 cup | 1.6 |
| Guava | 1 medium | 4.9 |
| Kiwi | 1 medium | 2.6 |

**Table5:**Grains&Others Products

| Food | Servingsize | FiberGrams/Serving |
|---|---|---|
| Amaranth | ¼Cup dry | 7.4 |
| Barley | ½ Cup cooked | 3.0 |
| Beans, black | ½cup cooked | 8.3 |
| Beans,red kidney | ½cup cooked | 8.2 |
| Beans,garbanzo | ½cup cooked | 5.0 |
| Bran cereals | ¾ cup | Checklabels(5.0-22.0) |
| Brownrice | ½cup cooked | 1.4 |
| Bulgur | ½cup cooked | 4.0 |
| Creamofwheat | ½cup cooked | 0.5 |
| Oatmeal | ¼ cup | 2.0 |
| Peanuts | ¼cupdry | 2.9 |
| Quinoa | ½cup cooked | 2.5 |
| Whiterice | ½cup cooked | 0.3 |

**Table6:**Vegetables

| Food | Servingsize | FiberGrams/Serving |
|---|---|---|
| Artichokes | 1 medium | 6.9 |
| Beets | ½cup cooked | 1.7 |
| Broccoli | ½cup cooked | 2.3 |
| Brussel sprouts | ½cup cooked | 2.0 |
| Carrots | ½cup cooked | 2.6 |



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| | | |
|---|---|---|
| Kale | ½cup cooked | 1.3 |
| Limabeans | ½cup cooked | 4.5 |
| Peas,green | ½cup cooked | 4.4 |
| Spinach | ½cup cooked | 2.2 |
| Squash,winter-type | ½cup cooked | 3.4 |
| Sweetpotatoes(yams) | ½cup cooked | 2.7 |

## II. Dietandbreastcancer

Ambrosone *et al*., (2004) suggested that the cruciferous vegetables (broccoli, cauliflower, cabbage,kale,Brusselssprouts,bokchoy,collardgreens, radish, watercress), in particular, are associated with a reduced riskof breast cancer. Consumption of cruciferous vegetables, particularlybroccoli,wasinversely,thoughnotstatisticallysignificantlyassociatedwithbreast cancer risk in women (Ambrosone *et al*., 2004; Terry *et al*., 2001; Brandi *et al*., 2005). A Swedish study of the postmenopausalwomen reported that one to two daily servings of cruciferous vegetables reduce the risk of breast cancer (Terry *et al*., 2001).

A high fiber diet reduce hormone levels that may be involved in the progression of breast cancer (Slavin., 2000; Stoll., 1996; Bagga *et al*., 1995; Adlercreutz., 1995; Rock *et al*., 2004).Hyperinsulinemia may contribute to the development of breast cancer in overweight or obese women (Gonullu *et al*., 2005). Study reported that carbohydrate intake significantly increased therisk of breast cancer; sucrose (table sugar) imparted the greatestrisk (Romieu *et al*., 2004). Italian case-control[*] study found that women who consumed the highest tertile of desserts and sugars had a 19% increased risk of breast cancer compared with women in the lowest tertile (Tavani *et al*., 2005).

*Invitro*andanimalresearchhassupportedtheprotectiveeffectofmelatoninagainstbreast cancer(Sartippour*etal*.,2004).Arecentstudyfoundthatwomenwithhigherurinarymelatonin levels had a 30-41% reduced risk of breast cancer (Leman *et al*., 2001).

## III. Discussion

Breast cancer incidence rates are increasing worldwide. In India, it is themost common cancer among women in many regions and has overtaken cervical cancer. Diet and nutrition are controversial factors. Dietary fat has received a great deal of Attention as a possible risk factor for breast cancer because of the high correlation between national per capita fat consumption and the incidence of the disease. In addition, a number of experiments in laboratoryanimalshavesuggestedalinkbetweentheamountandtypeofdietarylipidsandthe growth of mammary.



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ISBN:978-81-957858-1-0

## AnOverViewofDietandNutrients inOral Cancer

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### Abstract

Oral cancer encompasses all the malignancies originating in the oral tissues, including cancers ofthelip,tongue,gingiva,floorofthemouth,buccalmucosa,palateandtheretromolartrigone. It is projected that by 2020there will be every year 15 million new cancer cases and 10 million cancerdeaths.Itisestimatedthataround43%ofcancerdeathsareduetotobaccouse,unhealthy diets,alcoholconsumption,inactivelifestylesand infection.The consequencesareahigherrisk ofdevelopingdisease.Therelationshipbetweennutritionandcancerhastobeapproachedfrom twodifferentpointsofviews:Thedirecteffectofcarcinogenspresentinfoodandfoodadditives. *In vivo* synthesis of carcinogens caused by changes in metabolism due to altered dietary habit. The evaluated of over view all the staging of oral cancer, treatment, diet, and nutrition of oral cancer.

**Keywords:**oralcancer,vegetables,dietandnutrition

### Introduction

Cancer is one of the most common causes of morbidity and mortality today, with more than 10 million new cases and more than 6 million deaths eachyearworldwide(WHO,2004).More than 20 million persons aroundtheworldlivewithadiagnosisofcancer,andmorethanhalfall cancercasesoccurinthedevelopingcountries.Cancerisresponsibleforabout20%ofall deaths inhighincomecountriesand10%inlow-incomecountries.Itisprojectedthatby2020therewill be every year 15 million new cancer cases and 10 million cancer deaths. It is estimated that around43%ofcancerdeaths are due to tobacco use, unhealthy diets, alcohol consumption, inactivelifestyles and infection. In addition to lung cancer, tobacco consumption causes cancer of the oral cavity, pharynx, larynx, esophagus, stomach,pancreas, liver, kidney, ureter, urinary bladder, uterine cervix and bone marrow. Tobacco use and alcohol consumption act synergistically tocause cancer of the oral cavity, pharynx, larynx and esophagus. Infectious agents are responsible for almost 25% of cancer deaths in the developing world and 6% in industrialized countries (Jamison DT et.al,.2006) Dietary factors have been thought to account for about 30% of cancers in Western countries10, making diet second only to tobacco as a preventable cause of cancer. The contribution of diet to cancer risk in developing countries has beenconsideredtobelower,perhapsaround20%.(Keytj*etal*.2007)Theoverallgoalofcancer prevention and control is to reduce the incidenceand mortality of cancer and to improve the qualityoflifeofcancerpatientsand theirfamilies.Treatmentaimsto curedisease,prolonglife, andimprovethequalityoflife.Themosteffectiveandefficienttreatmentislinkedtoearly



ISBN:978-81-957858-1-0

detectionprogrammesandfollowsevidence-basedstandardsofcare.

I.Oralcancer

Oral cancer encompasses all the malignancies originating in the oral tissues, including cancers ofthelip,tongue,gingiva,floorofthemouth,buccalmucosa,palateandtheretromolartrigone. It is the 6th most common cancer worldwide (Parkin DM et al. 1984). The majority of malignancies consist of squamous cell carcinomas of the covering oral mucosa, while the remaining include malignant tumours of salivary gland, lymphoreticular disorders, bone tumours, malignantmelanomas,sarcomas,malignantodontogenictumours,andmetastasesfromtumours elsewhere in the body. (Figure 1-4).

**Fig 1:** Ulcerative lesion o fraternal tongue with a keratotic border raising the suspicion of a carcinomainayoungadultmalesmoker;**Fig2:**Anon-healingulcerofsoftpalateextendingto oro-pharynx in an elderly male.

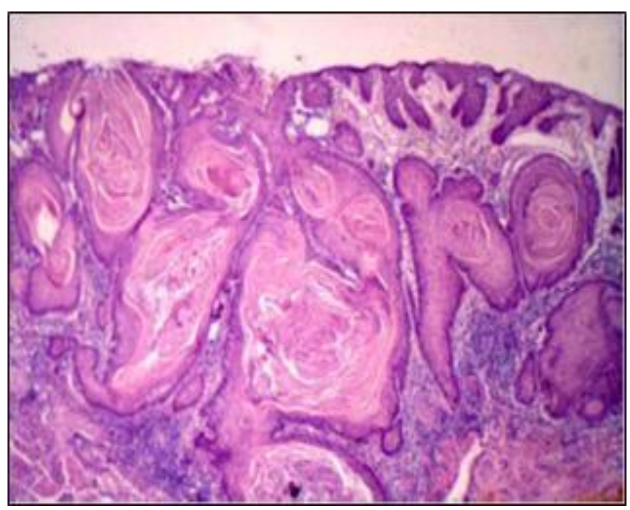

**Fig 3:** A verrucous carcinoma of commissure cheek in an Asian areca/betel quid chewer Epidemiology;**Fig4:**Well-differentiatedsquamouscellcarcinomaandoftheoralmucosa.



ISBN:978-81-957858-1-0

Globallyabout5,00,000newcasesoforalandoropharyngealcancersarediagnosedandthree quarters of these are from the developing world (Petersen PE et al. 2003). Oral and oropharyngeal cancers remain one of the more common cancers in the South and South East Asian countries, as opposed to Westernsociety, whereit accounts foronly about 1-4%ofthe of reported cancers incidence (Silverman. S 1998). High incidence countries include those in southAsiasuchasSriLanka,India,PakistanandBangladesh;BasRhinandCalvadosregions inFrance;countriesincentralandEasternEurope;andBrazil.Theincidenceoforalcancerin India is high, constituting about 12% of all cancer in men and 8% in women (Sankaranarayanan. R, 1990); In most parts of the world the male-female ratio is approximately 2:1 for oral carcinomas, except for carcinomas of the vermilion border of the lowerlip.Inthelattersitethereisastrongmalepredominance.Oralsquamouscellcarcinomas aremainly foundafterthefourth decade. Theoverall 5-yearsurvival rate forpatients without clinically evident cervical lymph node metastases is 85%. Among the Indian population, the overall 5-year observed and relative survival rates were 30.5% and 39.7%, respectively.

Aetiology

Theuseoftobaccoinitsvariousforms,includingtheuseofsmokelesstobacco,isregardedto be the main cause of oral cancer, particular when associated with the use of excess alcohol. High exposure to ultraviolet light increases the chance of developing cancer of the lower lip. In the Western population exposure to sunlight (lip cancer), cigarette-smoking, and alcohol consumption are the frontline etiologic culprits compared with the use of smokeless tobacco and combustible tobacco more prevalent in the South

EastAsiancountries(GrahamS.1977).Amongthedifferentsmokinghabits,thecigaretteor cigarincreasedtheriskofcancerby6times,hookahandpipeby16timesandbidismokingby 36 times as compared to nonsmokers. The chewing of quid containing betel leaves, tobacco, and lime and the smoking of bidi contribute to the majority of cases in parts of India and Southeast Asia (Mahboubi E. et al., 1982). Currently the role of viruses such as human papilloma virus (Koch. WM et al., 1999) is also implicated as a major risk factor.

Potentiallymalignantorallesions

OSCCmaybeprecededbyclinicallyevidentPMLs,particularlyerythroplakia(erythroplasia) andsomeleukoplakia.Erythroplasiaisrare,andpresentsasavelvetyredplaque.Atleast85% of cases show frank malignancy or severe dysplasia and carcinomas are seen 17 times more frequently in erythroplakia than in leukoplakia even though leukoplakias are far more common.

Symptoms



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Classic features of oral malignancy include ulceration, nodularity, induration and fixation (MashbergAetal.1995).andcancermustbesuspectedespeciallywhenthereisasingleoral lesionpersistingformorethan3weeks.OSCCmaypresentvariouslyasinduratedlump/ulcer i.e. a firm infiltration beneath the mucosa, granular ulcer with fissuring or raised exophytic margins,whiteormixedwhiteandredlesion,redlesion(erythroplasia),lumpsometimeswith abnormalsupplyingbloodvessels,non-healingextractionsocket,lesionfixedtodeepertissues or to overlying skin or mucosa.

Staging

Clinical staging refers to an assessment of the extent of the disease before undertaking treatment.Thetumorsaretraditionallygradedintowell-moderatelyandpoorlydifferentiated SCC. Well differentiated SCC resembles closely normal squamous epithelium. Moderately differentiated SC contains distinct nuclear pleomorphism and mitotic activity, including abnormalmitoses;thereisusuallylesskeratinization.InpoorlydifferentiatedSCC,immature cells predominate, with numerous typical and atypical mitoses and minimal keratinization. (Table 1 (Greene et al. 2002).

**Table1:**TNMclinical classificationifcarcinomasofthelipandoralcavity

| |
|---|
| T –Primary tumor |
| TX–Primary tumorcannotbeassessed |
| T0–Noevidenceofprimary tumor |
| Tis– Carcinomainsitu |
| T1– Tumor2cm orless in itsgreatest dimension |
| T2– Tumormorethan2cm but notmorethan4cm ingreatest dimension |
| T3– Tumormorethan4cm ingreatest dimension |
| T4a(Lip)–Tumorinvadesthroughcorticalbone,inferioralveolarnerve,floorofmouthor skin (Chin or nose) |
| T4b(Oralcavity) |
| –Tumorinvadesthroughcorticalbone,intodeep/extrinsicmusclesofthe tongue |
| (genioglossus,hyoglossus,palatoglossusandstyloglossus),maxillarysinusorskin offace |
| T4b(Lipandoralcavity) |
| –Tumorinvadesthroughmasticatorspace,pterygoidplates,orskullbaseorencasesinternal carotidartery |
| Note–Superficialerosionaloneofbone/toothsocketbygingivalprimaryisnotsufficient toclassifytumorasT4 |
| N–Regional Lymphnodes(Cervical nodes) |
| NX–Regionallymphnodescannotbe assessed |



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| |
|---|
| N0– Noregional lymphnodemetastasis |
| N1–Metastasisinasingleipsilaterallymphnode,3cmorlessingreatestdimension. |
| N2– |
| N2a–Metastasisinasingleipsilaterallymphnode,morethan3cmbutnotmorethan6cmor lessingreatestdimension. |
| N2b–Metastasisinmultipleipsilaterallymphnodes,nonemorethan6cmingreatest dimension. |
| N2c–Metastasisinbilateralorcontralaterallymphnodes,nonemorethan6cmingreatest dimension |
| N3–Metastasisinalymphnodemorethan 6cm ingreatest dimension |
| Note–Midlinenodesareconsidered ipsilateral nodes. |
| (M)– Distant metastasis |
| MX– Distantmetastasiscannot assess |
| M0– Noevidenceofdistant metastasis |
| M1– Distantmetastasis ispresent |

TreatmentSurgery

Mosthead-and-neckoncologycenterspreferprimarysurgeryand,inselectedcases,postoperative radiation rather than preoperative radiation and then surgery. In the presence of lymph node metastases, a neck dissection may be carried out at the same time.

Radiotherapy

In several centers radiotherapy is given as the treatment of first choice, particularly in T1 and T2 oral squamous cell carcinomas, including those of the lower lip.

Chemotherapy

In general, chemotherapy is not currently being used as the treatment of first choice in oral squamouscellcarcinoma.However,itmaybeusefulinadvancedoralcancerasapreoperativeor pre radiotherapeutic modality.

I. Dietandnutritioninoral cancer

Nutritionreferstothestatusofbodycellsintermsofnecessarymaterialsornutrients requiredfor physiologic growth and metabolism. Nutrition and health are closely connected and malnutrition canseriouslyendangerhealth(table1).Theconsequencesareahigherriskofdevelopingdisease. The relationship between nutrition and cancer has to be approached from two different points of views: The direct effect of carcinogens present in food and food additives (i.e., direct carcinogenesis).Invivosynthesisofcarcinogenscausedbychangesinmetabolismduetoaltered dietary habits (i.e., indirect carcinogenesis).



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**Table2:**Correlationbetweentheriskoforalcancer,especiallysquamouscellcarcinomawith environmental factors (food and habits) in the USA, Asia, andEurope

| **Risk factors** | **USA** | **Asia** | **Europe** |
|---|---|---|---|
| Habits | Very | Very | Very |
| Tobaccosmoking | strong | strong | strong |
| Alcoholconsumption | Moderate | Possible | Moderate |
| Opium smoking | Nodata | Moderate | Nodata |
| Dietary factors Lowintakeofantioxidantsandfiber (fruits, vegetables, oil seed, tea, soy, …) | Strong | Strong | Strong |
| High intake of monounsaturated fat (fried foods, pork, pasta, red meat, cheese, …) | Strong | Possible | Strong |
| Lowintake ofmicronutrients(vitaminC,E,zinc,folate, | Strong | Possible | Strong |
| Cooking method | | | |
| Frying/broiling | Strong | Nodata | Strong |
| Microwave | Strong | Nodata | Strong |
| Highcalorieintake/obesity | Strong | Possible | Strong |

Essentialfattyacidssuchasfishoilandvegetablesrichinn-3polyunsaturatedfattyacidsmust be incorporated into diet and have a protective effect against cancer. On the contrary, monounsaturatedfatty acids like n-9 oleic acid, as the main source of fat, behave as a tumor promoter in breast, colon, oral, and salivary gland cancers. (Clark. SD *et al*. 2000). Possible mechanisms through which fatty acids may influence carcinogenesis include effects on membrane integrity, increase in lipid peroxidase, and impairment of nutrient metabolism. (Woutersen. RA and Apple MJ 1999).

Dietaryfactorsassociated withreduced riskoforal cancerincludeherbal tea,apple,margarine, milk,andcitrusfruitorjuice.(Tatiana.NandJose.L.2004)becausethesenutrientscanprevent theactivation of carcinogens and increase their detoxification, especially the effects oftobacco, which is one of the most important factors in oral SSC.



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Although a great deal of attention has been given to protein and malnutrition in patients with head and neck cancer, micronutrients like vitamin C, E, β-carotene, lycopene, folate, and zinc haveimportantrolesincarcinogenesis.(Enwonwo.CO*etal*.2004)VitaminEandβ-carotenecan also cause regression of oral leukoplakia. (Nagao. T *et al*. 2003). Assessmentof serum zinc in patientswithheadandneckcancerindicatesthatthebaselinezincstatusiscorrelatedwithtumor sizeandthestageofmalignancies(DorrTPandPrasad.1997).Consumptionofalcoholanddiets highinmonounsaturatedfat,redorprocessedmeat,fryingorbroilingfoods,andemploymentof microwave cooking increase the risk of oral cancerincluding salivary gland tumors.

MicronutrientslikevitaminC,E,β-carotene,folate,andzinchaveanimportantroleinprevention of oral cancer. These factors can cause polymorphism in detoxifying enzyme GST1 and other metabolic genes, which modulate the risk of cancer and decrease the genotoxic damage. Consumption of very hot drinks and foods typically consumed in somecultures probably increases the risk of cancers of the oral cavity and pharynx. A reduced risk of oral cancer associatedwithvitaminEsupplementationhasbeenshowninonestudy(GridleyG*etal*.1992). Vegetarianismversusnonvegetarianismhasfailedtoshowanyroleinoral cancerdevelopment (ShantaV*etal*.1959).Highlevelsofcarotenoidshavebeenshowntobestronglyrelatedtolower risk of oral cancer development.

## Conclusion

A cancer patient is advised to work with a qualified nutrition consultant to address the multiple needs that arise before, during, and aftertreatment. To protect a vulnerable patient from conflicting therapeutic opinions, oncologists, nutritionists, and other providers should work together withpatients and their significant others, supporting them in being actively engaged in the recovery process through diet, nutrition, lifestyle,and spiritual practice.

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ISBN:978-81-957858-1-0

# GeneticallyModifiedOrganisms:ApplicationsandRelatedEthicalIssues

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**Abstract**

Humans have been modifying the genes of plants and animals for many years using traditional breeding procedures. Artificial selection methods for production of specific and desired traits have resulted in a diversity of different organisms, ranging from sweet corn to hairless cats. But thismethodofartificialselectioninvolvestheprocessinwhichorganismscarryingspecifictraits are chosen to breed for consecutive generations, have been limited by naturally occurring variations. In recent years, however, advances in the field of biotechnology including genetic engineering have allowed for definite control over the genetic variations introduced into an organism. Today, new genes can be incorporated from one species into an entirely unrelated species through genetic engineering,enhancingagricultural performance or promoting the productionofbeneficialpharmaceuticalmaterials.Cropplants,soilbacteriaandfarmanimalsare someofthemostpivotexamplesoforganismsthathavebeenaccountabletogeneticengineering. In this chapter main focus will be on applications of genetically modified organisms (GMO) in different sectors and the ethical controversies regarding their usage.

**Keywords:**GeneticallyModifiedOrganisms,Applications,Ethicalissues

## Introduction

A genetically modified organism (GMO) is the organism (animal, plant and microbe) in which DNAhasbeenmodifiedusinggeneticengineeringapproaches.Forthousandsofyears,breeding methods havebeen used to alter organisms. Within the last few years, advancement in biotechnology field has allowed scientists to directly alter the DNA of organisms including microorganisms, crops and animals. Conventional methods including selective breeding and crossbreedingareusedtomodifytheorganisms.Buttheseproceduresaretimeconsuming.Also, conventional procedures frequently lead to the production of mixed results, carrying unwanted traitsappearingalongsidewithdesiredcharacteristics.Modificationofspecifictargetedsequence ofDNAusingbiotechnologyprocesseshasallowedthescientiststoavertthisissueandimprovise the genetic makeup of an organism avoiding unwanted traits marking along the desired traits. Most organisms that are GMOs are formed for laboratory purpose. These organisms are used as “models”tostudytheroleofspecificDNAsequenceandrelationshipofthesesequencesrelated to health and diseases. Some GMO’s, however, are also formed for human consumption. For example Salmon has been genetically modified to develop faster and it is stated to be safe for consumption by the U.S. Food and Drug Administration. GMOs are perhaps also becoming noticeableintheagriculturalsection.Inthemid1990’s,firstgeneticallymodifiedplantwas



ISBN:978-81-957858-1-0

producedforhumanconsumptionandtodayapproximately90percentofthecorn,soybeansand sugar beets introduced in the market are GMOs. Production of higher yields, longer shelf life, resistance to diseases and pests, and even better taste are thecharacteristics found in the geneticallymodifiedcrops.Thesetraitsarebeneficialforbothfarmersandconsumerslikehigher yields and longer shelflife may lead to lower prices acting beneficial for consumers and pest- resistant crops involves less usage of insecticides and pesticides reduce expenditure of farmers andalsoleadto productionofgoodqualitycrops. GMOcropscanthus being consideredgentler to the environment than conventionally grown crops. Genetically modified foods lead to controversy as scientists insert genes into an organism from an entirely different organism thus raisingthe possible risk of unexpected allergic reactions to some GMO foods. Other concerns are thepossibility ofthe genetically engineered foreign DNAspreading to non-GMOplants and animals. So far, none of the GMOs approved forconsumption have caused any of these problems. GMO technology creates concern over potential environmental and human health impacts

GMOsarelikelytoplayanimportantroleinbiomedicalresearch(ZhangH.2019).GMOfoodsmayprovide better nutrition and perhaps even be engineered to contain medicinal compounds to enhance human health. If GMOscanbeshowntobebothsafeandhealthy,consumerresistanceto theseproductswillmostlikelydiminish.

## Applicationsofgeneticallymodifiedorganisms(GMO)inagriculture

Agricultural plants are often cited as examples for genetically modified organisms (GMOs) (Takeda & Matsuoka, 2008). Increased crop yields, reduced costs for food or drug production, reduced need for pesticides, enhancednutrientcompositionandfoodquality,resistancetopestsanddisease,greaterfoodsecurity,andmedical benefitstotheworld'sgrowingpopulationaresomebenefitsofgeneticengineeringinagriculture.Table1presents crops that mature faster and tolerate aluminum, salt, boron, frost, drought and other environmental stressors, allowingplantstogrowinconditionswhichareunfavorablefortheirgrowth.Otherrolesincludethe formationof nonprotein (bioplastic) or nonindustrial (ornamental plant) products.

**Table1:**ExamplesofGMOsused in agricultural sector

| **Geneticallyconferred trait** | **Exampleorganism** | **Geneticchange** |
|---|---|---|
| Herbicidetolerance | Soybean | Glyphosate herbicide (Roundup) tolerance conferred by expression of a glyphosate-tolerant form of theplant enzyme 5-enolpyruvylshikimate-3-phosphatesynthase(EPSPS)isolatedfromthesoilbacterium*Agrobacterium tumefaciens*, strain CP4 (Lehmann and Pengue., 2000) |
| Insectresistance | Corn | Resistancetoinsectpests,specificallytheEuropeancornborer,through expression of the insecticidal protein Cry1Abfrom *Bacillus thuringiensis* |
| Altered fatty acid composition | Canola | HighlaureatelevelsachievedbyinsertingthegeneforACPthioesterasefrom the California bay tree *Umbellularia californica* (Facciotti*et al.*, 1999) |



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| | | |
|---|---|---|
| Virusresistance | Plum | Resistance toplum pox virusconferredbyinsertion ofacoatprotein(CP) gene from the virus (Ravelonandro *et al*., 2000) |
| Diseaseprevention | Marmosets | Genehasbeentransferredintotheprimatespecies(Marmosets),against Parkinson's disease. (Sasaki E. *et al.* 2009) |
| Virusresistance | Mouse | Mousemodelgeneratedmimicshumanvirus(SARSCoV)(Cellpress: 2020) |

Manipulatedcropsarebasicallygrowninordertoachievemaximumyieldandreducetheusageofinsecticides or pesticides. Examples involve crops carrying gene isolated from *Bacillus thuringiensis*. This gene carries potential for the generation of natural pesticide Bt toxin which makes the crops resistant to various insects and pests.TheseBtcropswhencomparedwithnonBtcropsshows30-80%increaseinyieldleadstothesuccessful

invasion of GM into the agriculture field. However by 2004, the growth ofBt cotton production declines as population of other insect pest invaded which leads to application of Bt crops in controversies.

Another example of genetic modified crop is golden rice which after being genetically manipulated leads to the production of 20 times more beta carotene. Golden rice was created after modification of genome of rice by inserting gene from daffodil*Narcissuspseudonarcissus*thatproducesanenzymeknownasphytoenesynthase and a gene from the bacterium *Erwinia uredovora* that produces an enzyme called phytoene desaturase. These genes accumulate beta carotene in endosperm of rice which afterdigested by human gets converted to vitamin A in liver. In 2004 this altered crop was further modified and 23 fold increases in carotenoid productionwas observed in that genetically modified crop.

Anothervarietyofricewascreatedtoimproveirondeficiencywhichaffectsalmost30%ofworldpopulation. The rice genome was altered by introducing two genes. First gene was ferritin gene from the common bean, *Phaseolusvulgaris*and other genewasfromfungus *Aspergillusfumigatus* thathelpsinformation ofthoseenzymes thatdigestcompoundsthatelevatesironbioavailability.Italsodigestsphytate,aninhibitorofironabsorption.The iron fortified genetically modified rice was created to overexpress an existing rice genewhich produces cysteine rich metal binding protein which helps in absorption. A huge number of other crops are still being modified to survive in the extreme weather conditions.

## Roleofgeneticallymodifiedorganismsinmanagingbiodegradation

Genetically modified organisms also show crucial role in managementof environmentalconcerned issues. For example certain bacteria possess capability of producing biodegradable plastics. Their genes carrying this property can be introduced to those microbes which can be grown to in laboratory at large scale to combat the plastic related environment issue. In 1990s, Zeneca, a British company leads to the production of biodegradable plastic called Biopol (polyhydroxyalkanoate or PHA). This plastic was formed by using genetically modified bacterium,*Ralstoniaeutropha*(Das*etal*.,2012). Even thedyesandotherorganiccompoundshavebeenreported to be degraded with genetically modified organisms (Kumar *et al*., 2020). The isolation and insertion of desired gene into single host system demonstrated 10 to 100times higher degradation abilities as compared with wild strains.

## Roleofgeneticallymodifiedorganisminmedicines

Manyrecentbiomedicaldevelopments,inparticularthevaccines usedtopreventdiseaseanddefendagainstpandemics



ISBN:978-81-957858-1-0

such as Zika, Ebola and flu, rely on the same molecular biological methods used to produce genetically modified organisms. Scientists employed GMO technology to quickly examine new threats to health, produce enough protective vaccines to monitor and even predict new outbreaks in order to protect the public.

Biomedicalresearchhasbeenunderpinnedby GMOssincethe1980s. GManimalmodelsofhumangeneticdiseases, for example, have enabled researchers to test new drugs and investigate the positions of potential risk factors and disease outcome improvements. GM microbes, plants, and animals also revolutionized the production of complex pharmaceuticalsbyenablingthegenerationofsaferandcheapervaccinesandtherapeutics.Pharmaceuticalproducts ranging from recombinant hepatitis B vaccine produced by GM baker's yeast to injectable insulin (for diabetics) produced in GM *Escherichia coli* bacteria and to factor VIII (for hemophiliacs) and tissue plasminogen activator (tPA, for heart attack or stroke patients), both ofwhich are produced in GM mammalian cells grown in laboratory culture. Moreover, "edible vaccines" are in development with genetically modified plants. An edible vaccine is an antigenic protein that is produced in the consumable parts of a plant (e.g., fruit) and absorbed into the bloodstream when the parts are eaten. Once absorbed into the body, the protein stimulatesthe immune system to produce antibodies against the pathogen from which the antigen was derived. Such vaccines could provide an effective, affordable, and painless way to deliver vaccines, particularly in less- developed regions of the world, where the limitedavailabilityofrefrigerationandsterileneedleshasbeenproblematicforsomeconventional vaccines.Novel DNAvaccinesmaybeusefulinthestruggletoprevent diseasesthathaveprovedresistanttotraditionalvaccination approaches, including HIV/AIDS,tuberculosis, and cancer.

## GMO'sroleinpreventingparasiticaldiseases

Genetic modification of insects has now become a major area of research, especially in the battle to prevent parasite diseases.GMmosquitoes,forexample,havebeenproducedthatexpressasmallproteincalledSM1,whichprevents the entry of malaria parasite*Plasmodium* into the gut of the mosquito. It triggers a life-cycle interruption which makesthemosquitoimmunetomalaria.TheintroductionofTheseGMmosquitoeswillhelpreduce malaria parasite transmission. In another example, male *Aedes aegypti* mosquitoes engineered with amethod known as the sterile insecttechniquetransmitagenetotheiroffspringthatcausesthe offspringtodiebeforebecomingsexuallymature. In field trials in a Brazilsuburb,*A. aegypti* populations declined by 95 percent following the sustained release of sterile GM males.

Finally,geneticmodificationofhumansbygenetherapyisbecominga choicefortreatingdiseasesrangingfromrare metabolic to cancer disorders. Coupling stem cell technology with recombinant DNA methods allows the modification in the laboratory of the stem cells derived from a patient to introduce a desired gene. For example, a normalbeta-globingenemaybe introducedintotheDNAofbonemarrow-derivedhematopoieticstemcellsfroma patient with sickle cell anemia; introduction of these GMcells into the patient could cure the disease without the need for a matched donor.

## GMO'sroleinproductionofvaccines

Molecular biology is a jack-of-all-trades, for vaccine researchers. These tools enable scientists to figure out the keys tothesurvivalofavirusbydissectingitsDNA,designingnewvaccines,manufacturingthosevaccinescheaplyand quickly, and monitoring which wild viruses could become headaches to public health.

Onediseasethatiscurrentlybeingaddressedwiththehelpof molecularbiologyishepatitisB,whichkillsoneperson every minute throughout the world-although we have an effective vaccine.

During the 1960s, virologists discovered that hepatitis B antigen – an outer shell protein that induces an immune responsein an infectedindividual-emergedinthebloodofhepatitisBpatients.Totheirdelight,injectingahealthy



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person with the purified antigen protected against future infections. The first hepatitis B vaccine (HBV), approved in1981,wasmadebyharvestingtheantigenfromthebloodofhepatitisBcarriers,includingintravenousdrugusers.

UpontheintroductionofrecombinantDNAtechnology,scientistsmayseparatetheantigenproteingenefrom the virus, enabling HBV in laboratories to be generated using genetic directives rather than the infected blood. Both hepatitis B vaccines approved by the FDA currently comprisetherecombinantversionoftheantigen.And molecular biology can be usedto accelerate the development of new vaccines.For instance, for a human test against the Zika virus, "DNA vaccine" was the first to be approved. RatherthancontainingtheZikaantigen itself,thevaccinecontainsagenefor the Zika antigen which the patient’s body then produces.

Many vaccines and top-grossing pharmaceuticals contain proteins as themain ingredient. Proteins are toocostly and delicate to manufacture from scratch. Yet living cells have to produce proteins to survive and coax to manufacturemedicalproteinsinbulk,whichneedlittlemorethanaDNAandsugarbroth.Sincethesegenetic blueprintsmustbeinsertedintothecells, many vaccines and drugs are technically the product of GMOs.

Modified bacteria, yeast and even Chinese hamster cells are the unheralded molecular factories of the drug and vaccine industry. In 2014, 10 of the top 25 best-selling drugs were “biologics”-drugs made up of recombinantly produced proteins-including blockbuster treatments for arthritis, cancer and diabetes. Of the 10 vaccinesthattheCentersforDiseaseControlandPrevention(CDC)recommendfornewborns,threeareavailable in recombinant form; HBV, for example, is produced by modified yeast. Theearliest recombinant vaccines and drugs have been in use for three decades.

Perhaps the most dramatic example of GMO use in medicine came during the 2014 Ebola outbreak in West Africa. When American doctor KentBrantly and other Western volunteers contracted Ebola, several were cured bya“secretserum”calledZmapp.Manufacturedbygeneticallymodifiedtobaccoplants,it’samixtureofseveral proteins that attack the Ebola virus.

In the early 1990s, Charles Arntzen developed the technology for the manufactureofdrugs ingenetically modifiedplantscalled"pharming".Inthe case of Zmapp, the antibodies are made in the tobacco plant’s leaves. Once they are harvested, instead of beingturned into cigarettes, their cells are popped open and the drug is collected. Researchers call pharming “arevolution for the field” of manufacturing pharmaceuticals.

ThebiotechcompanyAppliedBiotechnologyInstitutehasembracedthetechniquetomakeanext-generation pharmed vaccine. They growageneticallymodifiedcornplantwhichproducesantigenforhepatitisB. The plant couldbeharvestedandtransformedintoanoralvaccinetabletthatlookslikeasmallwafer,asopposedtoaliquid that has to be cooled and injected. An oral vaccine can decrease the rates of hepatitis B in the developing world, whichiseithernotenoughorprohibitivelyexpensivetosupportthecoldsupplychain,sanitaryneedlesandskilled healthcare personnel.

## Ethicalissues

Genes being transferred to other species occur naturally, there are still many unknown consequences for the modulationofanorganism'snaturalstate through foreign gene intervention. After all, suchmodifications can lead to changeintheorganism'smetabolism,growth rate aswellasresponse to the environmental factors. These resultshave impact notonly in thegenetically modified organisms, butalso on the natural environmentin which it evolved. Risks on human health are exposureto new allergens in genetically modified foods and thealteration of genes resistant to antibiotics in gut flora. GMO technology develops concern overpotentialenvironmental as well as human health risks.



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## EffectsontheenvironmentEnvironmentalrisk

Genetically modified organisms lead to severe risks. Cross-pollination leads to the production of "super weeds" that resist herbicides and threatens plants. Modulating the genetic constitution of crops harms the food chain. Team of scientists says genetically modified organisms have executed butterfly populations in the US, or led to birth defects among other animals. By the time we find out the long-term impact, it could be too late.

## Herbicideuseandresistance

Considering background of genetically modified crops and foodproduction, environmental effects are at specificconcern.Productionofbiopesticideshelpsfarmerstouselesschemicalproductsandtogrowcropsunder less favorable circumstances. Nonetheless, the applicationof herbicides may be enhanced, which impose great negative influence on the environment. Even inadvertent hybrid strains of weeds as well asotherplants can establish cross-pollination strength across these herbicides and negate the potential advantage of the herbicide. One such herbicide that has already been added is Round Up. Example includes crops of Round Up- ready soybeans have already been enforced into agricultural studies, possiblyconsulting Round Up resistance to adjoining plants.

## Effectsonuntargetedspecies

Bt corn, which produces its own pesticide, is also in use today. Concernshavebeenposedaboutharmful effectsonpopulationsofMonarchbutterflies, which are not the pesticide's original target (Losey, 1999). Althoughthepesticidecanprotecttheplantsagainstunwantedinsects,itmayalsoaffectneutralorevenbeneficial species inadvertently.

## Effectsonhumanhealth

Genetically modified crops could have potential adverse effectson man's health. Examples are where consumers havegrown abruptallergic reactions while splicing genes within species. Scientists used a gene from theBrazilnuttoenhancethegenerationofMethionineinsoyabeans.AccordingtotheproductdeveloperPioneer Hi-Bred ("Biotech Soybeans"), the infusionof particular gene unintentionally leads to allergic reactions against soya bean in those with known nut sensitivity but no previous sensitivity to soya bean.

## Foodadditives

Geneticallymodifiedorganismsalsoprovideuswithpportunitiestoannounceadditionalnutrients,antibiotics as well as vaccines into foods. Thistechnology can present nutrition and disease resistance to undeveloped countries that don't have the means to present these otherwise. The circulation of these foods is more possible thanmassimmunizationforcurrentillness.However,eventheseprospectsbringpossiblewrongresultswith them such as the advancement of illness strains contrary to antibioticsor vaccines.

## Farmingpractices

Farmers used to purchase their seeds to plant for each period.Thefarmer possessed these seeds and the product of them. The farmer could savesome of the excess product at the end of each yield for planting in next time. Several farmers would even cross breed plants to make the appropriateproducts for the favorable location. These days companies that generate seedare patent holder of the seeds they trade. Farmers are no longer able to save seeds for next season. According to company, thisisacceptable-theyhave generatedan improvised product thattheyexpecttomakeareturnon.Inthe1990's,whenthesefirmsbeganfurnishingseedsforcropsmanipulated



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to either tolerate or produce pesticides, it was a hugeadvantage for farmers who could now save time, money, and generate more crops

## Unintendedeconomicconsequences

Anotherconcernrelatedtogeneticallymodifiedorganismsisthatprivatefirmsaredemandingownershipof the animals or crops they generated and not distributing them with people at a reasonable price.If these claims are equitable, it is argued that the application of genetically modified crops will damage the economy as well as environment, as the monoculture exercises of large-scale agricultural production centers (which can afford the costly seeds) will influence the diversity provided by small farmers who cannot manage with the technology. However, a new meta- analysis of fifteen investigations expose that, on average, two-thirds of the advantages of first-generation genetically modified crops are shared downstream, while only one-third accumulate upstream (Demont *et al*., 2007). These advantages shares are shown in developing countries. Thus, thealtercation that private firms will not share ownership ofgenetically modified organisms is not supported by proof from first-generationgenetically modified crops.

## Geneticcontamination/interbreeding

Introduced genetically modified organisms may interbreed the wild-typeor sexually adaptable relatives. In wildtypesthenewcharacterswillvanishunlessitconfersaparticularbenefittotherecipient.However tolerance abilitiesof wild typesmayalsoprosper,bythataltering theecologicalrelationshipandroleof thedomestic species.

## Competitionwithnaturalspecies

QuickgrowthofGMOgivesthemacompetitivebenefitoverthedomesticspecies.Thismaystrengthenthem to become intrusive, spread into novel environments and cause damage to the environment along with the economy.

## Increasedselectionpressureontargetandnon-targetorganisms

Pressure may enhance on target as well as non-target speciesto acclimate to theintroduced alterations as if to a geological transformation or a natural selection pressure causing them to evolve recognizable resistant populations.

## Impossibilityoffollow-up

Oncethegeneticallymodifiedorganismshavebeenmadeacquaintedintotheenvironmentandfewproblems rose, it is not possible to eradicate them. Number of these risks is similar to those acquired with regards to the establishment of naturally or regularly bred species. But still this does not suggest that GMOs are safe or have advantages neither that they should be less analyzed.

## Horizontaltransferofrecombinantgenestoothermicroorganisms

One problem of specific concern relating to genetically manipulation is the risk of horizontal gene transfer (HGT).HGTistheadditionofnon-nativegenes(viatransformation,transduction,andconjugation)byorganisms in a number of environmentalconditions. Itoccurs particularly in response to altering environment and provides organisms,especiallyprokaryotes,withapproachtogenesotherthanthosewhichcanbeinherited[Martin,1999; Ochman *et al*., 2000]. HGT of an infused gene from a GMO may confer a new character in another organism, whichcouldleadtopotentialharmtothehealthofpeopleandenvironment.Exampleincludesthetransmission



ISBN:978-81-957858-1-0

of antibiotic resistance genes to a pathogen that has the potential to deal human or animal therapy [Benett *et al*., 2004].HGThasbeennoticedforseveraldifferentbacteria,formanygenes,andinmanydistinctiveenvironments. It would thus be a blunder to understand that recombinant genes would not transmit to other bacteria, unless precautions are considered. New evidence from the HGT technology states that transgenic DNA in genetically modifiedcrops and products can transfer by being taken up directly by viruses or bacteria and plant and animals. Yoshida*etal*.2010observedthatHGTalso shiftedfromanuclearmonocotgeneintothegenomeoftheeudicots parasitewitchweed,whichaffectmanygrassspeciesinAfrica.FewofthenoticeablepotentialinfluencesofHGT from GMOs include the following [Keese,2008].

HGT may transmit the new genes from genetically modifiedorganisms to potential pestsand pathogens and many yet to be identified animals. This may change the ecological niche or ecological potential of the recipient animals or crops [Heuer and Smalla, 2007] and even bring about abrupt changes in structure and functions [Prescott *et al*., 2005]. Moreover the gene may introduce at variable sites of the beneficiary gene, not only introducinga new gene but also disrupting an endogenous gene, causing unexpected and inadvertent effects.

RegulatoryconfirmationforfieldtrialsofGMOsoftenrequiresstepsto controlthereleaseinspaceandtime. With the transmission of the introducedgene(s) to other species by HGT, a new GMO is generated. This novel GMOmay result into adverse effects which are not governed by managementmethodsimposedbytheoriginal license.

Sometimes the influence of HGT may be harsher in the long term. Even under strong selection pressure, it might take thousands of generations for a beneficiary organism to become the dominant form [Nielsen and Townsend,2004].Additionallynumberofotherfactorssuchastimingofspecificbioticandabioticenvironmental circumstances and changes in the recipient organism could delay adverse effects.

## Conclusion

The adoption of genetically modified organisms carries advantages in order to meet enhancing interest and improvise the existing settings of our environment. We are at an alarming crossroad where on one hand we encounter threats to human and environment and on the other hand we have opportunitiestoinnovatethings. Rulesandregulationsabouttheusageof

GMOs need a broader basis for awareness. Usage of GMOs should followconservative steps based on hazard assessment and its management.

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ISBN:978-81-957858-1-0

## Nanoscience:AGrowingNeedforAgriculturalSectors

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**Abstract**

Theneedfornanoscienceandnanotechnologyintheagriculturesectorbeganbytakinggrowing recognition that conventional agricultural technologies would not be able to increase the productivityorevenorrestoredamagedecosystems.Ontheotherhand,wiltcauses alossof10- 50%of cropseveryyear and a wide rangeof chemical fungicides areused to control wilt and it hasbecome aseriousproblemforhumanhealth. Biofungicidesmay be a potential alternative, but these have been observed to have slowand lesser effects in the field. In order to find more alternatives, the use of nanoparticles as a fungicide is increasing and has been shown as an alternative solution to control plant pathogens and nanoparticles have also been widely studied fortheirpotentialapplicationsincatalysis,biologicallabeling,biodetection,drugadministration, antibacterial andantiviralactivity and detection of genetic disorders, gene therapy andgene sequencing. Thus, nanotechnology has the potential to advance the agriculture and agri-food industrywithnewtoolsthatpromisetoincreasefoodproduction.Othernanoscienceapplications range from medicine toelectronics, textiles, construction, water treatment, food processing and cosmetics. In this review, we focus on the use of nanotechnologies in agriculturefromdifferent aspects.

**Keyword:**nanoparticles,agriculturalnanotechnology,diseases, fungicide

### Introduction

Nanotechnology or nanoscience is defined by the United States Environmental Protection Agency19asthescienceofunderstandingandcontrollingmatteratdimensionsofapproximately 1 to 100 nm. The physicalproperties unique of nanoparticles are of new applications for agriculture and othersectors.This definition is slightly rigid with regardto dimensions. Greater importancecouldhavebeengiventotheproblem-solvingabilityofmaterials.Otherattemptsto define nanoparticles from an agriculturalperspective include "particles between 10 and 1000 nm in size which aresimultaneously colloidal particles (Nakache *et al.*, 1999). In India, more than 60% of the population depends on agriculture fortheirdailybasicneeds.Nanotechnology is a multidisciplinary field, as itcombines knowledge from different disciplines: chemistry, physics andbiology among others (Schmid, *et al.*, 2010). In the 1980s, the basic idea of this definition was explored by many researchers, but in much more depth byDrexleronly,who promoted the technological significance of phenomenaand devices at the nanoscale through speeches and the books Engines ofCreation: The Era of Nanotechnology (1986) and Nano systems:MolecularMachinery,Manufacturing,andComputation(Mansoori,*et al.*,2007).New



ISBN:978-81-957858-1-0

applicationsofnanoparticlesaredevelopingrapidlyinvariousfieldsduetotheircompletelynew oreffectiveproperties,basedontheirsize,distributionand morphology.Nanotechnologyshows renovation in a large number of fields such as health care, cosmetics, food and foodstuffs, deliveryof drug genes, environment, health, mechanics, optics, chemical industries, electronics, spaceindustries, energy sciences, catalysis, lightemitters, single electron transistors, non-linear optical devices and photo-electrochemicalapplications (Salata, *et al.*, 2004). Among all the nanoparticles, silver nanoparticles are the most important due to their unique properties such as chemical stability, good conductivity, catalytic and most importantly antibacterial, antiviral, antifungal in addition to anti-inflammatory activities that can be incorporated intocomposite fibers, cryogenic superconductive materials, cosmetic products,food industry and electronic components(Ahmed,*etal.*,2016).Theapplicationsofnanoscienceinagriculturecansucceedif naturalprocesses are simulated with greater sophistication/scientific articulation forasuccessful implementation. In this context, nanobiotechnology, aconvergence of bioengineering and nanobiology, provides all the basic tools necessary to solve practical problems in the field of agriculture. Some advanced applications in the agri culture sector include the use of fertilizers buckyball, nanosensors for farmin accuracy of smart devices nano enabled for the management of nutrients as well as nanodiagnostics tools for genetic manipulation to get better performance.

## Nanosensorandagriculture

Nano science canalsobeusedin theformofnanosensors for monitoring crop growth and pest control by early identification of animal or plant diseases. Nanosensor systems have also been developed for monitoring environmental conditions, as well as interactions between pathogens and plants (Ghormade *et al.*, 2011). Therefore, nanosensors are very important for agriculture and also play an important role in improving productivity by providing accurate information about the field and condition of crops. The main objective of the application of nanotechnologyin the agricultural system is to increase productivity and reduce the application of fertilizers, pesticides and herbicides in order to avoid negative consequences on crops aswell as humans (Raliya *et al.,* 2013).

## Nanoformulation

NanoparticlessynthesizedtoimprovepesticideformulationsRecently,anumberofnanoparticlessynthesized by plants have been studied for their efficacy against economically important pests, such as moths, beetles, lice, lice and Hippobosca maculata (Roni. *et al*., 2015; Abduz Zahir, *et al.*, 2012; Jayaseelan, *et al.*, 2012).

## Cropimprovementandcropprotectionfrompests

Nanotechnology promises to improve current agricultural practices through improved management and conservation of crop inputs and has also demonstrated its ability to alter the genetic makeup of crops, thus contributingtotheimprovementofcultivatedplants.(Thornton,*etal.*,2010).Recently,nanoencapsulation has been the most importanttechnology for protecting host plants against insect pests. It ispossible to reduce the releaseofchemicalsincontrolledsituationsbyreducingthecurrentapplicationrateandimprovingefficiencywith thistechnique (Green, *et al.*,2007).Atthe research and development stage, nanoscale agrochemicals are mostly nanoformulationsofexistingpesticidesandfungicideswhicharegenerallyexpectedtoincreasetheapparent



ISBN:978-81-957858-1-0

solubilityofpoorlysolubleactiveingredients,toreleasetheactiveingredientinamannertargetedtoprotectagainst premature degradation (Wang, *et al.*, 2012). Silverhas been knownfor its natural antibacterial andantifungal propertiesforover100years(Morones*etal.*,2005).Theantifungaleffectsofsilvernanoparticlesweremeasured against eighteen pathogenic fungi of plants, including the genera of *Alternaria*, *Botrytis*, *Cladosporium*, *Corynespora*, *Cylindrocarpon*, *Fusarium*, *Pythium*, *Stemphylium*, *Aspergillus Niger*, *Aspergillus flavus*, *Alternaria macrospora*, *Rhizoctonia bataticola* and *Rolfs Sclerotium* (Ouda *et al.* 2014: Khadri *et al.*, 2013).

**Table1:**Nanotechnologyin agriculture

| **Product** | **Application** | **Institution** |
|---|---|---|
| Nanocides | Pesticides encapsulated in nanoparticlesfor controlled release | BASF,Ludwigshafen,Germany |
| Buckyball fertilizer | Ammonia from buckyballs | Kyoto University,Kyoto,Japan |
| Nanoparticles | Adhesion specific nanoparticles for the elimination of *Campylobacter jejuni* from poultry | ClemsonUniversity,Clemson,SC, USA |
| Food packaging | Waterproofplastic with packaging silicate nanoparticles | BayerAG,Leverkusen,Germany |
| Use of agricultural waste | CottonwastenanofibersBetter forclothing resistance | CornellUniversity, Ithaca,NY, USA |
| Nanosensors | Contamination of food packaged Pathogen detection | Nestlé, Kraft,Chicago, USACornellUniversity, Vevey, Switzerland |
| Precision farming | Nanosensors linked to a globalpositioning system monitoring unit for real-time monitoring of soil conditions and crop growth | United States Department of Agriculture, Washington,DC,UnitedStates |
| Livestock and fishing | Nano Veterinary medicine (nanoparticles, buckyballs, dendrimers, nanocapsulesfordrugadministration,nanovaccines; intelligent herds, cleaningof fish ponds (Nanocheck [Nano-DitechCorp.,Cranbury,NJ,USA])andfood (iron nanoparticles)). | Cornell University Nano Vic, Dingley, Australia |

**Note:**Kalpana-Sastry*etal.*

## Plantgerminationandgrowth

In previous research, numerous publications show that it hasbeen shown that gold and other nanoparticles suchassilverandzinkhaveasignificantinfluenceonplantgrowthafteran incubationperiodofonly15daysand alsoshowedthatwith the presenceof gold nanoparticles,plantbiomassincreased(Rodríguez,*etal.*,2009).The



ISBN:978-81-957858-1-0

seeds exposed to CNT germinated twice as fast as their control and the plantsweighed more than twice as much as the control. The seed size increased dramatically after just

3 days. CNT could penetrate the seed coat and therefore influence the germination and growth of plants (Khodakovskaya, *et al.,* 2009).

Nanoofdeliveryvehiclescan increasetheforceoftheseed,theplant growthand cropyieldinadditionto the protectionofcropsagainst pestsand diseases,sotheycanalsobeusedfor geneticmanipulation(Kole and*al.*,2013).Smallnanoparticlesoftenenterplantcellsbybindingtoacarrierprotein,ionchannelsorbycreating new pores (Rico *et al.,* 2011). The walls ofplantcellshavetheremarkableabilitytopreventthe entryof nanoparticles. Despite this dubious impact of the application of nanomaterials on plants, some of the current studies focus on the phytotoxicity of nanoparticles (Lee, *et al.,* 2010; Slomberg, *et al.,* 2012.

Nanoparticlescanefficientlyprovidebiomoleculesintheplantsrepresentedby(Torney,*etal*.,2007).Carbon nanotubeshaveapositive impactontomatoplantsthroughincreasedgerminationandseedgrowth,andtheyhave suggested that these effects are due to the ability of carbon nanotubes to penetrate the seed coat and improve crucial water absorption (Khodakovskaya, *et al.,* 2009). It has beenshownthatnanoparticlessuchas particlesof nanoparticles of zinc at a certain optimal concentration, promote the growth of mung bean seedlings, *Vigna radiata* (L.) R. Wilczek and Gram, *Cicer arietinum* L. (Mahajan *et al*. 2011). Treatment of castorseeds, *Ricinus communis* L., with silver NPs did not affect the rate of seed germinationor the growth of lepidopteran insectson the seeds (Usha Rani, *etal.,* 2013). Thus, studies on the germination of courgette seeds and silver nanoparticles have shown no negative effect on germination, but have reduced the biomass, prolonging their growth in the presence of silver nanoparticles (Shah, *et al.,* 2009).

## Nanofertilizersandnanofungicides

Nanofertilizers also play an important role in increasingplant production Nanofertilizers also improve germination of plants andsomeother traits as well, such as length of shoots, seedlings. Many physiological parameters such as increased photosynthetic activity andnitrogen metabolism have also been increased in vegetable crops using metal-based nanomaterials (Giraldo *et al*, 2014).

Nanomaterials that can provide one or more plant nutrients, which leads to an increase in growth and efficiencyatthesametime,or thosewhorealizethebestperformanceofconventionalfertilizers,nocropstofeed directly (Ghormade, *et al.,* 2011). In an area Des studies S have already demonstratedthe importance of using modern advanced nanomaterials. Some beneficial effects include increased efficiency of nutrient utilization, improved productivity of agricultural crops, and reduced soil contamination by pollutants (Sinha, *et al*., 2013). Hence, the effectiveness of the Nutrient absorption is greater and freshness loss is lower for CRF Products comparedto readily available forms of fertilizer (Khandelwal*et al.*,2016).Rejectionratesandthesolubilityof watersolublefertilizersdependonthecoatings. ThisideawasputintoevidencebyYang,*etal.*,2008,todevelop nanomaterials trapped. Consequently, fertilizers are therefore protected by nanomaterials for better survival in polluted soils, allowing their release into the soil (Kah, *et al.,* 2014).

Nanofertilizers balance the release of nitrogen, phosphorus and other macronutrient fertilizers absorbed by the plant, thus avoiding nutrient losses and avoiding undesirable interactions of nutrients with microorganisms, water and air (Blois, *et al.,* 2018). The absorption of nutrients by soil plants can be maximized by using a nanofertilizerandananosilicaencapsulatedbyafertilizercanformbinaryfilmsonthecellwalloffungiorbacteria after absorption of nutrients and prevent infections, hence improved growth and development of plants at high temperatureandhumidityisimproved,whileplantresistancetodiseasealsoincreasesthroughencapsulationof



ISBN:978-81-957858-1-0

nanofertilizers (Wang *et al.,* 2002). The silicon-based fertilizers used to increase plant resistance because the silicon dioxide nanoparticles can improve seedling growth and root development (Hutasoit, *et al.,* 2013). To increase food production, TiO2 or non-toxic titanium can be usedas additives in fertilizers.

### Securityof livelihoods

Theroleofnanotechnologyintheagriculturalsectortoimprovethelivelihoodsofpoorpeopleinthirdworld countries. With the gradual implementation of the Agreement on Trade-Related Aspects of Intellectual Property Rights,thenumberofinternationalandUSpatentsisincreasingfor alltypesofnanotechnologyaroundtheworld (Hillie *et al.,* 2009). Agricultural nanotechnology isa tool that can provide greaterbenefitsfor poor countries, as itispowerfulinimprovingtheproblemsassociatedwith themisuseofinputs, waterscarcity, poor sanitation and other similar problems faced by developing countries. However, developing countries can reap the benefits of nanotechnology if one realizes that the future cost of importing agricultural technology could be higher than that of its local development in a sustainable manner (Gruère, *et al..,* 2011).

## 2. Conclusion

The opportunity for the application of nanoscience in agriculture sector is prodigious. Previous researches hadshownthatnanoparticleshavebeenfoundtobeanecofriendlyandpotentialagainstvariouspestandbiological labeling, biosensors, drug delivery, antibacterial and antiviral activity and detectionofgeneticdisorders,gene therapyandgenesequencingin agriculture. The advancements, if implemented over the years, could hold promise of opening up huge possibilities for agricultural biotechnology, thus highlighting the possibility of a second green revolution in India. India still has a long way to go in agriculture and food with the helpof nanotechnology. However, more research, development and policy makingis still needed to use them as an alternative to harmful chemical fungicides inagricultural fields.

## 3. CorrelationofnanosciencewithancientIndianliterature

Nanoscience or nanotechnology was not a new phenomenon, it is from the ancient Indian society in ancient Indiathetechniqueofnanotechnologywasusedinthemedicaltreatmentofdiseasesinhumanbeings,theweapons used in the wars in the steel industry, the Indian crafts andthe cultural rituals. Charak Samhita is the oldest AyurvedicepicoftheIndianCulturalSocietyusedforthetreatmentofsickhumanbeings.Theconceptofparticle size reduction in metals is clearly discussed in Charak Samhita Extreme Particle size reduction in non-metals is called nanotechnology (Baboo, R., 2015).

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ISBN:978-81-957858-1-0

# BiosynthesisofFoodAdditivesandItsApplicationinFoodIndustry

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## Abstract

Consumer concern about human health and environmental issues isencouraging the food manufacturerstoutilizemorenaturalandsustainablefoodingredients.Foodindustrythroughout the globe is dependent on additivesto make food appealing to the consumersand to add quality to the final food product. Synthetic food additives pose the danger of hazardous effectsand toxicitytotheconsumerswhereastheapplicationofnaturaladditives as foodadditives is rathersaferandisinglobaldemand.Asaresult, much attention is focused in replacing syntheticingredientswithnaturalones.Therefore,aneedemergestoexplorethenovelstrainsof microorganisms and acceptable strategies for commercial production of microbial additives, in ordertomeetthehighdemandasfoodadditivesworldwide.Microorganismshavepavedtheway especially in food industry to be utilized for the derivation of natural additives. Microbial fermentation modifies the nutritional content of foods depending on the type of microorganism andthesubstrateused.Itdestructsthefoodspoilageorganismsandpermitspreservationoffood. In addition, microorganisms impart desirable flavors and enhances the texture of food without posing negative effect to the human body. Hence, could act as a sustainable alternative of synthetic additives.

**Keywords:** Fermentation,Microbialadditives,Humanhealth,Sustainable,Alternative

## Introduction

The United States Food and Drug Administration (FDA) has termed Food Additives as “any substance,theintendeduseofwhichresultsormay reasonablybeexpected toresult,directlyor indirectly, in its becoming a component or otherwise affecting the characteristics of any food”. Additives that are intentionally added to foods for specific purposes are known as direct additives[4].Additives,whichbecomeapartofthefoodbutinminor quantitiesduetohandling, packaging or storage are known as indirect food additives. A recent review-based study states thatpresentlynearabout2500typesoffoodadditivesarebeingusedworldwideandaround3000 ingredients US FDA lists in the food additive database [9]. Some additives have been used since ages,whichincludespreservingfoodwithvinegar,salting,andusingsulfurdioxideasinthecase ofwines. Withthe advancement of processed foods in the mid-20th century, more additives have been introduced including both natural and artificial origin. The benefitofincorporating additive is that it preventsfoodspoilagedue to the growth of microorganisms. Not only additives maintain the qualityand consistency of the foods, they also maintain the palatability andwholesomenessofthefood,enhancesitsnutritionalvalue,maintainappropriatepH,provide



ISBN:978-81-957858-1-0

leavening,colorandimprovesthefoodflavor[1].Foodadditivesareamongstthesafestchemicals infoodastheyarelesstoxicthanthesyntheticones,diligentsafetytesting,anditscontrolutility as per the law. The allowance to use particular food additives is recommended by the

Codex AlimentariusCommissionand isapproved by nationallegislation. The currentglobal market production of food additives is depicted in the Fig. 1 [64].

Fig1:GlobalMarketproductionofFoodAdditives

Classification of food additives

Foodadditivesmaybebroadlyclassifiedintofollowingcategories [1]:

a) Antimicrobialagents,whichpreventspoilageoffoodbymicroorganisms.Theseinclude not only vinegar and salt, but also other compounds such as nisin, organic acids that areused in products such as baked goods, salad dressings, cheeses, margarines, and pickled foods Antioxidants that prevent rancidity and damage caused to foods by the release of oxygen

b) Colors which are intended to make food more appealing in order to meet consumer expectations such as carotene, lycopene, astaxanthin

c) Flavors and flavor enhancers are the largest class of additives; their role isto make food taste better, and also to provide them a specific taste, such as vanillin etc. used to complement the flavor of certain foods

d) Chelatingagents, areusedtopreventdiscoloration,changein flavour, and ranciditythat might occur during food processing like citric acid, malic acid, and tartaric acid

e) Stabilizing and thickening agents, which function to change the texture of a food. Examplesincludetheemulsifiermannoprotein,lecithin,whichkeepsoilandvinegarblendedin salad dressings

ProductionoffoodadditivesusingmicrobesFlavouringagents

Flavouringagentsareconsideredasoneofthelargestsinglegroupsoffoodadditives.Theymay complement, enhance, or alter the aroma and taste of the food. Of the total available flavouring compounds, nearly 80% are synthesized using chemicals whose incorporation is limited due to development of racemic mixtures and lack of the specificity of substrate. The increasing awareness of consumers towards chemical supplemented food led to the evolution of the flavouring compounds of biological origin known as natural flavours or bioflavours. Identification of microbes producing essential food flavourants marked the way for substitute low cost, efficient and flexible method for the industrial production of flavour compounds. Flavourshavebeenbroadlyclassifiedasnaturalornature-identical.AccordingtoECFlavour



ISBN:978-81-957858-1-0

Directive(88/388/EEC),naturalflavoursaredefinedasthesubstancesorpreparationswhichare obtainedbyappropriatephysical,enzymaticormicrobiologicalprocessesfrommaterialofplant oranimalorigin[10].Someimportantclassesofflavorcompoundsproducedbymicroorganism are discussed below:

γ-decalactone

It is the most vital lactone for flavor application. It has an oily-peachy aroma, extreme strong odourandaverypowerful,creamy-fruity,peach-liketasteatconcentrationslessthan5mgL–1. Theproductionofγ-decalactone,withthesameenantiomericconfigurationasthenaturallactone, which are

found in peaches and other fruits, was first noticed by Okui et al., [6] in the catabolism of ricinoleic acid by yeasts of the genus Candida. Ricinoleic acid found in the castor oil has been converted into-□decalactone by partial- □oxidation, which is catalyzed by yeast strains of Sporidiobolus salmonicolor, Monilia fructicola, Rhodotorula glutinis, and Yarrowia lipolytica. Likewise, by the bioconversion of unsaturated fatty acids such as 11-hydroxypalmitic acid, corriollic acid using various strains of yeast and fungi such as Saccharomyces cerevisiae and Cladosporium suaveolens, production of-□decalactone can be obtained. Eq.1 showing the production of flavouring compound is mentioned below [10]:

Eq.1:formation offlavourcompound Decalactone

Pyrazines: These are heterocyclic, nitrogen-containing compounds found to have contributed remarkably to the unique taste and aroma of roasted or toasted foods since the mid-1960s [5]. Methoxy pyrazines are grape derived flavours, which give characteristic earthy aroma to grape wines. 2,3,5-Trimethyl pyrazine is used as a chocolate flavour enhancer, while 2-methyl-3-methoxy pyrazine improves the flavour of nuts. These are produced by some microbes, such as bacteria Corynebacterium glutamicum, which produce tetramethyl pyrazine from amino acids and also through the maillard reaction during the roasting of food [10]. Fermentation or biotransformation methods with submerged techniques or solid substrate fermentations can act as a useful tool for the formation of this kind of natural components [11].

Esters:Theseareorganiccompoundsnaturallyoccurringinplantsandanimalsandarecommon flavouringagentsknownfortheirfruityaroma.Theyareusedinbeverages,bakedproducts,wine anddairyproducts.Acetateesterslikeisoamylacetateand2-phenylethylacetateareformedby yeasts Hanseniaspora guillermondii and Pichia anomala respectively, which are major flavourantsingrape-derivedalcoholicbeverages[10].Methyl,propyl,butyl,isobutyl,amyland isoamyl esters are also of specific interest for flavors in the food industry. They are generally synthesized by various microorganisms through oxidative shortening of fatty acids and partial reductionofthedegradationproducts,orbyfreeaminoacidsdegradation,orbyconvertingthe



ISBN:978-81-957858-1-0

precursorsofterpenoids[7].

Ketones:Themost essentialketonicaromais2,3-butanedione(diacetyl),whichissimilartothe flavor of butter [8]. Since the lactic acid bacteria and other microorganisms are present in food andarereadilyavailable,thereforethisflavouredcompoundcaneasilybeproduced.Larroche [13] developed an interesting method to produce 2-heptanone (a ketone) with spores of Penicillium roquefortii in a water-organic solvent two-phase system.

Vanillin (4-hydroxy-3-methoxy benzaldehyde), is obtained from a climbing orchid Vanilla fragrans, a widely used aromatic flavour compound in food, beverages, and pharmaceuticals. ProducedbyfedbatchfermentationincorporatingAmycolatopsissp.HR167,12gofvanillinper litre of the medium has been obtained [10]. However, a low cost effective method for vanillin production employs maize and wheat-based agricultural wastes which can be transformed into ferulic acid, using polysaccharide-degrading enzymes and feruloyl esterases, ultimately ferulic acidcanbeconvertedintovanillinbytheactionofPycnosporuscinnabariusoritcanbeobtained throughatwostepfungalprocessinwhichinitiallyA.nigertransformsferulicacidintovanillic acid, which finally gets converted to vanillin by basidiomycete, Pycnoporus cinnabarinus or Phanerochaete chrysosorium

[10].

Emulsifiers

Various consumer products are designed using oil-in-water emulsions, either during their manufacturing or in the final product form, e.g., food, nutritional supplements, and pharmaceutical, personal care, and cosmetic products [14]. In food products, the fat droplets provide required physicochemical and sensory qualities such as appearance, consistency, mouthfeelandflavor[15].Moreover,theycanalsobeutilizedtoprotect,encapsulateandtransfer lipophilic bioactive components such as flavours, colors, antioxidants etc. [16] Bioemulsifier-producingmicroorganismscanbeclassifiedintothreetypes[97]viz.microorganismsproducing bioemulsifiers entirely with alkanes as carbon source, such as Corynebacterium sp.; microbes producingbiosurfactants exclusivelywithwatersolublesubstratesasthecarbonsource,suchas Bacillus sp.; and those producing biosurfactants with both alkanes and water soluble substrates as carbon sources, such as Pseudomonas sp. The schematic and mechanism of action of vital emulsifiers produced by microorganisms using biotechnological processes are presented in Figure 2.

Fig2:Productionofemulsifiersby microorganisms

Someoftheemulsifiersderivedthroughmicrobialfermentationare:

Sophorolipids:Theseareglycolipidsproducedbycertainspeciesofmicroorganisms,specifically



ISBN:978-81-957858-1-0

yeasts [17]. It can be produced on commercial scale using microbial fermentation processes i.e. suitableyeaststrains(suchasCandidabatistaeandCandidabombocola)andsubstrates(suchas carbon and nitrogen sources) [18]. Moreover, Candida bombicola is included in microorganism with technological advantages and have attained GRAS (Generally Recognized as Safe) status [95]. These molecules comprise of a hydrophilic sophorose group (a disaccharide) adhered to a hydrophobic hydrocarbon tail (a fatty acid chain) [17]. The nature of the sophorose head group and hydrocarbon tails depends on several factors such as the microbial strain, fermentation conditions, and the type of substrates used, which leads to the formation of biosurfactants with varied physicochemical and functional properties [19].

Mannoprotein: This is a glycoprotein with a molecular weight of about 14,000 to 15,800 dalton and are found within the yeast cell wall of Saccharomyces spp. and Kluyveromyces marxianus. Mannoprotein molecules are present in glucan, networks, and are released from the yeast cell wall by applying pressurized heat treatments. This emulsifier has the ability to stabilize oil-in wateremulsions(O/W).Accordingtoresearchers,theseemulsifierscanbeutilizedforproducing mayonnaisealongwithcarboxymethylcellulose(CMC),insteadofusingcostlyingredientssuch as ginseng for mayonnaise formulation [12]. In another study by Araujo et al.,

[94],β-glucanandmannoprotein(MP)wereextractedfromthecellwallof spentbrewer'syeast (Saccharomyces uvarum). The obtained mannoprotein revealed interesting emulsifying and stabilizingproperties,andcanbeusetoreplacexanthanguminmayonnaiseformulation.Studies have revealed that mannoproteins have similar or better emulsification properties than other natural emulsifiers, such as gum arabic and lecithin [96].

Liposan:Itisawater-solubleemulsifierobtainedfromextractingorganicsolventsfermentedby Candida lipolytica yeast. It is produced in the extracellular layer and the emulsifier formed comprises of 83% carbohydrate and 17% protein. The presence of protein portions in the polymeric molecule of bioemulsifier is important for its emulsifying properties. The maximum liposomal properties of liposan are observed at pH 2-5. Liposan stabilizes several types of emulsions in oil, such as hydrocarbons, vegetable oils including cottonseed, corn, soybean, sunflower, safflower, groundnut and olive oil [20].

Emulsan: It is anextracellularpoly-anionicemulsifierproducedbyAcinetobactercalcoaceticus RAG1bacteria.Thisbioemulsifierisapoly-anionicandamphiphiliccompoundwhichpossess theabilitytostabilitizethehydrocarbonemulsioninwaterbyformingavery thinlayerbetween the hydrocarbon and water molecules. Maximum concentration is attained when culture media contains 12 carbon-based fatty acids, which is then used as the carbon source. Another type of emulsion considered as bioemulsion is produced by Acinetobacter calcoaceticus, used in the formulation and production of soft cheese, ice creams as well as creams and skin protecting materials [12].



ISBN:978-81-957858-1-0

Sweeteners

Natural sweeteners have received much attention due to rising health concerns over the consumption of sugar as well as issues related to the safety of few nonnutritive artificial sweeteners. Recently, the need for noncaloric natural sweeteners in the food industry arose interestfortheextraction ofpolysaccharidesisolatedfrom fromplants and microorganismsdue to their various biological activities. Lactic acid bacteria (LAB) beyond the limit of their traditional role in acid, texture and flavour development, low- calorie sugars have been their recentaddition.Broadly,low- caloriesweetenerscanbecategorizedintotwogroups.Firstgroup of sweeteners include substances with extreme sweet taste, which is equivalent to sweetness where larger amount of sugar is used, for example, acesulfame K, aspartame, and sucralose. Secondgroupofsweetenersthatcanactasanalternateforboththephysicalbulkandsweetness of sugar, it comprises the sugar alcohols (also called "polyols") sorbitol, mannitol, xylitol, and are usually called as "sugar replacers" or "bulk sweeteners [21].

Mannitol: D-Mannitol is a sugar alcohol containing six carbon atoms, typically found in plants such as pumpkins, celery, onions, olives, and lichens. Mannitol finds its largest application as a food additive (E421). Mannitol is also found in high levels in brown seaweeds where it is invariablytheessentialproductofphotosynthesis[36].Mannitolwasproducedfromglucoseby various yeast and fungi including Aspergillus sp., such as Aspergillus elegans and Aspergillus nidulans. About 50% of yield, based on glucose, could be attained [34]. Production of mannitol from glucose with a yield of about 30%, has been obtained by using Byssochlamys fulva

[35].BacteriaespeciallyLAB arealsoknown toproducemannitol [22].

Heterofermentative LAB belongingto thegeneraLactobacillus andLeuconostocarethevigorous producers of mannitol. These bacteria contain the enzyme mannitol dehydrogenase to convert fructose into mannitol. The optimized reaction of mannitol production is shown in Eq.2. In this fermentationprocess,L. mesenteroidesisusedtoconvertamixtureofglucoseandfructoseinto mannitol. Here the conc. yields upto 50g/L or even higher [37]. The LAB reported to produce mannitol are L. sanfranciscensis [23] and recently Saha [24] studied mannitol production by L. intermediusNRRLB- 3693usinginulinasasubstrateandreportedthatwhenfructoseandinulin mixture (3: 5, total 400 g/L) was used as substrate, the bacterium produced

227.9±1.8g/Lofmannitol.MannitolispresentlyontheU.S.FDAGRAS- /INTERIM(generally recognized as safe) list [25].

Eq.2: Showingthe productionofmannitol

Tagatose: It is an isomer of fructose that occurs naturally in some dairy products. Tagatose is obtainedfromlactose,thesugarpresentinmilk.Itisafunctionalsweetener,whichresemblesto sucrose(tablesugar) intextureandis92%sweet,withonly38%ofthecalories.Severalstrains



ISBN:978-81-957858-1-0

of Mucoraceae fungi convert D-psicose to D-tagatose [38]. L-Arabinose isomerase has been studied thoroughly in recent years due to its commercial feasibility in D- tagatose production [39]. LAB were found as potential source of this enzyme [27]. This enzyme catalyses the conversionofD- galactosetoD- tagatoseandalsotheconversionofL- arabinosetoL- ribulose,an economically suitable tagatose manufacturing method [26]. L- arabinose isomerase has been of interest for its potential application in galactose isomerization into tagatose formation. Further, Ibrahim and Spradlin [28] have patented an enzymatic isomerization process using arabinose isomerase emerging from alacticacid bacterium. Several other microorganisms involved in the production of tagatose are shown in the Table 1.

Table1:Micro-organismsinvolvedintagatoseproductionatvariousconditions

| Strain for enzyme | Optimum temp (°C) | Optimum pHHalf-life (min) | |
|---|---|---|---|
| Aerobacter aerogenes 50 | 6.4-6.9- | [69] | |
| E. coli30 | 8.0 | 60 | [70] |
| Lactobacillusgayonii30-406-7 | - | [71] | |
| Mycobacterium smegmatis | 45 | 7.0-7.510 | [72] |

Sorbitol:ItisalsoknownasD- glucitol,naturallyfoundinvariousfruitssuchasberries,cherries and apples [29b]. Sorbitol is extensively used in various food products ranging from confectionery,desserts,andicecreamstodiabeticfoods.Intheseproducts,itimpartssweetness and performs technological functions such as humectant, softener or as a texturizer [30]. A recombinant strain of L. casei was constructed, cells of which when pregrown on lactose, were foundtobeabletosynthesizesorbitolfromglucose.InactivationoftheL- lactatedehydrogenase geneledtoanincreaseinsorbitolproduction.Asorbitol- producingL.caseistrainmighttherefore be of profound interest in the food industry [31].

Trehalose:Alsoknownasmycose,isanaturalalpha- linkeddisaccharideformedbyanα,α- 1,1- glucosidebondbetween2α- glucoseunits.Trehaloseisamongstthemostchemicallyunreactive sugars and its extreme stability is the reason of its highly low energy (1 kcal mol−1) [40]. Trehalose is found naturally in plants, insects, fungi, and bacteria; the major natural dietary source is mushrooms. It is used in various products due to its varied effect, such as inherently mild and sweet flavor, its ability to suppress bitterness/harsh flavors, such as the mal odour of raw foods, meats, and packaged foods [21]. Trehalose is widespread within the genus Propionibacterium[32].TrehaloseaccumulationinPropionibacterium,suchasP.acidipropionici and P. freudenreichii sub sp. shermanii [33] has been observed to occur in response to stress conditions. Particularly, P. freudenreichii subsp. shermanii strain NIZO B365 accumulates trehalosetoexceptionallevelsandthetrehalosecontentincreasessignificantlyinresponseto



ISBN:978-81-957858-1-0

osmotic, oxidative and acid stress (up to 40% [w/w] of the cell protein). In this microorganism, trehaloseresultsfromtheconversionofglucose6- PandADPglucoseviatrehalose6- Psynthase to trehalose 6- P and its subsequent dephosphorylation by trehalose 6- P phosphatase.

Preservatives

Foodpreservationbytheprocessoffermentationdependsontheprimeprincipleofoxidationof carbohydratesanditsrelatedderivativestoproduceend-productswhichareusuallyacids,alcohol and carbon dioxide. The end products so formed controls the growth of food spoilage microorganisms and since the oxidation is only partial, the food retains adequate energy to provide nutritional benefit to the consumer. The LAB has been divided into many genera, and those essential in food include Lactobacillus, Lactococcus, Enterococcus, Pediococcus, Leuconostoc and Streptococcus. With the findings of bacteriocins, the use of enterococci as starter cultures or co- cultures has been studied by numerous researchers not only for their organoleptic properties, but also for their negative impact on food pathogens by the production of enterocins [42].

Nisin: It is produced by Lactococcus lactis and belongs to a class of compounds known as the bacteriocins. ItisapprovedbyJointFAO/WHOExpertCommitteeonFoodAdditives(JECFA) as food additive and is defined as a mixture of closely related antimicrobial polypeptides produced by strains of Lactococcus lactis subsp. lactis. Nisin has to be formed in a sterilized mediumofSNF(solidnotfat)ofmilkoronanon-milk-basedfermentationsource,suchasyeast extract and carbohydrate solids [2]. Ability of nisin to hinder the growth of Gram-positive bacteria such as Staphylococcus and spore eruptions of various species of Clostridium and Bacillushasbeenitsmostbeneficialproperty.Moreover,nisinincombinationwiththechelating agent EDTA and/or the surfactants Triton X-

100andTween20hasbeenfoundtobepotentagainstvariousGramnegativebacteria,including Salmonella typhimurium and E. coli in laboratory media [46]. Le Blanc et al., [43] reported a phenotypic and physical evidence for a 28 MDa nisin plasmid in L. lactis. Another researcher [44],combinednisinproductionandresistancetoa30MDaplasmidandwasabletotransferthe trait to a non-producing plasmid-free strain of L. lactis. The genetic sequences of nisin and its structural analogue subtilin (from B. subtilis) have recently been interpreted by scientists [45]. The studies highlight the important background data required for the production of a range of useful bacteriocin analogues adjusted against the spoilage and pathogenic flora of particular foods. Recent applications of nisin include its use as a preservative in high moisture, hot baked flour products and pasteurized liquid eggs. Another scientist Chenga et al., [50] produced nisin

and lactic acid from corn stover through simultaneous saccharification and fermentation by inoculating bacterial species as shown in Eq.(3).



ISBN:978-81-957858-1-0

Eq.3:ProductionofNisinandLactic acidby SSF

Enterocin:Inadditiontothein-situproduction,semipureandpureformsofenterocinshavealso been discovered as preservatives in several foods, especially in non-fermented products. The most extensively studied enterocins is enterocin AS-48, which was the first enterocin to be characterizedandhomogenouslypurified.Likewise,enterocinsAandBhavebeentestedasfood preservativeschieflyinmeatproductsduetotheirintenseanti-listerialactivity.EnterocinAS-48 not only successfully controls the vegetative cells of Bacillus spp. and A. acidoterrestris sp. but also significantly increases the heat sensitivity of endospores, hence reducing the time and temperature of heat treatment during processing [41]. Utilization of broad-spectrum enterocins such as AS-48, or the intense antilisterial enterocins such as A and B have potential application in meat preservation and dairy products.

Organic acids: Organic acids commonly used for preserving food includes citric, acetic, lactic, tartaric, malic, gluconic, propionic and fumaric acids. Citric acid is commercially produced by large-scale fermentation generally using selected fungal or yeast strains in aerobic bioreactors. Currently its production uses submerged or surface fermentation processes, with beet molasses orglucosesyrupasthechiefrawmaterial.Theirprimeroleistopreventdeterioration,browning and to act as an antioxidant in frozen food and fats respectively [1]. Acetic acid (ethanoic acid) is the most commonly used organic acid since the dawn of civilization. Its current demand is nearly 13 million tons, and this figure is expected to increase to up to 18 million tons in 2020 [47]. Several microbes have been reported to produce acetic acid, e.g., Acetobacter, Thermoanaerobacter, Acetomicrobium and Clostridium [48]. It is produced from sugar-rich materials by successive anaerobic and aerobic fermentation as represented in Eq. 4.

Saccharomycescerevisiae

I) Sugar(glucose, fructose) EthanoAnaerobicAcetobacteraceti

II) Ethanol AceticacidAerobic

Eq. 4: Production of acetic acid

Species of anaerobic bacteria, including members of the genus Clostridium, can also directly convertsugarstoacetic acid,withoutusingethanolasanintermediate.Clostridiumlentocellum SG6 is reported to produce 30.98 g/L of acetic acid utilizing cellulose as the raw material [49].

Pigments

Plants and microorganisms produce certain substances which displays different colors due to particularcolorabsorption;thesesubstancesareknownaspigments.Thesepigmentsareisolated and utilized in textile and dyeing industry, pharmaceuticals, food & dairy industry [41, 44]. Accordingtotherecentstudiesitiswellevidentthatpigmentsisolatedfrommicrobesare



ISBN:978-81-957858-1-0

advantageousoversyntheticpigmentssuchasthepigmentsextractedfromplantsowingtotheir stability, availability throughout the year, low cost, and high yield through strain improvement [54].Microbialpigmentsnotonlyprovidecolortofood,theyalsohavegreatmedicinalproperties likeantioxidant,antimicrobial,anticancer,anti-inflammatory,andimmunosuppressiveetc.[57]. Most commonly used food grade pigments are b-carotene, riboflavin, lycopene and Monascus pigments [56]. Currently pigment production is carried out commercially in submerged state fermentation (SmF).However,solid-statefermentation (SSF)system could bebeneficial dueto its natural potential [58].

Monascus pigments

Monascus pigments belong to the family of Monascaceae group of Ascomycetes [62]. Main strainsisolatedforapplicationinfoodindustryareoffourtypesi.e.M.pilosus,M.purpureus, M.ruberandM.froridanus.Thesepigmentsaddred,orangeandyellowcolortothefooditems. They are utilized as food additives in red wines, tofu, sausages, hams, and meats etc. [61]. The production of Monascus pigment is shown in Fig. 3 has been reported by Wang et al., [63]. However,colordegradationisacommonconcernforthesepigments.Recentlyaresearch study explored the thermal stability of pigments produced by Monascus ruber in submerged fermentation and described the nature of the responses of color degradation using response surface methodology [61].

Fig3:ProductionofMonascuspigmentbysubmergedfermentation[63]

Carotenoids: The pigment ranges from yellow to orange-red colored. They are used as antioxidantstoreducecellularortissuedamageandmajorlyascoloringagentsforfoodproducts such as margarine, soft drinks, and baked goods. Microorganisms like Serratia, Micrococcus, Mycobacterium and Streptomyces produces carotenoid [56]. Another mould, Phycomyces blakesleeanusisalsoknownforitspotentialitytoproduceβ-caroteneatindustrialscale,andhas been studied by Almeida and Cerda- Olmedo [73]. Various scientists have explained the production of carotenoids by yeasts like Rhodotorula spp. Theproductionofcarotenoidsby genus Rhodotorula differs among the species, and is affected by medium components and environmental conditions. The amount of carotenoids produced by this genus can be classified as low (less than 100 μg g-1), medium (101 to 505 μg g-1) and high (more than 500 μg g-1) as reported by several others [74]. Also, there is a recent trend to utilize the agroindustrial byproducts, such as whey, molasses, glucose syrup, and beet molasses [80] as a substrate for producing carotenoids. Beta carotene is an antioxidant and has positive effects against few diseases.Accordingtoastudyconductedrecently,itisproducedmainlyusingBlakesleatrispora, Mucor circinelloides and Phycomyces blakesleeanus [52]. It is used as a food additive in vegetable oils, orange drinks, margarine, various emulsions and microencapsulated beads [51].

Riboflavin



ISBN:978-81-957858-1-0

Itisa yellowcoloredwater-solublevitaminproducedbyseveralmicrobes, andiscommercially produced using Ascomycetes Ashbya gossypii, which is preferred due to its high yield and genetic stability [59]. Ashbya gossypii was the first organism used in industrial riboflavin production, extracted as a plant pathogen, and characterized as a natural riboflavin producer. Production of riboflavin through fermentation can be of three types: weak over producer, moderate overproducer and strong overproducer. Eremothecium ashbyii, A. gossypii, Candida flower,SaccharomycescerevisiaeandB.subtilisareamongstthestrongproducersofriboflavin [60]. Riboflavin can be synthesized by A. gossypii using vegetable oil as a carbon source, and useofthefungustoconvertwaste-activatedbleachingearth(wABE),whichisawastematerial beingproducedduringcrudeoilrefining,toriboflavinhasalsobeenreported[71].Theriboflavin carbonyieldisabout4-5%(griboflavin/gglucose)onglucose[70]andabout18%(griboflavin/g oil)onoil[72].riboflavinareusedasfoodadditivesincereals,pastas,sauces,processedcheese, milk products, and energy drinks etc. [55].

Significanceoffood additives

In today’s world, numerous food products are available for consumption such as various types of bakery products, beverages, deserts etc. and in order to make them last long and fresh, food additives have become a necessity of all types of food products and food industry. Straightly from the aroma of the beverage, the texture and consistency of food, its visual appearance especially its colour, improves the appearance of certain foods to meet consumer expectations [29a] and is therefore enriched in order to make it more acceptable. Additives enhance the nutritional value of certain foods and make them more appealing by enhancing their taste, consistency, texture or color. Few of the worst additives includes the synthetic ones such as benzoates, bromates, saccharin, which can cause skin rashes, asthma, nausea, diarrhea and can causetoxicreactionsthatimpactthegastrointestinaltractandheart,aswell ascausetumorsand bladder cancer. Hence, certain chemical additives are banned by food legislation seeing their degradingeffectsonhumanhealth.Therefore,thedemandfornaturalalternativeshasincreased. Hence,variousadditives producedbyfermentationarebeingfocused recentlyasconsumersare demanding food and beverage products that are more natural and sustainable. As a result, the foodindustryistryingtoreplacesyntheticadditiveswithnaturalandbiosynthesizedalternatives which are safer and can be taken in acceptable and measured amount.

Conclusion

Food additives have gained a social acceptance in the processing and preservation in order to maintain the quality of food products. These additives are now legitimized because without altering the nutritional value of the food, they maintain the stability, quality and appearance of food in good order. Additives derived from microbial fermentation are naturally safe than the syntheticoneswhichcanposenegativeeffecttothehumanbody.Also,theuseofstartercultures



ISBN:978-81-957858-1-0

reducestheprocessingtime.Inaddition,therearesavingsinequipment,space,manpower,time and fuel and economically, microbial fermentation of food additives is less expensive than the production of synthetic ones. On the other hand the utilization of low-cost substrates as agro-industrial wastes reduces the process costs, and also providing an alternative to the use of these wastes contributing to lessen environmental contamination. Microbial fermentation is an exceptional preservation technique that increases the shelf life of the food after harvest thereby permittingtheextendedutilizationoffood.Further,theconsumer'sexposuretotoxicsubstances producedbytheuseofartificialadditivesisalsoreduced.Thischapteraimstoshowanoverview on the microbial fermentation processes for food additives production, and its possibility to produce them at low costs, high yieldsand toreduce the processing time. The knowledge about these processes is crucial to improve and produce more feasible methods for the production of natural and sustainable food additives.

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ISBN:978-81-957858-1-0

# ApplicationsofDNABarcodinginPlants

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**Abstract**

DNA barcoding is a technique, used for the identification of livingorganisms without involving any morphological characteristics. Itdiscriminates thespeciesby using an automatedsystem, so that unexplored living organism can be named easily and quickly identified. The aim of the barcodingistoidentifythespecies,adulterantsanditstoresalltheinformationabout the species, develops a simple diagnostic tool based on strong taxonomic data that is collected in the DNA barcode reference library. The reference library becomes useful by enabling the rapid identificationoflowtaxonomicleveltaxawithspecificshortDNAsequence.Thekeyprocessin DNA barcoding is identifying novel candidate gene universally. DNA barcodeproved to be a promising tool to identify the species across all forms of life including animals, plants and microbes in a rapid and reliable manner.

**Keywords:**DNAbarcoding,species,adulterants,Referencelibrary

## Introduction

DNAbarcodingisatechnique,whichprovidesquickidentificationofspecieswithoutinvolving themorphologicalcharacteristics.Itusesarelativelysmall-standardizedDNAfragmentasatag, todefineordiscoveraspecies.Thegeneissequencedtoknowthebase-pairdifferencesandthen depositedinthebarcodedatabase,whichistermedasDNAbarcodes.Thesegeneticcodescould be accessed through a digital library and used to identifythe unknown species by any scientist around the World. Ideal DNA barcode should be normally a uniform short sequence of DNA (400-800 bp), able to be simply generated and used to characterize all the living organisms[1]. Paul'sgroupwasthefirsttodesignandusetheshortDNAsequencesforbiologicalidentification at the University of Guelph, Canada. The idea of barcoding wasfirst emerged to describe the microorganisms, in which the morphological keys were lacking. Now it is being applied successfully to animals. A massiveon-line digitallibrary of barcodes will be a standard, to whichtheDNA barcodesequenceofanunknownsamplecanbematchedfortheidentification. DNA barcoding uses the information of one or a few regions in the genome torecognize all the species in a genus [2]. DNA barcoding will open up new opportunities in DNA based investigations ranging from community phylogenetics [3] to ecological genomics [4]. The suitability of a locus for large-scale DNA barcoding can be easily studied by comparing loci acrossthesimilarsetoftaxaunderaselectedsetofPCRconditions.Thus,thestatisticswastaken into the account between the ability to amplify a locus and the rateof divergence of that locus acrossaphylogeneticrangeoftaxa.Additionally,thesequencealignmentmethodologiesare



ISBN:978-81-957858-1-0

available, which can be evaluated for the use of DNA barcodes are purpose of assurance limits to species assignment, use of a part of sequences in database searches, strength of search algorithms of sequence length variation due to insertion/deletion events and the informative nature of these mutations.

DNA barcoding has the distribution of intra and intra- specific variation that is separated by a distance called DNA barcoding gap[5,6]. The Consortiumof Barcode of Life coordinates DNA barcodingdevelopmentandimplementationuniversally.DNAbarcodingisveryessentialforthe molecular identification of already described species [5] and the discovery of newspecies[7]. The DNA barcoding is the combination 3 aspectsMolecularization (use of the variability in molecular markers as a discriminator), Computerization (transposition of the data using informatics support) and Standardization (extending this approach to vast group of organisms). DNA barcoding is to discriminate the species using an automatedsystem, so that unexplored livingorganismscanbenamedasquicklyaspossiblebeforeitgetsextinct.DNAbarcodeproved tobeapromisingtooltoidentifythespeciesacrossallformsoflifeincludinganimals,plantsand microbes in a rapid and reliable manner.

## Barcodingsystems

TheDNABarcodeisastandardized,rapidandinexpensivespeciesidentificationmethod,which can be accessible to non-specialists around the World. The molecular identification system emerged gradually during the 1990‟s with the development of PCR-based methods for species identification. Molecular identification has largely been practical to bacterial species, microbial biodiversity surveys [8,9]and to diagnosethepathogenic strains [10,11,12]. Theuniversal barcode concept for eukaryotes based on a standard molecular approach was initiated in 2003 by the International initiative “Consortium for the Barcode of Life” (CBOL- http://www.barcodeoflife.org). Now,ithasmorethan150membersfrom45countriesincluding museum, zoo, herbaria, botanical garden, University departments as well as private companies and governmental organizations. The DNA barcode is a simple diagnostic tool based on strong taxonomic datathat is collectedin theDNAbarcodereferencelibrary [13]. DNABarcodeof Life DataSystem (BOLD,http://www.boldsystems.org) was initiated in 2004and formally established in2007[14].Thewell-knownsequencelibrarieslikeNCBIandBOLDareaninteractiveinterface, inwhichthesequencescanbedeposited,revisedandtaxonomicallyreassigned.Suchinformation on the distributionofspecies,geneticdiversitywillenhancethespeedandsuccessofpopulation studies.

## Theutility ofDNAbarcoding

DNAbarcodehaveapplicationsinvariousfieldslike,ecology,biomedicine,epidemiology, evolutionary biology, biogeography, conservation biology and in bio-industry. The low cost andrapiditymaketheprocesseasierforenablingautomatedspeciesidentificationespeciallyin



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massivesamplingcampaigns [15].

Molecularbasedidentificationisimportant in:

1. In determining the taxonomic uniqueness (e.g. goods, food andstomach extracts) and will help in preventing illegal trade and exportof vulnerable species (e.g. fishes and trees)
2. Intheidentificationofjuvenilespecimens(e.g.fishlarvae)
3. Morphological characters areunable to differentiate the species (e.g.redalgalspecies), when the species have polymorphic life cycles anddisplaying prominent phenotypic plasticity (e.g. Laminariales)

Advancesin barcoding

**Newinsightsintoecologyandspeciesbiology**

DNA barcoding is an efficient tool in understanding the complex host- parasite and symbiotic interactions [16]. It was also suitable to elucidate the symbiont and parasite transmission pathways from one host generation to thenext, which are studied in beetles (Lecythidaceae)with theirendosymbionts [17]. Moleculardating ofsymbiotic associations can also be detected using barcoding tools [18].

Technicaladvancesin barcoding

DNA barcoding assembles an accurate and a representative reference library, based on DNA extraction, PCR amplification and DNA sequencing. Therefore,the reference library becomesincreasingly useful,enablingthe

rapididentificationoflowtaxonomiclevel taxawithspecificshort-DNA sequences,i.e.mini-barcode[19,20].Ithasbeenshownthatspeciesuniquenesscanbevalidatedfromasmallnumber ofpolymorphicsiteswithinthebarcandSNP-based differentiation [22]. Molecular technologies likebioengineering (e.g.silicon-basedmicroarrays,nylonmembrane-basedmacroarrays,etc.) arebecoming cheaper, integrated into the “second step of DNA barcoding” [23]. The main drawback of molecular based study is inability to isolate the DNA from specimens, which are preserved in formalin. Museum collected animal samples represents a major part of voucher specimen for DNA barcoding studies.

Universalityof thebarcodeof lifedata(BOLD)system

TheBarcodeofLifeDataSystemsmainlyresidesinthesynergicandstandardapproachfor data acquisition and their compilation into BOLD, which is the main objective of the CBOL initiative.ThecurrentformatfordatasubmissiontoBOLDiscomposedof5fieldsforvoucher specimencharacterization,thespecimenidentifier(thecatalogueandcollectioncodes,the



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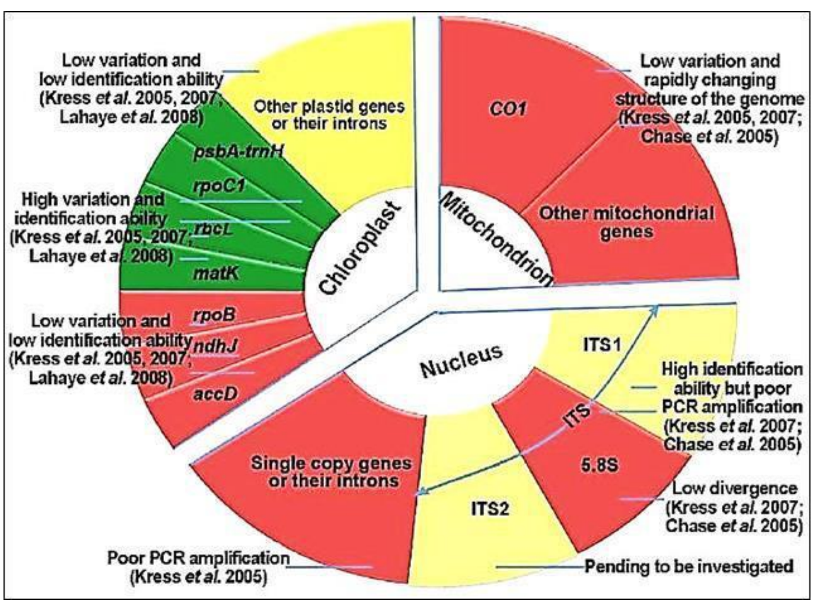
institutionresponsibleforprovidingthespecimensamples);thetaxonomicstatus;thespecimen characteristics (sex, life stage, vegetative/ reproductive tissues); the collected data (collector, collection date and location with GPS coordinates) and DNA barcode sequence (gene nameandlocation,tracefile,alignmentdetails,primersusedtogeneratetheamplicons).Allthe guidelinesare specifiedin the BOLD website (http://www.barcodinglife.com/docs/boldtutorial.html). BOLD will provide aDNA barcode to clearlyidentifytheunknownspecimensbyfacilitatingaccuratequeryassignmentsandto compare the data, which is obtained from geographically dispersed institutions. BOLD could serveastheuniversalstartingpointforspeciesidentification,whichwouldconveytheusersto referthe specialized databases (e.g. pathogenic strains, disease vector species and endangered species).TheCBOLhasalreadyinitiated,thenew International NetworkfortheBarcoding of InvasiveandPestSpecies(INBIPS;www.barcoding.si.edu/INBIPS.htm)thathelpsto coordinate the collection ofbarcode data on pest species around the world [24].

PlantDNA barcoding

Plant DNA barcoding have a huge role in the conservation biologyespecially in assessment of biodiversity hotspots and to monitor the international trade of the rare species apart from the routine identification. Plants have not been given much importance in the early stages of DNA barcodingduetoinabilityofcytochromeoxidase(*COX1*)toworkasabarcode [25]. The lack of consensus region in plants as in the case of *COX1* in animals as a universal barcodeforplantshasnotbeenfoundtillnow.Severalfactorsareconsideredinselectingaplant DNA barcode like universal PCR condition,range of taxonomic diversity, power of species differentiation, dry lab analysisand application. In plants, the mitochondrial genome evolves muchmoreslowlythaninanimals.ThemitochondrialgeneCOXIregionwasunsuitablefor



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plant species distinction [26]. The CBOL plant-working group (PWG) concluded that, plant DNA barcoding should be multi-locus, with one "anchor‟ (i.e. universal across the plant kingdom) and "identifiers" to distinguish closely related species At present, there is no consensus on, whichcandidate markers are the best for plant DNA barcoding. The future combination will certainly contain noncoding intergenic spacers like *trnH- psbA* [27,28,29]and plastidial coding sequences like *mat*K [30]. The feasibility ofbarcoding plants from highly degraded samples (e.g. permafrost samples) andother applied fields (e.g. processed food, customs and medicinal plants)suggested the chloroplast *trn*L (UAA) intron or a shorter fragment of this intron (the P6 loop, 10-143 bp), in spite of relatively low resolution could be improved with highly conserved primers.

**Fig1.1:**Existingbarcodecandidates fortheplantkingdom[31]

ApplicationsofplantDNA barcoding

1. **Identification of different life stages:** To distinguish between seedand seedlings and discovering the changes of metamorphosis

2. **Identification of fragments of plant material:** It is difficult to distinguish morphologically the young leaves, seeds and seed coats of certain species
3. **Forensics:**DNAbarcodingcanbeemployedinforensicanalysis
4. **Verification of herbal medicines/foodstuffs:** DNA barcoding helpsin identifying adulterated products from original components
5. **Biosecurity and trade in the controlled species:** In case of illegal import and export of economically valuable things, DNA barcodingaid as a cue to promote authorized trade
6. **Inventory and ecological surveys:** DNA barcoding can beemployed to assess the taxonomically diversified species both nativeand invaded species

*mat*K(MaturaseK)

The *mat*K gene of chloroplast codes for maturase like protein, which is involved in Group IIintronsplicing.Thegenecontainsapproximately1500 basepairs,which waslocatedwithin theintronofthe*trn*K.Thetwoexonsofthe*trn*Kgenethatflank the*mat*K willbelost,leaving thegeneintactintheeventofsplicing[32].Ahomologysearchspecifies102aminoacidsatthe carboxylterminusthatarestructurallyrelatedtoportionsofmaturase-likepolypeptideandthis mightbeimplicatedinsplicingofGroupIIintrons[33].The*mat*Kgenehasbeenusedeffectively inphylogeneticstudiesforthefamilies,Saxifragaceae[34],polemoniaceae[35],Orchidaceae[36],



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Poaceae [37] and Myrtaceae [38]. Among the available chloroplast genes, *mat*K has got high substitution rates, which makes it as one of the ideal barcode candidates but only to a smaller sub groups.

*rbcl*(RibuloseBisphosphateCarboxylase)

The*rbcL*geneinhigherplantsispresentasasinglecopyperchloroplastgenome,butmany copies of the genome are present in each plastid, hence theactual *rbcL* copy number per chloroplast can be high. It contains only exons, polypeptide with 475 amino acids. Several chloroplast genes, including *rbcL*,the transcriptional [39,40,41,42], identified sequences that resembleasthosefoundinprokaryoticorganismstotheextentthatchloroplast*rbcL*genescan bereadilyTranscriptionalinitiationratesfromthe*rbcL*promoterarenotonlyinfluencedbythe promoter sequence but also modified by the nearby *atpB* promoter. The two promoters are positioned 400 bp apart in opposite orientations, resulting in divergent transcription. They do not function independently, because RNA polymerase binding at the *rbcL* promoter interferes with binding and transcription of the *atpB* promoter, by steric hindrance at the two RNA polymerase binding sites. Removal of a promoter or increasing the space between them eliminates this mutual interference [39,43], which may be a control mechanism to regulate the differentlevelsof expression in chloroplasts. The substitutions between *rbcL* of the parent species are non-synonymous [44]. Even single amino acid replacement in *rbcL*could result in differencesinthe$CO_2$and$O_2$specificityofribulose1,5-bisphosphatecarboxylase/oxygenase (RuBisCO) [45]. The amino acid in *rbcL*plays an important role in ecological adaptation. It provides all the catalyticallyessentialresiduesof RuBisCO,animportant enzymeforboththe reductive and oxidative photosynthetic carbon cycles. The sequence of *rbcL* has great phylogenetic importance because of its conserved nature [45].

***psbA-trnH*(D1ProteinofPhotosystemII)**

Intergenic cp DNA regions contain a wealth of information for inquiries in population geneticsandlow-levelsystematics[46,47].Portionsofthesenon-codingregionswhosefunctions wasunknown,butmuchofthevariationmayresultfromthespreadofmutationsand[48,49]non- coding regions like 3‟UTRsare essential for proper RNA processing [50,51]. In the population genetic studies, intergenic spacer *psbA-trnH* shows that the end spacer nearest to *psbA*was highly conserved and reveals large inversion at the end nearest to *trnH*, which appears to be more variable. The structure of *psbA-trnH* has a small spacer region with the length of about 200-500bpinangiospermsandgymnospermspecies,whichwereamplifiedusingtheuniversal primers [52]. The *psbA- trnH* intergenic region contains 2 parts that differ in their evolutionary conservation,by*psbA*3´UTR,whichisresponsiblefortheregulationofgeneexpression,*psbA- trnH* non-transcribed intergenic spacer has no function but show variability across angiosperms.The*psbA*geneencodestheD1reactioncenterproteinofphotosystemII.Its



ISBN:978-81-957858-1-0

expressiondependsonlightintensity,theplantdevelopmentalstageandphysiologicalstate[53] high levels in chloroplasts, but low levels in amyloplasts [54]. The *trnH-psbA* region show several traits in its short length (often, 500bp), ubiquitous, high intra-specific sequence divergence and universal flanking primers that allow easy amplification and sequencing from both high molecularweightanditalsoeffectiveindegradedDNAwhichmakesitasoneofthe desirable barcode candidate [55,27,56,57]. Within some groups, *trnH-psbA*was not showing variation to differentiate among the closely related species

[58]andinothersintra-specificvariationwas foundtobehigh[59].

### *atpB*(AdenosineTriphosphateβ-Subunit)

The gene *atpB* (adenosine triphosphate β subunit) involve in the synthesisof β subunit of ATP synthase and the size of the gene is estimated to be about1497 bp in spinach [60]. The chloroplast ATPase is composed of five subunit α, β, γ, δ, and ε. The gene *atpB* and *atpE* lie closerto*rbcL*.Itwasdemonstratedthattheprotein canbesynthesizedby *in vitro*translationof chloroplast RNAthat had been selected on the basis of its hybridization to specific fragments ofspinachchloroplastDNAandfromthis,itisevidentthattheαandβsubunitare encoded by chloroplast DNA. The coding regions assigned to the β and ε subunit have 4 nucleotides in common and also the ε subunit translation startcodon overlaps with the β subunit stop codon. The overlapped coding regionsare co-transcribed into a vRNA species. The comparison of β and ε subunit ofspinach chloroplast ATPase with those of *E. coli* showed β subunit to be far morehighly conserved thantheε subunit. Also, it has been established that *atpB*and *rbcL*are transcribed divergently in the chloroplast genome.

### *ITS*(InternalTranscribedSpacer)

The internal transcribed spacer (*ITS*) region belonging to the nuclear genome is a non-functional RNA sequence located between18S and 25S rRNA coding regions. The *ITS*1 is presentbetween18Sand5.8SrRNAand*ITS*2ispresentbetween5.8Sand25SrRNA[61].*ITS*, the transcriptional unit situated between the structural ribosomal RNAs during rRNA maturation, the*ITS* spacers are non-functional maturation products are rapidly degraded. Mutationalstudiesinthe*ITS*regionofyeast(*Saccharomycescerevisiae*)revealedthatdeletions ofcertainregionswithin*ITS*1inhibitedtheproductionofmaturesmallandlargesubunitrRNAs [62,63],whereascertaindeletionsorpointmutationsin*ITS*2preventedorreducedtheprocessing oflarge subunit rRNAs[64].Thelengthof*ITS*1and*ITS*2ofallfloweringplantsvariesandthey range from 300 bp for *ITS*1 (187 to 298) and nearly 250 bp for *ITS*2 (187 to 252). The total lengthof*ITS*regionisaround700bpincludingthe5.8SrRNAregion,whichhasconstantlength of163or164bp [65,66,67].Thelength ofthe*ITS*regionofthenuclearDNA(nrDNA)occursas tandem repeats at multiplechromosomal loci [68,69]. The PCR efficiency of the *ITS* region is high,whencomparedtobarcodecandidatesandhenceitcanbefurthersubjectedtorestriction



ISBN:978-81-957858-1-0

digestion, which generates distinctive diagnosticbands that could effectively differentiate and identify the plants at their species level [70,71] comparisonofchloroplastDNAwiththatofnr DNAprovidedeffectivemeansofidentificationthatcansignificantlyimproveunderstandingof the origin ofpolyploid species [72] For this reason, the study was conducted on the nuclear genome and the following conclusions were made: nr DNA regions must be evolutionarily conservative, phylogenetically interpretable, easily examined in the laboratory with universal primers, potentially useful characters for phylogenetic reconstruction [73].

## Conclusion

PlantDNAbarcodingresearchisthesearchofuniquecandidategeneforidentifyingallthe plant species which included both coding and non-coding regions. Initially two noncoding regions were proposed to be *nrITS* and plastid *psbA-trnH* intergenic spacer. In the 4rth International Barcode of LifeConference,2011,heldinAdelaide,itwasconcludedthat*mat*K, *rbcL* and *ITS* gene as standard universal barcode candidates. Earlier, the quantitative measurementtocomparethebarcodecandidatewasbasedonsimplestatisticscalculation,PCR andsequencedivergence.Indiahasbeenknownforitsmegabiodiversity that includesenormous wealthoftraditionalmedicinalplants.Theplant-basedmedicinesarepreferredoverallopathic medicines, because of their non-toxic nature and less side effects. Identification of the right medicinalplantsatmolecularlevelisessentialinordertoassurethequalityandefficacyofthe herbal medicines.

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ISBN:978-81-957858-1-0

## Plant resources: *In vitro* production, challenges and prospects ofsecondary Metabolites.

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**Abstract**

ThemedicinalplantspeciesfromtheNorthwesternHimalayasarehighlyvaluedandareutilized inthepreparationofpharmaceuticaldrugs.Phytochemicals/bioactivecompoundswiththerapeutic potential have been pro- cured from high-altitude medicinal plant species for use in the manufacturingofdrugsinpharmaceuticalindustries.*Invitro*productionofsecondarymetabolites attributed with various medicinal properties has been known for three decades. However, the contentofmetaboliteswasfoundtobeverylowin*invitro*cultures,limitingtheiruseinmeeting thecurrentindustrialdemands.Informationoncurrent*invitro*metaboliteproductionstrategies, biosynthesisandtheirappli-cationswillopenupnewdoorstodesignnovelgeneticinterventions, including metabolomics, genomics and tissue culture technologies. Knowledge of *in vitro* production, the associated challenges and the prospects of attaining high-value bioactive compounds will provide a platform to not only explore but also gain an understanding of the metabolite biosynthesis to enhance phytochemical yields in various industries.

**Keywords**: Secondary metabolites, Medicinal plants, Biosynthesis, I*n vitro*, Pharma-ecological properties.

### Introduction

Secondarymetabolitesare“naturalproducts”mainlyproducedtoaidinthesurvivalofplants under stress conditions.Secondary metabolites can be dividedinto three groups consistingof 29,000 terpenoids, 12,000 alkaloid derivativesand 8,000 phenolics produced through different biosynthetic routes [1, 2]. Secondary metabolites are used as food additives, drugs, flavors,fragrances, dyes,colors, pesticides, pharmaceuticals, agrochemicals,bio-pesticides and, more recently, as nutraceuticals. It is generally acknowledged that the main problem in enhancingtheproductionofmetabolitestohigherlevelshasbeenthelackofbasicknowledge on the biosynthesis, transport and accumulation of metabolites.. Traditional approaches including labeled precursor addition, gene cloning, intermediate identification, expressed sequencetag(EST)libraries, enzyme purification and characterization have been used for decipheringthebio-syntheticpathwayofnaturalproducts/metabolites.Suchtechniqueshave some limitations like these are very time consuming and difficult to understand the metabolism. Thechemistry behind the biosynthesis of metabolites can be revealedbyvarioustoolslike metabolomics, transcriptomics, proteomics and functional genomics, which can lead to an understandingofsecondarymetabolitebiosyn-thesis.Secondarymetaboliteslike



ISBN:978-81-957858-1-0

podophyllotoxin, vinblastine/vincristine, taxol (paclitaxel), artemisinin, shikonin, quinine, picrosides,hypericum,ajmalicine,serpentineandcampothecinarebeingusedbytheindustriesfor theirlarge-scaleproductionbecauseoftheiranticancer,antimalarial,hepato-protective,anti-HIV, anti-pyretic, antifungal and anti-inflammatory properties [4, 5]. The world market for herbal drugs has an annual growth rate of between 5 and 15%, with a global market of US $62 billion, which is expected to grow to US $5 trillion bytheyear 2050. These metabolites have a high demand in international markets, but their supply is limited because of complexity in *in vitro* synthesis, the high cost of pro- duction and the decreasing availability of rawmaterialsof medicinalplants.Anotherreasonisthattheexactbiosyntheticpathwayofthesemetabolitesisnot known completely or the regulatory steps/genes controlling the metabolite bio- synthesis are not known clearly so as toaimatgeneticinterventionsforen- hanced metabolite yields. The empiricalmethodshavenotbeenabletomeettheincreasingworlddemandforvaluablenatural products/metabolites,including the anticancer agent paclitaxel,which reached 1040 kg per year in2013according to the Global Industry Analysts.

The higher cost of secondary metabolite production and the geographical limitation of medicinal plants have forced researchers to find out alternative methodsor sources for the production of these metabolites. Various research groups across the world have been working toward the enhancementofsecondarymetabolite productionin*in vitro*cultures,withverylimitedsuccess. Therefore,thereexistsanurgentneedtonotonlydecipherbiosyntheticpathwaysbutalsoidentify key points in the biosynthesis, transport and accumulation of metabolites [6, 7]. Despite tremendous efforts, ageneticallystabletransformed medicinal planthas not beenachievedto the best of our knowledge. Metabolic engineering requiresabasic understanding of metabolic networks and their regulation, identification of the accurate regulatory genes/enzymes, subcellular localization of the en- zymes, metabolic channels and transporters involved in the biosynthetic path-ways [8], and dueto lack of appropriate knowledge in the above-mentioned factors,metabolicengineeringoftenresultsinlowyieldsofmetabolitesandundesirableproducts.

Recentstudies have shown that various transporters and channels exist in plantsforthetransport andaccumulationofmetabolites.However,littleunderstandingexistsregardingthegenesinvolved intransportationandaccumulationvis-à-vismetaboliteproductioninvarioustissues,whichcould lead to an increase in the productivity of valuable secondary metabolites. Modern genomic technologies such as whole-genometranscriptomics, proteomics and metabolomics coupled with metabolicnetworkanaly-sisare expected touncover several gaps in the biology of metabolite biosynthesis and accumulation [4, 9, 10]. Currently, high-throughput *de novo* sequencing of the transcriptome of various valuable medicinal plants, such as *Podophyllumhexan- drum, P. peltatum, Picrorhiza kurroa, Artemisia annua, Hypericum perforatum, Catharanthusroseus, Atropa belladonna, Taxus brevifolia, Swertia chirata, Valeriana officinalis, Rauvolfiaserpentine,Digitalislanata,Linumflavum,Daturain-noxia,Acaciaaulacocarpa,Aglaia*



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*foveolata Pannell, Andrographis paniculata, Calophyllum antillanum, Camptotheca acuminata, Castanospermum australe A., Cephalotaxus harringtonii, Cinchona pubescens, Colchicum autumnale,Coleusfor-skohlii,Daturaceratocaula,Daturametel,DaturastramoniumL.,Datura wrightii Regel, Galanthus elwesii, Gloriosa superba, Huperzia lucidula, Huperzia squarrosa, Hyoscyamusniger,Larreatridentata,Linumusitatissimum,Narissuspseudonarcis-sus,Papaver somniferum, Pilocarpus pennatifolius, Pimpinella anisum, Plectranthus caninus, Strophanthus gratus*,*Taxusxmedia*and*Tripterygiumregelii*,provides a platform for rapid gene identification involved in the biosynthesis of a particular metabolite. Combining the transcriptomics, proteomics and metabolomics ap- proaches together can allow a better understanding of metabolite biosynthesisand its regulation [4, 9, 10].

We have, therefore, reviewed the *in-vitro* production, challenges and prospectsof high value secondary metabolites such as podophyllotoxin, with anosides andshikonin procured from high altitude medicinal plant species. Knowledge of these important metabolites will provide a useful resourcetoindustriesandthescientificcommunitytobetterexploreandgainanunderstandingof secondarymetabolitebiosynthesis.*In-vitro* production of secondary metabolites

Differentkindsofsecondarymetabolites,namelyalkaloids,terpenoidsandalka-loids,havebeen produced *in vitro* utilizing cell culture techniques/interventions. Bioactive compounds such as shikonin, podophyllotoxin, withanosides, vincres- tine, taxol, catharanthine, vindoline,ajmalicineandanthocyaninaresomeofthe important examplesof secondary metabolites that have been commercialized [11, 12] (Figure 5.1).

Various*invitro*production strategies have been employed in the past, suchasprecursorfeeding, modification in production media, elicitor's treatments, im- mobilization of cells and scaling up throughbioreactors[3,4, 6,13,14].Afewimportantsecondarymetabolitesproducedin*invitro* conditionsarelistedin Table 5.1.



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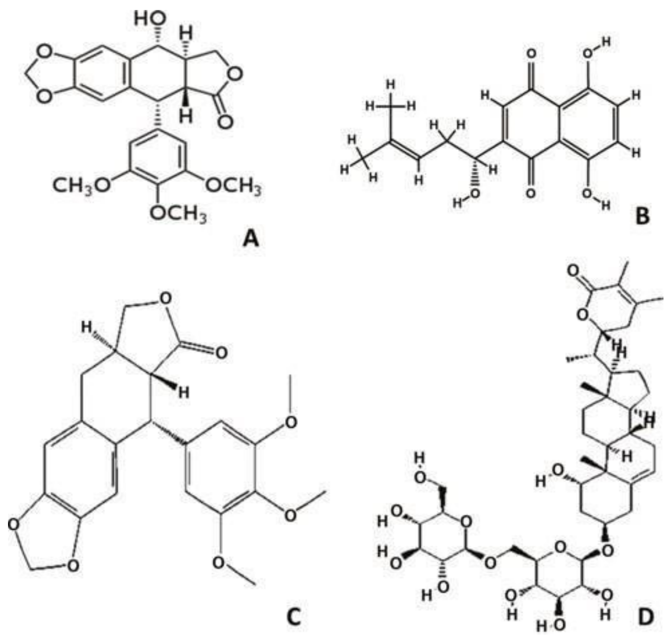


Figure5.1:Structuresofbioactivecompounds:(A)podophyllotoxin,(B)shikonin,

(C)deoxypodophyllotoxin and(D)withanosides.

Table5.1:Secondarymetabolitecontentsobservedindifferentmedicinalplantsandfungusspecies(*in vitro*conditions).

| Plant Family | Medicinal plants | Podophyllotoxincontent (% of dry weight) | Plantparts | References |
|---|---|---|---|---|
| *Berbediaceae* | *Podophyllum hexandrum* | 4.3 | Roots/rhizomes | [3,6] |
| | *P.peltatum* | 0.25 | Shoots,roots/ rhizomes | [6] |
| | *P.versipelle* | 0.32 | Roots/rhizomes | [15] |
| | *Diphylleia grayi* | 1.3 | Roots | [15] |



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| | | | | |
|---|---|---|---|---|
| | *Diphylleia cymosa* | 0.54 | Leaves | [15] |
| *Linaceae* | *Linumalbum* | 0.35 | Callus/suspensi on | [16] |
| | Kotschy ex Boiss | | cultures | |
| | *Linum nodiflorum* | 1.7 | Callus/suspensi on | [17] |
| | | | cultures | |
| | *L.flavum* | 0.2 | Callus/suspensi on | [18] |
| | | | cultures | |
| | *L.flavum* | 0.16 | Roots | [19] |



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Table5.1(continued)

| PlantFamily | Medicinal plants | Podophyllotoxincontent (% of dry weight) | Plantparts | References |
|---|---|---|---|---|
| *Cupressaceae* | *Juniperus chinensis* | 0.0025 | Leaves (needles) | [20] |
| | *J.chinensis* | 0.005 | Callus/suspension cultures | [20] |
| | *J.scopulorum* | 0.17 | Leaves (needles) | [21] |
| | *J.sabina* | 0.20 | Leaves (needles) | [21] |
| | *J.lucayana* | 0.10 | Leaves (needles) | [21] |
| | *J.virginiana* | 0.10 | Leaves (needles) | [21,22] |
| | *J.silicicola* | 0.04 | Leaves (needles) | [21] |
| | *J.thurifera* | 1.3 | Leaves (needles) | [23] |
| | *Callitris drummondii* | 1.4 | Leaves (needles) | [24] |
| *Polygalace* | *Polyga* | 0.08 | Wholeplant | [25] |



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| | | | | |
|---|---|---|---|---|
| *ae* | *la polygama* | | | |
| Fungus species | *Trametes hirsute* | 0.03 | Biomass | [26] |
| | *Fusarium oxysporum* | 0.02 | Biomass | [26] |
| *Boraginaceae* | *Lithospermum erythrorhizon* | 1–2.5µg/mL (shikonin content) | Driedroots, roothairs | [27,28,29] |

Elicitationapproachesfortheenhancementofsecondarymetabolitecontents

Secondarymetaboliteswereisolatedfromtheirnaturalplantresourcesincludingroots, rhizome, shoots, bark and flower because their chemical synthesis is quite complex and costly. The contents of *in vitro* compounds generated from different medicinal plant species are very low. Metabolite contents can be increased through elicitation approachesbyaddingelicitor's*invitro*techniques[30].Themetabolitescontentinthe cellsuspensioncultureof *Ammi majus* L., *Panax ginseng, Rubiaakane*wereelicited with benzo (1,2,3)-thiadiazole-7-carbothionic acidS-methyl ester, selenium and chitosan(0.5mM)[31–33].An*invitro*productionofsolasodinewith sodium chloride (150 mM) in the cell culture of *Solanum nigrum* was carriedout [34]. Similarly, hyoscyamine/scopolamine production was elicited 3–20 timesby the addition of $KNO_3$(35mM)inatissuecultureof*Atropabelladonna*L.[35].Silymarinproduction wasincreasedbymethyljasmonate(10µM)in*Silybummaria-num*tissueculture[36].

## Metabolicengineeringinmedicinalplantspecies

Metabolicengineeringisanalternativewayforoptimizinggeneticandregulatoryprocesses to attain the desired amount of natural products from medicinal plants. Many plant species suchas *Nicotiana tabacum* (tobacco), *Atropa belladonna,Artemisia annua, Catharanthus roseus* (Madagascar periwinkle) and *Digitalis lanata* have been genetically engineered to enhancethe metabolite content [37]. In the past few years, different genetic transformation technologies have been applied for DNA delivery into the hostcells like insertion of genes eitherindirectly,viageneticvec-torssuchas*Agrobacteriumtumefaciens*and*A.rhizogenes,* or directly, suchas through a particle gun, protoplast fusion, electroporation and microinjection,withsuccessfulincreaseinmetaboliteproduction[38].Recently,newtrends arebeingusedinmetabolicengineeringlikeheterologousexpression,metabolicflux



ISBN:978-81-957858-1-0

analysis, RNA interference technologies (RNAi) and overexpression analysis of genes involved in the biosynthetic pathways, which aim to achieve a highly efficient productive complex.One interesting example of genetic engineering has been found in*Catharanthus roseus* in which strictosidine synthase (Str) has been overexpressed to

achievehighermetaboliteproduction[39].Similarly,hyscyamine6β-hydroxylase

has been overexpressed in *Hyoscymus muticus* to increase the production of scopol- amine substantially [40].

## Pharmacologicalapplications

Inthischapter,wehavesummarizedtheimportantpharmacologicalpropertiesofsome bioactive compounds, namely withanosides, shikonin and podophyllotoxin.

### Withanosides

*Withania somnifera* is an important medicinal herb having numerous medicinal properties attributed to the presence of secondary metabolites or bioactive com- pounds.Thisherb, which is commonly known as *ashwagandha*, or Indian ginseng,is distributed in different regions of the Northwestern Himalayas. Different parts (roots and rhizomes) of Withania species have been utilized in the preparation of many drugs in several industries. This herb exhibits various medicinal properties such as anti-inflammatory activity, anti-stress activity, antibiotic activity, antipar-kinsonian properties, antiaging activity and antioxidant effects. The*in vitro* produc- tion ofbioactivecompounds fromthis herbis verylow in tissueculture conditions.TheglobalincreasingdemandsforsecondarymetabolitesfromWithaniaspecies have led the scientific community to find ways to further increase the *in vitro* me- tabolite contents.Anti-inflammatoryactivityBioactivecompoundsof*Withaniasomnifera*possessanti-inflammatoryactivityviain-hibition of 5-hydroxytryptamine, prostaglandins and histamine. Anti-inflammatory activity was particularly shown by Withaferin A, important bioactive compoundspro-curedfrom Withania species. Withaferin A is a primary compound that can inhibit arthritic syndrome with least toxic effects. Many studies have shown the effect of *Withaniasomnifera*in*in-vivo*models,withsignificantresultsofdifferentanti-inflammatory activitiessuchascottonpelletgranuloma,adjuvant-inducedarthritisandcarrageenan-induced inflammation [41].

### Anti-stressproperties

Since a decade, *Withania somnifera* has been known for its anti-stress properties, attributed to the presence of bioactive compounds. This activity of *Withania somni-fera* was demonstrated by Kaur *et al*. [42] in the C-H-R model (cold, hypoxia, re-strain) by applying bioactive constituents (20 mg/Kg bw) isolated from the roots of *Withania somnifera* in rats. Highly significant results were obtained from the de-signedexperimentalmodelastheratsweremoreresistanttostressconditions.



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Numerous studies across the globe have highlighted the importance of *Withania somnifera* in relation to its anti-stress properties.

Antibiotic activity

Besides being of interest to the scientific community because of its pharmaceutical properties, *Withania somnifera* – a high-value medical plant species – also has an important medicinal property, namely its antibiotic activity. Its antibiotic activitywas highlighted by Bisht and Rawat in 2014, where they used Withania leaf extract againstthe*Staphylococcusaureus*and*Enterococcus*species,anditwasfoundthat 2 mg/mL (100 µL) concentration inhibited the growth of microorganisms with an average zone of inhibition of 20.6 mm and 19.4 mm, respectively [43]. Different parts of *Withania somnifera* have been utilized for examining its antibiotic activity. The active constituents of Withaferin A (10 µg/mL) from Withania species suppressed the enzymatic activity of glucose-6-phosphatedehydrogenase in *Bacillus subtilis*. The antibiotic property of Withaferin A is due the presence of a lactone ring inits structure. The antibiotic activity of Withania species was also validated ina rabbit model that showed a higher activity compared to penicillin [44].

Antioxidanteffect

Theantioxidantcapacityofthetherapeuticmetabolite,fistein,hasbeenexploredre-centlyfor itsroleinscavengingfreeradicals,whichcanaltermolecularcomponentssuchasaminoacids, nucleic acids, lipids and carbohydrates. A proper balance be- tween free radicals and antioxidants is needed for proper physiological functioning; an imbalance might cause oxidative stress, which leads to numerous diseases such as mutagenesis, diabetes mellitus, neurodegenerative diseases, retinal degeneration, aging and carcinogenesis. Bioactive compoundsfrom*Withaniasomnifera*werealsotestedforantioxidantpotentialviadetermining the free-radical scavenging enzymes like glutathione peroxidase, catalase and superoxide dismutase[44].Differenttissues/partsofWithaniaspecieshavebeenutilizedforstudyingtheir antioxidant activities through 1,1-diphenyl-2-picrylhydrazyl (DPPH)2,2′-azino-bis(3-ethylbenzothiazoline-6- sulphonic acid) (ABTS) and Ferric Reducing Antioxidant Power (FRAP) methods.

Antiagingactivity

*Withania somnifera* extracts have antiaging-inducing properties. Aging is related to the telomeraseactivityinorganisms,andhencemaintenanceoftelomeraseisessentialtodelay the aging process. Bioactive compounds from *Withania somni- fera* are known for their antiaging potential by increasing the telomerase activity. The telomerase rapid amplification protocol (TRAP) assay is used to determine the antiaging potentialof *Withania somnifera*in thehuman HeLacell lines.A significant increase (45%) was reported in the telomerase activity in HeLa cell lines at 10–50 µg conc. of Withania root extracts [45].



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### Antiparkinsonianproperties

Parkinson's disease is a type of neurodegenerative disorder identified by the se- lective loss of dopamine (DA) neurons. One of the most commonly used animal models for Parkinson's disease is 6-hydroxydopamine (6-OHDA). A huge wealth of evidence is available in the literature supporting the role of 6-OHDA in toxic man- ifestations through oxidant stress. AntiparkinsonianpropertiesofWithaniaex- tract have been widely studied due to the presenceofbioactivecompounds/metabolites.Inaresearchconductedonratsforfiveweeks, Withania extract was orally given for 3 weeks to investigate its antiparkinsonian potential. The neuro- behavior of rats was checked by determining the levels of glutathione reductase, glutathione-S-transferase, catecholaminecontent,superoxidedismutase,etc.on the 21st day. This study highlighted the importance of *Withania somnifera* for its antiparkinsonian properties [46].

### Anticarcinogenicactivity

Withania species have been known to have anticarcinogenic properties attributed to thehigh-value biomolecules withanolides, withaferin and their derivatives. Different types of tissues/partssuchasroots,leavesandbarkhavebeenusedtoexaminetheanticanceractivity of Withania species [47]. Bioactive compounds ofthe medicinal herb *Withania somnifera* are responsible for its anticancer potential as has been revealed in many published reports. Withania extract suppresses the nuclear factor kappa B as well as the necrosis factor in cancer cell lines and hence has been suggested for use in controlling the proliferation of cancer [47]. Different types of cancers, including lung cancer, blood cancer and braincancer,have been treated with the bioactive constituents of Withania species. Many herbal for-mulationshaving anticancerproperties preparedusing Withaniaspeciesareavailable in the market.

### Shikonin

Shikonin,arednapthoquinonepigment,isextractedfrom *Lithospermumerythro-rhizon*. Itis biosynthetically derived from two key precursors, 4-hydroxy benzoate (4HB) and geranyldiphosphate (GPP). It is a secondary metabolite known for its different biological activitiessuchasantimicrobial,insecticidal,antitumorandantioxidants.Thesecompoundsare usually colored pigments and therefore have varied applications in food, textiles and cosmetics. Shikonin and its derivatives are distributed among members of the family Boraginaceae, which are commer- cially valuable for the production of naphthoquinone pigments isolated from roots; they are known to exert wound-healing effects. It includes differentspeciesof*Lithospermum*,*Arnebia*,*Alkanna*,*Anchusa*,*Echium*and*Onosma*Figure 5.2.There are various methods to increase the levels of shikonins in plant cells, suchas selectionofcelllines,optimizationofcultureconditions,elicitation,*insitu*product removal, genetic transformation and metabolic engineering.

### Anti-inflammatoryactivity



ISBN:978-81-957858-1-0

In autoimmune hepatitis disease, several inflammatory cytokines(IL-1$\beta$,TNF-$\alpha$, IFN-$\gamma$ and IL-6)are released, which are the main causes of liver injury [48, 49].Especially cytokine IL-1$\beta$ thatisreleasedbymacrophages playsa significantrole in the necrosis of liver tissues [50]. Shikonin acts as an anti-inflammatory molecule and downregulates the expressionsof theinflammatorycytokinesTNF-$\alpha$,IFN-$\gamma$ and IL-1$\beta$. The levels of serum aminotransferase (AST), alanine aminotransferase (ALT), hepatocyte apoptosis and necrosis of liver tissues significantlyreducedwiththeaccurateshikonindose[51].Shikoninalsosuppressedthec-Jun N-terminal ki- nase (JNK) signaling pathway, which is activated by immune responses, cell stressand inflammatory cytokine. Shikonin could also prevent liver tissues from injuryby inhibiting the expression of interleukinandthephosphorylationofJNK. Shikonin can also be helpful in relieving symptoms of rheumatoid arthritis by sup- pressing the proliferation of synovial fibroblasts andinhibitingcytokineexpres- sion and production [52].

Antitumoractivity

Shikonin and its derivatives were initially observed in *in vitro* cytotoxicity against cancerous cells in 1974 in the United States The anticancer activity of shikonin was closely associated with thepromotionofapoptoticdeath.Several*invitro*and*in vivo* studies have demonstratedthe antitumoractivitiesofshikonin and its deriv- atives toward various types of cancer cells, such as leukemiacells, breastcancer cells,gliomacells,bladdercancercells and lung cancer cells. Shikonin functions asa proteasome inhibitor and topoisomerase-I inhibitor, which helps in cancer treat- ment. In addition, shikonin exerts neuroprotection activity by inhibiting cell apo- ptosis and oxidative stress [53].

Antioxidantactivity

Shikonin can decrease toxicity from living organisms owing to its radical scaveng-ing properties. It can provide protection against neurodegradation and hepatic is- chemia by reducingthereactiveoxygenspecies(ROS)[54].Similarly,toxicityinPC12cellsduetoROS can be gradually reduced with the help of shikonin. However, shikonin could improve the antioxidant activity of ROS by increasing the concentra- tion of specific enzymes such as superoxidedismutase, catalase and glutathione peroxidase [54].

Antimicrobial activity

Shikonin exhibits *in vitro* antibacterial activities againstboth methicillin-sensitive and methicillin-resistant *S. aureus*. Subsequently, shikonin ointment was proved to exhibit an antibacterial effect against *S. aureus* in open wounds in rats [55]. Shikonin has stable fungi-staticeffectsagainstvariousculturesofthegenuscandidaand*Trichosporon*genus.Propionyl shikonin and b-hydroxy isovaleryl shikonin, isolated from the roots of *Lithospermum erythrorhizon*, showed both antifungal (*Cladosporium herbarum*) and antiviral (tobacco mosaicvirus)activities.Itwasobservedthatshiko-ninanddeoxyshikoninhavemuchstronger activities than fluconazole against yeast- like fungi (*Candida kcrusei*, *Saccharomyces cerevisiae* and *C. glabrata*).



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Shikonin,whichisaneffectivenaturalantibiotic,hasthepotentialtosubstan-tiallyreducethe massive use of existing antibiotic doses. However, shikonin may be important for understanding the stochastic mechanism behind the antibacterial activity in natural compounds.

Wound-healingactivity

Shikonin has natural wound-healing activities at the molecular and cellular levelsby controlling the cell trans-differentiation processes and microRNA regulation [56]. Shikonin extracted from the root bark of *Onosma echioides* is found to promote the wound-healing process [57].

*Podophyllumhexandrum*asapotentialsourceofpodophyllotoxin

*Podophyllum hexandrum* Royle (syn. *P. emodi* Wall), which is native to the alpine and subalpineregionsof Himalayancountrieslike India,Nepal,Pakistan,China,Afghanistanand Bhutan(2500–4200mamsl),iscommonlyknownas“bankakriorGiriparpat”intheWestern


Himalayan region (Figure 5.2). *P. hexandrum* Royle hasa high level of podophyllotoxin content(4.3%)comparedtootherpodophyllotoxin-producingmedicinalplantssuchasNorth American *Podophyllum peltatum* (0.25%), *Linum album* (0.35%), *Juniperus chinensis* (0.0025%), *Linum nodiflorum* (1.7%) and *Callitris drummondii* (1.4%). Currently, the roots andrhizomeof*P.hexandrum* Roylearethemainsources ofpodophyllotoxin. Therhizome of *P. hexandrum* is preferred moreover*P.peltatum* becauseitsresin ismore copious andricher inpodophyllotoxin,witha content of about 4.3% dry weight as against 0.25% in *P. peltatum* [4]. Althoughit is possible to chemically synthesize podophyllotoxin, this process has not yet been optimized to be economically feasible. Consequentially, the rhizomes of *P. hexandrum* have been indiscriminately collected to meet the ever-increasing demands for the drugand its derivatives. This over-collection has led to severe habitat destruction, followedby an acute depletion in the population of this herb. The costof production, lack of organized cultivation, long juvenile phase, poor fruit-setting ability, seed dormancy, overexploitation and geographicallimitationof *Podophyllumspecies*,allforcedre-searcherstofindothermethods or sources to address the ever-increasing demands ofpodophyllotoxin in the industries.



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Figure5.2:Medicinalplantspeciesintheirnaturalhabitats:(a)*Podophyllumhexandrum*Royle (Indian/HimalayanMay Apple), (b) *Podophyllum peltatum* (North American May Apple) and

(c)*Arnebiaeuchroma*(Ratanjot).

## Conclusions

Bioactive compounds of immense value have been procured from diverse medicinal plant species across the globe. The demands for high-value metabolites/phyto-chemicals are gradually escalating, but their *in vitro* production isvery low in tissue culture conditions. Genetic engineering is the only way to enhance the *in vitro* metabolitecontentand fulfill theindustrialdemands.Knowledgeofthe *in vitro* pro-duction, challenges and prospects of these bioactive compounds could prove useful in developing a new way to explore high-value medicinal plant species. Comprehensive information of metabolites/phytochemicals will be very helpful to the scientific community for further research in this field.

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ISBN:978-81-957858-1-0

## StudytheUseofRice HuskAshintheConcrete

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**Abstract**

The rice husk is an agricultural waste which is obtained by milling process of paddy and approximately 22% of the weight of thepaddy is rice husk. The waste is used as a fuel in the producingstreamintheparboilingprocess.The25%oftheweightofhuskisconvertedintothe ashwhichisknownasricehuskash(RHA)andisawastewhichisdisposed.Thisashconsists of amorphous silica contents which can be used as pozzolana in making concrete and cement insteadofdisposingitwithoutcompromisingonthepropertiesofcementorconcreteifreplacedinthe specificproportionwiththeotherconstituentsofcementorconcrete.Inthisstudytheordinary Portland cement is replaced in different proportion with the RHA to obtain concrete with comparable and satisfactory strength and properties to that of normal concrete. Theproportionsofreplacementchosenisat2.5%intervalstartingfrom5%to15%andthencastedconc retewereteestedundercompressionatdifferent ages andresultsobtained arecompared withthe normal concrete of same grade and it is concluded that there sults are comparable.

**Keywords**: Rice Husk Ash, Cement, Concrete, Compressive strength, Split tensile strength, RHA.

### Introduction

The rice husk is produced in rice mill in the milling process of paddy and after the burning process of rice husk in boiler the RHA is obtained. The paddy grain is surrounded by the by productknownashusk.Inthemillingprocessofpaddyapproximate78%ofweightisreceived asriceand22%ofweightisreceivedashusk.Thehuskisuseasfuelintheparboilingprocess forproducesteam.Inthefiringprocessofricehusk,thishuskhasapproximately75%organic volatile substance and remaining 25%weightof husk is transformed into ash and this ash is known as rice husk ash(RHA). The RHA contains about 80-90% amorphous silica. In every 1000kgofpaddy,approximate22%(220kg)ofhuskisproduced,andaround78%(780kg)of rice is produce. In the milling process when this husk is burnt in the boiler approximate 25% (55 kg) of rice husk ash is production. India is a major rice producing country, and the husk generatedduringmillingismostlyusedasafuelintheboilerforprocessingpaddy,producing



ISBN:978-81-957858-1-0

energy through direct combustion and / or by gasification. About 20 million tons of RHA is producedannually.ThisRHAisagreatenvironmentthreatcausingdamagetothelandandthe surroundingeainwhichitisdumped.Lotsofwaysarebeingthoughtoffordisposingitbymakingcom mercialuseofthisRHA.Inthepresentinvestigation, Portland cement was replaced by rice husk ash at various percentages to study compressive and flexural strength [4,5].

**Materialsused**

**Cement**

Cement used in the experimental work is ordinary Portland cement of 53GradeconformingtoIS:12269-2013 of specific gravity 3.15[6].Thephysicalpropertiesofthecementobtainedonconductingappropriatetestsandtherequir ementsas perIS: 12269-2013isgiveninTable 1.

RiceHusk Ash

RiceHuskAshusedinthepresentexperimentalstudywasobtainedfromKRBLricemill Ghaziabad, U.P. Specifications and Physical Properties andofthisRHAaregiveninTable2.

*Table1:PhysicalpropertiesofprocuredOPC*

| Particulars | Test Results | Requirements ofIS: 1489-1991 |
|---|---|---|
| SpecificGravity | 3.15 | 3.00-3.25 |
| Fineness($m^2$/kg) | 369 | 300 |
| NormalConsistency | 32% | 24-32% |
| SettingTime(Minutes): | | |
| Initial | 220 | 30 |
| Final | 320 | 600 |

**Table2:PhysicalpropertiesofprocuredRice HuskAsh**

| **Physical State** | **Solid–Non-Hazardous** |
|---|---|



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| | |
|---|---|
| Appearance | Veryfine powder |
| ParticleSize | 25microns–mean |
| Color | Grey |
| Odour | Odourless |
| SpecificGravity | 2.3 |

Aggregates

FineAggregate

Fineaggregatewaspurchasedwhichsatisfiedtherequiredpropertiesoffineaggregaterequired for experimental work and the sand conforms to zone III as per the specifications of IS 383:1970.

(i)Specificgravity=2.62

(ii)Finenessmodulus=2.58 Coarse

Aggregate

Crushedgraniteof20mmmaximumsizehasbeenusedascoarseaggregate.Thesieveanalysisof combined aggregates confirms to the specifications of IS383:1970 for graded aggregates:

a)Specificgravity=2.64

b)FinenessModulus=6.816 Super

Plasticizers

Super plasticizers are usually highly distinctive in their nature, and theymake possible the production of concrete which, in its fresh or hardened state, is substantially different from concrete made using water-reducingadmixtures [7].

ConplastSP430G8isthenameofthesuperplasticizingadmixturemanufactured by “FOSCROC Chemicals” used in this project. The main objectives of using this super plasticizer are to produce high workability concrete requiring little or no vibration during placing[8].

ComplastSP430A2isbasedonSulphonatedNaphthalenePolymersandissuppliedasabrownliquidinstantlydispersible inwater.ConplastSP430A2hasbeenspeciallyformulatedtogivehighwaterreductionupto25% without loss of workability or to produce high quality concrete of reduced permeability. The parameters considered for experiments were:

(i) Specificgravity:1.265–1.280at270 C

(ii) Chloridecontent:Lessthan0.05%

(iii) Airentrainment:Lessthan1%overcontrol

Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps toformthestrengthgivingcementgel,thequantityandqualityofwaterisrequiredtobelookedintoverycarefully.Mixing water should not contain undesirableorganicsubstancesorinorganicconstituentsinexcessiveproportion.Some specification alsoacceptwaterformakingconcreteifthepHvalueofwaterliesbetween6and8andthewaterisfreefromorganicmatter. Carbonates and bi-carbonates of sodium and potassium effect the



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settingtimeofcement.Whilesodiumcarbonatemaycausequicksettingtime, the bi-carbonatesmayeitheraccelerateorretardthesetting.Theotherhigherconcentration of these salts will materially reduce the concrete strength[9]. In this study clean potable water was obtained from Department of Civil Engineering, Vidya college of Engineering, Meerut for mixing and curing of concrete.

BURNINGPROCESSOFRICEHUSK

The rice husk is burn into ferrocement furnace or sometimes in boilers to produce RHA at controlled temperature. In furnace air ducts are provide which play two roles, one is supply air to husk in combustion process and other is act as passages for fire. Air ducts are controlling commotion temperature. Electric fans are attached to air ducts which control thecombustiontemperature.Airductsalsoreducethecarboncontentin RHA,iftherearenoairductsthecarboncontentwillbe moreinashandthestrengthofconcretewillbelow.IntheburningprocessofRHAthetemperatureofboilerorfurnaceisaround 500-800°Cfor24hours.Afterthe24hoursthetemperatureisabout52°C.Afterthe48hoursthetemperatureofashisabout25°C. At 500-800°C temperature the silica is remain in amorphous state.

MixingConcrete

Theconcreteshallbemixedbyhandorpreferablyinalaboratorybatch mixer,insuchamannerastoavoidlossofwater or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moulding the desired number of test specimens.

Hand Mixing

The concrete batch shall be mixed on a water-tight, non-absorbent platform with a shovel, trowel or similar suitable implement, using the following procedure.

The cement and fine aggregate shall be mixed dry until the mixture is thoroughly blended and is uniform in color. The coarseaggregateshallthenbeaddedandmixedwiththecementandfineaggregateuntilthecoarseaggregateisuniformly distributed throughout the batch, and the water shall thenbeadded, and the entirebatch mixed until the concrete appears to be homogenous and has the desired consistency. If repeated mixing is necessary, because of the addition of water in increments while adjusting the consistency, thebatch shallbe discarded, and a fresh batch made withoutinterrupting the mixing to make trial consistency test.

MIXDESIGN

A trial mix has been designed for an assumed compaction factor of 0.80 as per IS10262-1982 for M40 grade.Thetrialmixisobtainedas1:0.865:2.59 for water cement ratio of 0.40. The proportions for differentingredientsofthemixwithoutRHAareshowninTable3whileingredientsof the mix with RHA (in different proportions) and super plastisizer(SP)are shown in Table4.

**Table3:MixproportionswithoutRHA**

| Grade of concrete | Water(Kg) | Cement(Kg) | Fine aggregate(Kg) | Coarse aggregate(Kg) |
|---|---|---|---|---|
| Inm$^3$ | 1.53 | 382.5 | 482.46 | 1394.06 |
| M-40 | 0.40 | 1 | 1.261 | 3.64 |

**Table4:MixproportionsofRiceHuskConcrete**

| Amount of Ricehusk(in%) | Cement(Kg/m$^3$) | RHA(Kg/m$^3$) | Water(Kg/m$^3$) | Fine aggregate (Kg/m$^3$) | Coarse aggregate(Kg/m$^3$) | SP (1%of cementweight) |
|---|---|---|---|---|---|---|



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| | | | | | | |
|---|---|---|---|---|---|---|
| 0%RHA | 382.5 | 0 | 153 | 482.46 | 1394.06 | 3.82 |
| 5%RHA | 363.37 | 19.13 | 153 | 482.46 | 1394.06 | 3.63 |
| 7.5%RHA | 353.81 | 28.68 | 153 | 482.46 | 1394.06 | 3.53 |
| 10%RHA | 344.25 | 38.25 | 153 | 482.46 | 1394.06 | 3.44 |
| 12.5%RHA | 334.68 | 47.81 | 153 | 482.46 | 1394.06 | 3.34 |
| 15%RHA | 325.13 | 57.37 | 153 | 482.46 | 1394.06 | 3.25 |

RESULTSANDDISCUSSION

The cube compressive strength of M-40 mix results at the various agessuchas7and28daysandatthereplacementlevelssuchas0%,5%,7.5%,10%,12.5%and15%ofricehuskasharepresented in Table5.The variationsof compressive strength at7 and28 dayswith differentpercentage ofRHA were plotted inthe form of graphs as shown in Table 6. The Split tensile strength resultsat the various ages such as 7and 28 day sand at the replacement level such as 0%, 5%, 7.5%, 10%, 12.5% and 15% of rice husk ash are presented in Table 7. The variations of split tensile strength at 7 and 28 days with different percentage of RHA were plottedintheformofgraphsasshowninTable8.

*Table5:CompressivestrengthofM-40mix*

| RiceHuskAsh(in%) | 7days(Mpa) | 28days(Mpa) |
|---|---|---|
| 0 | 27.8 | 41.70 |
| 5 | 26.6 | 39.90 |
| 7.5 | 28.3 | 42.45 |
| 10 | 27.3 | 40.95 |
| 12.5 | 26.2 | 39.30 |
| 15 | 25.9 | 38.85 |

| **Rice Husk Ash(in%)** | **7days (Mpa)** | **28days (Mpa)** |
|---|---|---|
| 0 | 2.1 | 3.1 |
| 5 | 1.8 | 2.9 |
| 7.5 | 2.2 | 3.2 |



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| | | |
|---|---|---|
| 10 | 1.9 | 2.8 |
| 12.5 | 1.6 | 2.7 |
| 15 | 1.5 | 2.6 |

**Table6: Split tensile strength of**

**cylinderCOSTANALYSISFOR1m$^3$OFCONC**

**RETE**

The price for 1m$^3$concrete without RHA is INR 5555.07 and for 1 m$^3$concrete with RHA is INR 5309.67 hence total savingin1m$^3$concreteisINR245.4(4.417%).ThepricedistributionfordifferentingredientsofM-40mixwithoutRHA is shown below in Table 7 and that for with RHA is given in Table 8.

**Table7:(pricedetailsofM-40mixfor1m$^3$concretewithoutRHA)**

| Ingredients | Cement | Fineagg regate | Coarsea ggregate | SP(1%of cemen tweigh | TotalPrice |
|---|---|---|---|---|---|
| Quantit y(inK | 382.5 | 482.46 | 1394.06 | 3.8 2 | INR55 55.07 |
| Price (inIN | 3213 | 562.87 | 1626.40 | 152.8 | |

*Table8:(pricedetailsofM-40mixfor1m$^3$concretewithRHA*

| Ingredi ents | RHA(7. 5%) | C e | Fin eag | Co ars | SP (1.05% of | TotalPr ice |
|---|---|---|---|---|---|---|
| Quantity | 28.69 | 353. 81 | 482. 46 | 1394. 06 | 3.71 | I N |
| Price(in INR) | 0 | 2 9 | 562. 87 | 1626. 40 | 1 4 8 | |



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CONCLUSIONS

The addition of RHA had a significant effect on the compressive strength of concrete. Compressive strength of concrete increases with the addition of RHA up to a certain level, after which it decreases. Optimum cement replacement level (by RHA) is 7.5%, for which the compressive strength and split tensile strength is maximum. In this study the replacement of cementbyricehusk(RHA)about7.5%,theoverallcostoftheworkisdecreasedby4.417%for1m$^3$ofM-40concretemix. It would be the great opportunity to make the concrete at low price and hence the reduction of cost of construction.

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ISBN:978-81-957858-1-0

# InOrdertoPrepareforRainwater Collection

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**Abstract**

Tocollectandstorerainwaterforlateruse,beforeitseepsintothegroundandbecomesunusable, is known as rainwater harvesting. Water for human consumption, livestock, and crop irrigation have all been drawn from this source. Rainwater collected from homes, tents, and community buildingscanbeusedtosupplementthewatersupply.Stormwaterharvestingreferstotheprocess of collecting water from the ground, usually in regions that have been specifically designed for thisfunction.Rdrinkingwaterrainfallmaybetheonlyavailableorcost-effectivewatersupplyin somelocations.Mostplaceswherepeoplelivecouldbenefitfrominstallingarainwaterharvesting system because they are cheap, easy to build, and available in most places.

**Keywords**:Rainwater,Collection,Aquifer,Treatment, Drinkingwater

## Introduction

Rainwater collected from rooftops often has a high quality and often does not need to be treated before being consumed. Even though some roofing materials can cause rainwater to contain contaminantsthatarehazardoustohumanhealth,rainwatercanstillbeputtobeneficialusessuch as flushing toilets, washing clothes, watering the garden, and washing cars; these four activities alone can reduce the amount of water that is required to maintain a typical household by half. Rainfallcatchmentsystemsforhomesareaviableoptioninregionsthatreceiveanannualrainfall totalling more than 200 millimetres (7.9 inches) on average but have no other readily available water resources (Skinner and Cotton, 1992). In a process known as groundwater recharge, overflowfromrainwaterharvestingtanksystemscanbeutilisedtorefillaquifers.Althoughthisis a similar operation, it is important to note that rainwater harvesting should not be mistaken with groundwater recharge.

## Basicconfiguration

Rainwaterharvestingsystemschannelrainwaterthatfallsontoaroofintostorageviaasystemof guttersandpipes.Thefirstflushofrainwaterafteradryseasonshouldbeallowedtoruntowaste asitwillbecontaminatedwithdust,birddroppingsetc.Roofguttersshouldhavesufficientincline toavoidstandingwater.Theymustbestrongenough,andlargeenoughtocarrypeakflows.



ISBN:978-81-957858-1-0

Storage tanks should be covered to prevent mosquito breeding and to reduce evaporation losses, contamination and algal growth. Rainwater harvesting systems require regular maintenance and cleaning to keep the system hygienic. Around the world Currently in China and Brazil, rooftop rainwater harvesting is being practiced for providing drinking water, domestic water, water for livestock,waterforsmallirrigationandawaytoreplenishgroundwaterlevels.Gansuprovincein China and semi-arid north east Brazil have the largest rooftop rainwater harvesting projects ongoing.InRajasthan,Indiarainwaterharvestinghastraditionallybeenpracticedbythepeopleof theTharDesert.InBermuda,thelawrequiresallnewconstructiontoincluderainwaterharvesting adequate for the residents. The U.S. Virgin Islands have a similar law. In the Indus Valley Civilization,ElephantaCavesandKanheriCavesinMumbairainwaterharvestingalonehasbeen usedtosupplyintheirwaterrequirements.InSenegalandGuinea-Bissau, thehousesofthe Diola -people are frequently equipped with homebrew rainwater harvesters made from local, organic materials. In the United Kingdom water butts are often found in domestic gardens to collect rainwater which is then used to water the garden. However, the British government's Code for Sustainable Homes encourages fitting large underground tanks to new-build homes to collect rainwaterforflushingtoilets,washingclothes,wateringthegardenandwashingcars.Thisreduces by 50% the amount ofmains water used by the home. In the Myanmar, the groundwater is saline andcommunitiesrelyonmud-linedrainwaterpondstomeettheirdrinkingwaterneedsthroughout the dry season. Some of these ponds are centuries old and are treated with great reverence and respect.

Until 2009 in Colorado, water rights laws almost completely restricted rainwater harvesting; a property owner who captured rainwater was deemed to be stealing it from those who have rights to take water from the watershed. Now, residential well owners that meet certain criteria may obtainapermittoinstallarooftopprecipitationcollectionsystem.Upto10largescalepilotstudies mayalsobepermitted).ThemainfactorinpersuadingtheColoradoLegislaturetochangethelaw was a 2007 study that found that in an average year, 97% of the precipitation that fell in Douglas County, in the southern suburbs of Denver, never reached a stream-it was used by plants or evaporated on the ground. In Colorado you cannot even drill water well unless you have at least 35 acres. In New Mexico, rainwater catchment is mandatory for new dwellings in Santa Fe.In Australia rainwater harvesting is typically used to supplement the reticulated mains supply.

**NEEDFORWATERHARVESTING**

Waterisanimportantnaturalresourceandistheverybasisofourlife.Weusewaterfordrinking,irrigation,industry, transport and for the production of hydro-electricity. Water is a cyclic resource which can be used again and again after cleaning. Thebest way to conservewater isitsjudicious use. Rain water harvestingisone ofthe most effective methodsofwatermanagementandwaterconservation.Itisthetermusedtoindicatethecollectionandstorageofrain water used for human, animals and plant needs. It involves collection and storage of rain water at surface or in sub-surfaceaquifer,beforeitislostassurfacerunoff.Theaugmentedresourcecanbeharvestedinthetimeofneed. The collectedwateris storedandpumpedinaseparatepipedistribution.This is averyuseful methodfora developing



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country like India in reducing the cost and the demand of treated water and also economising the treatment plants operation, maintenance and distribution costs.

The scarcity of water is a well-known fact. In spite of higher average annual rainfall in India (1,170 mm, 46 inches) as compared to the global average (800 mm, 32 inches) it does not have sufficient water. Most of the rain falling on the surface tends to flow away rapidly, leaving very little for the recharge of groundwater. As a result, most parts of Indiaexperiencelackofwaterevenfordomesticuses. Surfacewatersourcesfailtomeettherisingdemandsofwater supplyinurbanareas;groundwaterreservesarebeingtappedandover-exploitedresultingintodeclineingroundwater levels and deterioration of groundwater quality. This precarious situation needs to be rectified by immediately recharging the depleted aquifers. Hence, the need for implementation of measures to ensure that rain falling over a regionistappedasfullyaspossiblethroughwaterharvesting,eitherbyrechargingitintothegroundwateraquifersor storing it for direct use.

## SCIENCEOFWATERHARVESTING

In scientific terms, water harvesting refers to collection and storage of rainwater and also other activities aimed at harvestingsurfaceandgroundwater,preventionoflossesthroughevaporationandseepageandallotherhydrological studiesandengineeringinventions,aimedatconservationandefficientutilizationofthelimitedwaterendowmentof physiographic unit such as a watershed. Rain is a primary source of water for all of us.

Therearetwomaintechniquesofrainwaterharvesting:

- Rechargetogroundwater.
- Directlycollectedrainwatercanbestoredfordirectuseorcanberechargedintothegroundwater.

All the secondary sources of water like rivers, lakes and groundwater are entirely dependent on rain as a primary source.

The term water harvesting isunderstood to encompassa wide range of concerns, includingrainwater collection with both rooftop and surface runoff catchment, rainwater storage in small tanks and large-scale artificial reservoirs, groundwater recharge, and also protection of water sources against pollution. The objective of water harvesting in India differs between urban and rural areas. In urban areas, emphasis is put on increasing groundwater recharge and managing storm water. On the other hand, in rural areas securing water is more crucial. There the aim is to provide water for drinking and farming, especially for life-saving irrigation, and to increase groundwater recharge.

### MethodsofRainwaterHarvesting

Broadlytherearetwowaysofharvestingrainwater

1. Surfacerunoffharvesting
2. Rooftoprainwaterharvesting

Rainwater harvesting is the collection and storage of rainwater for reuse on-site, rather than allowing it to run off. These stored waters are used for various purposes such as gardening, irrigation etc. Various methods of rainwater harvesting are described in this section.

### 1. Surfacerunoffharvesting

Inurbanarearainwaterflowsawayassurfacerunoff.Thisrunoffcouldbecaughtandusedforrechargingaquifersby adopting appropriate methods.



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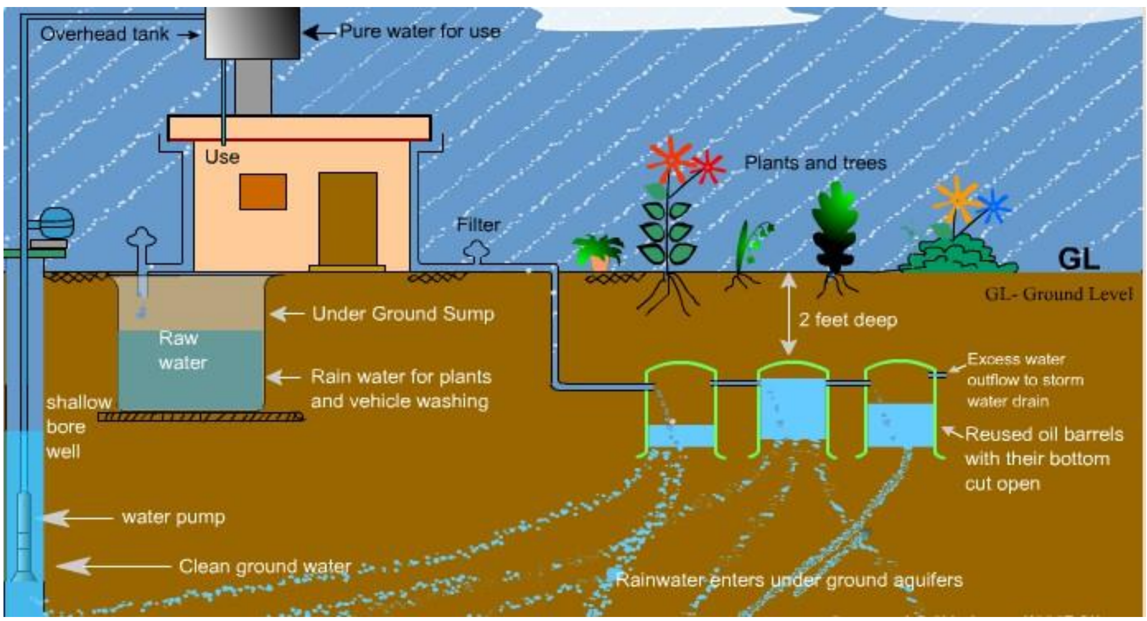
**2. Rooftoprainwaterharvesting**

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system. This method is less expensive and very effective and if implemented properly helps in augmenting the groundwater level of the area.

ROOFTOP/RUNOFFRAINWATERHARVESTINGFORARTIFICIALRECHARGETOGROUNDWATER

Water harvesting isthe deliberate collection and storage of rainwater that runs offon natural or manmadecatchment areas.Catchmentincludesrooftops,compounds,rockysurfaceorhillslopesorartificiallypreparedimpervious/semi-pervious land surface. The amount of water harvested depends on the frequency and intensity of rainfall, catchment characteristics,waterdemandsandhowmuchrunoffoccursandhowquicklyorhoweasyitisforthewatertoinfiltrate throughthesubsoilandpercolatedowntorechargetheaquifers.Moreover,inurbanareas,adequatespaceforsurface storage is not available, water levels are deep enough to accommodate additional rainwater to recharge the aquifers, rooftopandrunoffrainwaterharvestingisidealsolutiontosolvethewatersupplyproblems.




**POTENTIALAREAS**

- Wheregroundwaterlevelsaredecliningonregularbasis.
- Wheresubstantialamountofaquiferhasbeende-saturated.
- Whereavailabilityofgroundwaterisinadequateinleanmonths.
- Whereduetorapidurbanization,infiltrationofrainwaterintosubsoilhasdecreaseddrasticallyand recharging of ground water has diminished.



ISBN:978-81-957858-1-0

ADVANTAGESOFRAINWATERHARVESTING

- To meet the ever increasing demand for water. Water harvesting to recharge the groundwater enhances the availability of groundwater at specific place and time and thus assures a continuous and reliable access to groundwater.
- Toreducetherunoffwhichchokesstormdrainsandtoavoidfloodingofroads.
- Toreducegroundwaterpollutionandtoimprovethequalityofgroundwaterthroughdilutionwhenrecharged to groundwater thereby providing high quality water, soft and low in minerals.
- Providesself-sufficiencytoyourwatersupplyandtosupplementdomesticwaterrequirementduringsummer and drought conditions.
- It reduces the rate of power consumption for pumping of groundwater. For every 1 m rise in water level,there is a saving of 0.4 KWH of electricity.
- Reducessoilerosioninurbanareas
- Therooftoprainwaterharvestingislessexpensive,easytoconstruct,operateandmaintain.
- Insalineorcoastalareas,rainwaterprovidesgood quality waterandwhenrechargedtoground water,it reduces salinity and helps in maintaining balance between the fresh-saline water interfaces
- In Islands,duetolimited extentoffreshwater aquifers,rainwater harvestingisthemostpreferredsourceof water for domestic use.
- Indesert,whererainfallislow,rainwaterharvestinghasbeenprovidingrelieftopeople.

**CONCLUSION**

The method of water collection helps farmers raise their income, and it is becoming increasingly widespread. The system is fragile, and in really dry years, it is not possible to prevent crop failure without aid from outside sources. Foramorecomprehensiveunderstandingofthegroundwatersystem'sresiliency,hydrologicalstudyisrequired.The localcommunityhasastrongfamiliaritywiththetechnology,buttheyoungergenerationswillneedtobeeducatedin order for them to understand the context of the situation more broadly. Rainwater collecting is an option worth considering as a supplementary source of water for human activities that do not include consumption, such as irrigation.Whenusedasasupplementtomunicipalwatersupply,rainwaterharvestingsystem's overalleffectiveness improvesinproportiontotheareaitcovers.Thetechnologywouldbeparticularlyusefulinheavilycommercialareas thathaveanumberoflargebuildingsandstoragefacilities.Theselocationsalsohaveasmalleramountoflawnspace, which allows for the water to be used for purposes other than irrigation.

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ISBN:978-81-957858-1-0

# ToInvestigatetheFunctionandImplementationofHigh-QualityCement

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**Abstract**

The building industry is a source of national pride. A nation's level of development can be measured by looking at its consumption of cement and steel on a per-capita basis. These are the two primary components of any building. It is difficult to conceive of a world devoid of concrete and of the primary ingredient in its production, Ordinary Portland cement (OPC). Although there are numerous varieties of concrete that have been designed specifically for use in a variety of contexts,thesematerialsshareanumberofdesirablequalities,includingaffordability,familiarity, versatility,strength,anddurabilityaswellaswideavailability,resistancetofire,andresistanceto the effects of the elements. The cement business is expanding at a breakneck speed all over the world,includinginIndia.Eventhoughtherearemanynewbrandsonthemarket,pickingaquality cement is one of the most crucial things for an engineer to do. The poor quality of the cement contributes to the failure of many construction projects. In this paper, you will learn about the various elements that influence the choosing of cement as well as the classification of cement strength. Moreover, the quality control of cement and the essential requirement for quality uniformityincement.Becauseofthis,thesuccessoftheprojectcanbeensuredtosomedegreeby selecting cement of the appropriate quality.

## Introduction

Indiaisthesecondlargestproducerofcementintheworld.Eversinceitwasderegulatedin1982, the Indian cement industry has attracted huge investments, both from Indian as well as foreign investors. In India the cement industry underwent a number changes and reforms mainly to suit the government policies and the economics of the manufacture. The annual cement production from nearly 5 million tonnes in 1952 shot up to over 54 million tonnes in 1993. The strict government control for years and rising costs of production of poor quality of cement thereby resulting in poor quality of concrete structures.

CementdemandinIndiaisexpectedtoincreaseduetogovernment’spushforlargeinfrastructure projects,leadingto45milliontonnes(MT)ofcementneededinthenextthreetofouryears.India’s cement demand is expected to reach 550-600 Million Tonnes Per Annum (MTPA) by 2025. The housingsectoristhebiggestdemanddriverofcement,accountingforabout67percentofthetotal consumptioninIndia.Theothermajorconsumers ofcementincludeinfrastructureat13percent, commercialconstructionat11percentandindustrialconstructionat9percent.Thepartial



ISBN:978-81-957858-1-0

relaxation of Government control from March 1982 and a total relaxation of control after March 1989 revived the cement industry and resulted in its phenomenal growth. This resulted in a competitive market and cement manufactures had to improve their quality of cement, as it was now a battle for survival of the best.

Afterlate80scementmanufacturerstookahugestepmodernizingtheiroldplants,whichwerein various stages of obsolescence. The wet process plants were converted to more economical and dry efficient process or semi-dry process plants. This leads to the production of high quality cement.Severalleadingorganizationsdiversifiedintocementmanufactureandtherebycreatedthe much desired consumer oriented market with the range of brands available at competitive prices. The33-grade ordinaryPortland cement (IS: 269-1989)has virtually disappeared and is displaced byhigherstrengthordinaryPortlandcementof43-grade(IS:8112-1989)and53-grade(IS:12269-1987).

**CHOOSINGASUPERIOR CEMENT**

since there are various options available in market the consumer has a good option to select the productrequired.However,thisprocessdependsonthemainfactoroffinance.Withthefinancial constraints, the other factor to be considered is the specifications. It must be understood by the consumerthat anygood qualityproductisgenerallyavailableatahigherpricethananotsogood qualityproduct.Itisthereforenecessaryfortheconsumertoknowmoreaboutthebenefitshegets when he selects a high quality cement and how best he can put to use such benefits considering both technical as well as the economical aspects.

A high strength cement although preferable to a lower strength cement may not give a consumer the complete benefit until and unless it is giving consistently high strength with minimum variations. The high strength concrete if specified for any structure will also be more desirable fromadurabilitypointofview. Itisoftenobservedthatlowstrengthconcrete ismorevulnerable to environmental forces than high strength concrete but at the same time, high strength concrete tooneedstobeextremelycarefullybatched,mixed,transported,andplaced,compactedandcured. The durability requirements of the structure are as important, if not more, as the strength of the structure. A strong concrete may not result in high performance concrete if the durability requirements are not complied with. Selection of high quality cement can only mean a good beginning but it does not assure the consumer of a final product, which is the strong and durable concretestructure.However,selectionofpoorqualitycementorcementofinconsistentqualityis liketaking awrong stepright at thebeginning and will certainly lead to thepoorquality concrete structure if not a disaster.

**CEMENTSTRENGTH CLASSIFICATION**

The most common type of cement used in India is ordinary Portland cement (OPC) and has generallygradesviz.33,43,45gradedependinguponthe28dayscompressivestrength.IS:



ISBN:978-81-957858-1-0

10262-1982givesustherecommendedguidelinesforconcretemixdesign,hasgenerallyclassified the cement grade wise from A to F, depending upon 28 days strength as follow:

**Table1:Classificationof CementgradesAtoFasperIS: 10262-1982**

| Grade | Range of 28 days strength of cement (kg/cm$^2$) |
|---|---|
| A | 325-375 |
| B | 375-425 |
| C | 425-475 |
| D | 475-525 |
| E | 525-575 |
| F | 575-625 |
| *G | 625-675 |

*Has been introduced in view of higher grade cement available in India However, it may noted that some brands sold as 53-grade cement generally give 28 days' strength of around 625 to 675 kg/Sq.cm and they can be classified even as G grade cement. However, most of the 53-grade cement available in the market generally falls in the category F or above and the 43 grade cement available in the market is generally in the category D. It must be ascertained either from the manufacturer or through laboratory tests the actual strengthofthecementbeforeitsuseintheconcretemixdesigntogetthemaximumbenefitoftheadditional strength and superior quality.

**CEMENT SAVING DUE TO HIGH STRENGTH**

The relation between the free water-cement ratio (W/C) and concrete strength for different cement strengths (grades A to F) is giveninfig.2page8ofIS:10262-1982.ThisfigureisusedtodeterminetheW/Cofthe concretemixforspecifiedtargetconcrete strengthifthecementgradeisknown.Thetargetconcretestrength(fm)iscalculatedusingthefollowingequationfm=fck+(t*s) where'fck'isthespecifiedcharacteristicstrength,'t'isthestatisticalconstantgenerallyequalto1.65forthespecifiedaccepted proportionoflowresultsof1in20(seetable2)and's'isthestandarddeviation,thevaluesofwhicharesselecteddependingon the degree of quality control expected under different site conditions (see tables 3 and 4).

**Table2:Valueof't'(IS:10262-1982)**

| Acceptedproportion of low results | Time |
|---|---|



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| | |
|---|---|
| 1 in 5 | 0.84 |
| 1 in 10 | 1.28 |
| 1 in 15 | 1.5 |
| 1 in 20 | 1.65 |
| 1 in 40 | 1.96 |
| 1 in 100 | 2.33 |

**Table 3: Degree of qualitycontrol Expected (IS: 10262-1982) under different site conditions.Table 4: Recommendedvalues of standard deviation IS: 10262-1982 standard deviation(s) for a different degree of control N/mm. Sq.**

| Gradeof concrete (fm) | Verygood | Good | Fair |
|---|---|---|---|
| M10 | 2 | 2.3 | 3.3 |
| M15 | 2.5 | 3.5 | 4.5 |
| M20 | 3.6 | 4.6 | 5.6 |
| M25 | 4.3 | 5.3 | 6.3 |
| M30 | 5 | 6 | 7 |
| M35 | 5.3 | 6.3 | 7.3 |
| M40 | 5.6 | 6.6 | 7.6 |
| M45 | 6 | 7 | 8 |
| M50 | 6.4 | 7.4 | 8.4 |
| M55 | 6.7 | 7.7 | 8.7 |
| M60 | 6.8 | 7.8 | 8.8 |
| M10 | 2 | 2.3 | 3.3 |

From table 4 it can be seen that lesser value off's' and 'fm' for consumption works out to be better. Hence, for concrete controlresultsingreater better quality control results in a same 'fck'. Therefore cement lowerwhenthequalitycontrolis manufacture better quality economy.

Table5:Percentagesavingas comparedto'A'gradecement

**RECOMMENDATIONS TO USINGHIGHSTRENGTH IMPROVE DURABILITY CEMENT**

However,thedurability 456- under revision must be various exposure conditions. concretemanufacturedusinga requirements as specified in IS satisfieddependingontheFrom table 5 it is obvious that highergradeofcementevenafter



ISBN:978-81-957858-1-0

consideringthatlowergradecementmaybemarginallycheaperthanthehigher-gradecement.

Table6:RequirementofdurabilityasperIS:456-2000.Maximumcementcontent,maximumwater-cementratioandaminimum grade of concrete for different exposures with normal weight aggregates of 20 mm nominal maximum size.

Note 1- Cement content prescribed in this is irrespective of the grades of cement and it is inclusive of Mineral Admixtures specifiesin IS456-2000.Theadditionssuchasflyashorgroundgranulated blastfurnaceslag maybetaken into accountin the concretecompositionwithrespecttothecementcontentandwater-cementratioifthesuitabilityisestablishedandaslongasthe maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (part 1) and IS 455 respectively.

Note2-Minimumgradeforplainconcreteundermildexposureconditionisnotspecified.

The figure below shows that F grade cement can be utilized for 200 kg/cm. Sq. Reinforced concrete in mild environment condition only while C to E grade cement can be used for mild or moderate environmental conditions. However, for high-performance concrete generally, it is very important to go for a higher grade of concrete (above M25 grade). If this concrete is madewithhighstrengthcementthenitwillfetchbothtechnicalaswellasafinancialadvantage.Tableno.7showstheextentto which different grades of cement can be used for different environmental conditions and various grades of concrete.

Watercementratiovs.Average28days'strengthofcementin(kg/cm.sq.)

ItisgenerallyobservedthateventodaythestructuralengineersandarchitectsspecifytheM15andM20gradeofconcretein the coastalarea.Thishasalreadyledtoseriousdurabilityproblemsandlowperformanceofconcretestructures.M15gradeconcrete can be achieved with W/C much greater than 0.55 if 43 and 53 grades of cement are used and since 33-grade cement has now virtually disappeared from the market. All M15 grade concrete structures in coastal areas are therefore bound to be a happy hunting ground for concrete rehabilitation agencies as is being observed at present. The durability problem is most likely to multiply several times if, at the specification stage itself, proper precautions are not taken.

EvenM20gradeconcretemaynotbethecorrectsolutiontothedurabilityproblemintheUrbanized/Industrializedcoastalareas.

Lower grades of concretes with the generally poor type of quality control prevalent are observed to be of very poor durability, needing of extensive repairs within a few years. As good quality cement are now available it is strongly recommended to go in forhighergradesofconcretei.e.aboveM25grade.Thiswillimprovetheperformanceofthestructures;provemoreeconomical in most cases and in the process of achieving higher strengths it will automatically comply with the durability requirements.

**CONSISTENCYOFCEMENTQUALITY**

Concrete mix design(CMD) is one of the techniques to determine the most economic proportions of cement, sand, aggregates, water and other additives. However, after choosing the economic proportions of various materials any change in their physical or chemical property will lead to considerable variations in the desired cohesiveness, workability, strength and durability. The maximum impact is always due to variation in cement properties and therefore it is not only essential that cement should have good strength, proper fineness and correct setting time but it is also essential that the variation of its chemical and physical properties especially the strength and fineness should be minimal. The good quality in minimizing variations is now possible with proper quality control monitoring systems and modern sophisticated instrumentation control systems the cement manufacturers have installed in their modern up to date plants.

**QUALITYCONTROLINCEMENTMANUFACTURE**

Whilehighstrengthistheindicationofthegoodphysicalqualityofcement,consistencyofthishighstrengthandotherphysical andchemicalpropertiesisanindicationofgoodqualitycontrolandsuperiortechnologypracticedbythecementmanufacturing company.

Thequalitycontrolinthecementmanufacturingplantstartsfromtheinspectionandtestingofthelimestone.Onlyafterextensive testingforitsCaOcontent,itisutilized,makingsurethatCaOcontentisuniform.Thethoroughlycrushedlimestonepowderis


ISBN:978-81-957858-1-0

then stored in a stacker. It is reclaimed in vertical slices to get homogenous limestone, which is then conveyed, to the vertical ballmill,whichensuresuniformlycrushedlimestone.Afterthis,homogenizationofthelimestoneisdoneintheblendingsiloby meansofaeration.Thereafterhomogenizedmaterialsarepassedthroughseriesofsuspensionpreheatersandarefedintothekiln for the production of clinker. Hourly samples of clinker are taken and tested to assure uniformly of quality. On line X-ray analyzers' help inascertainingthe variationsincompound compositions of thecementsothatimmediateaction canbetaken to improvethequalityoftheproductifrequired.Theclinkeristhenprocessedthroughclosedcircuitgrinding.Thisensuresproper particle size distribution. A device called high-efficiency cyclonic separator, which controls the grinding process right down to the specific micron size required, does this. After initial grinding in the tube mill, the materials move into the high-efficiency cyclonic separator. The separator separates the ground particles into two streams. The airflow exerts an aerodynamic force and separates the finer particles (between 5 and 30 microns) from the oversize coarser particles (above 30 microns), which are influenced by centrifugal and gravitational forces. The coarse particles are collected into grit collection and brought for recirculation into the grinding process. The fine particles are removed from the air stream in high cyclones mounted symmetricallyaroundtheseparatorhousing.Thisprocessassuresthatcementhasthe idealsurfaceareaandtheidealproportion ofparticlesizebetween5to30microns.Thisprocessguaranteesthehighestnumberofaparticlebetween5to30micronsto the extent of over 50%. Hourly samples are taken and tested to assure uniformity of quality. The consistency of particle size is checkedusingsophisticatedparticlesizeanalyzers,whichimmediatelyindicatethegrainsizedistribution.Adjustmentsrequired in cement productions, if any, can be controlled in the plant to obtain the optimum particle size distribution and thereby assure consistent quality. If cement has a large number of particles finer than 5 microns it tends to set quickly producing high early concretestrengthwithoutacorrespondingincreaselateron.Thiscementisalso moresusceptibletomoistureattackandhydrates fast resulting in unnecessary wastage. On the other hand, if cement possesses a large number of particles above 30 microns it takeslongertimethannormaltosetandwillalsodisplaylowinitialstrengthwhichincreasesatalaterstage.Thecementisthen transferredtothepackinghousewhereitispackedinwovenHDPEand4plypaperbagsandtransportedtovariousstockiestand construction sites. The hourly samples are also collected from the packinghouse to check the quality. Daily tests for various chemical and physical properties are done and various parameters are recorded to study the monthly variations and to improve the product quality from time to time and thereby minimize variations.

**NEED FOR CONSISTENCY OF QUALITY**

many do clearly not understand the importance of consistency of cement quality hence a small illustrative example is given below. Assume that three brands of cement say AA, BB and CC are available having identical mean strength for a particular month of manufacture, say 600 kg/cm. Sq. However, the standard deviations for these cement during the same month were differentandthereforethecharacteristicstrengthofthiscementanditsgradeareworkedoutasbelow.Hencefromtheabove,it can be observed that cement having identical mean 28 days strength for the month can be classified as F, E or D based on the variations (standard deviation). It is therefore of prime importance to control these variations to the barest minimum so that the cement can beclassified as a highergrade.It isgenerallyobserved that monthlystandarddeviation ifranging between15 to 25 kg/cm. Sq. can be considered as a good control for cement manufacture.

**Furthereconomicbenefitsofhigh-strengthconsistentcement**

Besides saving of concrete quantity and cement cost per cubic meter of concrete, there are several other advantage and savings due tothe useofhighstrengthcement.It isobserved that the best advantage of specifyinghighstrength cement isderived if, at theplanninganddesignstageitself,highgradesofconcretesarespecified.Thehigher-gradeconcretesmayhaveasmallercross sectional area under identical conditions and thereby the quantity of concrete reduces considerably. The saving in concrete quantity can easily between 1% of 25% depending on the type of structural member, its layout and its function. However, in addition to this saving, higher grades of concrete will be less permeable and more durable than lower grades.

**CONCLUSION**

- Thepreservationofthereinforcingsteel.
- Reductionintheamountofformworkrequired.
- Adecreaseinthetotalamountoffinishingwork,includingplastering,painting,andothersimilartask.



ISBN:978-81-957858-1-0

- Ageneralreductionintheamountoftimeandlaborrequiredforbuilding.
- Anexpansionofthebuildingscarpeted surface.

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ISBN:978-81-957858-1-0

# NanotechnologyApplicationsintheConcreteIndustry

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**Abstract**

The application of nanotechnology in construction materials for the purpose of a variety of civil engineering mechanisms is the topic of discussion in this article. The characteristics of matter are profoundly modified as a direct result of the utilization of nanotechnology, which exerts control over the subject at an extremely minute level. Under a scale of nanometers, there is a significant change in theways in which materials' strengths, durability, and other qualities behave(10-9m).This article also explains how the application of nanotechnology can improve the strength and durability of concrete while also making it easier to place. The many different kinds of nanomaterials that are used and their widerangeofapplicationsareaddressed.Studiesarebeingdoneonthepropertiessuchasself-sensing, self-rehabilitation, self-structural health monitoring, self-vibration damping, self-cleaning, and self-healing. Following this, the analyses were carried out in ductile structural composites along with its improved properties, low repairs coatings, improved properties of cementitious materials, reduction of the thermal transfer rate of fire retardant and insulation, various nano sensors, smart materials, and intellectual construction technology.

**Keywords:**Nanomaterials,self-cleaning,self-healing,structuralhealth monitoring

## Introduction

Richard P. Feynman, an American physicist, first brought up and advocated for nanotechnology in a 1959talkattheCaliforniaInstituteofTechnology.Theword "Nano"whichisevolvedfromtheGreek word forDwarfindicates abillionth. Nanotechnology is thecreation ofnewlarge-scalematerials from tinyparticlesofexistingones,orfromthemanipulationofsuchparticles.Yet,atthelengthscaleofthe nanometer, 109 m, the properties of material are affected greatly by the size of the molecule. One nanometer is equal to one billionth of a metre. Particles between 1 and 100 nanometers in size are of interest. A nanometer is one billionth of a metre.

1Nanometer (nm)=1 X10-9 m.

**Nanotechnology is not a new scienceor technology; it is rather an augmentation of the sciences and technologies which already exist from many years and it is logical progression ofthe work that has been done to analyze the nature of our world at an even smaller scale.**



ISBN:978-81-957858-1-0

Applicationsof Nanotechnologyin Civil Engineering

- Toenhancepropertiesofmattersusedinconstruction.
- Toreducecostofconstructingstructures.
- To reduce energyconsumption formaintenanceofstructures.
- Tosatisfythegeneral aspectofpeoplei.e.ofquality,controland reliability.

NeedofNanotechnologyinConstruction

Nanotechnology has changed and will pursue to change our perception, expectations and abilities to control the materials world. Several applications have been developed for this specific sector to improve the energy efficiency, durability of construction elements,and safety of the buildings, delivering the ease of maintenance and to provide increased living comfort. The role of Nanotechnology in conceiving of innovative infrastructure systems has the potential to transform the civil engineering practice and dilate the vision of civil engineering. Many disciplines of civil engineering, in conjunction with design and construction processes can be benefited from this technology.

For example, new structural materials with unique properties, stronger and lighter composites, sound absorber,fireinsulator,lowmaintenancecoating,nano-clayfilledpolymers,self-disinfectingsurfaces, water repellents, air cleaners, nano sized sensors, solarcells, ultra-thin strong-conductive wafers etc. this article introduces, inbrief, the areas of application of thistechnology incivil engineering and the science & technology behind the improved performance.

NanoMaterialsUseinPractice

CarbonNanoTubes(CNT)Nano-silica(SiO2)technologyandyetithasundergonegreatchangesover itshistory.Inthesamevein,nanotechnologyisnotanewscienceanditisnotanewtechnologyeither. Itisratheranextensionofthesciencesandtechnologiesthathavealreadybeenindevelopmentformany years. The size of the particles is the critical factor. At the nanoscale (anything from one hundred or more down to a few nanometers, or 10-9 m) material properties are altered from that of larger scales. Anotherimportantaspect is that,asparticlesbecomenano-sized, theproportionofatomsonthesurface increasesrelativetothoseinside andthisleadstonovelproperties. Itisthese“nano-effects”,however, that ultimately determine all the properties that we are familiar with at our “macro- scale” and this is where thepowerofnanotechnology comes in – if we can manipulate elements at thenanoscale we can affect the macro-properties and produce significantly new materials and processes.

BenefitsofNanotechnology–Materials&Properties

StrengthandDurability,WearandTearResistance,CorrosionResistance,FireResistanceand



ISBN:978-81-957858-1-0

RetardantsAesthetics

Economical

Life-CycleandMaintenance,CostLabor,PricingandProfitCustomerSatisfaction,MarketValueand Brand Image

SustainabilityTitanium

oxide(TiO2)

VanadiumNanoparticlesMolybdenumNanoParticleCopperNanoparticle
**Carbonnanotube(CNT)**

Theyarecylindrical withnanometer diameter.Theycan beseveralmillimetersinlength.

Theyhave5timestheyoung'smodulusand8times(theoretically100times)thestrengthofsteelwhilst being 1/6th the density.

Thermalconductionisalsoveryhighalongthetubeaxis.

Titanium dioxide (TiO2)

Titanium dioxide is a widely usedwhite pigment. It can oxidize oxygen or organic materials, and so addedto paints, cements, windows, tiles, or otherproducts for sterilizing, deodorizing and anti-fouling properties. When incorporated into outdoor buildingmaterials can substantially reduce concentrations of airborne pollutants. Additionally, as TiO2 is exposed to UV light, it becomes increasingly hydrophilic, thus it can be used for anti-fogging coatings or self- cleaning windows.

Introduction

As people involved in construction, we are very familiar with the concept of getting raw materials, bringing them together in an organized way and then putting them together into a recognizable form. The finished product is a passive machine. It works and slowly decays as it is used and abused by the environment and the owners of the project.Constructionthenisdefinitelynotanewscienceor

Energy Efficiency, Material Consumption, Social and Ethical Benefits, Reduced levels of several environmental pollutants, Potential for numerousLEED point credits

ApplicationofNanotechnologyinvariousconstructionmaterial

**Steel-**

Steel is one of the most important building materials used today. The major problem of usingsteel however, is dealing with " exhaustion is one of the significant issues that can lead to the structural failure of steel subject to cyclic loading," fatigue can occur atstresses that are lower than the yield stress of the steel and leads to a shortening of the steel's life. The best way to reduce the fatigue is to addcoppernanoparticlestothesteel.Thecoppernanoparticlescanhelpreducetheunevennessinthe surface of the steel, which in turn reduces the amount of stressrisers. Since the steel now has less stress risers, fatigue cracking is limited as well. "The new steel can also bedeveloped with higher corrosion-resistance and weld ability". Another steel-related issue that is resolved bynanotechnology isintheareaofwelding.Weldingstrengthisanextremelyimportantissue.Theareaaffectedbyheat



ISBN:978-81-957858-1-0

in a weld can be brittle and fail without warning at times. The addition of nano particles such as magnesium and calcium can help solve this issue by making “the heat affected zone grains finer in plate steel”. Which leads to strong welds? Improved fire resistance can also be achieved through nanotechnology. This is frequently done through a coating however, where the coating is “produced by a spray-on-cementations process”.

Nanotechnologyinwood-

Wood is also composed of nanotubes or “nanofibrils”,lignocelluloses are twice as strong as steel. Nanofibrils would lead to a new paradigm in sustainable construction. Functionality onto lignocellulosessurfacesatthenanoscalecouldopennewopportunitiesforsuchthingsasself-sterilizing surfaces, internal self-repair and electronic lignocelluloses devices. Currently, however, research in these areas appears limited. Researchers have developed a highly water repellent coating based on the actions of the lotus leaf as a result of the incorporation of silica and alumina Nanoparticle and hydrophobic polymers.

NanotechnologyinGlass-

NanotechnologyisusedinGlass.Nano-Titaniumdioxideisusedtocoatglasscangivetheglassaself- cleaning property. Titanium dioxide breaks down organic wastes and compounds, and because it also attracts water, the glass can attract rain water and use that to clean the dirt offofitself. Another use of nanotechnology in glass is to make it fire-protective. This can be done when a layer of silica nanoparticlesisplacedbetweenglasspanels.Thislayerturnsintoa fire-shieldwhenheated.Pavement is yet one more area that can be improved by nanotechnology. Nano scale materials can be added to current roads tonano-sizedcells,poresandparticles,givingverylimitedpathsforthermalconduction are currently available.

Thistypeofpaintsisused,forcorrosionprotectionunderinsulationsinceitishydrophobicandrepels water from the metal pipe and can also protest metal from salt water attack.

NanoConcrete

The most frequent and beneficial use of Nanotechnology in terms ofcivil engineering, is the use of it inconcrete.Concrete “is ananostructured, multiphase,compositematerialthoseagesovertime. Itis composed of an amorphous phase, nanometer to micrometer size crystal and bound water.” It is used inalmost all construction from roads to bridges to buildings. Concrete can be modified in numerous ways;

Oneofwhichistoaddmonoparticlestoit.Mostresearchdonewithmonoparticlesisdonewithnano-silica,nano-titaniumoxideandsomestudiesinvolvingnano-iron,nano-aluminaandnano-clay.These “ nano particles can act as nuclei for cement phases, further promoting cement hydration due totheir highreactivity,as nanoreinforcement and as filler, densifyingthemicro structureandtheITZthereby leading to reduced porosity.” Each of the nanoparticleshasadifferentonconcrete.Nano-silica



ISBN:978-81-957858-1-0

Improve features such as the hardness of the road, the durability, and water and skid resistance. With theapplicationofZnO2,itispossibletomakehydrophobicroadsthatcausequickerrun-offandhelp

prevent hydroplaning. Nanotechnology can even be used in water treatment. Some of the uses of nanotechnologyinwater treatmentinclude“water purificationseparationandreactivemediaforwater filtration,” Nanotechnology also has the possibility to

Help improve water quality, availability, and “viabilityof water resources, such as through the use of advanced filtration materials that enable greater water reuse, recycling, and desalinization”. Nanoparticlesto"clean-up"contaminatedareas,theycancreatenewcompoundsthatcanhaveanimpact on the environment.

## Nanotechnologyin Paint

Nanotechnology is being applied to paints and insulating properties, produced by the addition of improve strength, resistance to water penetration, and helps control calcium leaching. Nano-titanium hasbeenproventoassistinthe“selfcleaningofconcreteandprovidestheadditionalbenefitofhelping toclean theenvironment.”nano-ironhasshowntogiveconcreteself-sensingcapabilitiesandimprove its “compressive and flexible strength.”

Concrete is one of the most common and widely used construction materials. Nanotechnology is widelyusedinstudyingitspropertieslikehydrationreaction,alkalisilicatereaction(ASR)andflyash reactivityAlkalisilicatereactioniscausedduetoalkalicontentofcementandsilicapresentinreactive aggregateslike chart. The use of pozzolona in the concrete mix asa partial cement replacement can reduce the likelihoodof ASR occurring as they reduce the alkalinity of a pore fluid. Fly ash not only improvesconcrete durability, strength and, importantly for sustainability,reduces the requirement for cement,however,thecuringprocessofsuchconcreteissloweddownduetotheadditionofflyashand earlystagestrengthisalsolowincomparisontonormalconcrete.AdditionofNano-silicaleadstothe densifying of the micro and nanostructure resulting in improved mechanical properties. With the additionofnano-$SiO_2$partofthecementisreplacedbutthedensityandstrengthofthefly-ashconcrete improves particularly in the early stages. For concrete containing largevolume fly ash,at early age it can improve pore size distribution by filling the pores between large fly ash and cement particles at Nano scale. The dispersion/slurry of amorphous nano-$SiO_2$is used to improve segregation resistance forself-compactingconcrete.The additionofsmallamountofcarbonnanotube(1%)byweightcould



ISBN:978-81-957858-1-0

increase both compressive and flexural strength.This can also improve the mechanical properties of samples consisting of the main Portland cement phase and water. Oxidized multi-walled nanotubes (MWNT's) show the best improvements both in compressive strength (+ 25 N/mm$^2$) and flexural strength(+8N/mm$^2$)comparedtothereferencesampleswithoutthereinforcement.Crackingisamajor concernformanystructures.UniversityofIllinoisUrbana-Champaignisworkingonhealingpolymers, which include a microencapsulated healing agent and a catalytic chemical trigger. When the microcapsules are broken bya crack,thehealing agentisreleasedintothecrack andcontactwiththe catalyst. The polymerization happens and bond the crack faces. The self-healing polymer could be especiallyapplicabletofixthemicrocrackinginbridgepiersandcolumns.Butitrequirescostlyepoxy injection. Research has shown that an anaerobic (one that does not require oxygen) microorganism incorporatedintoconcretemixingwaterresultsin a 25%increasein 28-day strength. TheShewanella microorganism was used at a concentration of 105 cells/ml and nanoscale observation revealed that therewas a deposition of sand-cement matrix on its surface.This led to the growth of filler material within the pores of the cement sand matrix and resulted in increased strength. Finally, fibre wrapping of concreteis quite common today for increasing the strength of pre-existing concrete structural elements.Anadvancementintheprocedureinvolvestheuseofafibresheet(matrix)containingnano- silica particlesand hardeners. These nanoparticles penetrateand close small cracks on the concrete surface and, instrengthening applications, the matrices form a strong bond between the surface of the concrete and the fibrereinforcement.

ItisevidentfromtheFig.1thattheSCCNFC(self consolidatingconcreteNanofibreconcrete)column failed at higher loads and with larger deflection than the SCRC (steel confined reinforcedconcrete) column. Additionally, the SCCNFC columnwas much stiffer than the SCRC column and exhibited higher energy dissipation. SCCNFC can also be used as a type of self- Structural Health Monitoring system.

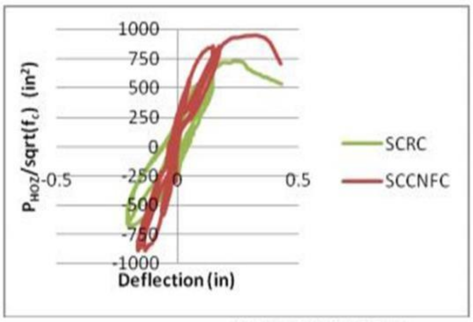


Fig. 1. Horizontal Force vs. Displacement Curves

ImprovedPerformance

OfNanoConcretethegivenfiguresshowsthenanoconcretewithless voidsand cracks

**OpportunitiesforNano-concrete**Material(55%ofInitialCost)Labor(45%ofInitial Cost)

Decrease schedules by 20%



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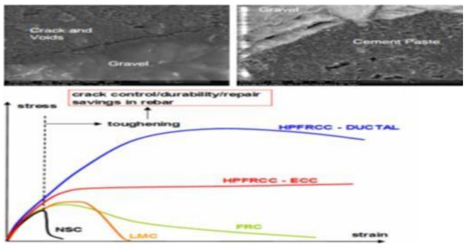

**Properties**

Tougher

Density(Weight!)

Low ductility,weakintensionDurability(Cracking!)**Environmentalload**

$CO_2$ <10%

Smogeating,reducepollutionby40% Benefits

of Nano Concrete-

-

Cessation of contamination caused bymicro silicasolidparticles. Lower

cost per building site.

Concretewithhighinitialandfinalcompressiveandtensile strengths.

Concretewithgoodworkability.Cessationofsuperplasticizingutilization.Cessationof silicosis risk.

RESULT

Resistancetocompression–40to90MPain1day.Resistancetocompressionfrom70a100MPa(or more) in 28 days.

Produceshighresistanceevenwithlowaddition(1to1.5%ofthecementsweights)andgivesself compacting characteristics with higher proportions (2.5%).

FUTUREPROJECTIONOFNANOTECHNOLOGYINCONSTRUCTION

Researchthatisrelevanttonanotechnologyiscurrentlyreceivingalargefinancialinvestmentfromboth multinational organizations and venture capital firms. The majority of the largest firms in the world, including IBM, Intel, Motorola, Lucent, Boeing, Hitachi, and others, are all engaged in substantial nanotechnology-related research projects or has established their own nanotechnology programmes. According to projections made by the National Science Foundation, the impact of nanotechnology on the overall economy will reach one trillion dollars by the year 2015. To reach this market-sized prediction, companies will employ roughly two million individuals towards breakthroughs in several Nanomaterials,Nanostructures,andNanosystems.Theprocessofbringingaproducttomarketmight take a long time since businesses often choose to first keep an eye on how it is being developed in researchinstitutionsandlaboratoriesbeforemakingsignificantfinancialcommitments.Inaddition,the developmentofnanotechnology,particularlywhencombinedwithresearchonbiomimicry,willlead to



ISBN:978-81-957858-1-0

truly revolutionary approaches to the design and production of materials and structures that have significantly improved efficacy, sustainability, and adaptability to their environments.

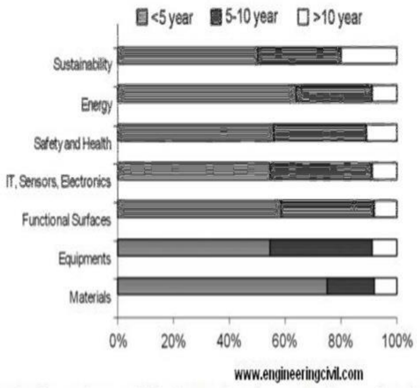


Fig. 4. Expected successful implementation of nanotechnology products in construction

CONCLUSION

In the field of architecture and the materials used in the construction industry, nanotechnology has the potential to usher in a whole new era. In spite of the fact that recreating natural systems is one of the mostpotentiallyfruitfulapplicationsofthistechnology,researchersarestillworkinghardtounderstand thestaggeringcomplexityofthesesystems.Nanotechnologyhasthepotentialtohaveagoodimpacton our everyday lives as well as the building sector. It also has the potential to deliver improved infrastructure,whichiscriticalforbothenterprisesandcivilizations.Furthermore,nanotechnologyisa rapidlyexpandingfieldofresearchwherenovelpropertiesofmaterialsmanufacturedonnano-scalecan be utilized for the benefit of construction infrastructure. Additionally, there are a number of promising developments that exist that have the potential to change the service life and life-cycle cost of construction infrastructure in order to make a new world in the future.

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ISBN:978-81-957858-1-0

# ToStudytheCurrentStandardsinCement Research

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**Abstract**

Cementisoneoffewmodernprocessedmaterialsknownasworldwidetolaymanandexpertalike. Therearefewpeopleintheworldwhohavenotwatchedabricklaid,awallrenderedorafencepost set. The large fraction of the world's population who live in urban areas are often surrounded by concrete–acompositeceramicofhydratedcementandaggregate–throughouttheirworkingday andtheireveningrest.Cement,morethananyothermaterial,definesmodernurbanlife.Annually, 2.7 billion tones are manufactured around the world[1], which in turn makes 20 billion tons of structuralconcrete,foundations,blocksandpavingslabs,mortarandrendering,rooftilesandother products. The first, and perhaps most pernicious, is that such amature technology JosephAspdin patented Portland cement in Leeds, England in 1824 must be completely understood.What can there possibly be left to learn about such an omnipresent and venerable material. A brief look at theparlous stateof many ofthe relatively modern concretebuildings that blight yournearest city should alert your suspicions in this regard. Secondly, cement is normally only associated with construction projects, from the simple mortar maintaining the brickwork of our houses to the complex concrete used in large civil engineering infrastructure components such as bridges. But why should a material so useful on such a grand range of scales remain the sole preserve of the construction industry. In fact, it is not; for example, your dentist may well have put some in your teeth… Thirdly, even within the wide remit of its traditional uses, there is an enormous diversity of classes, blends, formulations and recipes of cement and concrete. We often talk about cement and concrete as though they were simple, invariable, materials with generic attributes and properties,yetthevarietyofcementsandconcretesusedinconstructiontoday-andthustheability totailoraconcretetoperfectlyfitagivensituation–faroutstripsthatoftimberorsteel.Here,we highlight recent research that dispels these myths and misconceptions, showcasing cement and concreteasvibrant,hi-tech,bespokematerialsprovidingcost-effectiveandtechnicallyappropriate solutionstobothtraditionalandmodernproblems. Inparticular,wewillreviewsomeofthewide varietyofcutting-edgeresearchpresentedoverthelastfewyearsattheannualCement&Concrete ScienceConferenceandsubsequentlypublishedinthisandpreviousSpecial Issues of Advances in Applied Ceramics.



ISBN:978-81-957858-1-0

**Keywords:**Cement,Characterization,Innovation, Novelcements, review

**Innovativeanalysisand characterization**

There would be no need to use transmission electron microscopy to examine the structure of calcium silicate hydrateto builtenvironment'sglue.WewouldnotbeusingdynamicSEMtoviewthehydrationofcementonthemicro-scaleor*in-situ*Ramanspectroscopytoobservethereal-timeformationofhydrationproductson clinkermineral surfaces. All of this work has helped to give valuable insights into the complex interplay of thechemicaland the physical in thedevelopmentofhydrated cementpastes.

Cementandconcretesciencehasmovedbeyondthedaysofparametricstudies,mixingcubesand testingthem to destruction - the traditional make „em and break „em approach. Nowadays a wide varietyofdifferent analyticaltechniquesisusedto probethe fine, complex, highlyheterogeneous structure ofcement clinkerand hydrated cementpaste.

Conventionalanalytical methodshavebeenusedextensivelyformanyyearsincement science,includingthermal analysis, x-ray diffraction and fluorescence, scanning electron microscopy and wet chemicalmethods. Whilst these were all valuable, they all left unanswered questions, being restricted to, say, bulkanalysis, identification of crystalline compounds only, or otherwise missing the fine interplay of themyriad of species present cement or concrete. Technological advances have enabled us to probe, in everfiner detail, some of the complex minutiae within cement and concrete, increasing our understanding ofthestructureand performanceoftheworld‟skeyconstructionmaterial.

It is known that the principal binding phase in hydrated Portland cement is calcium silicate hydrate,commonly abbreviated to C-S-H according to the standard cement chemistry notation. It is also knownthat this C-S-H is poorly ordered, and that its composition depends on curing conditions and the presenceof additional materials such as fly ash or slag. However, the precise structureofC-S-Hremainselusive,andtherehasbeenconsiderablediscussion,disagreementeven, within the scientific literature as to itsstructure. Early models suggested a mixture of nanometer sized 14 Å tobermorite ($Ca_5[H_2Si_6O_{18}].8H_2O$)and jennite ($Ca_9[H_2Si_6O_{18}](OH)_8.6H_2O$) domains, with subsequent mode[2]ls based on solid solutions oftobermorite and portlandite ($Ca(OH)_2$) or isolated silicate chains of variable length and OH content,intergrown with Ca(OH) . In fact, the precise structureof C–S–Hdepends upon the system in question,but appearsto be a combination of the tobermorite–jennite model and the tobermorite–portlandite model[6].However,determinationofthestructureofC-S-Hhasbeenadrivingforceinthefieldformany



ISBN:978-81-957858-1-0

years.

TheuseofneutronscatteringinitsmanyguisesledtothepropositionthatC-S-Hcouldbe represented ascomprisinghighandlowdensityregions,andsubsequentlyrevealedvariationsinthedistributionofthe water around the C-S-H grains[11]. Similarly, nano-indentation has been used to characterise cementhydration products and also shown a bimodal distribution. Both nano-indentation and neutronscatteringhavebeenusedtovalidatearecentlyrevisedmodelforcalciumsilicatehydrate. However, theinterpretationofthe nanoindentation datahasrecentlybeen questioned.

A more conventional probe of hydrate structure is nuclear magnetic resonance (NMR) spectroscopy.Skibsted and Hall gave a thorough review of the capabilities of NMR in cement science,showinghowSiandAlMASNMRcanbeusedtodetermineaveragesilicatechainlength and the degree ofaluminium incorporation into the (alumina)-silicate structure. The low natural abundance of suitableisotopes of other elements has limited the application of NMR primarily to AlandSi,althoughtherehasbeenisolatedwork,forexample,SNMR.AvaluableuseofNMR is in conjunction with transmissionelectron microscopy (TEM) to provide valuable information on C-S-H composition andstructure. The combination of morphological and compositional information which can beobtained from this combination of techniques has shed light on the composition of hydrated phases incement.

Otherapproacheshavebeenemployedtostudyhydratedphasestructure.Buildingonworkinthefieldofm ineralogy, x-ray photoelectron spectroscopy has been used to examine the earliest stages of cementhydration and probethesilicatestructureoffresh and aged C-S-Hphases, and nowin this issue forthe first time hydrated aluminate phases formed upon the exposure of cement clinker to water vapour.The extreme surface sensitivity of this technique has been employed to look at the earliest stages of bothhydrationandsample ageing.

XPS and NMR studies have all shown that C-S-H ageing leads to silicate polymerisation, with freshpastes comprising dimers, ($Q^1$), which transform to chains ($Q^2$) upon further hydration. Subsequentpolymerisation of the C–S–H gels to sheets ($Q^3$) and 3D structures ($Q^4$) is possible in mature and partlycarbonated cementpastes.

A great many other techniques have been used to investigate the structure of hydrated cements andchanges occurring during ageing. These include vibrational spectroscopic techniques such as Raman andFourier Transform Infra-red (FTIR) spectroscopy and microstructural probes such as transmissionelectron microscopy (TEM), focussed ion beam (FIB) microscopy and x-ray microtomography. Morerecently has seen the advent of hyphenated techniques combining microscopy and molecular probes suchasRaman-SEM.

FTIRhasnotfoundagreatdealofapplicationincementscience,primarilyduetoproblems



ISBN:978-81-957858-1-0

associatedwiththeintensebandsduetowateroftenobscuringmanyofthefinebandsinthespectra ofhydratedcementpastes.However,therehavebeensomeisolatedstudies.FletcherandCoveney used artificialneural networks and FTIR spectra to predict the thickening times of cement pastes, whilstYlmenusedFTIRandothertechniques,tofollowtheearlystagesofcementhydration,with the changes in spectrabeing relatedto changes in silicate structure. García Lodeiro *et al*. have also used FTIR to study thestructureofC-S-H gels, plusthephasesfoundingeopolymer systems(vide infra),i.e.calciumaluminatesilicatehydrate (C-A-S-H) andsodiumaluminatesilicate hydrate(N-A-S-H)gels.

A complementary technique to FTIR is Raman spectroscopy, pioneered in the 1970s by Bensted, andthen with isolated exceptions ignored until recently, when instrumental advances made the techniquemore favourable. Recent years have seen the burgeoning use of Raman spectroscopy as a molecularprobe,takingadvantageofthetechnique‟sabilityto„see‟throughwaterbyfollowinghydration,or

then using the information gleaned from the spectra to look at changes in structure with changes in eithercomposition or ageing . The high spatial resolution available from modern spectrometers has alsoopenedupnewpossibilities,obtaininginformationfromheterogeneouscement pastes,bothtraditional,

e.g. Portland cement or lime, and more developmental, e.g. calcium sulphoaluminate cements[43], orthenlookingattraditionalcementsinnovelenvironments,suchastheuseofPortlandcementasa dentalmaterial[44]. Thereis thenalso the aforementioned workusingthe latest development, attaching a Ramanspectrometerontoalowvacuumscanningelectronmicroscopetoenablecombinedstructuralinformatio n(fromtheRamanspectra)withmorphologicalandchemicalinformationfromtheSEMandEDX system.The technique was proved suitable for clinker analysis, but the potential is there to examine now thecomplexinterplayofchemistryand morphologyin hydrated systems.

The ability to probe the microstructure of cementitious systems is a key aspect of modern research, withpastemorphologyplayingakeyrole indefiningtransport propertiesandtherefored urability.

Transmission electron microscopy has been used on many occasions to investigate the nanostructure andelemental composition of C-S-H formed under different conditions. Richardson showed how C-S-H couldbe foil-like or fibrillar depending upon hydration conditions or the presence of slag or pfa[6], with themicrostructure of the C-S-H becoming finer over time[3], and being dependent upon temperature[21]. Movingfrom the nanoscale to the microscale there have been numerous uses of electron microscopy, but that ofGallucci and Scrivener was particularly interesting in that it was the first demonstration of wet SEMtechnology in cement science[4]. Here, the use of a thin electron transparent film held over a hydratingcement paste enabled hydration to be followed almost in real time. Edwards *et al*. meanwhile usedfocussed ion beam microscopy to examine the microstructures of lime-waste glass blends, whilst x-raymicrotomography has been used to examine the three dimensional arrangement of cement paste,aggregatesand poresin ahydrated concrete.

In summary, the section above is by no means exhaustive, and yet is shows clearly that characterization ofcementandconcreteisafieldexploitingsomeoftherecentadvancesinmaterialscharacterizationto



ISBN:978-81-957858-1-0

thefull, and given the continual evolution of both analytical equipment and cements themselves, this is likelytocontinuefora longtime to come.

## CEMENTINGTHEFUTURE:NOVELAPPLICATIONSFORCEMENT

It is difficult to obtain figures on the proportion of the cement manufactured annually that is used outsidetheconstructionindustry,but itseemsreasonabletoassumethat itwould belessthan1%interms ofweight or volume. Nevertheless, in terms of value, there is a rather more significant market for cementand related materials in novel applications. Established alternative markets include refractory materialsand the management of various pernicious waste streams, from contaminated „brownfield‟ landremediationtoencapsulationofintermediatelevel radioactivewasteforlong-termrepositorystorage.

There is a rapidly emerging market in specialised cements for medical applications, especially in dentalandbonesurgery.Concreteisincreasinglyusedbysculptorsandartiststorealiseformsandconceptsthatca nnotbeachievedbyothermedia.Researchgroupsaroundtheworldareturningtocementsforapplications as diverse as rapid prototyping, rainwater harvesting and storage in the developing world, orretrieval of sea-bedinstrumentation.Theseand otherapplications exploit somecombination ofcement‟suniquesuite of properties – activation by aqueous solution; initial fluidity; room-temperature/pressurecuring; complex,microstructurecombiningamorphousandcrystallinephases; tunablechemistry,

strength,stiffness,porosityandadsorptivity;andrelativecheapnessandabundance–toprovidesolutions that cannot be economically achieved with other materials.

## REFRACTORYMATERIALS

Refractory cements exploit the ability of calcium aluminate cements to form ceramics that retain theirintegrity at high temperatures. Calcium aluminate cements (CAC) hydrate to form mixtures ofmicrocrystalline $CAH_{10}$, $C_3AH_6$ and amorphous $AH_3$. Above 300°C, these compounds dehydroxylate; ataround 700°C the residual minerals fuse, replacing hydrated bonds with ceramic bonds. Combined withappropriate aggregates, heat-resistant concrete can thus be made. This is used for high-temperatureinsulation, furnace bodies and chimney linings in preference to traditional refractory bricks, either toprevent heat and/or gas loss joints, or to form more complex functional shapes. Simple refractorycastables are stable up to 800°C while more specialised, complex formulations can be used up to1850°C.

### Wastemanagement

Cement is crucial to many waste management technologies. It has a unique three-pronged ability toimmobilise pollutants; physically solidify the waste by physico-chemical adsorption of pollutant ions bythe poorly crystalline hydrated phases, and reduce the solubility of heavy metals by virtue of the cementpore solution chemistry. For example, zinc, lead and cadmium are immobilised by chemical precipitation,sinceinthehigh-pHenvironmentofacementgrouttheyforminsolublehydroxides.Copper,



ISBN:978-81-957858-1-0

zinc andchromium can react with the calcium in the cement to form double hydroxides. Many ions can beincorporatedintothe hydratedgelphasesbysubstitution;nickelandcobaltforcalcium,andchromium foreither calcium or silicon[48]. This makes it particularly well suited for situations where a wide or poorlycharacterisedrangeof problematicionsmaybeencountered,suchasincontaminatedbrownfieldsites.

Aparticularlywellestablishedapplicationisinthestabilisationofintermediate-levelradioactivewaste.As well as the attributes listed above, cement provides an encapsulant with low permeability and a degreeof radiation shielding. It can cope with most of the huge range of ions encountered, particularly in thosepoorly-characterised wastes associated with legacy and research reactors; Evans lists 29 in his review[49].Thestandardapproachistoplacethewasteintolarge(~0.5–3m$^3$)stainlesssteelcontainers,which arethen filled with a fluid Portland cement based grout modified with up to 90% w/w pozzolanic (reactivesilica-bearing) powders such as pulverised fuel ash or ground granulated blast-furnace slag. Theseadditives slow the reaction rate and thus heat output, reducing the risk of thermal gradient-inducedcracking,andalsoreducethepermeabilityofthecementedwasteform.AlthoughthesesimplePC-basedsystems have been successfully used for many years, they are not ideal for all applications. For example,therearesomeconcernsoverthelong-termstabilityofreactivemetalwastessuchasmagnesium andaluminium derived from fuel rod casings[50]. These can react with the free $OH^-$ions in the cement poresolution to produce gaseous hydrogen and special modifiers such as sulphates may be added to the cementto modify the corrosion behaviour[51]. Other problems, include interference with the hydration reactions bycertainions(e.g.phosphates,zincandtin) causingretarded settingandhardening,reactionswithironflocsinthewaste formingporoushydrationproducts, anddegradationofcellulose.Fortunately,therearea large range of cement chemistries – e.g. calcium aluminates, calcium and/or magnesium phosphates,calcium sulpho-aluminates – that can be investigated for encapsulating any given waste, and employing adiverse„toolbox‟ofdifferentcementsystemscanhelptocopewithawiderangeofimmobilisation

**CHALLENGES**

Alkali activated systems, such as the so-called „geopolymers‟, could potentially beparticularly useful for ionssuchascaesiumwhosehighsolubilityatanypHmakesencapsulationincementproblematic.Byusing CsOH as the activating alkali, preliminary work suggests that 50-75% ofthe Cs used is sufficiently well incorporatedintotheceramicstructuretobepreventedfromleachingout.However,knowledgethelong- term behaviour of both novel and traditional systems – measured inthousands of years for radioactive waste immobilisation – is still incomplete. Even in well characterisedsystems, examination of the microstructure of the cements after 20 years shows they are still changing,contrarytopopularbelief.

Biomaterials

The ability to mould a soft material into shape and then let it harden into a functional component is asattractivetosurgeonsasitistostructuralengineers.Therearemanycementsystemsthatarecompatiblewith



ISBN:978-81-957858-1-0

the human body and thus a range of inorganic biocements are available to compete with traditionalrepairmaterialssuchasdentalamalgams,polymethylmethacrylatebonecementsandsurgicalsteel.

Cementsfortherapeuticusefallintothreechemicalfamilies;calciumphosphates(CP),glass-ionomersand those based on traditional cements or plasters. The most extensively researched are probably thevarious inorganic bone cements used in orthopaedic surgery and reconstruction. These are calciumphosphate powdersactivatedeitherwithwater,ortho-orpyro-phosphoricacid.Theymayhydratetoformarange of calcium phosphate minerals, including hydroxapatite ($Ca_{10}(PO_4)_6(OH)_2$, the mineral componentof bone), brushite ($CaHPO_4.2H_2O$) or DCPP (dicalcium pyrophosphate) ($Ca_2P_2O_7$). The degree ofcrystallinity and size of crystals formed is controlled by, among other things, the pH of the activatingsolution and the size oftheprecursorpowders. CPcements havemanyadvantagesoverpolymers,theirmaincompetitors:they canbe placed either by hand or by injection; they are non-toxic, being based onbone chemistry; they have comparatively minimal temperature rise during setting; they bond well toparent bone; and are relatively lowcost.However,theuniquesellingpointofCPcementsisthattheyareabsorbedbythebodyovertime, acting as a scaffold for – and eventually replaced by – natural bone.Thetimescaleof replacementvariesfrom3–36months,dependingonthe cementchemistryandhydrated porosity[56]. Attempts have been made to further increase the biocompatibility by using bloodplasma as the hydrating fluid but this can affect setting and hardening behaviour. The inherent porosityof most hydrated CP cements (~40- 50%atanaverageof8 – 15µm)permitssufficient nutrienttransportfor surfacebonegrowthbutdoes not allow intergrowth, so artificial pore-forming agents areoften added to encourage bone to colonise the implant. These have a detrimental effect on strength,particularly tensile strength, which is generally only 1 – 10 MPa (despite the compressive strength beingcomparable to that of bone, 10 – 100 MPa). This is currentlythemajorlimitontheapplicationsinwhichCPcementscanbeused,restrictingittonon-primary loadbearingrepairs(e.g.maxillofacialsurgery)unlessreinforcedwithstainlesssteelframeworks.Attempts to increase the inherent strength by e.g. usingorganic polymer acids as the activating liquid to produce a polymer-modified cement have had limitedsuccess so far . Strengthening continues to be a focal research area. An alternative approach is to use theCP cement system to make precursor green forms for implants which are subsequently sintered to givehigh strength. It is particularly useful for forming calcium pyrophosphate ceramic implants, which aremore bioactive than hydroxyapatite ceramics. This approach is quicker and easier than the traditionalmethod of producing green forms (high pressure slurry compaction at ~300 MPa) which cannot formcomplexorganic shapesandis associatedwith significant shrinkage.

The inherent porosity of CP cement systems does however combine with their low hardening temperatureto offer a uniqueadvantageover other systems;the abilitytobe impregnated withdrugsand thenslowlyreleasethemattherepairsiteinacontrolledmanner.Asinanysystem,tailoringthemicro/nano scaleporosity is the key to controlling the drug dose rate. Since this is easily done in cements by varying thepowder/liquid ratio, they are an ideal slow-release, topical delivery mechanism. For example, growthfactorscanbedeliveredmoreeffectivelyandsafelybyCPcementsthaninjections[61]andtwo-



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stagecontrol of the release rate of antibiotics can be achieved via a surface mechanism where releaseproportional to the square root of time (and thus presumably diffusion controlled), and a CP resorptionreleasemechanismproportionaltotime.

Glassionomercementsarewidelyusedinalmostallaspectsofdentistry,fromcavityliningto cosmeticreconstruction. They are fluoro-alumino-silicate glass powders activated with organic acids. As withCPsystems,theycompetewithpolymer-basedmaterials,offeringincreasedbiocompatibilityand greatlyreducedtoxicityandheatgenerationduringhardeningastheirmainadvantages.Theyalso slowlyreleasefluoridesintotherepairedtootharea,encouragingnaturalbondingandremineralisation,althoug hthenatureand formationofinterfacebetweenthecementandtooth substrateis poorlyunderstood.

Powderandliquidfractionsmaybesupplied„pre-proportioned‟,ordentalprofessionalscanmixtheirown cementformulationseithertosuitaparticularapplication,foreconomicreasonsorsimplytoretaingreater control over the process. As with all cements, the powder-liquid ratio (p/l) controls the mechanicalpropertiesbutbiomaterialsresearchersoftenattributethedecliningstrengthwithincreasingp/l to reducedrelative aggregate fraction, e.g. rather than to the well-known porosity effect first established forconstruction cements by Feret in 1896 ; this seems unlikely and worthy of further research andclarification.

Some use is made of traditional cements and related materials in medical applications. Plaster of Paris is awell known example (although not strictly a cement, since it loses integrity when wet) but in generalcalcium sulphates dissolve too rapidly to be used inside the body. They may be used to adjust the settingandhardeningratesofotherbiocements.Anotherdentalmaterial,theflamboyantlynamed „mineraltrioxideaggregate‟(MTA)isactuallyasimplemixtureofordinaryPortlandcementwithbismuthoxide.It is used in root canal surgery, where it seems that the calcium hydroxide produced during its hydrationacts both as an antiseptic and to encourage beneficial cell growth. Research into its hydration chemistryand properties in a biomaterials context seems to be undertaken without reference to the 100 yearsworthofliteratureonPortlandcementavailabletoconstructionresearchers;aswithGIcements,there is clearlyscopeforsynergiesto bedeveloped byincreasingdialoguebetweenthesetwo communities.

EMERGINGAPPLICATIONS

Cementandconcreteareusedinsmallquantitiesinotherfields.Sculptorsareincreasinglyturning toconcreteasauniquemediuminwhichnovelandengagingformscanbecreated,includingTurner PrizewinnersAntonyGormley(*Allotment,*1993)andRachelWhiteread(*House,*1993).Morerecently, RoyalAcademicianAnishKapoorhasexperimentedwithusingconcreteforhugesculpturesthatblur theboundariesbetweenarchitectureandart,includingusinga„concretepiping‟machinetocreateaseries ofsinuous,primaeval„wormcast‟sculpturesathis2009RoyalAcademyexhibition.Amore prosaicextensionofthisideaistheuseofcementfor3Dprinting,amanufacturing/prototypingprocessthat printsbespokeformsdirectfromaCADmodelbyusingink-jettechnologytoimprintsuccessivethinlayers ofpowderwithliquidreactant(i.e.water).Commercial3Dprintingsystemsuseplaster-basedpowdersandthe



ISBN:978-81-957858-1-0

resultantformsareweakandsusceptibletomoisturedamage.Byreplacingtheplasterwith hydrauliccement,strongerandmoredurableformscanbeproduced.Proof-of-conceptofthishasbeendemonstrated,showingfavourablestrength-densitycorrelationsalthoughsignificantoptimisation ofprocessparametersstillremainstobecarriedout.Someinvestigatorshaveusednovelprocessingmethodsfor cementitious materials, such as compression moulding and supercritical carbonation, carriedoutwiththeaimofproducinghigh-performanceand/orsustainableceramicsforvariousapplications[e.g.

. Others have taken a converse approach, exploiting our knowledge of a particular concrete deteriorationmechanism–thaumasiteattack–toproduceamaterialwithcarefullycontrolleddegradation behaviour,designed to release instruments from the seabed after a specified period. Concrete is also finds uses inthe developing world outside of construction. Cement mortars are used to build rainwater harvesting tanksplacing the material in tension. Large local variations in material and artisanal quality require that robustdesignmethodologiestodetermine optimummaterialandstructuraldesignparametersareestablished.

Cutting-EdgeConstruction:NewCementitiousMaterialsForEstablishedApplications

Whilst the Earth‟s geology dictates that the most common cementitious material comprise primarilyofcalcium, silicon and aluminium, there are an increasing number ofalternatives to Portland cementbeingreportedintheliterature,e.g.tonamebutafew;hydrauliclime,geopolymers,activatedslags and sulphoaluminate cements. A key driver in these developments appears to be a desire toreduceabioticdepletionandfindapracticalapplicationformaterialscurrentlyconsideredtobewastes.

There are alsoa number of approaches based on traditional, i,e. Portland cement, binders, but with anon-traditionalpre-orpost-treatment step,suchassol-gel synthesisorhydrothermal treatment.

Hydraulic limes have been used for millennia, but it was Smeaton who perhaps pioneered their use inmodern civil engineering during the construction of the Eddystone Lighthouse, realising that hydraulicbehaviourwasrelatedtotheclaycontentfromwhichthelimewasmade.Recently,therehasbeen aresurgent interest in hydraulic limes, particularly in the heritage sector where the material‟s perceivedenvironmental benefits are touted. It may be argued that there is nothing novel in using technologyavailable since Roman times, but more recent applications have strived to combine the use of hydrauliclimes withnovel materialssuchasground glassculletand other waste materials,using the lime to inducea pozzolanic reaction. Zawawi and Banfill effectively synthesised artificial hydraulic limes from a low-silica limestone blended with waste siliceous materials such as pfa, burnt shale and glass cullet. Theyshowedthatgroundglassreactedwiththelimethushelpingthemixtodevelopstrength.Edwards *et al.*similarly investigated the behaviour of hydraulic lime mortars mixed with ground glass cullet, using arangeofnovel analyticaltechniquestoshowthe formationof C-S-Hasa bindingphase.

Perhapstheoppositeextremetolime-basedsystemsaregeopolymers.WhenDavidovitscoinedthetermhe intendedthatit referspecifically tocalcium-freematerials.However,theterm isnowusedmoreliberally,



ISBN:978-81-957858-1-0

being applied to both calcium-free and calcium-bearing materials formed by mixingconcentrated alkalis (>8 M) with glassy aluminosilicates. Duxson *et al*. provided a thorough review ofgeopolymers and their applications, stating how their rapid strength development, dimensional stabilityand chemical resistance made them suitable for construction purposes. However, geopolymers have alsobeen shown to have excellent thermal barrier properties and, as mentioned earlier, be suitable for wasteimmobilisation.Asidefromalkaliactivation,„geopolymeric"systemshavealsobeenmadebyactivationw ithsodiumsilicateor other activators,suchassulphate,aspresentedbyCollier*etal*.laterinthis

issue.Manyofthesealternativesystemsstrivetoimprovetheirenvironmentalcredentialsbyutilisingwaste materials such as slags, fly ash or other such wastes, thus reducing the depletion of the World"snatural resources.Thisapproachhasalsobeenusedinthe manufactureofPortlandcementsandalternativessuch as sulphoaluminate cements, which can be made in standard cement kilns, but at slightlylower temperaturesandusingwasteasrawmaterials.Morerecently,andstillatthelaboratoryscale,Dováletal. usedasol-gelprocessfollowedbythermaltreatmentatbetween600and1250$^{o}$Ctosynthesisehighlyreactive gehlenite ($C_2AS$)and $C_2S$.

Another approach to low energy construction systems is autoclave curing under saturated steam pressurewhere quartz, lime and clay react, with or without cement, at temperatures of 100 to 300$^{o}$C. Suchtreatment often leads to the formation of crystalline calcium silicate hydrates such as tobermorite orxonotlite,andtheresultantstrong,yetporous,blocksfindapplicationfortheirinsulatingpropertiesoras a filler toimprove the flexuralpropertiesof cementmatrices[90].Recentlythere have beenstudieslookingat replacing calcium with magnesium without significant changes in either performance ormorphology,orlookingatchangesinmorphologywith steamtemperatureor durationoftreatment.

Researchintohydrothermaltreatmentsof silicatebasedsystemsisstillripeforfurther development,withawiderange ofapplications available for thislowenergymaterial.

CONCLUSIONS

This paper has shown that there is far more to cement and concrete science than is normally believed.Noveltycomesinmanyguises,fromtheapplicationofnovelcharacterisationtechniques,through novelapplicationsofconventionalcementstonovelalternativestoPortlandcement.Theremainingarticles inthis Special Issue continue this theme, broadening cement and concrete science beyond its normalboundariesandencompassingthethreethemesgivenabove.Dubina *etal*.haveusedabroadarray ofanalyticaltechniquestolookatthe firststagesof the interactionof cementmineralswith water vapour,the processknownasprehydration.AlternativestoPortlandcementsarediscussedbyCollier *etal*.,lookingat sulphate activated matrices for waste immobilisation, and by Tyrer *et al*. who investigate thepotential for carbon reduction by the use of industrial wastes in cement and concrete. Finally, novelapplications of cements are then covered by the remaining papers. Gibbons *et al*. show that 3D printing ofcementitious materials is a possible route for rapid prototyping. Bolarinwa *et al*. discuss the application ofphosphate cements inbone replacement,Xiangetal.investigatethe useof super absorbentpolymerstoproduce self-healingcement, andfinally Justnes *et al*.haveturnedconventionalconcretedesign onitsheaddesigningconcreteblocks



ISBN:978-81-957858-1-0

withservice livesof onlysix monthsfor veryspecificapplications.

Insummary,it‟sfairtosaythatevenafteralltheseyears,"Wedon‟tknowallaboutcement,dowe!"

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ISBN:978-81-957858-1-0

# Axial Load Distribution in a Plane-Piled Raft Foundation Under Medium-Stiff Clay was the Subject of a Finite Element Analysis

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*[3]Ph.DResearchScholarDITUniversity,Dehradun, 248009*

*[4]Department of Management, PIT, Rajpura*

*[5]ChandigarhSchoolofBusiness,CGC,Jhanjeri* **Abstract**

The nonlinear finite element approach was utilized for the study of the piled raft foundation that is presented in this study. The behavior of axial load distribution can be predicted using a three-dimensional nonlinear finite-element analysis. The fluctuation in axial load is nonlinear for each and every one of the piles. The measurement of axial load distribution in a pile field is extremely challenging and expensive.

**Keywords:**Raftfoundation,Axialload,Finite-elementanalysis

**Introduction**

Piled raftfoundation is a newtypeoffoundation in which the total structural loadis taken by pilethrough skin friction and the remaining load is taken by raft through contact with the soil. It is an economical foundation than the pile foundation and the settlement is less than the raft foundation.

**Literaturereview**

**Tayabji et.al (1986)** developed the program JSLAB for analyzing pavements resting on a Winkler foundation. The model incorporates features similar to ILLI-SLAB, utilizing plate elements to model the slab and a bonded or unbounded base. Dowels were modeled with modified beam elements that incorporated the effect of shear deformations and elastic support provided by the concrete. As in ILLI-SLAB, aggregate interlock and keyways were modeled with springs

**Krauthammer and Western (1988)** focus on the relationship between shear transfer capabilities across pavement joints and the effects on the behavior of the pavement. The approach of the present study is to develop a numerical model that could accurately represent the mechanism for shear transfer across reinforced concrete pavement joints and implement it in an existing finite element code. The tool is then used for the analysis of various pavements for which experimental data are available; the model is further refined until the numerical results are in good agreement with the experimental information. Important paperswhichtalkonpiledraftfoundationsareClancyandRandolph(1993).PrakosoandKulhawy(2001), LinandZheng(2006),SanctisandMandolini(2006),Shuklaet.al.(2010),Al-Mosawiet.al(2011),El-



ISBN:978-81-957858-1-0

Garhyet.al(2013),Rautet.al(2015).Basedonliteraturereviewithasbeenfoundthatnotmuchworkhas been done on piled raft foundation by finite element method especially three-dimensional nonlinear finite element method to predict the axial load distribution in a pile in piled raft foundation.

**FINITEELEMENT ANALYSIS**

Forfiniteelementdiscretizationonefourthofpiledraftwithequivalentareaofrafttakenfromasinglepile with equivalent area of raft from pile forest model. The bottom degrees offreedom are completely fixed. On the x-axis plane and the plane parallel to itztranslation are fixed. Similarly on the z-axis plane and planeparalleltoitthextranslationsarefixed.Thesoil,pileandrafthavebeendiscreditedaseightnodded brickelements.Thematerialbehaviourofpileandrafthasbeenconsideredaslinearelasticmediumwhile the soil has been idealized as nonlinear material by Extended Drucker-Prager yield criterion. The total number of nodes is 1275 and the total number of elements is 800.



ISBN:978-81-957858-1-0

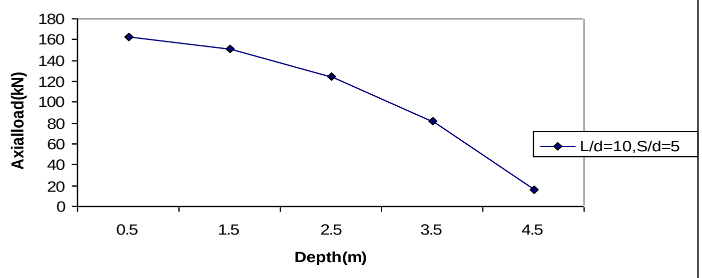


**Fig.1.Axialloaddistributioninpile**

## RESULTSANDDISCUSSIONS

Fig.1 shows the axial load distribution for a single pile of length to diameter ratio of 10 for spacing to diameter ratio5.Theaxialloadismaximuminthetopportionandthenitdecreaseswithdepth.Thevariationofaxialload distribution is nonlinear with depth.

Fig.2showstheaxialloaddistributionforasinglepileoflengthtodiameterratio20andspacingtodiameterratio of5.Theaxialloadismaximuminthetopportionand minimumatthebottomportion.Theaxialloaddistribution is nonlinear. When compared with the axial load distribution of pile of length to diameter ratio 10 it is found that at any depth, the axial load is greater for pile of length to diameter ratio 20. Thus the total load taken by pile of lengthtodiameterratio20isgreaterthanthetotalloadtakenbypileoflengthtodiameterratioof

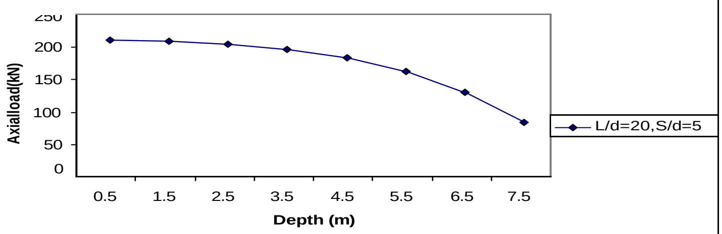


**Fig.2Axialloaddistributioninpile**

Fig.3showstheaxialloaddistributionofpileoflengthtodiameterratioof30.Thevariationofaxialloaddistribution is nonlinear. At any depth the axial load distributionin apile of length to diameter ratio 30 is greater than the axial load distribution of pile of length to diameter 10 and 20.

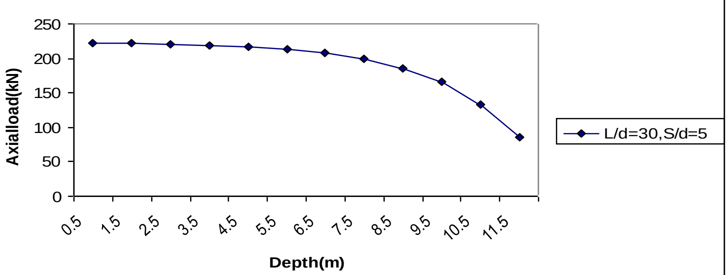


**Fig.3Axialload distributionin pile**

Fig.4showsthevariationofaxialloaddistributioninapileoflengthtodiameterratio40.Theaxialloaddistribution is maximum in the top portion and minimum at the bottom portion. The variation of axial load distribution is nonlinear. Atany depththe axial loaddistributionis greater in pileoflengthtodiameter ratio40thanthepiles of length to diameter ratio of 10,20 and 30.



ISBN:978-81-957858-1-0

Fig.5 shows the axial load distribution of pile of length todiameter ratioof50. Behaviour is similar as for piles of length to diameter ratio of10,20,30 and 40. At any depth the axial load distribution is greater than the piles of length to diameter ratio of 10,20,30 and 40.

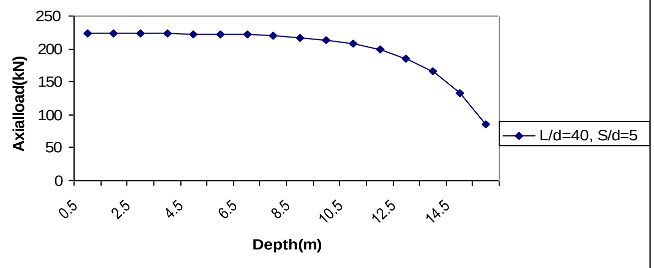


**Fig.4Axialload distribution inpile**

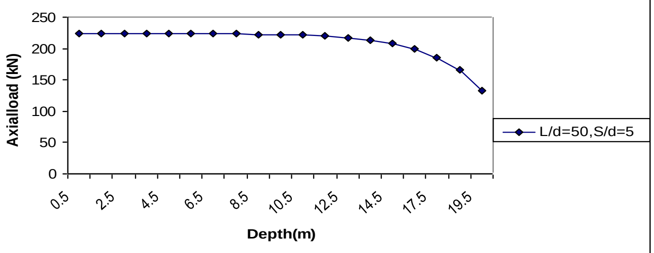


**Fig.5Axialloaddistributioninpile**

## CONCLUSIONS

Deflection (settlement) decreases nonlinearly with height. Elemental stressishighestatthe top and diminisheswith height. The pavement is stiff because the horizontal settlement is practically uniform. Non linear depth dependentnodaldeflectionandelementstress.Dimensionalnonlinearfiniteelementanalysispredictsaxialloaddistributi on in piles of varied length-to-diameter ratios.

For piles with lengthtodiameter ratios 10,20,30,40, and 50, the axial load distribution is highest at the top and lowest at the bottom.Allpileshavenonlinearaxialloadfluctuation.Fieldmeasurementofpileaxialloaddistributionischallenging and expensive.

Nonlinearfiniteelementanalysissolvesthis.

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ISBN:978-81-957858-1-0

# TotestvariouscuringmethodsonCementConcreteCompressivestrength

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**Abstract**

Concretecompressivestrengthisassessedusingvariouscuringtechniques. Standardconcrete has 0.40 water-cement ratio. Cube specimens were cast for compressive strength testing at 7, 14, 21, and 28 days of curing utilizing five curing methods: covering concrete surfaces with hessian or gunny bags, sprinkling water, Ponding method, Membrane curing, Steam curing, and Covering concrete surfaces with hessian or gunny bags. Water and sprinkling (spraying) curingoutperformedmembranestreamcure.Membranecuringaccelerateddrying.Thisslowed hydration and reduced hardened concrete's compressive strength. Wet covering, sprinkling, uncured for two days, and entirely uncured cubes have the lowest compressive strength and density and the highest shrinkage limit.

**Keywords:**Curingmethod,compressivestrength, concrete,membrane.

**Introduction**

There are various methods of curing. The adoption of a particular method will depend upon the nature of work and the climatic conditions. The following methods of curing of concrete are generally adopted. Curing of Concrete

- Wet-covering
- Coveringconcretesurfaceswithhessianorgunnybags
- Sprinkling ofwater
- Ponding method
- Membrane curing
- Steamcuring.
- Plastic sheet

**1. Wet-covering**

Hessiansacwasusedlikeamulchtomaintainwateronthesurfaceoftheconcretecubes;also,itis important to ensure that the whole areas were covered. Wet covering material was placed as soon as the concrete cubes were hardened sufficiently to prevent surface damage. Through the curing period the sac is kept saturated with water.

**2. Coveringconcretesurfaceswithhessianorgunnybags**

This is a widely used method of curing, particularly for structural concrete. Thus exposed surface ofconcreteispreventedfromdryingoutbycoveringitwithhessian,canvasoremptycementbags.



ISBN:978-81-957858-1-0

Thecoveringoververticalandslopingsurfacesshouldbesecuredproperly.Theseareperiodically wetted. The interval of wetting will depend upon the rate of evaporation of water. It should be ensured that the surface of concrete is not allowed to dry even for a short time during the curing period. Special arrangements for keeping the surface wet must be made at nights and on holidays.

**3. Sprinklingofwater**

Sprinkling of water continuously on the concrete surface provides an efficient curing. It is mostly used for curing floor slabs. The concrete should be allowed to set sufficiently before sprinkling is started.Thespraycanbeobtained fromaperforatedplasticbox. Onsmall jobssprinklingofwater may be done by hand. Vertical and sloping surfaces can be kept continuously wet by sprinkling water on top surfaces and allowing it to run down between the forms and the concrete. For this method of curing the water requirement is higher.

**4. Ponding method**

This is the best method of curing. It is suitable for curing horizontal surfaces such as floors, roof slabs,roadandairfieldpavements.Thehorizontaltopsurfacesofbeamscanalsobeponded.After placing the concrete, its exposed surface is first covered with moist hessian or canvas. After 24 hours, these covers are removed and small ponds of clay or sand are built across and along the pavements. The area is thus divided into a number of rectangles. The water is filled between the ponds. The filling of water in these ponds is done twice or thrice a day, depending upon the atmosphericconditions.Thoughthismethodisveryefficient,thewaterrequirementisveryheavy. Ponds easily break and water flows out. After curing it is difficult to clean the clay.

**5. Membranecuring**

The method of curing described above come under the category of moist curing. Another method ofcuringistocoverthewettedconcretesurfacebyalayerofwaterproofmaterial,whichiskeptin contact with the concrete surface of seven days. This method of curing is termed as membrane curing. A membrane will prevent the evaporation of water from the concrete. The membrane can be either in solid or liquid form. They are also known as sealing compounds. Bituminized water proof papers, wax emulsions, bitumen emulsions and plastic films are the common types of membrane used. Whenever bitumen is applied over the surface for curing, it should be done only after 24 hours curing with gunny bags. The surface is allowed to dry out so that loose water is not visible and then the liquid asphalt sprayed throughout. The moisture in the concrete is thus preserved. It isquiteenoughforcuring. Thismethodofcuringdoes notneedconstant supervision. It is adopted with advantage at places where water is not available in sufficient quantity for wet curing.Thismethodofcuringisnotefficientascomparedwithwetcuringbecauserateofhydration is less. Moreover, the strength of concrete cured by any membrane is less than the concrete which is moist cured. When membrane is damaged the curing is badly affected.

6. **Steamcuring**

Steamcuringandhotwatercuringissometimesadopted.Withthesemethodsofcuring,thestrength development of concrete is very rapid. These methods can best be used in pre cast concrete work. Insteamcuringthetemperatureofsteamshouldberestrictedtoamaximumof75$^0$Casinthe


ISBN:978-81-957858-1-0

absenceofproperhumidity(about90%)theconcretemaydrytoosoon.Incaseofhotwatercuring, temperaturemayberaisedtoanylimit,ay100$^0$C.Atthistemperature,thedevelopmentofstrength is about 70% of 28 days strength after 4 to 5 hours. In both cases, the temperature should be fully controlledtoavoidnon-uniformity.Theconcreteshouldbepreventedfromrapiddryingandcooling which would form cracks

**7. Plasticsheet**

Plastic sheet materials, such as polyethylene film, were used to cure the concrete cubes. Polyethylene is a lightweight, effective moisture retarder and was used easily applied to simple cubes shapes.


ISBN:978-81-957858-1-0

**LITERATUREREVIEW**

Thus, for complete and proper strength developments, the loss of water in concrete from evaporation should be prevented, and thewaterconsumedinhydrationshouldbereplenished.Thistheconcretecontinuesgainingstrengthwithtimeprovidedsufficient moisture is available for the hydration of cement which can be assured only by creation of favorable conditions of temperature and humidity. This process of creation of an environment during a relatively short period immediately after the placing and compaction of the concrete, favorable to the setting and the hardening of concrete is termed curing (Gambier, 1986).

Thenecessityforcuring arisesfromthefactthathydrationofcementcantakeplaceonlyinwater-filledcapillaries.Thisiswhy losswatermustbeprevented.Furthermore,waterlostinternallybyself-dedicationhastobereplacedbywaterfromoutside,i.e. Ingress of water into the concrete must take place. (Neville,et al,1987).

Curingofconcreteisaprerequisiteforthehydrationofthecementcontent.Foragivenconcrete,theamountandrateofhydration and furthermore the physical make-up of the hydration products are dependent on the time-moisture-temperature history (Neil Jackson et al, 1996

Concrete curing isoneof themost importantandfinalsteps in concrete constructionthough it isalsooneof the most neglected and misunderstood procedures. It is the treatment of newly placed concrete during the period in which it is hardening so that it retain enough moisture to immunize shrinkage and resist cracking (Lambert Corporation, 1999).

Apropercuringmaintainsasuitablywarmandmoistenvironmentforthedevelopmentsofhydrationproducts,andthusreduces theporosityinthehydratedcementspasteandincreasesthedensityofmicrostructureinconcrete.Thehydrationproductsextend from the surfaces of cement grains, and the volume of pores decreases due to proper curing under appropriate temperature and moisture (Safiudeen et al,2007).

A proper curinggreatly contributes to reduce theporosity and dryingshrinkage of concrete, and thus to achieve higherstrength and greater resistance to physical or chemical attacks in aggressive environments. Therefore, a suitable curing method such as water ponding (immersion), spraying or sprinkling of water, or covering with polythene sheet material is essential us order to produce strong and durable concrete.The study present the effect of different curing methods on the compressive strength of concrete using Portland cement and finally identifies the most effective curing process for normal concrete.

**MATERIALS AND METHODS**

Locallyavailablecrushedgranitestonesandfineaggregate(quartzitesand)wereusedascoarseandfineaggregaterespectively. Thefractionsofdifferentsizesofcrushed granitestoneandfineaggregates,asshown in Table1 werein therangesspecified in Bs 812 (1960) methods for sampling and testing of aggregates.Ordinary Portland cementwas used as the main binder.Portable water from borehole was used for preparing the concrete. It was also used for curing purposes. The major properties of the constituent materials are given in Table 2.

| SIEVESIZE | %FINERBYMASS | |
|---|---|---|
| | **Crushed GraniteStone**<br>**(Fineness Modulus:4:81)** | **Sand**<br>**(FinenessModulus:4.23)** |
| 28.00mm | 100 | |
| 20.00mm | 85.91 | |



ISBN:978-81-957858-1-0

| | | |
|---|---|---|
| 14.00mm | 19.86 | |
| 10.00mm | 10.82 | |
| 6.30mm | 1.28 | |
| .00mm | 0.29 | 99.48 |
| 3.35mm | – | 99.21 |
| 2.00mm | – | 98.47 |
| 1.18mm | – | 93.60 |
| 850µm | – | 86.97 |
| 600µm | – | 75.40 |
| 425µm | – | 56.62 |
| 300µm | – | 43.66 |
| 150µm | – | 13.53 |
| 75µm | – | 10.03 |
| Pan | – | 0.00 |

**Table1:Gradationofcrushedgranitestoneandquartzitesand.**

**Table 2: Properties of the constituent materials of concrete**

| **Materials** | **Properties** |
|---|---|
| **Crushed Granite Stone** | Max.size:20mm,unitweight: 434.50kg/$m^3$ Specific gravity: 2.68, Absorption:0.77%,Moisture content: or 14%, void ratio: 0.46, Porosity: 9.27% |
| **Fine Aggregate** | Max.size:5mm,unitweight: 518.70kg/$m^3$, Specific gravity: 2.77, Absorption:2.29%,Moisture content:4.71%, void ratio: 0.45, Porosity: 0.07% |



ISBN:978-81-957858-1-0

| | |
|---|---|
| **Ordinary Portland Cement** | SpecificGravity:3.15,unit weight: 1440kg/$m^3$ |
| **Borehole Water** | Density:1000kg/$m^3$,PH= 6.9 |

**MixtureProportionsofConcrete**

Thenormalconcretewaspreparedbasedonwatercementratioof0.50andacementcontentof340kg/$m^3$toobtainacompressive strength greater than20N/$mm^2$at 28days(Immersion methodof curing). Quartzite sandwas used with aquantity of33.33% of total aggregates by weight. The concrete mixture was proportioned to have a minimum slump of 48mm and also a minimum compacting factor or 0.94. The concrete mixture was assumed to be fully compacted and the proportions of the materials were determined on the basis of absolute volume of the constituents.

**Mixture Proportions of Concrete**

Crushed granite stone – 1360 Kg/$m^3$
Fine aggregate – 680 Kg/$m^3$
Ordinary Portland Cement – 340 Kg/$m^3$
PortableBoreholeWater-170Kg/$m^3$

**PreparationofTestSpecimens**

Atotalof48cubeshavingdimensions150mmx150mmx150mmeachwerecast.Thespecimensweremoldedinoiledtimbers mouldsusingthreelayersoffillingandeachlayertamped25timestoexpeltheentrappedair.Thetopsofthecubesweremarked after a while for identification purpose. Immediately after this, the specimens were kept in a cool place in the laboratory. The specimens were removed from the wooden moulds at the age of 24+ – 2 hours.

**Curing -**The test specimens were cured under three types of curing until the day of testing. These were water curing(WAC), sprinklingofwater(SWC)andwrappingwithplasticsheeting(PSC).Inwatercuring,thespecimensweremeighedandimmersed in water. Portable borehole water was used in water curing. In sprinkling method, the specimens were also weighed and kept moistbysprinklingwateronthespecimens2timesdaily(morningandevening)untilthedateoftesting.Inplastic sheeting,the specimensweremeighedandwrappedinflexibleplasticsheetsuntilthetestingdate.Atleast2layersofwrappingwereused to preventmoisturemovementfromconcretesurface.Thecuringtemperaturewasmaintainedat27+2$^o$Cinallthecuringmethods.

**COMPRESSIVESTRENGTH**

Theresultsofcompressivestrengthhavebeenpresentedintables4-9andinthegraphicalrepresentationofaveragecompressive strength versus curing age for different methods of curing used in the experiment (see fig 3). In all curing methods, the compressivestrengthoftheconcreteincreaseswithage.Thehighestcompressivestrengthatallageswasproducedbyimmersion (water) curing. The average compressive strength of watercured concrete was 13.56w/$mm^2$and 20.34 N/$mm^2$at 7 and 28 days respectively.Sprinklingmethodproducedcompressivestrengthclosetoimmersion(Water)curing.Sprinklingmethodproduced acompressivestrengthof12.25w/$mm^2$and18.38N/$mm^2$at7and28daysrespectively.Thedevelopmentofhighercompressive strength in immersion (Water) curing and sprinkling method of curing is credited to sufficient moisture and suitable vapor pressure, which were maintained to continue the hydration of cement.Plastic sheeting (membrane) method of curing produced thelowestcompressivestrengthatallages.Itcausedareductionincompressivestrengthof1.89N/$mm^2$and2.92N/$mm^2$at7and 28 days,respectively,ascompared to watercuring.Theearly dryingofconcrete stopped thecementhydrationbeforethe pores were blocked by adequate calcium silicate hydrate.

**CONCLUSIONS**



ISBN:978-81-957858-1-0

Curing with water wasthe mostefficientway.The resultwasthe highestcompressive strength ever recorded.Thisisbecause a higher degree of cement hydration response without moisture loss from the concrete sample leads to better pore structure and lower porosity.

Thereisasignificantincreasein compressivestrength whenusing thesprinkling methodof curing ascompared tocuring using plasticsheeting.Forthisreason—lessevaporationfromtheconcretespecimensandmorecementhydration—theplasticsheeting curingprocessyieldstheweakestcompressivestrength.Thisisbecausetheplasticcoveringapproachallowedmoremoistureto escape from the concrete specimen, leading to premature drying. As a result, the cement hydration reaction slowed down.

The degree ofmoisture transfer was highly sensitive to curing technique. The plastic sheeting (membrane)approachresulted in greater moisture migration, which negatively impacted the concrete's strength quality.•

To have the best hardened qualities, regular concrete must be cured by immersing it in water. Water curing prevents moisture loss, which improves the cement hydration reaction. Sprinkle curing can replace wrapped (plastic sheeting) curing if there is a water scarcity.

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ISBN:978-81-957858-1-0

# Analysis of Bamboo and Other Building Materials for Their Strength and Durability in Civil Engineering Structures

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[4]*Department of Management, PIT, Rajpura*

[5]*ChandigarhSchoolofBusiness,CGC,Jhanjeri* **Abstract**

Bambooisthewoodyplantthatgrowsatthequickestrateintheworld.Bamboohasagrowth rate that is three times that of most other species. Housing is one of the top items, and administrative authorities all over the world are finding it difficult to come up with a solution forthecurrent housing shortfall, despitethefact that theyareawareofthe lack. In addition to theothermaterials that arealready in use, bamboo appearsto bethemost promising material. The structural frame approach that is used in bamboo building construction is quite similar to the approach that is used in the design and construction of conventional timber frames. It has been demonstratedthat bamboo is suitablebecauseto its low weight, great strength, beautiful appearance,andlong-lastingnature.Thecharacteristicsoftheseanimalsvarygreatlyfromone another. The selection of the appropriate species of bamboo is the first step in developing a successful use of bamboo in engineering. As a result, identification of the many species of bamboo is essential prior to its effective application. Building applications have also made extensiveuseofit,includingasflooring,ceiling,walls,windows,doors,fences,housingroofs, trusses, rafters, and purlins. Additionally, it is utilized in construction as a structural material forbridges,watertransportationfacilities,andskyscraperscaffoldings.Thisstudyonbamboo can also contribute to sustainable development, which should take into careful consideration not only technology and economics but also the environment, culture, and traditions.

**Keywords:**Concrete,Bamboo,Reinforcement,Waterabsorption,Bonding strength.

## Introduction

The Industrial Revolution more and more new industrial materials have been invented and developedto meet the ever-growing needs of people in the industrial world. As a symbol of the industrialization cast iron and later steel have been developed and widely used in mass productionsincethemiddleofthe19thcentury.Nowpeoplecanfindthemeverywhere:from buildingconstructionintheindustrytothekitchenknifeinthehousehold.Anotherindustrial material–aluminum–hasbeenmassproducedandusedinindustrynomorethanonehundred years, butnow hastakenoverthe placeofsteelinmanyfieldsbecauseitisasstrongassteel,



ISBN:978-81-957858-1-0

butlighterComparedtosteel,cementsandplasticsbamboohasmanyadvantageslikestrength, elasticityandlightness,butalsodisadvantagesinprocessingandconnection:itstubestructure is very good for tensile and press loadings. At last they found bamboo which is used for replacementsofreinforcingbarin concrete forlowcost constructions.Bambooisavailable in commercialquantitiesusingtheestablishedsupplysystem.Itisarenewableplantwithashort rotationperiod.Bamboogrowstoitsfullsizeforaboutayear.Anothertwo orthreeyearsare required for the plant to gain its high strength. A natural material which is available in bulk andeaseofuseintheruralareasinthedevelopingcountriesisbamboo.Bamboosoccurmostly in tropical and subtropical areas, from sea level to snow-capped mountain peaks, with a few species reaching into temperate areas.

**Literaturereview**

**Fujji et al. [1993]** investigated the chemistry of the immature culm of a mosobamboo (*Phyllostachys pubescens Mazel*). The results indicated that the contents of cellulose, hemicellulose and lignin in immature bamboo increased while proceeding downward of the culm.Theincreaseofcelluloseinthelowerpositionwasalsoaccompaniedbyanincreasein crystallinity.

**Amada et al. (1997**) investigated the mechanical and physical properties of Bamboo. They conducted a thorough investigation into the structure and purposes of the nodes, which they foundto strengthentheBambooCulm.They also commentedon the advantageBamboohas over other natural buildingmaterials with its fast growth rate.

**Mardjono (1998)** provided research with the effort to give some sort of organization of a system to building with Bamboo between cultures, species, and countries having varying designs. The objective oftheir research was to improve the functions of Bamboo buildings bythisorganizationtoprovideprivacy,safety,comfort,durability,andaccessibility.Overall Bamboo used as a structural material suffers from an incredible disadvantage due to inadequate applied scientificresearch. They do feel that Bamboo productsshould bebrought to the level of acknowledged and received building materials. The results of their research will be published as a thesis and guide for designing Bamboo structures to be dispersed to peoplein developing countries.

**A study reported in International Standard Organization (ISO) (1999)** fashioned lab manual for determining the physical and mechanical properties ofBamboo. The purpose for publishing this manual is first of all so that these methods are available all over the world. Research is done in so many places, very precise, yet is stuck in the laboratories. With this document,themethodsaremade available.Secondly, thisdocument gives apractical step by stepexplanationofhowtoperformeachtestspecificallyfollowingtheInternationalStandard ComplementDocument "DeterminationofPhysicalandMechanical Propertiesof Bamboo." Another complement document is Bamboo Structural Design (1999).

**Janseen(2000)**conductedherstudy onbuilding with Bamboo.Thisbookcoveredawidevariety ofaspectsof



ISBN:978-81-957858-1-0

Bamboo going back to the structure of the plant and its natural habitat. It gives calculations to show why it"s economically competitive, mechanical properties, its many uses, its natural durability, and the preservation of the Bamboo. In much more detail, it discusses the joints and building with pure Bamboo. In relation to this project,herbookdoestouchonBamboousedasreinforcementinconcrete.Listedinherbookareseveralthings that are more of a hassle than steelreinforcement. Of those, the bonding between the Bamboo and concrete is considered the biggestproblem due to absorption of water and smooth wall**.**

**Power(2004)**tellsofastudyconductedbytheU.K.DepartmentofInternationalDevelopmentin responsetoa devastating earthquake that killed 40,000 peopleinIran.Theengineerswerelookingforcheapearthquake-proof housing to take the place of mud brick. They constructed a prototype Bamboo reinforced concrete house and used an earthquake simulator to find that the house stood sound during a

7.8 (on the Richter scale) earthquake. They found no cracking in the concrete, the Bamboo to be extremely resilient to earthquakes, and the cost to be split in half compared to mud-and-brick construction

**The American Bamboo Society (2005)** provided a very intricate collection of specialized terms followed by their definitions relating to Bamboo. It also has a glossary of questions and answers common to someone new to the topic. These questions rangedfrom identifying Bamboo, preservingBamboo,finding help with your Bamboo, to other topics not as closing connected to the research of this project.

**Atulagarwal andDamodarmaity(2009)** they studied axial compression and bending testwasperformed on Plain,Steel&Bambooreinforced members.Asexplained inthereexperimentalprogram,Forexample,atotal of12columns(150x150x1000mm)werecastedusingdesignmix(M20)asperIScode.Thesecolumnsincluded 3

oftheBamboo Culm

**Amada and Untao (2001)** mention that bamboo is themost effective material in construction by the superior character of bamboo such as being physically powerful, tough, and a low-cost material. Normally, the Culm of bamboo with outer surfacelayer withstand strongly to any loading with stronger fracture resistance than the node. It

suggests that the fibers in the node do not contribute any fracture resistance. The tensile strengthof bamboo fibers almost corresponds to that of steel. Themain discovery is that the fracture properties of bamboo depend upontheoriginoffracture.Inthenodes,itisfoundthatthe averagefracturetoughnessislowerthantheminimum value of the entire Culm, suggesting that the fibers in the node do not contributeany fracture resistance

**Seinfeld (2001)** researched the remarkablecurrent uses of Bamboo around the world. In the United States, it is almostcompletelyusedasdecoration.AdiscussionispresentedontheastonishingfeatureBamboobringstothe table as mentioned in otherarticles. Another special feature about Bamboo is that harvesting Bamboo does not harm theplant, producing more of its timbers. Bamboo buildings are definitely a prospect of the future in the US; however in Asia, the Pacific islands, and South & Central America, they are quite traditional. The main prevention of Bamboo structures in America are building codes. There are not standardized codes for buildings of Bamboo though there are attemptstowards them. Bamboo is also still being looked at asa way to clean environmental pollution. It is a consumer of Nitrogen, which could soon be part of a huge effort to prevent air pollution.

DESIGNSFORCONSTRUCTIONOFBAMBOOSCAFFOLDS

The commonly used bamboo types are Kao Jue and Mao Jue. They should be 3 to 5 years old and air-driedin verticalpositionsunderindoorconditionforatleast3monthsbeforeuse.ThenominallengthofbothKaoJueand Mao Jue is 6 m. All bamboo members should be free from visual defects, and meet the following requirements on the cross-sectional dimensions. This section provides detailed standards of design and construction of some typicaltypesofsinglebambooscaffold,includingdouble-layered,truss-outandsignboardbambooscaffolds.



ISBN:978-81-957858-1-0

Whentherecommendedstandardsgiveninthissectionarenotfollowedorwhenothertypesofbambooscaffold not covered in this section are used, they should be designed by a design engineer. For a bamboo scaffold for demolition.

CONCRETEMIXPROPORTIONS

The same mix designs can be used as would normally be used with steel reinforced concrete.Concrete slump should be as low as workability will allow. Excess water causes swelling of the bamboo. High early-strength cement is preferred to

Minimizecrackscausedbyswellingofbamboowhen seasonedbamboocannotbewaterproofed.

SIMILARITIES WITH STEELREINFORCED CONCRETE

Bambooreinforcedconcretedesignissimilartosteelreinforcingdesign.Bambooreinforcementcanbeassumed to have the mechanical properties.hen design handbooks are available for steel reinforced concrete, the equations and design procedures can be used to design bamboo reinforced concrete ifthe above mechanical properties are substituted for the reinforcement. Due to the low modulusofelasticity of bamboo, flexural memberswillnearlyalwaysdevelopsomecrackingundernormalservice loads.Ifcrackingcannotbetolerated, steelreinforceddesignsordesignsbasedonunreinforcedsectionsarerequired. Experiencehas shown that split bamboo

works, irrespectiveofitssize,thedesignengineer should also ensure the bamboo scaffold is capable to withstand the increased wind load acting on the plasticsheeting.

# SteelBracketsScaffolds

Steel brackets are essential to the overall stability of a bamboo scaffold. The details of a steel bracket for the support of posts of a bamboo scaffold for constructionsite. All steel brackets should be securely mounted onto thestructuralelementsofabuildingwithhigh qualityanchorboltsandcomplywiththefollowing requirements. The horizontal spacing between the steel brackets should not be larger than 1.3m;and the concrete strength of the structuralelement to which the steel bracket is fixed should be not less than 25 N/mm2. All anchor bolts shouldbeinstalledstrictlyinaccordancewiththemanufacturer'srecommendations.Theremaybeoccasionsthat apostofabambooscaffolddoesnotrestonthesteelbracket;thedesign engineershouldensurethattheloading from the misaligned post can be effectively transferred to the steel bracket

# 3.1.1GuidelinesforBambooScaffolds

Performance
DesignEngineer
DrawingsandSpecifications Engineering

Justifications

Performs better than whole culmswhen used asreinforcing.Better bond develops betweenbambooand concrete when the reinforcement is-split inaddition to providing more compact reinforcement layers.

CONCLUSIONS

The addition of bamboo to concrete as a reinforcing material. It hasbeen demonstrated that bamboo can replace steel in the construction of basic houses for urban poor people who reside in close proximity to places where bambooisgrown.Thesamemethodofbambooreinforcementthatwasutilizedpreviouslyforsteelreinforcement isnow beingused forboththemain andthedistributionreinforcement.The structuralbehaviorof the reinforced concretebeamcanbestrengthenedbyutilisingbamboosticksasaretrofittedmaterial.Bamboohasahightensile strengthandcanbeutilizedasareplacementmaterialforsteelreinforment duetothefactthatitislessexpensive.



ISBN:978-81-957858-1-0

The approach of using bamboo as reinforcement is employed for both the main and distribution reinforcement, just like how it was previously done with steel reinforcement.The elasticity modulusof bamboo is significantly lower than that of steel.

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ISBN:978-81-957858-1-0

# AReviewofGreenConcrete–FutureofConstruction

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**Abstract**

Green concrete has a major impact on sustainability. Concrete is the most used material on earth. Construction The industry is growing fast and new technologies are developed very quicklytoovercomevariousdifficultiesinconstructionIndustry.Amongallmaterialsusedin constructionIndustrialConcreteisthemainmaterialforconstructionpurposes.Billionsoftons are mined for the natural material Concrete production that leaves enough signs on the environment.NowadaysrecyclingandwasteIndustrialproductsarebecomingmoreandmore popular for concrete production.They can be called environmentally friendly materials and concretelikegreenconcrete.ThisreviewdocumentgivesusabriefoverviewAlsoonthepros and cons of green Solid.

## Introduction

Cement is made from concrete waste which they are the so-called environmentally friendly green concrete. The other name for green concrete is resource-saving structures with reduced Environmental impact for example energy saving, CO2 emissions, wastewater, net emissions reductionfromproduction.Greenconcreteisarevolutionarytopicinthehistoryoftheconcrete industry. Dr. WG. Was the first inventor and give this theory in Denmark in 1998.

## Reasonbehindgreenconcrete?

- Greatimpacton sustainability
- Themostwidespread materialon earth
- 30%ofallmaterialsflowon earth
- 70%ofall materialsflowinto thebuilt environment.
- 2.1billion tons per year.
- >15billiontonsarecasteachyear.
- Over2 tonsper personper year

## Whatis GREEN concrete?



ISBN:978-81-957858-1-0

Most people associate it with GREEN concrete Colored concrete with pigments. However, it is too indicated, that it has not yet hardened. But within the scope of in this context, green concretemeansenvironmentallyfriendlyFriend concrete.Thismeansconcretethatconsumes lessenergyinitsproductionandproduceslesscarbondioxidethannormaltheconcreteisgreen concrete.EngineersandarchitectshaveChoosingthematerialsandproductstheyusetodesign Projects: When it comes to building structure, the choice is yours typically between concrete, steel and wood. Material selection depends on several factors including initial cost and life cycle cost and performance for a specific application. Because of the growth Interested in sustainabledevelopment,engineersandarchitectstheyaremoremotivatedthanevertochoose materials that they are more sustainable. However, such a choice is not so straightforward forward such as selecting an Energy Star rated device or a High fuel consumption vehicle. engineersand Architects can comparematerials and chooseonethat is morebesustainableor specifyabuildingmaterialassuchminimizetheenvironmentalimpact?NewfocusonClimate changeandtheimpactofgreenhousegasemissionsonourenvironmenthasledmanytofocus onCO2-Emissionsasthemostcriticalenvironmentalimpactindicator.Lifecycleassessment (LCA) is the parameter; the construction industry should deal with this. LCA considered Materials for the entire life cycle including material extraction, production, construction, operation and possibly reuse/recycle. Concrete is one of them the most common construction in theworld Material. High quality concretethat meets specifications requires a newstandard of process and material control Optimization. Concrete is increasingly recognized its strong environmental benefits supporting creativity and effective sustainable development. The concrete is significant Benefits of sustainability.

Themaincomponentofconcreteiscementanditismadeupoflimestone(calciumcarbonate $CaCO_3$). While manufacture of cement, the ingredients of which are heated to approx. 800 - 1000°C.Duringthisprocess,carbondioxidecrazyAbout1kgofconcreteisreleased900gof carbon dioxide in the atmosphere.

**Characteristicsofgreenconcrete:**

Cementproductionaccountsformorethan6%.CO2emissions,whichareanimportantfactor worldwideheating (greenhouse gases). India is the third largest cement Producer in the world andoneofthelargestconsumersofcement percapitaintheworld. Approximatenumbersare India consumes about 1.2 tons/year/capita while as world the average is 0.6 tons/year/head. Therewereanumberof Effortsto reduceCO2emissionsfromconcretemainlyduetotheuse ofsmallerquantitiesofcementandthelikelargerquantitiesofadditionalcementitiousmaterial (SCM) such as fly ash, blast furnace slag etc. $CO_2$ emissions of 1 ton of concrete produced vary between 0.05 and 0.13 Metric tons. 95% of all $CO_2$ emissions from one cubic meter Concrete come from cement production. Its important Reduction of $CO_2$ emissions thanks to the increased use of SCM.

**a- Cement:**



ISBN:978-81-957858-1-0

Most of the CO2 in concrete comes from the cement manufacturing process. A typical cubic meterofconcretecontainsabout10%byweightofcement.Ofalltheingredients,cementemits themostcarbondioxide.Thereactioninthecementproductionprocessis:$CaCO_3=CaO+CO_2$

**b- Aggregate:**

The use of virgin aggregate contributes about 1% to all CO2 emissions from a typical cubic meter of concrete. Therefore, the use of alternative aggregates is desirable. The use of local and recycled aggregates is as desirable as possible Reduce transportation and fuel costs and provides sustainable support Development.

**c- Resources:**

The growing shortage of natural aggregates and sand is another aspect that the construction sectormusttakeintoconsideration.Whilethisdoesn'tappeartobeapriorityissue,pressureis by environmentalists and conservationists around the world continue to encourage both legislators and the construction industry Engineers looking for valid alternatives to natural resources. Using recycled materials like aggregates and water is something Ingredient that should be promoted due to fresh resources they are becoming increasingly scarce.

**Greenconcrete:**

Identify the most appropriate mix based on the Specifying or suggesting improvements in the mix are as well can help with the most suitable concrete for the project. Cement that can fall into the category of "green musts" the following properties.

- Optimizethe useof available materials
- Better performance
- Improvedprocessability/cohesiveconsistency
- Reducedshrinkage/creep.
- Durability–Betterconcretelife
- Reductionofthecarbonfootprint
- Nocostincreases
- CertifiedLEEDIndia

**Materialsforgreenconcrete:**

Green building materials are made of renewable rather than non-renewable resources. Green the materials are ecological because they have an impact are considered for the entire life of theproduct.Dependingon specificprojectgoals, greenmaterialsmayincludeoneEvaluation of one or more of the following criteria.

- Available on site: building materials, Components and systems found on site or regional, saving energy and resources Transportation to the project site.



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- Rehabilitated, Refurbished or Rebuilt: Includes saving a material before disposal e renovate, repair, restore or in general Improved appearance, performance, quality, functionality or value of a product.
- Reusable or recyclable: Choose materials that can easily disassembled and reused or recycledend of their useful life. Recycled materials that industry has found to work advantageousinplaceofconventionalmaterialsare:flyash,blastfurnaceslag,recycled concrete, Construction rubble, micro silica, etc. Generation and use of recycled materialsvaryfromplacetoplaceandfromtimetotimeintermsoftimedependingon locationandconstructionactivityaswellasthetypeofconstructionprojectataspecific location.Thefollowingmaterialscanbeconsideredinthiscategorytheyarediscussed here.

  A. Recycleddemolitionmaterial

  B. Recycledconcrete aggregate

  C. blastfurnaceslag

  D. Processedsand

  E. Glassaggregate

  F. Flyash

  Theyaredividedintoconcrete,cementmaterial,coarseandfineaggregate.Your definitions are as usual.

EnvironmentalbenefitsofusinggreenconcreteGeopolymerconcreteorgreenconcreteispart of it a movement to create building materials that a less environmental impact. It consists of oneCombinationofaninorganicpolymerand25to100percentindustrialwaste.Hereisalist of 4 benefits of using greenery

Concreteforyournextproject.

**1. Lasts longer**

Greenconcretegainsstrengthfasterandhasalowershrinkageratethanconcretealone Portland cement.Structuresmadewithgreenconcreteabetterchanceofsurvivingafire(canwithstand temperatures up to 2400 degrees on the Fahrenheit scale). It also has greater resistance to corrosion important with the impact of pollution on the Environment (acid rain reduces the longevityoftraditionalbuildingmaterials).Allofthesefactorsaddupabuildingthatwilllast much longer than what it was built with ordinary concrete. Similar concrete mixes have been madefoundinancientRomanstructuresandthismaterialwasalsousedinUkraineinthe1950s and 1960s. Over 40 years later these Ukrainian buildings are still standing. Whether to build they don't have to be constantly rebuilt, less construction sites Necessary materials and environmental impact during the manufacturing process of these materials is reduced.



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**2. Useindustrial waste**

Insteadofa100%Portlandcementmix,greenconcreteusesanywherefrom25to100percent flyAsh.Fly ashisabyproductofcoalburninganditisfromthechimneys ofindustrialplants (e.g. - power plants) that use coal as an energy source. There are large quantities of this industrialwasteproduct.HundredsThousandsofacresoflandareusedforflyashdisposal.A sharp increase in the use of fresh concrete in construction it will provide a way to use up the fly ash and hopefully release a lot of it morning country.

**3. Reducesenergyconsumption**

If you use less Portland cement and more fly ash you consume less energy when mixing concrete. The materials used in Portland cement require tremendous effort Amount of coal or naturalgastobeheatedtotheappropriatelevelTemperaturetoturnthemintoPortlandcement. Fly ash therefore it already exists as a by-product of another industrial process they don't consume much more energy to use to create green concrete.

AnotherwaygreenconcretesavesenergyConsumptionisthatabuildingbuiltfromitismore resistanttotemperature changes.An architect can usethisanddesigngreen concretebuilding to consume energy heat and cool more efficiently.

4. **ReducesCO2 emissions**

To make Portland cement–one of the most important Ingredients in common cement - powderedlimestone,clay,andsandareheatedwithnaturalgasorto1450degreescoalasfuel. Thisprocessisresponsiblefor5to8percentofallcarbondioxide($CO_2$)emissionsworldwide. TheProduction offresh concretehas up to 80 percent less $CO_2$emissions.Aspartofaglobal effortReduceemissions,gocompletelygreenConcreteforconstructionwillhelpsignificantly.

**ProductionofGreen Concrete**

Concrete with inorganic residual products. Ceramic waste used as green aggregate. By replacing

Cement with fly ash, micro silica in larger quantities. To Development of new green cements and binders (e.g. by increasing the use of alternative raw materials and alternative fuels and through the development/improvement of cement low energy consumption). Use leftover products from the concrete industry, I. H. Stone dust (from the crushing of aggregate) and concrete sludge (from washing mixers etc

Other equipment). To use new types of cement with reduced inputs Ecological damage. (Mineralized cement, limestone additionally, fuels obtained from waste).

**Greenlightweight aggregates**

Synthetic lightweight aggregates made from Environmental waste are a viable new source of structural aggregate material. The use of lightweight structural quality Concrete reduces the deadloadofastructuresignificantlyandenablesthehandlingoflargerfinishedparts.Water



ISBN:978-81-957858-1-0

absorption of the green aggregate is large, but the breaking strength of the resulting concrete can be high. The 28 Day Cube Compressive strength of the resulting lightweight aggregateConcrete with a density of 1590 kg/m3and corresponding strengthof 34 MPa. Most normal weight aggregates are normalWeight Concrete is like limestone and natural stone Granite.

**SuitabilityofGreenConcretein Facilities**

Reducing the dead weight of a 5 ton façade about 3.5 tons. Reduce crane age load, allow handling, Lifting flexibility with less weight. Good thermals and fire Resistance, acoustic insulation compared to traditional granite rock. Improves the damping resistance of the building. Speed of Construction, shortens overall construction time.

**Advantages**

Advantageof greenconcrete:

Therewillbebettercohesion,soeasytouse-easiertomakeplacing,compactingandfinishing theconcrete.ItcanbeseeninconcreteDropindicatedinFigure13.Someotheradvantagesof such Mixes are:

- Optimizedcompounddesign meanseasierhandling,bettertexture andeasierfinishing
- Reductionofshrinkage and creep
- GreenConcreteuseslocalandrecycledmaterialsintheconcrete.Theheatofhydration of fresh concrete is significantly lower than with conventional concrete
- ThisresultsinaloweroveralltemperaturerisePourconcrete,whichisakeybenefitfor green concrete.

Improvedtechnicalfeatures:

- MixingcanleadtoareductioninthevolumeofthepasteinsidetheConcretestructure, resulting in a higher level Protection against concrete damage.
- Increasedstrengthperkilogramofconcrete
- Increaseddurabilityandreduced permeability
- Moreaggregateusuallymeanshighermodulusthan Elasticity.

**Restriction**

Usingstainlesssteelcostofreinforcementincreases.Havestructuresbuiltwithgreenconcrete relativelyshorterservicelifethandesignswithconventionalonesConcrete.Thecrackingstress of fresh concrete is lower than that of conventional concrete.

**ReachedTo India**

Greenconcreteisarevolutionarytopicinthehistoryoftheconcreteindustry.B.Freshconcrete isproducedCementwastetakeslongertoarriveinIndiabecauseindustrieshaveproblems



ISBN:978-81-957858-1-0

disposing of waste. Also with reduced environmental impact thanks to the reduction of $CO_2$Emission.

**CONCLUSION**

Green concrete with low environmental impact Effects in $CO_2$reduction of the concrete industry 30% commissions. Green concrete is good thermal and fireproof. In this concrete recyclinguseofWastematerialsuchasceramicwaste,aggregates,etcIncreasetheuseofwaste productsintheconcreteindustryby20%.Therefore,greenconcreteconsumeslessenergyand becomes economically. So make sure you use concrete products like green concrete of the futurewill not only reduce$co_2$ emissions in theenvironment and environmental pollution, but also produce economically.

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ISBN:978-81-957858-1-0

## AReviewofSeismicEffectsonShearWall

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**Abstract**

Adevastatingearthquakeisthemostdangerousandupsettingnaturalcalamitythereis.Ifyou're buildingamultistoryprojectthatneedstowithstandearthquakes,shearwallsareyourbestbet. Shearwallsareusedtoresistforcesthatareperpendiculartothewall'splaneandcanbefound anywhereinabuilding,fromthebasementtotheroof.Inordertocounteractthelateralstresses generatedbynaturaldisasterslikeearthquakesandhighwinds,structuralelementscalledshear walls are installed. This document summarizes the findings of several studies on the topic of multistorybuildingswithandwithoutshearwalls.MostbuildingsinIndiaarebuiltwithshear walls to withstand earthquakes. All buildings have structural walls, but their design and function vary, and their placement determines how well those walls resist lateral stress**.**

**Keywords:**ShearWall, Non-ShearwallBuilding,Earthquake,LateralForcesetc.

### Introduction

Earthquakesingeneralhavealonghistoryofwreakinghavoc.Essentially,theresponseofthe structure to ground motion is an important factor to consider when analyzing and designing any earthquakeresistant structure. Theloadsorforces that astructuresubjectedto earthquake motions is required to resist, as well as the distortions caused by the movement of the ground on which it rests. Earthquakes can be measured in terms of energy release i.e., measuring amplitude, frequency, and location of seismic waves and also by evaluating intensity i.e., consideringthedestructiveeffectofshakinggroundonpeople,structuresandnaturalfeatures. A building's properties include lateral stiffness, lateral strength, and ductility. Although the stiffness ofthebuilding decreases with increasing damage, lateral stiffness refersto theinitial stiffnessofthebuilding.Lateralstrengthisthemaximumresistancethatabuildinghasoffered to relativedeformation overits entirehistory.The ratio ofmaximum deformation to idealized yielddeformationisreferredtoasductilitytowardslateraldeformation.Exceptincantilevers, theeffectoftheverticalcomponentofgroundmotionisgenerallyregardedasinsignificantand is ignored.

### Shearwall and its properties

A shear wall is a structural member located in various locations throughout a building, from the foundation level to the top parapet level that is used to resist lateral forces, i.e., forces paralleltotheplaneofthewall.Shearwallscanbebuiltfromavarietyofmaterials,but



ISBN:978-81-957858-1-0

reinforced concrete (RC) buildings frequently include vertical plate-like Reinforced concrete walls(Figure1)inadditiontoslabs,beams,andcolumns.Inhigh-risebuildings,theirthickness canrangefrom150mmto400mm.Shearwallsaretypicallyinstalledalongboththelengthand width of building.

Thesewallsaremoreimportantinseismicallyactiveareasbecauseshearforcesonthestructure increaseduringearthquakes.Shearwallsshouldbestrongerandstiffer.Shearwallsarestrong andstiffenoughtocontrollateraldisplacements.Shearwallsserveadual purposeinthatthey serve as both lateral and gravity load-bearing elements. Concrete shear wall structures are typically regular in plan and elevation.

**PURPOSE**

Thesewallsaremainly used

- Toresistlateralloadsofearthquakeandwind.
- Toresistgravity orvertical loadsduetoits self-weightand otherliving ormoving loads.
- Toresistshear aswellas upliftforcesonthe building.
- Toenhancethestrengthand stabilityofa structure.
- Toprovide adequatestiffness tothe structure.



ISBN:978-81-957858-1-0

Figure1:-Shear wallin building

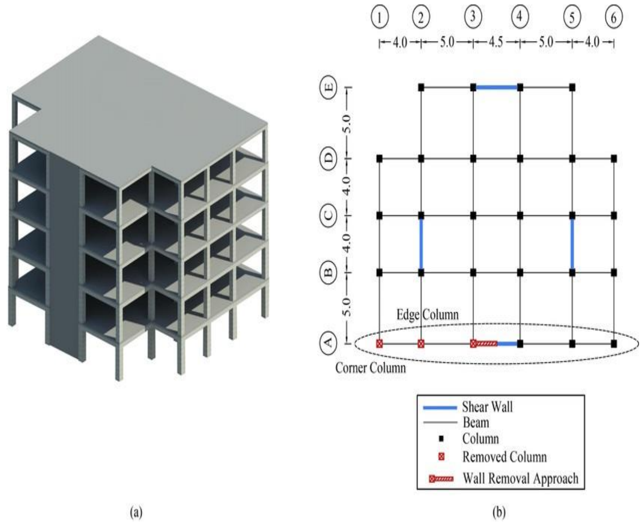


*Figure1:-Shear wallin building*

FORCESONSHEARWALL

Thesewallsmainlyresisttwotypesofforces;

1. Shear Force:Shear forces are generated in buildings due to ground movement and lateral forcessuchaswind,wavesandearthquakes.Theseforcesactthroughouttheheightofthewall between the top and bottom wall connections.

2. Uplift Force: Uplift forces are produced on shear walls due to horizontal forces act on the top of the wall. These forces lift up one end of the wall and push the other end down.

ADVANTAGESOFSHEARWALLSINRCSTRUCTURES

- Shearwallsareresistingtohorizontallateralforce andearthquakes.
- Ithashighin-planestiffnessandcan resistlateralloads.
- Shearwallshelpinthecontrolof deflectioninverticalandlongitudinal directions.
- RCCshearwallsaresimpleforreinforcementdetailing
- Itreducesearthquakedamageto alltypes ofstructural andnon-structural structures.
- Well-designedshearwallsnotonlyprovideadequatesafety,butalsoahighlevelofprotection against costly non-structural damage during moderate seismic events.



ISBN:978-81-957858-1-0

LITERATUREREVIEW

Concrete shear walls are the most common and useful shear wall type for any multistory building. Many researchers and scholars have studied the shear wall configuration in any building and the different types of shear walls. The resistance of a shear wall to lateral forces generated by an earthquake and wind force is studied. An effort was made to study these literatures and reach a conclusion on this topic.

**Dr.B.Kameshwari et.al**[1] analyzes the impact of erosion and erosion between the floor of the building on the various configurations of shear wall panels on high-rise buildings. The blank frame is compared to various configurations such as i) Normal shear wall ii) Different shear walllayoutiii)Diagonallayoutofthebarberwindowiv)ZigZaghaircutarrangementv)Impact of lifting the middle barber wall. From the study it was found that the Zig Zag shear wall improvesthestrengthanddurabilityofthestructurecomparedtoothermodels.Inearthquake- prone areas the shear diagonal wall has been found to work well in the building.

**B.R.Reddyet.al**[2]useStaddProsoftwaretoanalyzeanddesignearthquake-resistantstructures using Shear wall. According to their research work, the construction made of shear walls not only provides extra strength but also increases the strength limits and efficiency of horizontal loads. Shaving walls have unusual behavior on a variety of loads. The research project was approved at theVITS block collegebuilding, Deshmukhi town Hyderabad using ashear wall. The behavior of the structure was assessed for the strength of the element, the reaction, the shearing center, the shear strength and the bending moment. A shear wall solution in a multi-storeybuildingbasedonbothstretchableandelas-to-plasticbehaviorwasalsoconsidered.The number of earthquakes was calculated and used in the same 3-storey building with 3 floors. Theresults ofthemodels arecalculated and analyzed fortheeffective area of thebarberwall. Aftercomparingtheresultitwasfoundthattheprovisionofashearwallforthisbuildingwould make the building completely resistant to earthquakes in zone II

Hyderabad.InadditiontothefactthatthemanualandSTAADProresultsarealmostidentical, the STAAD Pro results save a significant amount of reinforcement.

**P. Chandurkar et.al.**[3] investigated a building with Shear wall and outside Shear wall was considered and compared. As their research work The building walls provide an efficient binding system and provide great strength to withstand side load. The structures of these seismic shear walls control the structural response; therefore, it is important to evaluate the seismic response correctly. According to their research, the main focus was on finding a solution for the barbecue area in a multistory building. The function of the barber wall was studied with the help of four different models. One model was a blank frame structure system andtheotherthreemodelswereatwo-dimensionalstructure.Whiletheseismicloadisusedin the construction of the ten stories found in zone II, zone III, zone IV and zone V, parameters suchasLateralmigration,storyfloodingandthetotalamountofcostrequiredfortheground



ISBN:978-81-957858-1-0

floor were calculated in both column-changing cases. . E-Tabs software accepted for review. Fromtheanalysis,itisnotedthatinthe10-storybuilding,buildingabarbed-wirebuildingina short corner (model 4) will be economical compared to other models. So the large size of the barber wall does not apply to 10 cases or to less than 10 buildings. It was noted that the shear walliseconomicalandeffectiveinhighconstruction.Fromtheresearchworkitwasnotedthat changing the location of the shear wall will affect the attraction of energy, so that wall should be in the right condition. And if the shear wall size is large then a large amount of horizontal force is taken by the shear wall. Providing shear walls in adequate areas greatly reduces migration due to earthquakes.

**M.D.KevadkarandP.B.Kodag[4]**performedalateralloadanalysisoftheR.C.C.Build(G+ 12)byconsidering3models.Inthismodel1ithasnobracingandshearwall,thesecondmodel with a different shaving wall system and the 3rd Model with Different bracing system computer-assistedanalysiswasperformedusingE-TABStodeterminetheeffectivebackload systemduringmajorearthquakes.places.PropertyperformanceisassessedintermsofLateral Displacement, Storey Shear and Storey Drift, Base shear and Demand Capacity (Workspace).

**Anshuman.S et al.[5]** determined the shear wall solution in a multi-storey building based on its elastic and elastoplastic behavior. The magnitude of the earthquake is calculated and applied tothe15-storybuildinginzoneIV.Theelasticandelastoplasticanalysiswasperformedusing both the STAAD Pro 2004 and SAP (2000) software packages. The shear strength, bending timeandscalingofthestorywerecalculatedinbothcasesandthelocationoftheshavingwall was established based on the results.

**Romy Mohan et al.[6]** presented Dynamic Analysis of RCC buildings with Shear Wall. for analysis consider the two multi storey buildings, one of six and other of eleven storeys have been modeled using softwarepackageSAP 2000forearthquakezoneVin India.Six different types of shear walls with its variation in shape are considered for studying their effectiveness in resisting lateral forces. This paper also deals with the effect of the variation of the building height on the structural response of the shear wall.

**Manoj S. Mendhekar et.al.[7]** mentioned ways in which the economy could be achieved to withstandtheburden ofthepartiesin amulti-storeybuilding.Intheirstudy, seismicbehavior, mechanisms of failure, and factors influencing structural responses were discussed. Many expressions were developed to measure the flexible strength of the smaller rectangular wall sections with straight reinforcement evenly distributed. In this study various aspects of the designanddesignofthebarbersarediscussed,anddifferenttypesofbarbersarediscussedand their methods of failure. Algebraic expressions for calculating the flexibility of the shear wall sectionsweredevelopedandatemporaryinteractiveloadingdiagramwasdevelopedusing



ISBN:978-81-957858-1-0

theseexpressions. The results of both approaches have been quite positive. Also the details of the composite wall were also mentioned and the difference between the solid shear wall and the jointed wall (open bar wall) was investigated. And the power-calculating relationships on the shaving wall of its design are shown. From their research it became clear that parts of the wall of the shear flange were expanded to be analyzed and designed and are very suitable.

**Syed.M.Katamiet.al**[8]presentedtheresultsoftimehistoryanalysiswhichaddressedtheeffect of openings in shear walls near- fault ground motions. A model of ten storey building with three different types of lateral load resisting system: Complete shear walls, shear walls with square opening in the centre and shear wall with opening at right end side were considered. Fromtheresultsitwasobservedthatshearwallswithopeningsexperiencedadecreaseinterms ofstrength.Themaximumlateraldisplacementofcompleteshearwallis17%lessthanthatof shear walls with openings at centre whose displacement is found to be 8% less than that of shear walls with openings at right end.

**VenkataSairamKumar.Net.al.**[9]reviewedvariouspapersonshearwallsandstatedthatshear walls are structural systems which provide stability to structures from lateral loads like wind, seismicloads.Thesestructuralsystemsareconstructedbyreinforcedconcrete,plywood/timber unreinforcedmasonry,reinforcedmasonryatwhichthesesystemsaresubdividedintocoupled shear walls, shear wall frames, shear panels and staggered walls. The paper was made in the interest of studying various research works involved in enhancement of shear walls and their behaviour towards lateral loads. As shear walls resists major portions of lateral loads in the lower portion of thebuildings and the frame supports the lateral loads in the upper portions of buildingwhichissuitedforsoftstoreyhighrisebuilding.Buildingwhicharesimilarinnature constructed in India, as in India base floors are used for parking and garages or officers and upper floors areused for residential purposes. They have concluded with a broad note that researches was carried mainly on application of cyclic load tests and behaviour of different typesofshearwallsincyclicapplicationofloads.Researchersstudiedvariousparameterslike enhancement of stiffness, drift, development forces in buildings and also to observe perfect location of shear wall location in building frame for construction. It was seen that any type of building which is tall and can be affected with lateral forces like earthquake and wind forces can be constructed with shear walls. Shear walls can be used as lateral load resisting systems and also retrofitting of structures. Internal shear walls are more efficient than external shear walls when compared with cyclic load tests by researchers.

**Varsha.R.Harne**[10] considered a six storey RCC building which is subjected to Earthquake loading in zone IIto determine the strength of RC wall by changing the location of shear wall using STAADPro. Seismic coefficient method is used to calculate the earthquake load as per IS1893– 2002(PartI).Fourdifferent modelslikestructurewithoutshearwall,structurewith L type shear wall, structure with shear wall along periphery, structure with cross type shear wallweremodeledforanalysis.Comparedtoothermodelstheshearforceandbending



ISBN:978-81-957858-1-0

moment,forstructurewithshearwallalongtheperipheryisfoundtobemaximumattheground level and roof level respectively. Hence the shear wall provided along the periphery of the structure is found to be more efficient than all other types of shear wall.

**Bhruguli H. Gandhi**[11] explored the behavior of the barber wall openings under the action of an earthquake load. In this study, it is said that barbering walls are usually found on the sides of buildings or arranged in the form of a staircase that holds stairs and elevators. Due to operational requirements such as doors, windows, and other openings, the barber wall in the buildingcontainsmanyholes.Mostapartmentbuilding,sizeandopeningsintheshearwallare madewithoutconsideringitseffectonthebehaviorof thebuildingstructure. Inthisstudy,the study was performed on 6-story frame-shear wall structures, using a straightforward stretch analysiswiththehelpofalimitedobjectsoftware,StaddProunderearthquakeloadsinthesame vertical analysis. Six types of models were created and analyzed, from the beginning, Concentric 20% opening, 40% focus opening, 50% focus opening, 60% focus opening, Eccentricopening20%,Zigzagopening-20%.Theresultsrevealthatthestrengthandvibration ofbuildingsareaffectedbythesizeofthespacesandtheirlocationsonthebarbecuewall.Itis alsotestedthat thehighlateralinclinationofthesystemcan alsobe reducedbythickeningthe element in the model near the opening of the shaft wall. From a survey percentage of opening increases deviation up to 40% on average but after that as the opening percentage increases deviation increases much faster. At 20% opening the Eccentric zigzag has a slight deviation and the Eccentric Straight has a higher deviation and the loaded load has a smaller deviation than the Eccentric Straight. And the opening raises the lower pressures also increases equally by up to 40% and then after the Stresses increase significantly.

**S.M. khatami et.al.**[12] investigateted the effect of flange thickness on nonlinear behavior of flanged shear walls. Four T-shape flanged shear walls were studied and analyzed using finite elementmethod.Thetotalvolumeofeachmodelissimilar,suchthatwhenthicknessdecreases in the model, the length of wing increases. The results indicated that in thepresence of lateral loads,thethicknesshasasignificanteffectontheshearabsorption,ductility,displacementand crack pattern of the flanged shear walls. Numerical results show that shear walls with thick flanges behave more efficient than walls with thin flanges. It was found that, lateral strength resisted by shear walls with thin flanges is 1250 kN which is 14 percent decrease compared withthickflangedwall.Moreover,nonlinearbehaviorofflangedshearwallwiththickflanges showsthatstrengthandductilityareequivalent.Finally,theanalysesindicatedthatwhileflange is in pressure, the global behavior is much more improved compared with condition which is in tension. The comparison of models indicated that finite element model used in thisstudyis capable ofpredicting the nonlinearbehaviorofthe models when these aredifferent thickness. Resultsofanalysisinfourmodelsandload-displacementofthemindicatedthatmodelnamed -2500TSW had better behavior. It had resisted about 1248 kN. This load is 14% higher than othermodels.Also,ductilityofthismodelshowedagoodagreement.Ductilityinthemodel-



ISBN:978-81-957858-1-0

2500TSWmodelis4.58whichis3%higherthanmodel-3100TSW.Resultsofanalysisshowed that model-3100TSW had better strength after yield, which was 18% higher than model-2500TSW. Crack pattern in all of models showed that increase of thickness could decrease crack in shear wall.

CONCLUSIONS

It can be deduced from the aforementioned research that numerous scholars have investigated various earthquake-related issues and agreed that shear walls are the most effective means of mitigating the effects of lateral force during an earthquake. Manual research is supplemented with computational analysis using programmes like StaddPro and Etabs, among others. To determine where in the building shear walls can be placed to minimise the structural displacement caused by the walls, models are produced. Researching shear wall buildings raisesconcernsaboutopeningsintheshearwallaswell.Openingsinshearwallstendtocause building displacement. Other studies also found that the attractive forces changed when the shearwall'spositionchanged.Nobuilding'sshearwalllocationismorereducesdisplacements and reduces impact on the structure. Thus building without shear wall is a subject of concern and need to be retrofitted in places of high earthquake and wind impact.

Future scope of studying this type of research work is an essential part of this review paper. Study of effect of shear wall building and without-shear wall building can be studied further byintroducingaflangetocolumn.Comparisoncanbemadewithabuildingwithoutshearwall, with shearwall and with column flanges typestructure. Moreoverplacement ofshear walls at different locations is an essential aspect to be thought of for further study.

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ISBN:978-81-957858-1-0

# Application of Password Security Techniques for implementation of cyber security

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**Abstract**

It is very difficult to secure passwords from hackers in this era because there are many tools present in the hacking world. In this paper I have discussed about the types of passwords and lengths of passwords chosen and the ones which should not be used, the type of passwords which are comparatively safer to use and the most common cracking techniques in use. The measureswhichcanbeappliedinordertosecureourpasswordshavealsobeendescribedhere. Ihaveincludedalgorithms which ambushed to secureourpasswords. Themethods by which we can secure our passwords from attacks have also been described here. In this paper I have included the types of Wi-Fi passwords.

**Keywords:**Password,Safety,Privacy,Access,Safety,Algorithm,Hacking,Cracking

## Introduction

A password is a set of characters used for user authentication to prove identity or access approvaltogainaccesstoaresourcewhichistobekeptsecretfromthosenotallowedaccess. We can't store password in plain text because of cyber threads. To secure our password from variouscyberthreadsweusemanymethodsandconceptslikealgorithmsHashingisatypeof algorithm which takes any size of data and turns it into a fixed-length of data.

ModernHashingAlgorithm:

- MD-5
- SHA-1
- SHA-2
- SHA-3

*Hashing Passwords algorithms*

*Therearecurrentlythreealgorithmswhich aresafeto use:*

- PBKDF2
- bcrypt
- scrypt

As we all known in today world hacking is major issue. There are many attacks which takes ourpasswordwith-outourpermissionwhichisdangerousbecausewhiledoingsoourpersonal data is in unauthorized person.



ISBN:978-81-957858-1-0

Therearemanythreads:

- Dictionary attacks
- Brute-forceattacks
- Rainbowattacks
- *Denial-of-ServiceAttack*
- Man-in-the-MiddleAttack
- Birthdayattacks

Ihavediscussedinthispaperhowpreventourpass-wordsfromaboveattacks.Aspasswordis most important part of our life so we need to make it as a secure password.

TYPESOFPASSWORDS

Typesofcomputerpasswordsinclude

Supervisor (BIOS) password

The BIOS or Supervisor password protects the system information stored in the BIOS. A password is needed for the user to access the BIOS Setup Utility to change system configurations.

OperationSystem password

Operatingsystemsincludeforinstance,Windows,Windows7, Windows8, Macand Linux.

TheWEP,WPA,andWPA2Wi-FiPasswords

**WiredEquivalentPrivacy(WEP)**

WiredEquivalentPrivacy(WEP)isthemostwidelyusedWi-Fisecurity algorithm in the world. This is a

Power-onpassword:-Thispasswordpreventsyoursystemfrombeingpoweredonbyunauthorized users. Hard drive

password.Therearetwokindsof hard :

-userharddrivepassword and

-masterharddrivepasswordforadministrators

function of age, backwards compatibility, and the fact that it appears first in the encryption types election menus in many

routercontrol panels.

WEPwasratifiedasaWi-FisecuritystandardinSeptemberof1999.ThefirstversionsofWEP weren’tparticularlystrong,evenforthetimetheywerereleased,becauseU.S.restrictionson



ISBN:978-81-957858-1-0

the export of various cryptographic technologies led to manufacturers restricting their devices toonly64-bitencryption.Whentherestrictionswerelifted,itwasincreasedto128-bit.Despite the introduction of 256-bit WEP encryption, 128-bit remains one of the most common implementations. Despite revisions to the algorithm and an increased key size, over time numerous security flaws were discovered in the WEP standard and, as computing power increased, it be-came easier and easier to exploit them. As early as 2001 proof-of-concept exploitswerefloatingaroundandby2005theFBIgaveapublicdemonstration(inaneffortto increase awareness of WEP’s weaknesses) where they cracked WEP passwords in minutes using freely available software. Despite various improvements, work-around, and other attempts to shore up the WEP system, it remains highly vulnerable and systems that rely on WEP should be upgraded or, if security upgrades are not an option, replaced. The Wi-Fi Alliance officially retired WEPin2004.

Wi-FiProtectedAccess(WPA)

Wi-Fi Protected Access was the Wi-Fi Alliance’s direct response and replacement to the increasingly apparent vulnerabilities of the WEP standard. It was formally adopted in 2003, a year before WEP was officially retired. The most common WPA configuration is WPA-PSK (Pre-SharedKey).ThekeysusedbyWPAare256-bit,asignificantincreaseoverthe64-bitand 128-bitkeysusedintheWEPsystem.SomeofthesignificantchangesimplementedwithWPA included message integrity checks (to determine if an attacker had captured or altered packets passed between the access point and client) and the Temporal Key Integrity Protocol (TKIP). TKIP employs a per-packet key system that was radically more secure than fixed key used in theWEPsystem.TKIPwaslatersupersededbyAdvancedEncryptionStandard(AES).Despite what a significant improvement WPA was over WEP, the ghost of WEP haunted WPA.TKIP, a core component of WPA, was designed to be easily rolled out via firmware upgrades on to existing WEP-enabled devices. As such it had to recycle certain elements used in the WEP systemwhich,ultimately,werealsoexploited.WPA,likeitspredecessorWEP,hasbeenshown via both proof-of-concept and applied public demonstrations to be vulnerable to intrusion. Interestingly the process by which WPA is usually breached is not a direct attack on the WPA algorithm (although such at-tacks have been successfully demonstrated) but by at-tacks on a supplementary system that was rolled out with WPA, Wi-Fi Protected Setup (WPS), designed to make it easy to link devices to modern access points.

Wi-FiProtectedAccessII(WPA2)

WPAhas,asof2006,beenofficiallysupersededbyWPA2.Oneofthemostsignificantchanges between WPA and

WPA2 was the mandatory use of AES algorithms and the introduction of CCMP (Counter Cipher Mode with



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Block Chaining Message Authentication Code Protocol) as a replacement for TKIP (still preserved in WPA2 as a

fallbacksystemandforinteroperabilitywithWPA).

Currently,theprimarysecurityvulnerabilitytotheactualWPA2systemisanobscureone(and requires the attacker to

already have access to the secured Wi-Fi network in order to gain access to certain keys and then perpetuate an attack against other devices on the net-work). As such, the security implications of the knownWPA2 vulnerabilities are limited almost entirely to enterprise level networks and deserve little to no practical consideration in regard to home network security.

Unfortunately, the same vulnerability that is the big-gest hole in the WPA armor, the attack vector through the Wi-Fi Protected Setup (WPS), remains in modernWPA2-capable access points.AlthoughbreakingintoaWPA/WPA2securednetworkusingthisvulnerabilityrequires anywhere from 2-14 hours of sustained effort with a modern computer, it is still a legitimate securityconcernandWPSshouldbedisabled(and,ifpossible,thefirmwareoftheaccesspoint shouldbeflashedtoadistributionthatdoesn’tevensupportWPSsotheattackvectorisentirely removed).

**3** ALTERNATIVESTOPASSWORDSFORAUTHENTICATION

Single-use passwords. Having passwords which are only valid once makes many potential attacks ineffective. Most users find single use passwords extremely inconvenient. They have, however, been widely implemented in personal online banking, where they are known as Transaction Authentication Numbers(TANs). As most home users only per-form a small number of transactions each week, the single use issue has not led to in tolerable customer dissatisfaction in this case.

- Time-synchronize done-time passwords are similar in some ways to single-use passwords, but the value to be entered is displayed on a small (generally pocket able) item and changes every minute or so.
- Pass Window one-time passwords are used as single-use passwords, but the dynamic characterstobeentered arevisibleonlywhenausersuperimposesauniqueprintedvisualkey over a server generated challenge image shown on the user's screen.
- Access controls based on public key cryptography e.g. ssh.The necessary keys are usually too large to memorize (but see proposal Pass-maze) and must be stored on a local computer, security token or portable memory device, such as a USB flash drive or even floppy disk.
- Biometricmethodspromiseauthenticationbasedonunalterablepersonalcharacteristics,but currently (2008) have high error rates and require additional hardware to scan, for example, fingerprints,irises, etc. They have proven easy to spoof in some famous incidents testing commercially available systems, for ex-ample, the gummie fingerprint spoof demonstration, and,becausethesecharacteristicsareunalterable,theycannotbechangedifcom-promised;



ISBN:978-81-957858-1-0

this is a highly important consideration in access control as a compromised access token is necessarily insecure.

- Single sign-on technology is claimed to eliminate the need for having multiple passwords. Such schemes do not relieve user and administrators from choosing reasonable single passwords, nor system designers or administrators from ensuring that private access control informationpassedamongsystemsenablingsinglesign-onissecureagainstattack.Asyet,no satisfactory standard has been developed.

- Evaluatingtechnologyis apassword-freewaytosecuredataon removable storagedevices suchasUSBflashdrives.Insteadofuserpasswords,accesscontrolisbasedontheuser'saccess to a network resource.

- Non-text-based passwords, such as graphical passwords or mouse-movement based passwords.Graphicalpasswordsareanalternativemeansofauthenticationforlog-inintended to be used in place of conventional password; they useimages, graphics or colors instead of letters,digits or special characters. One system requires users to select a series of faces as a password,utilizingthehumanbrain'sabilitytorecallfaceseasily.Insomeimplementationsthe userisrequiredtopick fromaseries ofimages inthecorrectsequenceinordertogain access. Anothergraphicalpasswordsolutioncreatesaone-timepassword usingarandomlygenerated grid of images. Each time the user is required to authenticate, they look for the images that fit their pre chosen categories and enter the randomly generated alpha numeric character that appears in the image to form the one-time password.

Sofar,graphicalpasswordsarepromising,butarenotwidelyused.Studiesonthissubjecthave been made to determine its usability in the real world. While some believe that graphical passwords would be harder to crack, others suggest that people will be just as likely to pick common images or sequences as they are topic k common pass-words.

- 2DKey (2-DimensionalKey)is a2 Dmatrix likekey input method having thekey styles of multilinepassphrase,crossword,ASCII/Unicodeart,withoptionaltextualsemanticnoises,to create big password/key beyond 128 bits to realize the Me PKC (Memorizable Public-Key Cryptography)using fully memorizable private key upon the current privatekey management technologies like encrypted private key, split private key, and roaming private key. Cognitivepasswords use question and answer cue/response pairs to verify identity.

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ISBN:978-81-957858-1-0

PasswordCracking Techniques

**Dictionaryattacks**

Dictionary attacks quickly compare a set of known percent). Password cracking speed is increased in a rain dictionary-type words. Including many common passwords against a password database. This database is a text file with hundreds if not thousands of dictionary words typically listed in alphabetical order.

Brute-forceattacks

Brute-force attacks try every combination of numbers, letters, and special characters until the password is discovered. Many password-cracking utilities let you specify such testing criteria as the character sets, password length to try, and known characters (for a“mask”attack).

Rainbowattacks

Arainbowpasswordattackusesrainbowcrackingtocrackvariouspasswordhashesfor LM, NTLM, Cisco PIX, and MD5 much more quickly

Fig1.0

| Scheme | Stolen Password | Stolen Data | Stolen Data and Password |
|---|---|---|---|
| Password Safe | N/A | 74.6 secs | $\leq$ 74.6 secs |
| LPWA | 0.5 secs | N/A | N/A |
| PwdHash | 0.1 secs | 0.1 secs | 0.1 secs |
| Our Scheme | 116 days | 116 days | 2.8 hours |

Table 3: Resistance to a dictionary attack under three attack scenarios—Times to test 100,000 password guesses using a fast modern PC.

Andwithextremelyhighsuccessrates(near100)

Bow attack because the hashes are pre calculated and thus don’t have to be generated individually on the fly as they are with dictionary and brute-force cracking methods.

There’s a length limitation because it takes significant time to generate these rainbow tables. Given enough time, a sufficient number of tables will be created. Of course, by then, computers and applications likely have different authentication mechanisms and hashing standards—including a new set of vulnerabilities to contend with.

Password-BasedAttacks

A common denominator of most operating system and network security plans is password-based access control. This means your access rights to a computer and network resources are determined by who you are, that is, your user name and your password.



ISBN:978-81-957858-1-0

Olderapplicationsdonotalwaysprotectidentityinformationasitispassedthroughthe networkforvalidation.Thismightallowan eavesdroppertogainaccesstothenetwork by posing as a valid user.

When anattackerfinds a valid useraccount, theattackerhas thesamerights asthereal user. Therefore, if the user has administrator level rights, the attacker also can create accountsforsubsequentaccessatalatertime.Aftergainingaccesstoyournetworkwith a valid account, an attacker can do any of the following:

Obtainlistsofvaliduserandcomputernamesandnetwork information.

Modifyserverandnetworkconfigurations,includingaccesscontrolsandrouting tables.

Modify,reroute,or deleteyourdata.

Denial-of-ServiceAttack

Unlike a password-based attack, the denial-of-service attack prevents normal use of your computer or network by valid users. After gaining access to your network, the attacker can do any of the following:

Randomize the attention of your internal Information Systems staff so that they do not see the intrusion immediately, which allows the attacker to make more attacks during the diversion. Send invalid data to applications or network services, which causes abnormal termination or behavior of the applications or services. Flood a computer or the entire network with traffic until a shutdown occurs because of the overload. Block traffic, which results in a loss of access to network resources by authorized users.

Man-in-the-MiddleAttack

As the name indicates, a man-in-the-middle attack occurs when someone between you and the person with whom you are communicating is actively monitoring, capturing, and controllingyourcommunicationtransparently.Forexample,theattackercanre-routeadata ex-change. When computers are communicating at low levels of the network layer, the computersmightnotbeabletodeterminewithwhomtheyareexchangingdata.Man-in-the-middle attacks are like someone assuming your identity in order to read your message. The personontheotherendmightbelieveitisyoubecausetheattackermightbeactivelyreplying *asyou*tokeeptheex-changegoingandgainmoreinformation.Thisattackiscapableofthe same damage as an application-layer attack, described later in this section.

Birthdayattacks

This attack exploits the Birthday paradox, which in brief states that, having a large set of user password digests, the probability of generating a password which di-gest collides with at least one of the digests in the set is very much higher than what you would intuitively expect.Andthisprobabilityincreasesdramaticallyasthesizeoftheset(thenumberof



ISBN:978-81-957858-1-0

users)augments.

## **4.** ALGORITHMS

### Hashing

Hashing is a type of algorithm which takes any size of data and turns it into a fixed-length of data. This is often used to ease the retrieval of data as you can shorten large amounts of data to a shorter string (which is easier to compare). For instance let's say you have a DNA sample of a person, this would consist of a large amount of data (about 2.2 – 3.5 MB), and you would like to find out to who this DNA sample belongs to. You could take all samples and compare 2.2MB of data to all DNA samples in the database, but comparing 2.2MB against

2.2 MB of data can't take quite a while, especially when you need to traverse thousands of samples. This is where hashing can come in handy, instead of comparing the data, you calculate the hash of this data (in reality, several hashes will be calculated for the different locations on the chromosomes, but for the sake of the example let's assume it's one hash), whichwillreturnafixedlengthvalueof,forinstance,128bits.Itwillbeeasierandfasterto query a database for 128-bits than for 2.2MBof data.

The main difference between hashing and encryption is that a hash is not reversible. When wearetalkingaboutcryptographichashfunctions,wearereferringtohash functionswhich have these properties:

- Itiseasytocomputethehashvaluefor anygivenmessage.
- Itisin feasibleto generateamessagethat hasagiven hash.
- Itisin feasibleto modifyamessagewithout changing thehash.
- Itisinfeasibletofindtwodifferentmessageswiththesamehash. The

hash function should be resistant against these properties:

- Collisions(twodifferentmessagesgeneratingthesame hash)
- Pre image resistance: Given a hash h it should be difficult to find anymessage m such that h

  =hash(m).
- Resistancetosecond-preimages:givenm,itisinfeasibletofindm' distinct from m and such that MD-5(m) =MD-5(m').



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**5.** ModernHashingAlgorithms

Somehashingalgorithmsyoumayencounterare:

- MD-5
- SHA-1
- SHA-2
- SHA-3

MD-5

MD-5 is a hashing algorithm which is still widely used but cryptographically flawed as it'spronetocollisions.MD-5isbrokeninregardtocollisions,butnotinregardofpreimages or second-pre images. The first at-tacks on MD-5 were published in 1996, this was in fact an attack on the compression of MD-5 rather than MD-5itself. In 2004 a theoretical attack wasproducedwhichallowedforweakeningthepre-imageresistanceproper-tyofMD-5.In practice the attack is way too slow to be useful.

SHA

SHAorSecure Hashing Algorithm is afamily of cryptographic hash functions published by the National Institute of Standards and Technology (NIST) as a U.S.

FederalInformationProcessingStandard(FIPS).Currentlythreealgorithmsaredefined:

- SHA-1:A160-bit hash function which resembles the earlier MD-5 algorithm. This was de-signed by the National Security Agency (NSA )to be part of the Digital SignatureAlgorithm.CryptographicweaknesseswerediscoveredinSHA-1,andthe standard was no longer approved for most cryptographic uses after 2010.
- SHA-2:Afamilyoftwosimilarhashfunctions,withdifferentblocksizes,knownas SHA-256 and SHA-512. They differ in the word size; SHA-256 uses 32-bit words where SHA-512 uses 64-bit words. There are also truncated versions of each standardized, known as SHA-224 and SHA-384. These were also designed by the NSA.
- SHA-3:SHA-3isnotyetdefined.NISTisworkingontheexactparameterstheywill use;SHA-3willbeKeccak,or"closeenough",butnotnecessarilytheKeccakwhich was submitted (it is a configurable function, and they seem to want to tweak the parameters a bit differently than what was first proposed).

NotethatwhileSHA-1is"cryptographicallybroken"thepropertiesweseekinapassword



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hashingalgorithmarestillvalid.Intherealworldfindingapasswordhashingalgorithmbuilt on SHA-1 is still securein the sense, that if it's implemented there is no reason to assume it should be immediately changed to something newer.

## 6 HASHINGPASSWORDSALGORITHMS

Therearecurrentlythree algorithmswhicharesafeto use:

- PBKDF2
- bcrypt
- scrypt
- PBKDF2

**PBKDF2** is an algorithm which is used to derive keys. It wasn't intended for password hashing,butdueto itspropertyofbeingslow,itlendsitselfquitewellforthispurpose.The resultingderivedkey(HMAC)canactuallybeusedtosecurelystorepasswords.It'snotthe idealfunctionforpasswordhashing,butit'seasytoimplementandit'sbuiltuponSHA-1or SHA-2 hashing algorithms (any HMAC will do, but these are the most common used ones and the most secure ones). Wait, didn't you say SHA-1 and SHA-2 were bad to use when hashing passwords? Yes indeed, that's why we use PBKDF2 to make the hashing a lot slower.Youstill will need to chooseyourhashing algorithm carefully, PBKDF2 +Keccak isasubstantiallyworsechoicethanPBKDF2+SHA-256,whichisalreadysomewhatworse than PBKDF 2 + SHA-512 if your server is a 64-bit PC.

To derive a key PBKDF 2 does the following : DK=PBKDF 2 (PRF, Password, Salt, c, dkLen)

password is used as a key for the HMAC and the salt as text), c is the amount of iterations anddkLenisthelengthofthederivedkey.Asaltshould,bydefinitionofthestandard,beat least 64-bits of length and the mini-mum amount of iterations should be 1024. What the algorithmwilldoisSHA-1-HMAC(password+salt),andrepeatthecalculation1024times ontheresult.Thismeansthehashingofapasswordwillbe1024timesslower.Stillthisdoes not actually offer a lot of protection when brute-forcing on distributed systems or GPU(Graphic Processing Unit).

There's also a caveat when the password exceeds 64bytes, the password will be shortened by applying a hash to it by the PBKDF2 algorithm so it does not exceed the block size. For instance when using HMAC-SHA-1 a password longer than 64 bytes will be reduced to SHA-1(password),whichis20bytesinsize.Thismeanspasswordslongerthan64bytesdo notprovideadditionalsecuritywhenitcomestobreakingthekeyusedtomaketheHMAC, but may even reduce security as the length of the key will be reduced (note that even when reducedto20bytes,currentlyourgreat-great-great-great-great-great-great-great-great-great



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grandchildrenwill belongdead beforethekey isbrute forced).

**bcrypt**

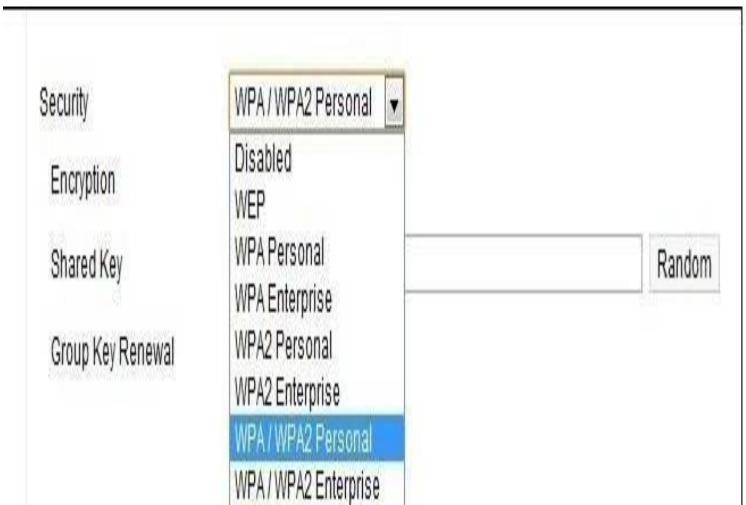
Where DK is the derived key, PRF is the preferred HMAC function (this can be a SHA-1/2HMAC, the bcrypt is currently the defacto secure standard for pass-word hashing. It's derived from the Blowfish block cipher which, to generate the hash, uses look up tables which are initiated in memory. This means a certain amount of memory space needs to be usedbeforeahashcanbegenerated.ThiscanbedoneonCPU,butwhenusingthepowerof GPU it will become a lot more cumbersome due to memory restrictions. Bcrypt has been around for 14 years, based on a cipher which has been around for over 20 years. It's been well vetted and tested and hence considered the standard for password hashing.

There is actually one weakness, FPGA processing units. When bcrypt was originally developed its main threat was custom ASICs specifically built to attack hash functions. These days those ASICs would be GPUs (password brute-forcing can actually still run on GPU,butnotinfullparallelism)whicharecheaptopurchaseandareidealformultithreaded processes such as password brute-forcing.

FPGAs(FieldProgrammableGateArrays)aresimilartoGPUsbutthememorymanagement is very different. On these chips brute-forcing bcrypt can be done more efficiently than on GPUs, but if you have a long enough passwords it will still be unfeasible.

Scrypt

For password hashing, the current fashion is to move the problem away to another level; insteadofdoingalotofhashfunctioninvocations,concentrateonanoperationwhichishard for anything else than a PC, e.g. random memory accesses. That's what scrypt is about. Scrypt is another hashing algorithm which has the same properties as bcrypt, except that when you increase rounds, it exponentially increases calculation time and memory space required to generate the hash. Scrypt was created as response to evolving attacks on bcrypt andiscompletelyunfeasiblewhenusingFPGAsorGPUsduetomemoryconstraints.Scrypt requires the storage of a series of intermediate state data "snapshots", which are used in further derivation operations. These snapshots, stored in memory, grow exponentially compared when rounds increase. So adding a round, will make it exponentially harder to bruteforcethepassword.Scryptisstillrelativelynewcomparedtobcryptandhasonlybeen around for a couple of years, which makes it less vetted than bcrypt.



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**7.** PasswordStrength

Strong passwords

A part from choosing a good hashing algorithm you should also force your users to choose apasswordwhichisbuiltupofatleasteight,randomcharacters.Unfortunatelypeoplearen’t designed to remember and generate random sequences of characters. This is why we force our users to make passwords which contain numbers, letters, signs and at least one capital letter. But how does this help in regard to password hashing?

Toattackhashed passwordstherearedifferent strategies:

- DictionaryAttacks
- Brute-force
- Rainbow Tables(generate everything up front in a database and do a lookup for each hash)

With a dictionary attack you will try to use word lists, these can consist of mostly used passwords, words, names, years, etc. Foreach word you will runthehashing algorithm and see if the generated hash is the same as the hash in the database. If this is the case then you know that the word from which you derived the hash is the password. With a brute-force attackyouwilltryallpossiblecombinationsofcharacters.Whenusingpasswordsofatleast eight characters long, only using the ASCII characters set, there are 128^8 possibilities of passwords.

To show the importance of the length of a password: These days, using a single, modern GPU,youcanprocessabout10.323.000.000passwordsper*second*whenbrute-forcingplain MD-5.Withthisspeed,whenusingapasswordofeightrandomcharacters,itwilltakeabout eighty days to generate every single possibility. This single GPU only cost about 500 USD (AMDRade on 6990). People have actually constructed clusters which contain25 of these cards, optimized it and managed to generate 350 *billion* passwords per second. This means they can generate all possible passwords of eight random characters long in less than two days.

Now when you add one character to the password, the possibilities will be 128^9. With previouscalculationof350billionitwillnowtake 305days.10 characters >106years.This seems long, but we need to take into account Moore’s law:

Moore’slawistheobservationthat,overthehistory ofcomputinghardware,thenumberof transistors on integrated circuits doubles approximately every two years. The period often quotedas “18months”isdueto Intel executiveDavidHouse, whopredictedthatperiodfor a doubling in chip performance (being a combination of the effect of more transistors and their being faster).



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Computershavebecomefasterandfasterovertheyears,whichissomethingweneedtotake into account. From a crypto graphical point of view, 106 years is still a short period. We want infinity (something which will take several hundred-thousand to millions of years).

**Preventionfromattacks**

- Brute-force

By iterating the hash function to a number like 1,000(minimum recommended), the overheadofpassworddigestcreationfortheuseratsign-uporsign-intimeisnotsignificant, but the accumulated cost for a brute force at-tacker generating millions of digests will be very considerable. Remember that one of the best ways to protect your encrypted data is making the cost of breaking your security too high to be worth the effort.

- DictionaryAttacks

By adding a random salt, the weakness of the dictionary-based passwords many people use is reduced (they are no longer dictionary words), and the possibility of the digest appearing on a set of digests previously created by the attacker is minimal.

- BirthdayAttacks

By adding a random salt the possibilities of a birthday attack to succeed are minimum, because the attacker would have to attack each password separately, and not the set of passwords as a whole, to find a collision. This is because he/she would have to find a passwordthatcreatesthesamedigestastheattackedoneusingthesamesaltwhichwasused for digesting it, which is different for each password (this is, it would become a brute force attack).

- Unlike dictionary and brute-force attacks, rainbow attacks cannot be used to crack passwordhashesofunlimitedlength.ThecurrentmaximumlengthforMicrosoftLMhashes is 14 characters, and the maximum is up to 16 characters (dictionary-based) for Windows Vista and 7 hashes.

Securingyour accounts

**Makeyourpasswordasentence**:

A strong password is a sentence that is at least 12 characters long. Focus on positive sentences or phrases that you like to think about and are easy to remember (for example, “I love country music.”). On many sites, you can even use spaces!

Uniqueaccount, uniquepassword:

Havingseparatepasswordsforeveryaccounthelpstothwartcybercriminals.Ataminimum, separateyourworkandpersonalaccountsandmakesurethatyourcriticalaccountshavethe strongest passwords.

Writeit downand keepit safe:



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Everyonecan forget apassword. Keep alist that’s stored in asafe, secureplaceaway from yourcomputer.Youcanalternativelyuseaservicelikeapasswordmanagertokeeptrackof your passwords.

Lockdownyour login:

Fortifyyouronlineaccountsbyenablingthestrongestauthenticationtoolsavailable,suchas biometrics, security keys or a unique one-time code through an app on your mobile device. Your usernames and passwords are not enough to protect key accounts like email, banking and social media.

### 7.3Don’tuseasapassword

- Usingastandard'wordsuchasboss,master,do all,passwd
- Usingadictionary wordor thenameofthebusiness
- Using repeatingletters or numerals(AAAAAA,111111andsoon).
- Nameof parent.
- UpdateYourRouterand UpgradetoThirdPartyFirmware IfPossible.
- ChangeYourRouter’sPassword
- Nameofbestfriends.
- Commonname

## 8. CONCLUSION

Today many users (including those who should know better) fail to take secure steps to protecttheirpasswords.Oftenthecauseisnotafailuretounderstandthatstrongpasswords areimportant,butratherfrustrationwiththedifficultyofdoingtherightthing.Inmystudy Iinformedyoutomakestrongpasswordandtoprotectyourselffromattacks.Thismaterial is based upon Internet resources.

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ISBN:978-81-957858-1-0

# StudyofAtomicLayerDeposition'sEffectsandApplications

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**Abstract**

A common vapor phase technique for creating thin films of a range of materials is atomic layer deposition (ALD). ALD provides remarkable conformance on high aspect ratio structures, thickness control at the Angstrom level, and customizable film composition because it is based on successive, self-limiting reactions. These benefits have made ALD a potent tool fornumerous industrial and scientificapplications. In this reviewstudy, theALD principle, procedures, and impacts on the conductivity, dielectric properties, passivation quality, and other material properties of materials are briefly introduced. Current uses in the fields of microelectronics, energy, and other industries include solid oxide fuel cells, high-k transistors, capacitors, and Cu(In,Ga)Se2 solar cell devices. To clarify the range of technologies that are impacted by ALD, the range of materials that ALD can deposit, from noblemetalslikePttometaloxideslikeZn1_xSnxOy,ZrO2,andY2O3,andthewayinwhich the special features of ALD can enable new levels of performance and deeper fundamental understanding, a number of examples are taken into consideration.

## Introduction

A thin film deposition technology called atomic layer deposition (ALD) is based on the successive application of a gas phase chemical reaction. A subset of chemical vapour deposition is knownas ALD. ALDwas first developedby Dr.To enhancetheZnS films used in electroluminescent displays, Tuomo Suntola and colleagues carried out research in Finland in 1974 [1]. Atomiclayerepitaxy (ALE, Finland) and molecularlayering (ML, Soviet Union) arethedesignationsgiventoALDintwoseparatediscoveries[2],[3].InMicrochemistryLtd., a firm created for this purpose by the Finnish national oil company Neste Oy, Suntola began developing the ALE technology for new applications such as photovoltaic devices and heterogeneous catalysts. Microchemistry ALE reactors that were appropriate for processing silicon wafers were the focus of ALE development in the 1990s.Markku Leskelä, a professor attheUniversityofHelsinki,suggestedtheterm"atomiclayerdeposition" asan alternativeto ALEinwriting[4].Anumberofdifferentthinfilmmaterialscanbedepositedfromthevapour phase using the atomic layer deposition (ALD) process. In developing semiconductor and energy conversion technologies, ALD has showed considerable potential. The goal of this review is to emphasise and expose the reader to the fundamentals of ALD.Two compounds, commonly referred to as precursors, are used in the majority of ALD processes. Saturated surfacereactionsarethebasisforseveraltypesofchemicalvapourdeposition(CVD),physical vapour deposition (PVD), and atomic layer deposition (ALD). ALD is a self-limiting adsorptionreactionprocess,andthequantityofdepositedprecursormoleculesissolelybased



ISBN:978-81-957858-1-0

on the quantity of reactive surface sites and is unrelated to the amount of exposure to the precursor after saturation.

The potentialfor ALDtoscaledownmicroelectronicdevicesinaccordancewithMoore'slaw [6] is a key factor in the new attention. The scientific literature has hundreds of distinct processesrelatedtoALD,manyofwhichdeviatefromtheidealALDprocessintermsoftheir behaviours. , as well as reflective coatings (Table 1). pharmacists [7, 8].such as coatings with enhancedcharacteristics formagnetic, refractive, oxide,nitride,insulator, semiconductor,and metal surfaces (Table 1). pharmacists [7, 8].

Table1-PrecursorsforALDandatomic layerdepositionmaterials

| OXIDES | | | | | NITRIDES | | SULFIDES | METALS/ |
|---|---|---|---|---|---|---|---|---|
| $AI_2O_3$ | $Fe_2O_3$ | $Li_3PO_4$ | $NiFe_2O$ | $V_2O_5$ | AlGaN | MnN | CdS | Co |
| $Al:HfO_2$ | $Fe_3O_4$ | LiPON | NiO | $WO_3$ | AlN | NbN | CoS | Cu |
| Al:ZnO | $FePO_4$ | $LiFePO_4$ | NiO | $Y_2O_3$ | BxGa1-xN | NbTiN | $Cu_2S$ | Fe |
| AlGaN | $Ga_2O_3$ | $Li_2MnO_4$ | $PO_4$ | YSZ | BxIn1-xN | SiN | $Cu_2ZnSnS_4$ | Mn |
| BOx | $HfO_2$ | $Li_5TaOz$ | $SiO_2$ | $ZnAl_2O_4$ | CoN | TaN | $In_2S_3$ | Ni |
| $BiFeO_3$ | HfSiON | MgO | $SnO_2$ | ZnO | Hf3N4 | TiN | MnS | Pd |
| $CeO_2$ | $In_2O_3$ | $MnO_2$ | SrO | ZnMgO | InAlN | WN | PbS | Pt |
| $Co_3O_4$ | ITO | $MoO_3$ | $SrTiO_3$ | ZnOS | InGaN | ZrN | $Sb_2S_3$ | Ru |
| $CoFe_2O_4$ | $La_2O_3$ | NaTiO | $Ta_2O_5$ | $ZrO_2$ | InN | | SnS | $Bi_2Te_3$ |
| $Er_2O_3$ | $Li_2O$ | $Nb_2O_5$ | $TiO_2$ | | | | ZnS | $Sb_2Te_3$ |

Numerous industries, including energy, optical, electronics, nanostructures, biomedical, and others, show great promise for atomic layer deposition.

## PRINCIPLEANDTECHNIQUE ofALD



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Atomic layer deposition (ALD) and chemical vapour deposition (CVD) both operate on a similar concept; however, ALD splits the CVD reaction into two half-reactions, keeping the precursor materials apart throughout the reaction [9]. Since the growth of ALD films is self-limitedanddependentonsurfacereactions,atomicscaledepositioncontrolisfeasible.Inorder tomanagethefilmgrowth'satomiclayerthicknessdowntothemonolayerlevel,theprecursors must remain distinct throughout the coating process.

Atomiclayerdepositioniscarriedoutbyrepeatedlypulse-formingspecificprecursorvapours, each ofwhich creates around oneatomiclayer with each pulse(reaction cycle). In contrast to chemical vapourdeposition, which introduces numerous precursor materials at once, reaction cyclesarethenrepeateduntilthedesiredlayerthicknessisreached.IfthethicknessoftheALD is uniform throughout, including deep within pores, trenches, and cavities, it is ideal and efficient. several different types of thin films The Al2O3 layer's deposition is depicted in Figures (1–7) [11]. (a) Figure 1. Precursors in the ALD cycle for Al2O3 deposition can be depositedusinggas,liquid,orsolidformsofSi-O-H(Step1a).TheALDcycleconsistsoffour phases, beginning with a conditioned surface [10]. The process chamber is filled with a first precursor gas, which causes a monolayer of gas to form on the wafer surface. The chamber is then filled with a second precursor of gas, which reacts with the first precursor to create a monolayer of film on the wafer surface. There are two basic mechanisms: Sequential surface chemical reaction process and chemisorptions saturation process.

Step 1: During the precursor dosing, adsorption of precursor molecules occurs on reactive surfacesitesandreactionproductsareformed.Theexcessprecursorandreactionproductsare purgedoutofthedepositionchamberanda(sub)monolayerofprecursorremainsadsorbedon the substrate surface.

Step 2: The co-reactant, in this case water, is added to the chamber and reacts with the TMA molecules adsorbed there to produce a (sub) monolayer of the desired material, Al2O3.

Step 3: Unreacted co-reactant molecules and by-products are eliminated, and after a series of cycles, the required material (Al2O3) is deposited in a uniform layer.

DepositionofAl$_2$O$_3$layerisshowninFigures(1-7)[11].. [

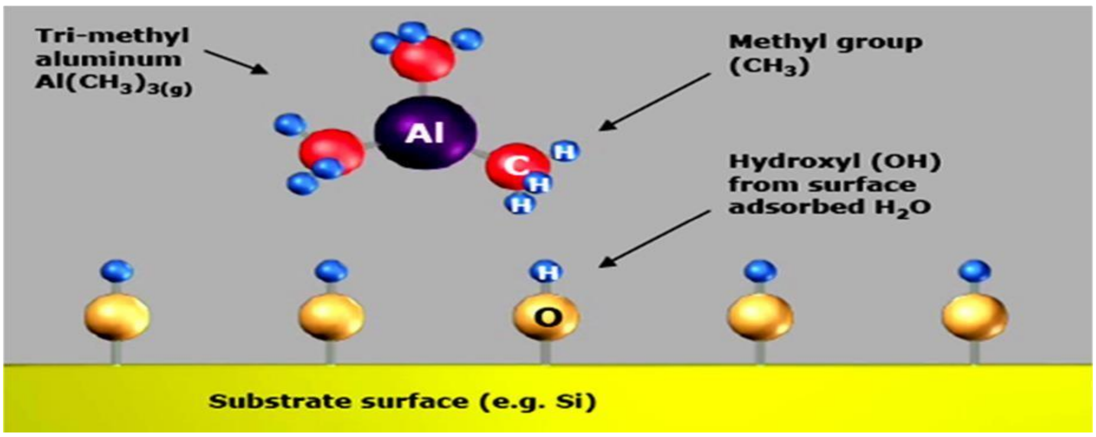




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Figure1(a).ALDcycleforAl$_2$O$_3$deposition-FormationofSi-O-H(Step1a)

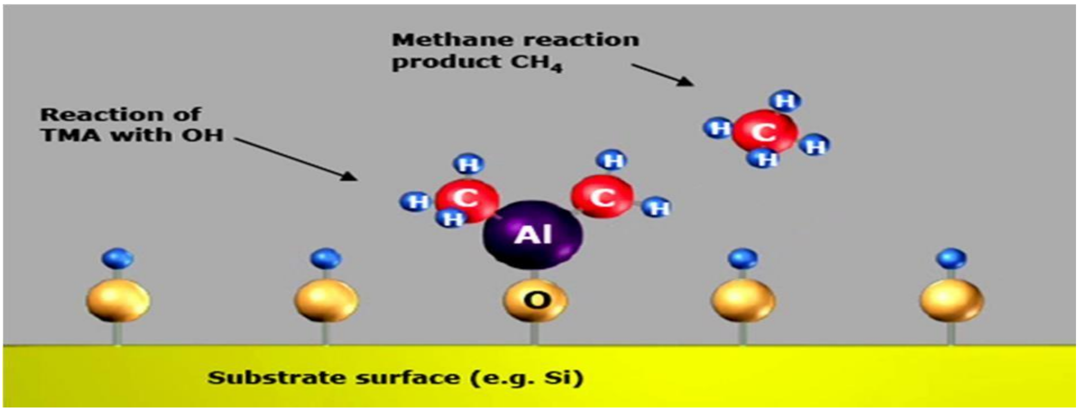


Figure1(b)ALDcycleforAl$_2$O$_3$deposition-FormationofSi-O-Al(CH$_3$)$_3$(Step 1b)

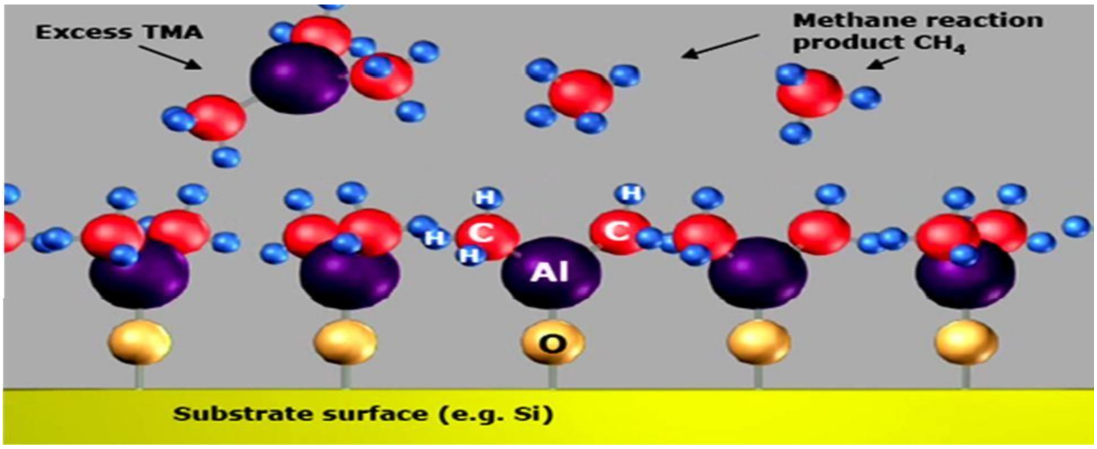


Figure1(c).ALDcycleforAl$_2$O$_3$deposition-Formationofuniform layer of Al$_2$O$_3$(Step 1c)

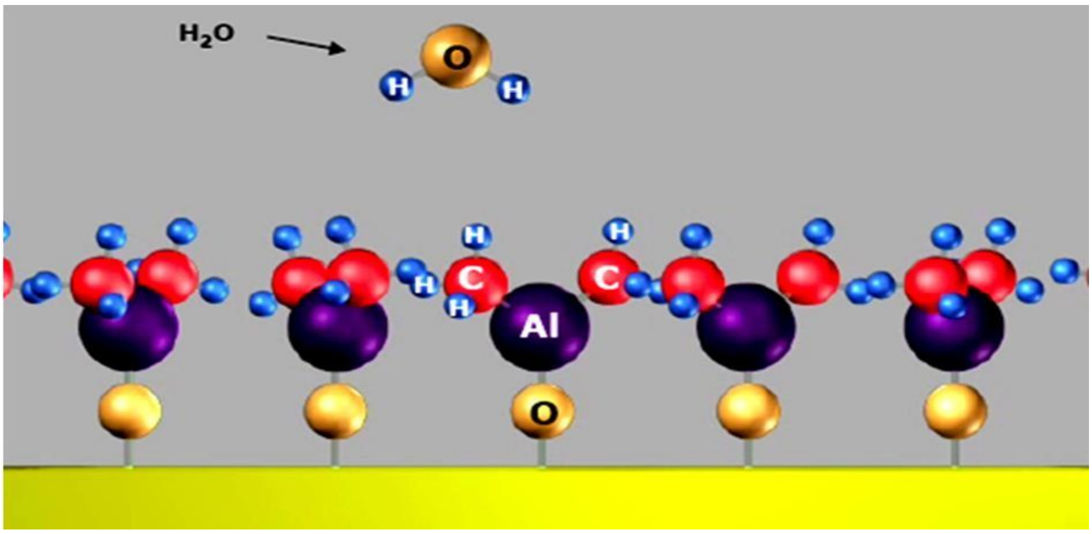


Figure2(a).Cycle 2,Repeatofstep1a(Step2a)



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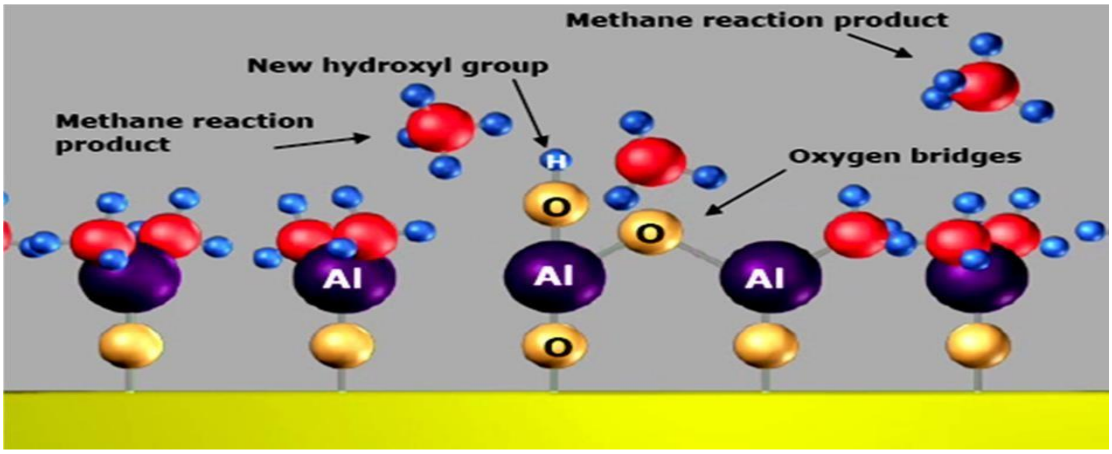


Figure2(b). Cycle2, Repeatofstep1b(Step 2b)

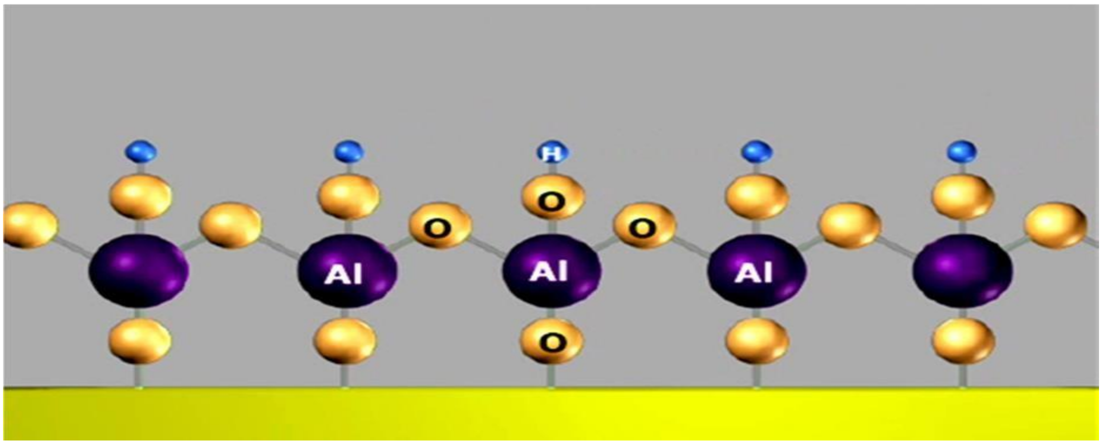


Figure2(c)Cycle2, Repeatofstep 1c(Step 2c)

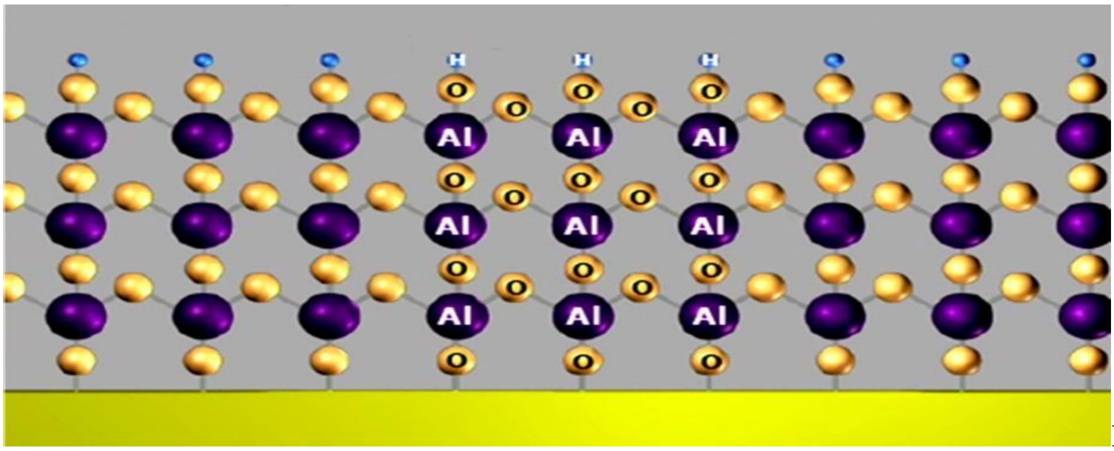

Figure 3.DepositionofAl$_2$O$_3$uniformlayerAfter3cycles

To deposit more monolayers and reach the desired film thickness, the cycle is repeated. The numberof deposition cycles can accurately control how thick the final film will be since each pairofgaspulses(orcycle)createsexactlyonemonolayeroffilm.ALDreactorscanbedivided



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into four categories: closed system chambers, open system chambers, semi-closed system chambers,andsemi-open systemchambers.Reactorswithclosedsystemsaremost frequently employed.

EFFECTSofALD

ALD (Atomic Layer Deposition) provides accurate control at the atomic level. Numerous sectors, including energy, optical, electronics, nanostructures, biomedicine, and others, show great promise for ALD. The ALD leads to increased optical activity, thermal sensitivity, and photosensitivity. For their distinctive material properties, materials have been investigated for theirelectricalconductivity,passivationquality[12],dielectricproperty,storagecapacity,and barrier protection. Band gap semi-conducting properties, photoluminescence, and absorbance havebeenobservedintwo-dimensionaldichalcogenidesasthefilmthicknessisreducedtoone monolayerthickness[13].Surfaceswithextremelyhighaspectratiotopographiesandsurfaces needing multilayer films with high-quality interfaces can both be coated with outstanding success using ALD.

APPLICATIONSofALD

Numerous industries, including energy, optical, electronics, nanostructures, biomedicine, and others,useawiderangeofALD-basedmaterialsextensively.Thecurrentstudyrevealstheuse ofALDinanumberofdifferentfields,includinganti-tarnishingcoatingsforsilver,thinfilms for photovoltaic applications in the energy sector, passivations and hermetic barrier coatings on plastics and metals, tribological coatings for highly precise parts, premiering applications on plastics and metals for other surface finishes, storage capacitor dielectrics, High-k gate oxides, thin films for LEDs, barrier layers on glass, gate oxide and bar

primer layers, gate electrode, optical coatings, flat-panel displays, solar panels, magnetic heads, memory devices, fuel cells, for example, single metal coating for catalyst layers, sensors,Bio MEMS, pinhole-freepassivation layersfor OLEDs and polymers, Passivation of crystal silicon solar cells, gas permeability reduction of plastics, wear resistance, primer for other coatings, smoothing of rough surface, construction of 3D structures, nozzles, pipes, porous structures, and adhesion Below is an illustration of some of the most significant ALD materials and their uses.

**A) Microelectronicsapplications**

ALD is being researched as a possible method to deposit High-k (high permittivity) in microelectronics[14].Ferroelectrics,high-kmemorycapacitordielectrics,gateoxides,metals andnitridesforelectrodes,andconnectionmaterialsaresomeexamples.ALDisonlylikelyto becomemorewidelyusedinhigh-kgateoxides,wherethecontrolofultrathinfilmsiscrucial. Conformal films are necessary for metallizations; it is currently anticipated that ALD will be



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used in widespread manufacturing at the 65 nm node.The conformality requirements are much stricter in dynamic random access memory (DRAMs) [15], and ALD is the only technique that can be employed when feature sizes are less than 100 nm.[16]. Magnetic recording heads, MOSFET Gate stacks, and DRAM are a few items that utilise ALD.

**B) Gateoxides**

One of the most well studied aspects of ALD has been the deposition of the high-k oxides Al2O3,ZrO2,andHfO2.Theissueofexcessivetunnellingcurrentthroughtheoftenemployed SiO2 gate dielectric in metal-oxide-semiconductor field-effect transistors (MOSFETs) [17] when it is downscaled to a thickness of 1.0 nm and lower serves as the driving force behind high-k oxides. In order to achieve the necessary capacitance density, a thicker gate dielectric can be created with high-k oxide, which lowers the tunnelling current across the structure.

**C)** Transition-metalnitrides

Transition-metalnitrides, suchasTiN andTaNfindpotential use bothasmetal barriersand as gatemetals.Metalbarriersare used in modern Cu-based chips to avoid diffusion of Cu intothesurroundingmaterials,suchasinsulatorsandthesiliconsubstrate,andalso,toprevent Cu contamination by elements diffusing from the insulators by surrounding every Cu interconnection with a layer of metal barriers. The metal barriers have strict demands: they should be pure; dense; conductive; conformal; thin; have good adhesion towards metals and insulators.Therequirementsconcerningprocesstechniquecanbefulfilledby ALD.Themost studied ALD nitride is TiN which is deposited from $TiCl_4$and $NH_3$. [19].

MotivationsofaninterestinmetalALDare:

1. Cu interconnects andW plugs, or at least Cu seed layers[20]forCuElectro-deposition and W seeds for W CVD,
2. Transition-metalnitrides(e.g.TiN,TaN,WN)forCuinterconnectbarriers
3. Noble metals forferroelectricrandomaccessmemory(FRAM)andDRAMcapacitor electrodes
4. High-andlow-workfunctionmetals fordual-gateMOSFETs.

**D)** Magneticrecordingheadsutilizeelectric fieldsto polarizeparticles andleaveamagnetized patternonaharddisk.$Al_2O_3$ ALDisusedtocreateuniform,thinlayersofinsulation[21].By using ALD, it is possible to control the insulation thickness to a high level of accuracy. This allows for more accurate patterns of magnetized particles and thus higher quality recordings [22].



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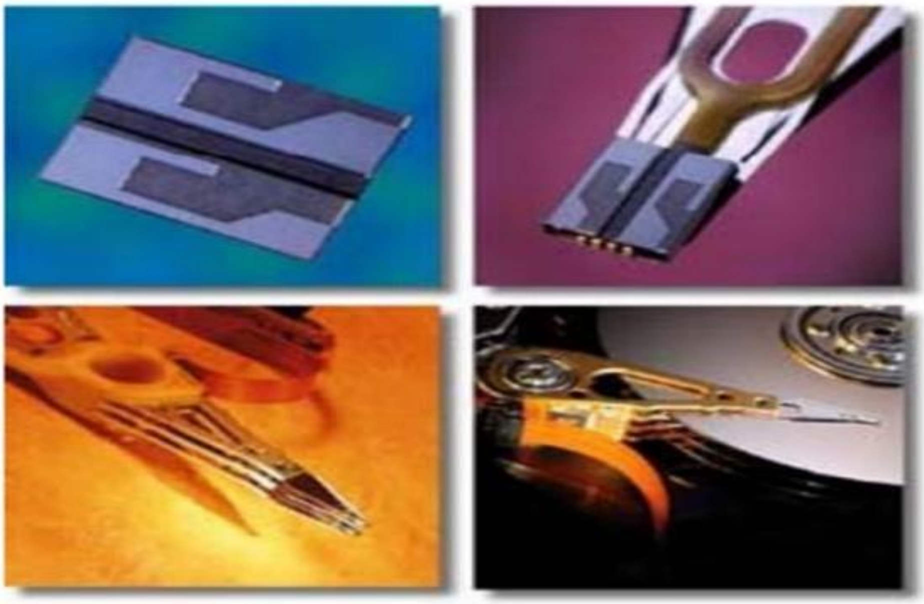

**E)** DRAMcapacitors

Dynamic random-access memory (DRAM) capacitors are yet another application of ALD. AnindividualDRAMcellcanstoreasinglebitofdataandconsistsofasingleMOStransistor andacapacitor.Majoreffortsarebeingputintoreducingthesizeofthecapacitorwhichwill effectively allow for greater memory density. In order to change the capacitor size without affecting the capacitance, different cell orientations are being used. Some of these include stacked or trench capacitors [23]. With the emergence of trench capacitors, the problem of fabricating these capacitors comes into play, especially as the size of semiconductors decreases. ALDallowstrench features to bescaled to beyond 100 nm. The ability to deposit singlelayersofmaterial allowsforagreatdealofcontroloverthematerial.Exceptforsome issues of incomplete film growth (largely due to insufficient amount or low temperature substrates), ALD provides an effectivemeans of depositing thin films like dielectrics or barriers [24].

Optics

High uniformity and accurate thickness control make ALD attractive for optics. Planar developedamultiple-cavity Fabry-Perot filterfor WDM(wavelength division multiplexing) applications. The device consists of about 200 layers and has thickness of device consists of about 200 layersand has thickness of 45 µm.

High-EfficiencySiliconSolarCells

Recently, it was shown that thin films of aluminum oxide ($Al_2O_3$) grown by atomic layer deposition(ALD)providean excellentlevelofsurfacepassivationonlow-resistivityp-and n-type silicon wafers. The PERC-type solar cell structure demonstrate the applicability of $Al_2O_3$rear surface passivation to high-efficiency silicon solar cells [25].



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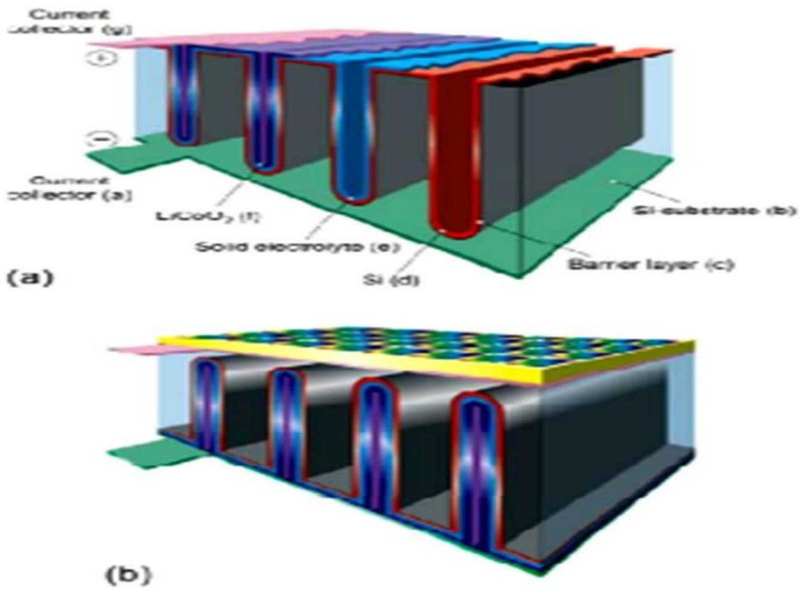


ADVANTAGESANDLIMITATIONSofALD

A) Advantages

ALD provides avery controlled method to produce a film to an atomically specified thickness. Also, the growthof different multilayer structures is straightforward. Due to the sensitivity and precision of the equipment, it is very beneficialto those in the field of microelectronicsandnanotechnologyinproducingsmall,butefficientsemiconductors.ALD is typically run at lower temperatures along with acatalyst which is thermo-chemically favored. The lower temperature isbeneficial when working with fragile substrates, such as biologicalsamples. Someprecursors that arethermallyunstablestillmaybeusedso longas their decomposition rate is relatively slow [34].

B) Disadvantages

Highpurityofthesubstratesisveryimportant,andassuch,highcostswillensue(Stanford).
Although this cost may not be much relative to the cost of the equipment needed, one may needtorunseveraltrialsbeforefindingconditionsthatfavortheirdesiredproduct.Oncethe layer has been made and the process is complete, Once the layer has been made and the process is complete, there may be a requirement of needing to remove excess precursors from the final product. In some final products there are less than one percent of impurities present [35].

**ECONOMICVIABILITY&LIMITATINSofALD**

Atomic layer deposition instruments can range anywhere from Rs. 130,00000 to Rs.520,00000 based on the quality and efficiency of the instrument. There is no set cost for running a cycle of these instruments; the cost varies depending on the quality and purity of the substrates used, as well as the temperature and time of machine operation. Some substratesarelessavailablethanothersandrequirespecialconditions,assomearevery



ISBN:978-81-957858-1-0

sensitive to oxygen and may then increase the rate of decomposition. Multi-component oxidesandcertainmetalstraditionallyneededinthemicroelectronicsindustryaregenerally notcostefficient[36].TheprocessofALDisveryslowandtheprecursorssousedmustbe volatile and these problems are known to be its major limitation.

**UTUREPERSPECTIVEof ALD**

With devices becoming ever smaller andincreasingly structured into complex three dimensionalshapes,theneedforcontrollableandconformalthinfilmshasneverbeengreater. ALD, with its sequential self-limiting reactions, is able to meet these demands in one of the most effective methods possible. Comparable techniques, such as CVD and PVD, cannot always provide the same level of uniformity, conformality and thickness control at the Angstromlevel.Becauseoftheadvantages of ALD, ALD processes havebeen developedfor awidevarietyofmaterials,rangingfrommetalstometaloxidestocomplexternarymaterials, allowing ALD to become incorporated into industrial procedures.

On the basis of effectiveness and applicability ofALD based materials, this technology will surely be result into the more precise smart devices. The applications of ALD and nanotechnology shall be helpful in developing high data storage devices, supercomputers,power and energy storage devices, rocket and satellite technology. Power transmission, media communication and wireless technology shall be even more precise and faster. It can be expected that in the next decade the technology shall help in exploring the universe.

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ISBN:978-81-957858-1-0

# Review: The Memristor MOS content addressable memory is designed at22nmVLSI Technology

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**Abstract**

A crucial component in a wide range of applications is large capacity content addressable memory (CAM). Thecomplexity ofscaling MOS transistors presents asignificant obstacle to thedevelopment ofsuch systems. Theconvergenceof many technologies that work well with CMOS processing may allow Moore's law to continue for another year. The design and modelling of memristor-based CAM (MCAM) employing a combination of MOS devices as the core of a memory or logic cell, which serves as the fundamental unit of the CAM architecture, is presented in this study as a novel approach. The non-volatile properties, nanoscale geometry, and compatibility of the memristor with CMOS processing technology increase packing density, allow for new approaches to power management by disabling CAM blockswithoutlosingstoreddata,cutdownonpowerindulgence,andhavepotentialforspeed improvement as thetechnology advances. Thememristorfunctions muchlikeatransistoras a switch.Itisatwo-terminalratherthanathree-terminaldevice,unlikethetransistor,anditdoes not require power to maintain either of its two states. The movement of mobile ionic charge within an oxide layer allows a memristor to vary its resistance between two values. This tendency affects thearchitectureofCAMsystems; stored datais notlosteven when theCAM blocks' power source is turned off. Memristor-based CAM cells hence have the potential to significantly reduce power dissipation.

***Keyword:*** Content addressable memory (CAM), memory, memory resistor-based CAM MCAM), SRAM**.**

## Introduction

Forbothcircuitdesignersandsystemarchitects,findinganewmodelwithprocessingspeedin the exa flop and later zeta flop orders is a significant issue. As CMOS scaling slows, the proliferationofnetworkslikethe Internetalsonecessitatesthedevelopmentofnewcomponents and related circuits that are compatible with CMOS process technology. The integration of many different technologies, including spintronics, carbon nano tube field result transistors, optical nano circuits based on meta materials, and more recently, the memristor, are coming into greater focus as Moore's law becomes more challenging to implement, opening up new opportunitiesfortherealizationofnovelcircuitsandsystemsinthesystem-on-systemdomain. Using a mix of switches acting as memristors and n-type MOS devices, a memory cell is modelled as a component of a memristor-based content addressable memory (MCAM) architecture. A typical content addressed memory cell is made up of two p-type MOS transistorsandiscalledanSRAMcell.ThefundamentalgoalofmodernCAMresearchisto



ISBN:978-81-957858-1-0

reducepowerconsumption,andtheconstructionofanSRAMcellusingmemristortechnology, whichhasnon-volatilememorybehaviourandcanbebuiltasanextensiontoaCMOSprocess technology with nanoscale geometry, addresses this goal. The memristor, a fourth inactive circuit component predicted by Chua in 1971 and produced by Kang, is the foundation of the construction of a CAM cell. Theone valued relationship d=Mdq, which states that the current flowingthrough amemristorisproportionate tothefluxofmagneticfieldpassingthroughthe material,wasproposedbyChuaasareplacementcircuitcomponentthatmustexist.Therefore, memristor-based CAM cells could significantly reduce power dissipation.

**Conventional CAM Structures**

search term is entered into a content addressable memory, which then returns the memory locationthatmatches.Withthismethod,theenormousspaceoftheinputsearchtermismapped tothesmallerspaceofthematchlocationinasingleclockcycle.Toforwardinternetprotocol (IP)packetsinnetworkrouters,therearedifferentapplicationsaswellastranslationlookaside buffers(TLV),imagecoding,classifiers,etc.Memristorsareusedinthearchitecturetoensure thatdataiskeptevenifthepowersupplyisturnedoff,openingupnewdesignpossibilitiesfor the system, including the crucial issue of power management.

**Conventional CAM**

WegiveaquickdescriptionoftraditionalCAMcellsemployingstaticrandomaccessmemory so that you may better understand some of the advantages of our suggested structure. Two p-typetransistors, which typically require moresilicon area, areamong the fourtransistors used bythetwoinvertersthatmakeupthelatch.FornanoscaledCMOStechnology,issuesincluding relatively high leakage current and the requirement to include both VDD and ground lines in eachcellposeadditionaldifficultiesforCAMdesignerswhowanttoenhancepackingdensity while preserving reasonable power indulgence. As a result, cheap, high-performance, extremely dense designs were needed.

The SRAM cell is the main consideration in the architectural design. For instance, the static noise margin (SNM) of a standard 6-T SRAM for extremely low-power applications is one of the known issues. Fundamentally, voltage scaling, which lowers CMOS operation to the subthreshold rule, is the basictechnology used to develop an ultra-power memory. In orderto solvethelowSNMforsubthresholdsupplyvoltage,VermaandChandrakasanpresentedan8- T SRAM. Verma and Chandrakasan demonstrate that at very low supply voltages, the static noisemarginforSRAMwillvanishduetoprocessvariation.Thisindicatesthatalargeincrease in silicon area is required to reduce failure when the supply voltage is lowered. Failure is a significant problem in the design of super dense memories. Consequently, a variety of fault tolerancestrategiesaretypicallyused.AslongastheSRAMstructureistoblamefortheflaws and failures, a standard strategy like memory cell duplication can be used.

Itmanifestlyresultsinasignificantamountoftransparencyinthesiliconarea,aggravatingthe problem of power consumption.



ISBN:978-81-957858-1-0

## LITRATUREREVIEW&RELATEDWORK

According on a thorough analysis of relevant work and the body of published literature, it is apparent that numerous researchers used unique strategies to create MOS content addressable memory.

When designing and analysing MOS content addressable memory, researchers have taken on unique systems, processes, or phenomena in an effort to uncover any unknown parameters. GiventhatVLSI/CMOScurrentlyholdsadominantpositionintheactualworld,itissurprising that so few academics have focused on building MOS content addressable memory using CMOS/VLSI technology.

CircuittheoristLeonChuafirstproposedthememristorin1971asamissingnon-linearpassive twoterminalelectriccomponentlinkingtherelationshipbetweenelectricchargeandmagnetic flux. Although some experimental data disputes this assertion, Leon Chua has recently advocated that the concept should be expanded to include all types of 2-terminal nonvolatile memory devices based on resistance switching effects. The creation of switching memristors based on a titanium dioxide film was disclosed by the HP laboratories team in 2008. These devices are used in computer logic and nanoelectric memory.

Capacitors and inductors, whose characteristics depend on the state and history of the system, were added to the concept of a memory system by Di Ventra, Pershin, and Chua in January 2009. Memristor-based content addressable memory (MCAM) was unveiled on April 20. On June1,MouttetstatedthattheHPLabsdevicebelongedtoalargerclassofmemristivesystems and that it was erroneous to interpret the memristor as a fourth fundamental.

UjwalaA.Belorkarconductedresearchontheuseof45nmVLSItechnologytocreatethelayout of static RAM memory between September and October 2010.

Tse showed printed memristive counters based on response processing in October 2011 with potential uses as inexpensive packaging components (no battery required; powered by energy scavenging mechanism). The first operational memristor array constructed on a CMOS chip for use in neuromorphic computer architectures was announced by HRL Laboratories and the University of Michigan on March 23, 2011. Meuffels criticised the idea of a generalised memristor on July 31, 2012.

ThomascreatedamemristorthatissimpletolearnonFebruary27,2013.Memristorsareused asessentialpartsofthestrategy'sdesignforanartificialbrain.Valov,etal.statedonApril23, 2013,thatthecurrentmemristivetheoryneedstobeexpandedintoacompletelynewtheoryto function effectively.

DrawReRAM,whichusesredox-basedresistivelyswitchingcomponents.

Themaincauseistheuseofnanobatteriesinredox-basedresistiveswitches,whichgoesagainst the pinched hysteresis requirement of the memristor theory. Dongbu HiTech's 0.18-m technologyhasbeenusedtocreateboththetraditionalCAMandMCAMcircuits,wherethe



ISBN:978-81-957858-1-0

nominal operating voltagefortheCAMis 1.8V.Without avoltagesource, theMCAMcellis constructed with nMOS components and memristors. The results of my survey regarding memristor-basedMCAMdesignshowthatresearchershaveplannedavarietyofapproachesto design the chip and to enhance its features and various parameters, according to a careful analysis of the reported work.

It is also commonly known that the fastest-growing industry nowadays is VLSI technology. And in accordance with Moore's law, which states that an integrated circuit's transistor count will double every 18 months. We can optimise factors like electricity usage by growing with thetechnology. Upuntil 2008, current technology was in thelowernm range. Thedecision to use a higher order of nm technology for the proposed project was made in light of the advancementoffuturetechnologyandtheadvantagesof45nmtechnologyover65and90nm technology.

Research has been done to create a low power MCAM using 22nm VLSI technology in light of these constraints and the requirement for rapid communication in the modern world.

**DESIGN METHODOLOGY**

The behaviour of memristors, a recently discovered fundamental circuit component, can be anticipated by utilising either the flux- or charge-dependent function known as memductance or memristance. Finding the memristor's memristance or memductance function is crucial for this reason. The methodology suggests conducting anumber ofexperiments with amemristor using a square-wave signal to gather data before employing an algorithm that was motivated by the ionic memristor experiment. Content addressable memory (CAM), memory, memory-resistorbasedCAM(MCAM),memory-resistorbasedMOShybriddesign,andmodellingare the keywords used for this design. Every stage of design adheres to the microwind 3.1 software's design flow. The design process will follow the flow of the VLSI backend device.

1. CMOStransistorsareusedintheproposedMCAM'sschematicdesign.

2. Performance evaluation of the aforementioned for various aspects.

3. CMOSconfigurationwith VLSIbackendfor theproposed MCAM.

4. TestingofparametersandCMOSlayoutverification.

The design will be ready for IC manufacturing if the goal is accomplished for all anticipated parameters, including detail verification, and sing off for design analysis.If the detailed parameter authentication is not complete, repeat the first step using an alternative manner.

Different research methodologies and procedures can be employed in order to realise the intended MCAM. The MICROWIND3.1 programme enables the physical description level design and simulation of integrated circuits. The package includes a list of common analogue andlogicintegratedcircuits(ICs)foranalysisandsimulation.Thecommandsforamaskeditor



ISBN:978-81-957858-1-0

are all included in MICROWIND3.1, along with other unique tools that have never been compiledintoasinglemodule(2Dand3Dmethodread,VERILOGcompiler,lessononMOS devices). By pushing a single key, circuit simulation can be made more accessible. The analogue simulator instantaneously generates voltage and current curves after mechanically removing the electric circuit.

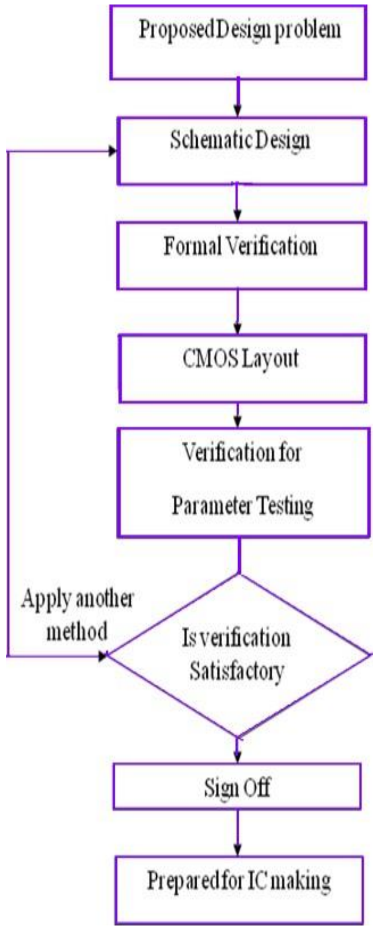


Fig1:DesignFlowChart.

CONCLUSION

Analysis of the assumption of a memristor-based structure provided utilising a behavioural modelling strategy. Because the technology is more developed and better understood, further performance improvements may be anticipated.The read and write amplifier's local power supply is simple to reconnect, resulting in good performance and low leakage.

Inordertoillustratehowtheproposedcellfunctionswithregardtotiming,stability,variation, and cache implementation, a thorough functional and theoretical analysis is provided. Additionally, a design process for portless SRAM cells is described along with its advantages over conventional 6T cell methods.



ISBN:978-81-957858-1-0

Thedecision to choose a higherorder of nm technology fora futureproject was made in light of the evolution of technology and the advantages of 22 nm technology over 65 and 90 nm technology. Given these limitations and the need for quick communication in the modern world, research has been done to develop low power MCAM using 22nm VLSI technology.

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ISBN:978-81-957858-1-0

# InvestigatingtheUseofIoTforSmartEducationSolutions

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**Abstract**

The advent of the Internet of Things (IoT) has revolutionized numerous industries, and education is no exception. The integration of IoT technologies into educational environments hasthepotentialtoenhancethelearningexperience,improveoperationalefficiency,andfoster a collaborative and interactive educational ecosystem. This research paper explores the applications, benefits, challenges, and future prospects of leveraging IoT for smart education solutions.Byanalyzingexistingliteratureandcasestudies,wepresentanoverviewofhowIoT cantransformtraditionaleducationalsettingsandproviderecommendationsforimplementing IoT-based solutions effectively.

**Keywords-**InternetofThings(IoT),WirelessSensorNetworks(WSNs),CloudInfrastructure, RFID (Radio-Frequency Identification, Beacons.

## Introduction

Education plays a crucial role in shaping individuals' lives and societies at large. Traditional education systems have predominantly relied on face-to-face interactions, physical resources, andmanualprocesses.However,therapidadvancementoftechnology,particularlytheInternet of Things (IoT), has presented opportunities to transform and enhance the educational landscape.TheIoTreferstothenetworkofinterconnectedphysicaldevices,sensors,actuators, and software applications that collect, exchange, and analyze data. This technology has been successfully employed in various domains such as healthcare, transportation, and manufacturing. Integrating IoT into education holds the potential to create smart education solutions that improve teaching and learning methodologies, administrative processes, and overalleducationaloutcomes.Theprimaryobjectiveofthisresearchpaperistoinvestigatethe use of IoT for smart education solutions. By exploring the applications, benefits, challenges, and future prospects of IoT in education, this study aims to provide a comprehensive understanding of how IoT can revolutionize educational environments. The research aims to:

a) IdentifythedifferentapplicationsofIoTinthe contextofsmarteducation.

b) Examinethebenefitsand advantages ofimplementing IoT-basedsolutions in education.

c) ExplorethechallengesandconsiderationsassociatedwiththeintegrationofIoTin educational settings.

d) Provideinsightsintosuccessfulcasestudiesandreal-worldimplementationsofIoTin education.

e) OfferrecommendationsandguidelinesforeffectivelyleveragingIoTineducationalinstitutions.



ISBN:978-81-957858-1-0

### 1.3 Methodology:

To achieve the research objectives, this study adopts a mixed-method approach that combines a comprehensive review of existing literature and the analysis of relevant case studies. The methodology involves the following steps:

a) Literature Review: Conduct an extensive review of academic journals, conference papers, reports,andreputableonlinesourcestogatherexistingknowledgeontheapplications,benefits, challenges, and future prospects of IoT in education. This will help establish a theoretical foundation for the research.

**b) Case Studies Analysis:** Analyze and evaluate real-world case studies and success stories that showcase the implementation of IoT in educational settings. These case studies will provide practical insights into the challenges faced, solutions implemented, and outcomes achieved in IoT-enabled smart education environments.

**c) DataSynthesis:**Synthesizethefindingsfromtheliteraturereviewandcasestudiesanalysis to provide a comprehensive overview of the use of IoT in smart education solutions. Identify common themes, trends, and gaps in the existing knowledge.

**d) Recommendations and Conclusion:** Based on the synthesized findings, provide recommendations for educators, policymakers, and technology practitioners on how to effectivelyintegrateIoTintoeducationalsettings.Concludetheresearchpaperbysummarizing the key findings and highlighting the potential future developments in this field.

By adopting this methodology, the research aims to present a well-rounded and evidence-based exploration of the use of IoT for smart education solutions.

## 2. OVERVIEWOFIOTIN EDUCATION

### Definitionof IoTintheEducation Context:

In the context of education, the Internet of Things (IoT) refers to the network of interconnected devices, sensors, and systems that collect, transmit, and analyze data to enable smart and efficient educational processes. IoT in education involves the integration of technology to create an interconnected ecosystem where devices and data work together to enhance teaching and learning experiences, streamline administrative tasks, and improve overall educational outcomes.


ISBN:978-81-957858-1-0


*Fig.1-Smartclass usingInternet of Things*

**ComponentsandArchitectureofIoTinEducation:**

The architecture of IoT in education comprises several key components that work in tandem to create a connected environment. These components include:

**a) Devices**: IoT devices in education encompass a range of hardware such as sensors, wearables, smart boards, tablets, and smartphones. These devices are embedded with sensors and actuators to collect and transmit data.

**b) Connectivity**:IoTdevicesrequirerobustconnectivitytocommunicatewitheachotherand transmit data. This connectivity can be achieved through various means such as Wi-Fi, Bluetooth, or cellular networks.

**c) Data Collection and Analytics**: Sensors embedded in IoT devices collect data related to student behavior, environmental conditions, resource utilization, and more. This data is then transmitted to a central system or cloud infrastructure for storage and analysis. Data analytics tools are employed to derive meaningful insights and support data-driven decision-making.

**d) Cloud Infrastructure**: IoT-based education systems often rely on cloud computing platforms to store and process data. Cloud infrastructure provides scalable storage, computationalpower,anddataprocessingcapabilitiesrequiredformanagingandanalyzingthe vast amount of data generated by IoT devices.

**e) Applications and Interfaces**: User-friendly applications and interfaces enable educators, students, and administrators to interact with IoT devices, access data, and utilize the insights provided by the system. These applications can range from learning management systems to mobile apps or web portals.

**KeyTechnologiesEnablingIoTinEducation:**

Several technologies enable the implementation of IoT in education. Some of the key technologies include:

**a) Wireless Sensor Networks (WSNs):** WSNs consist of a network of small, low-power sensorsthatcollectdataandcommunicatewirelessly.Ineducation,WSNsareusedtomonitor



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environmental conditions, track student movements, and collect real-time data for various purposes.

**b) RFID(Radio-FrequencyIdentification):**RFIDtechnologyuseselectromagneticfieldsto automatically identify and track tags attached to objects or individuals. RFID systems are employedineducationforassettracking,attendancemonitoring,andaccesscontrolpurposes.

**c) Beacons:** Beacons are small devices that transmit Bluetooth signals to nearby devices. In education,beaconsareusedtoprovidelocation-basedinformation,personalizednotifications, and context-aware learning experiences.

**d) Data Analytics and Machine Learning:** Data analytics techniques and machine learning algorithms are utilized to process and analyze the data collected from IoT devices. These technologies enable educators to gain insights into student performance, identify learning patterns, and personalize the learning experience.

**e) Cloud Computing:** Cloud computing infrastructure provides the necessary storage, computingpower,andscalabilityrequiredformanagingandprocessingthevastamountofdata generated by IoT devices in education.

**f) Artificial Intelligence (AI) and Natural Language Processing (NLP):** AI and NLP technologies can be integrated into IoT-based education systems to facilitate intelligent tutoring, virtual assistants, and automated grading systems, among other applications.

Byleveragingthesecomponentsandtechnologies,IoTineducationenablesthecreation of smart classrooms, personalized learning experiences, efficient campus management, and innovative teaching methodologies, ultimately enhancing the overall educational ecosystem.

## 3. APPLICATIONSOFIOT INSMART EDUCATION

### Smart Classrooms:

Smartclassroomsareoneoftheprimaryapplicationsof IoTineducation,transforming traditional learning spaces into dynamic and interactive environments.

### AdaptiveLearningand Personalization:

IoT enables adaptive learning and personalization by collecting and analyzing data on students'learningbehaviors,preferences,andprogress.Smartclassroomsystemscanadjustthe pace, content, and delivery of educational materials to cater to individual students' needs. Adaptive learning platforms utilize IoT data to provide personalized recommendations, adaptive assessments, and customized learning paths, ensuring that students receive tailored instruction and support.

### Real-TimeLearning Analytics:

IoT devices in smart classrooms collect real-time data on student engagement, participation, and performance. This data is then processed and analyzed to provide valuable insightstoeducators.Real-timelearninganalyticsempowerteacherstomonitorstudent



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progress, identify areas of improvement, and make informed instructional decisions. It also enables early intervention strategies and supports personalized feedback, fostering a data-driven teaching and learning environment.

**CampusManagementandSecurity:**

IoT-based solutions enhance campus management and security systems, ensuring the safety and well-being of students and staff.

**AssetTrackingand Management:**

IoTenablesassettrackingandmanagementwithineducationalinstitutions.IoTdevices, such as RFIDtags, can beattached to school equipment, books, and other resources, allowing administratorstomonitortheirlocation,availability,andutilization.Thisstreamlinesinventory management, reduces loss, and optimizes resource allocation.

**SecurityandSurveillanceSystems:**

IoT-based security systems enhance campus safety through real-time monitoring and surveillance.Connectedcameras,motionsensors,andaccesscontrolsystemscanbeintegrated to detect unauthorized access, monitor critical areas, and alert security personnel in case of emergencies.IoT-poweredsecuritysolutionsprovideaproactiveapproachtocampussecurity, ensuring a safe and secure learning environment.

**RemoteLearning andVirtual Labs:**

IoT facilitates remote learning and virtual lab experiences, enabling educational institutions to overcome geographical constraints and offer innovative learning opportunities.

**RemoteTeachingand Collaboration:**

IoTdevicesandtechnologiesenableremoteteachingandcollaborationamongstudents and educators. Video conferencing tools, online collaboration platforms, and IoT-enabled communication devices allow students and teachers to connect and engage in virtual classrooms.IoT-supportedremoteteachingpromotesinclusivity,flexiblelearning,andaccess to educational resources regardless of physical location.

**VirtualLaboratoriesandExperiments:**

IoT-based virtual laboratories provide a simulated environment for conducting experiments and practical learning activities. Connected sensors and actuators replicate real-world scenarios, allowing students to engage in hands-on learning experiences remotely. VirtuallabssupportedbyIoTtechnologyoffercost-effective,scalable,andsafealternativesto traditional laboratory setups, facilitating practical education across various disciplines.

By leveraging IoT applications in smart classrooms, campus management, and remote learning, educational institutions can create a more interactive, personalized, and secure educationalenvironment.IoT-poweredsolutionspromotestudentengagement,improve



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learningoutcomes,optimizeresourceutilization,andexpandaccesstoeducationbeyond physical boundaries.

## 4. BENEFITSOF IOTIN EDUCATION

**EnhancedLearningExperience:**

IoT in education enhances the learning experience by providing personalized and adaptive learning opportunities. Through real-time data collection and analysis, IoT devices cantailoreducationalcontent,pacing,anddeliverymethodstoindividualstudents'needs.This customization promotes active learning, student autonomy, and better comprehension. Additionally, interactive IoT technologies, such as smart boards,augmented reality (AR),and virtualreality(VR),createimmersiveandengaginglearningexperiencesthatstimulatestudent curiosity and knowledge retention.

**ImprovedOperationalEfficiency:**

IoTsolutionsoptimizeoperationalprocesseswithineducationalinstitutions,leadingto improved efficiency and resource management. Automated systems for attendance tracking, asset management, and scheduling minimize manual administrative tasks, reducing time and effort. IoT-enabled campus management systems ensure better utilization of facilities, streamlinedworkflows,andeffectiveallocationofresources.Thisincreasedefficiency allows educators and administrators to focus more on teaching and student support, leading to a smoother educational ecosystem.

**IncreasedStudentEngagementandCollaboration:**

IoT devices foster increased student engagement and collaboration through interactive learning tools and real-time communication platforms. IoT-powered smart classrooms enable activeparticipation,hands-onlearning,andpersonalizedfeedback,makingthelearningprocess moreinteractiveandengaging.CollaborativeplatformssupportedbyIoTfacilitatepeer-to-peer interaction, group projects, and remote collaboration, enhancing teamwork, communication, and problem-solving skills.

**Data-DrivenDecisionMaking:**

IoT generates vast amounts of data that can be analyzed to drive data-driven decision making in education. By collecting and analyzing real-time data on student performance, behavior,andlearningpatterns,educatorscangainvaluableinsightsinto individualandgroup learning trends. This data empowers educators to make informed instructional decisions, implementtargetedinterventions,andpersonalizelearningexperiencesbasedonstudentneeds. Data-driven decision making improves educational outcomes, identifies areas for improvement, and supports evidence-based practices.

**EnhancedLearningExperience:**



ISBN:978-81-957858-1-0

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*Fig.1-InternetofThingsBenefitsintheEducation Sector*

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**Accessibilityand Inclusivity:**

IoT technology promotes accessibility and inclusivity in education by breaking down barriers and providing equal opportunities for all learners. IoT-enabled remote learning platforms allow students to access educational resources and participate in classes regardless oftheirphysicallocation.Thisbenefitsstudentsinruralareas,thosewithdisabilities,orthose facing mobility challenges. IoT also facilitates assistive technologies and adaptive learning tools, catering to diverse learning needs and ensuring equitable access to education for all students.

Overall, the benefits of integrating IoT in education lead to an enhanced learning experience, streamlined operations, increased engagement and collaboration, data-driven decision making, and improved accessibility. By leveraging IoT technology, educational institutions can create an inclusive, personalized, and efficient learning environment that prepares students for the challenges of the digital age.

## 5. CHALLENGESAND CONSIDERATIONS

**SecurityandPrivacyConcerns:**

The integration of IoT in education raises security and privacy concerns. IoT devices are vulnerable to cyber threats, and the data collected by these devices may contain sensitive student information. Educational institutions must implement robust security measures to protect against unauthorized access, data breaches, and ensure data privacy compliance. Encryption,securenetworkprotocols,regularsoftwareupdates,andstrongaccesscontrolsare essential to safeguard IoT systems and maintain data privacy.

**Infrastructureand Scalability:**

Implementing IoT in education requires a robust and reliable infrastructure to support the connectivity and data processing requirements. Upgrading existing networks, deploying IoT devices, and managing the data influx pose infrastructure challenges. Educational institutions need to ensure scalable and efficient network architecture, sufficient bandwidth, and storage capacity to handle the increasing volume of data generated by IoT devices.

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**Interoperabilityand Standardization:**

Interoperability and standardization are significant challenges in IoT implementation. IoTdevicesfromdifferentmanufacturersmayusedifferentcommunicationprotocols,making it difficult to integrate and manage diverse devices in an educational ecosystem. Lack of standardizationhindersseamlessconnectivityanddataexchangebetweendevices,limitingthe interoperability of IoT solutions. Collaboration among stakeholders, industry-wide standards, and open protocols are necessary to address interoperability challenges.

**CostandReturnon Investment:**

IoT implementation in education requires financial investments for acquiring IoT devices, infrastructure upgrades, and ongoing maintenance. The initial costs of procuring IoT devices, connectivity solutions, and setting up the necessary infrastructure can be significant. Educational institutionsmust carefully evaluatethereturnon investment (ROI)and long-term benefits of IoT implementation. Cost-effectiveness analysis, budget planning, and identifying potential funding sources are essential considerations to ensure sustainable and viable IoT deployments.

**UserAcceptanceandTraining:**

SuccessfuladoptionofIoTineducationreliesonuseracceptanceandadequatetraining. Educators,students,andadministratorsmayrequiretrainingtoeffectivelyuseandmanageIoT devices and platforms. Resisting change, lack of technical expertise, and concerns about the integration of IoT in existing teaching practices can hinder user acceptance. Institutions need toinvestincomprehensivetrainingprograms,providesupportresources,andcreateawareness about the benefits and value of IoT in education.

Addressing these challenges and considerations is crucial to maximize the benefits of IoT in education. Educational institutions should prioritize security, plan for scalable infrastructure,advocateforinteroperabilitystandards,conductthoroughcost-benefitanalyses, and invest in user training and support to ensure successful implementation and utilization of IoT in education.



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## 6. CASESTUDIESANDSUCCESSSTORIES

### IoT-basedSmartClassroomImplementations:

**CaseStudy 1:**ArizonaStateUniversity, USA

Arizona State University implemented a smart classroom solution using IoT devices and analytics. The classrooms were equipped with sensors that collected data on temperature, humidity, noise levels, and student movement. The data was analyzed to optimize environmental conditions for better learning outcomes. Real-time feedback on student engagement and understanding was provided to instructors, enabling them to adapt their teaching strategies. The implementation resulted in increased student participation, improved student-teacher interactions, and enhanced learning experiences.

*Fig.3-ArizonaStateUniversity, USA*

### CampusManagementandSecurity Solutions:

**CaseStudy 1:**University of California,Los Angeles, USA

The University of California, Los Angeles implemented IoT-based campus management and security solutions. RFID tags were attached to university assets, such as library books and equipment, enabling real-time tracking and management. IoT-enabled security cameras and access control systems were deployed across the campus to enhance security and monitor critical areas. The implementation improved operational efficiency, reducedassetloss,andenhancedcampussafetybydetectingunauthorizedaccessandpromptly alerting security personnel.



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**CaseStudy2: NanyangTechnologicalUniversity, Singapore**

NanyangTechnologicalUniversityimplementedanIoT-poweredcampusmanagement systemtooptimizeresourceallocationandenhanceoperationalefficiency.Thesystemutilized IoT sensors to collect data on classroom occupancy, energy consumption, and facility utilization.Thedatawasanalyzedtooptimizespaceallocation,adjusttemperatureandlighting settings based on occupancy, and identify areas for energy conservation. The implementation resulted in significant energy savings, improved space utilization, and streamlined facility management processes.

**RemoteLearningandVirtual Labs:**

**CaseStudy 1:**University ofHelsinki, Finland

The University of Helsinki implemented IoT-based remote learning solutions to offer virtual lab experiences for science and engineering students. IoT sensors and actuators were utilizedtosimulatereal-worldlaboratoryexperimentsandcollectdataremotely.Studentscould access the virtual labs from any location and perform experiments using IoT devices. The implementationenabledstudentstogainpracticalexperience,conductexperimentssafely,and receive real-time feedback, regardless of their physical location.


*Fig.4-RemoteLaboratoryEnvironmentforEmbeddedSystem Experiments*

**CaseStudy2:**QueenslandUniversity ofTechnology, Australia

Queensland University of Technology implemented an IoT-powered remote learning platformtoenablecollaborativevirtuallearningenvironments.TheplatformincorporatedIoT devices,videoconferencingtools,andshareddigitalspacesforstudentstointeract,collaborate, andwork onprojectsremotely.Theimplementationfacilitatedgroupwork,peerlearning,and knowledgesharing,creatinganengagingandinteractiveremotelearningexperience.Students reported increased collaboration, improved communication, and enhanced problem-solving skills.

These case studies illustrate successful implementations of IoT in smart classrooms, campus management, and remote learning. The use of IoT devices and analytics led to improved learning outcomes, streamlined operations, enhanced security, and expanded access to educational resources, demonstrating the potential and benefits of IoT in education.



ISBN:978-81-957858-1-0

## 7. FutureProspectsand Recommendations

**EmergingTrendsandTechnologies:**AsIoTcontinuestoevolve,severalemergingtrends and technologies are expected to shape the future of smart education:

a) Edge Computing: Edge computing brings data processing and analysis closer to the IoT devices, reducing latency and enabling real-time decision making. In smart education, edge computing can enhance the responsiveness of IoT devices, enable faster data analytics, and support resource-constrained environments.

b) ArtificialIntelligence(AI)andMachineLearning(ML):AIandMLalgorithmscanleverage the data collected by IoT devices to provide more sophisticated and personalized learning experiences. AI-powered virtual tutors, intelligent content recommendations, and automated assessment systems can enhance student engagement and learning outcomes.

c) Augmented Reality (AR) and Virtual Reality (VR): AR and VR technologies create immersive learning experiences by overlaying virtual objects and environments onto the real world. IoT integration can enhance AR/VR applications in education, allowing students to interact with IoT devices and sensors to explore and manipulate virtual content.

**AddressingChallengesandMitigatingRisks:**

To successfully leverage IoT in education, the following measures should be taken to address challenges and mitigate risks:

a) Security and Privacy Measures: Robust security measures, such as encryption, access controls, and regular updates, should be implemented to protect IoT devices and student data. Privacypoliciesandcompliancewithdataprotectionregulationsshouldbeenforcedtoensure the responsible handling of sensitive information.

b) Scalable Infrastructure Planning: Educational institutions should plan for scalable and resilient networkinfrastructureto accommodatetheincreasing numberof IoT devices and the data they generate. This includes considering bandwidth requirements, storage capacity, and network reliability.

c) Interoperability and Standardization: Collaboration among stakeholders, including educational institutions, IoT device manufacturers, and technology providers, is essential to establish interoperability standards. Common protocols and frameworks enable seamless integration and data exchange between IoT devices, promoting scalability and ease of management.

d) Cost-Benefit Analysis and Long-term Planning: Educational institutions should conduct thorough cost-benefit analyses to evaluate the financial implications of IoT implementation. Long-term planning, including budgeting for device acquisition, infrastructure upgrades, and maintenance costs, ensures sustainable and successful IoT deployments.

**StrategiesforSuccessfulImplementation:**



ISBN:978-81-957858-1-0

To ensure successful implementation of IoT in education, the following strategies are recommended:

a) ClearlyDefineObjectives:Educationalinstitutionsshouldclearlydefinetheirobjectivesand desiredoutcomesforIoTimplementation.Thisincludesidentifyingspecificeducationalgoals, addressing pain points, and aligning IoT solutions with the institution's strategic vision.

b) Pilot Projects and Iterative Approach: Implementing IoT in education can be complex and challenging. It is advisable to start with pilot projects in specific areas or classrooms to test feasibility,identifypotentialissues,andrefinetheimplementationstrategy.Takinganiterative approach allows for continuous improvement and gradual expansion.

c) Professional Development and Training: Comprehensive training programs should be providedtoeducators,administrators,andtechnicalstafftofamiliarizethemwithIoTdevices, platforms, and related technologies. Ongoing professional development ensures that stakeholderscaneffectivelyleverageIoTtoolsandmaximizetheirpotentialintheeducational context.

d) Collaboration with Stakeholders: Collaboration with stakeholders, including technology providers, industry experts, and researchers, fosters knowledge sharing, best practices, and innovation. Engaging in partnerships and leveraging external expertise can accelerate the successful implementation and adoption of IoT solutions in education.

**Collaboration and Partnerships:**

Collaboration and partnerships play a vital role in harnessing the potential of IoT in education. The following collaborations can be beneficial:

a) Industry-AcademiaCollaboration: Educationalinstitutionscancollaboratewithtechnology companies and IoT solution providers to access the latest innovations, share expertise, and develop customized IoT solutions that meet their specific needs.

b) Cross-Institutional Collaboration: Collaborating with other educational institutions allows for the sharing of best practices.

By investigating the useof IoT for smart education solutions, this research paper aims to provide educators, policymakers, and technology practitioners with valuable insights into the potential of IoT in transforming education. It emphasizes the benefits that can be gained from implementing IoT-based solutions while acknowledging the challenges that need to be addressed. By understanding the applications, benefits, challenges, and future prospects, stakeholders can make informed decisions and take the necessary steps to create an interconnected and intelligent educational ecosystem that fosters improved learning outcomes and prepares students for the digital era.

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ISBN:978-81-957858-1-0

# Voice Transmission Using LiFi Technology: A Comprehensive Research Study

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**Abstract**

LiFi (Light Fidelity) technology is an emerging wireless communication technique that utilizesvisiblelightforhigh-speeddatatransmission.WhileLiFihasbeenpredominantly explored for data communication, this research paper focuses on investigating the feasibility and performance of using LiFi technology for voice transmission. The paper presents an in-depth analysis of the key aspects involved in voice transmission over LiFi, including signal processing, modulation techniques, channel characteristics, and system design considerations. Experimental evaluations and simulations are conducted to assess the performance of voice transmission over LiFi, comparing it with traditional wireless communicationtechnologies.Thefindingscontributetotheunderstandingofthepotential applications and limitations of LiFi technology in voice communication scenarios.

**Keywords:**LiFi,VLC,LightFidelity,wirelesscommunication

## Introduction

Voice transmission is a fundamental aspect of communication, enabling real-time audio exchange between individuals. Traditional voice communication relies heavily on wired and wireless technologies such as telephony and cellular networks. However, the increasing demand for high-speed and reliable wireless communication has led to the exploration of alternative technologies. LiFi (Light Fidelity) technology, a form of visible light communication (VLC), has emerged as a promising solution for wireless data transmission. While LiFi has primarily been investigated for data communication, this research paper aims to investigate the feasibility and performance of using LiFi for voice transmission.

## Backgroundand Motivation

With the increasing demand for wireless communication and the proliferation of connected devices, there is a growing need for efficient and reliable voice transmission technologies. Traditionalradiofrequency(RF)technologies,suchasWi-Fiandcellularnetworks,havebeen theprimarymeansofvoicecommunication.However,thesetechnologiesfacechallengessuch as limited bandwidth, interference, and security vulnerabilities. LiFi, or Light Fidelity, is an emerging wireless communication technology that utilizes visible light for data transmission. It offers several advantages over RF technologies, including higher data rates, lower latency, andimmunitytoelectromagneticinterference.LiFitechnologyhasprimarilybeenexploredfor data communication applications, but its potential for voice transmission is an area of significant interest.



ISBN:978-81-957858-1-0

**Objectivesof theStudy:**

The main objective of this research study is to comprehensively investigate the use of LiFitechnologyforvoicetransmission.Thestudyaimstoexploretheprinciples,components, and modulation schemes specific to LiFi communication for voice applications. It also seeks toevaluatetheperformancefactors,suchasdatarate,latency,reliability,andsecurity,relevant to voice transmission over LiFi. Furthermore, the study aims to identify potential deployment scenarios and applications for LiFi-based voice communication.

**Scopeand Limitations:**

This study focuses specifically on voice transmission using LiFi technology. It delves into the principles, components, and modulation schemes relevant to LiFi communication for voice applications. The study evaluates performance factors such as data rate, latency, reliability,andsecurityinthecontextofvoicetransmissionoverLiFi.Italsoexplorespotential deployment scenarios in telecommunications, healthcare, smart cities, and other domains.

However, it is important to acknowledge the limitations of this study. Firstly, the research is based on current knowledge and understanding of LiFi technology up until the knowledge cutoff date in September 2021. Recent advancements or developments in LiFi technology may not be covered. Secondly, the study focuses on voice transmission and does not extensively cover other aspects of LiFi technology, such as data transmission or indoor positioning. Additionally, the study does not include experimental results or real-world case studies but rather provides a comprehensive overview based on existing literature and knowledge.

Despitetheselimitations,this research study aims to providevaluableinsights into the potential of LiFi technology for voice transmission, identify performance considerations, and highlight potential applications and deployment scenarios.

**PrinciplesofLiFi Communication**

LiFi(LightFidelity)technologyisbasedontheprincipleofvisiblelightcommunication (VLC),whichutilizeslightwavestotransmitdata.Thebasicconceptinvolvesmodulatingthe intensity of light emitted by an LED (Light Emitting Diode) to carry digital information. This modulation is imperceptible to the human eye but can be detected and decoded by LiFi receivers.

**ThekeyprincipleofLiFicommunication involvesthefollowingsteps**:

1. LEDEmission:TheLiFitransmitterconsistsofhigh-speedLEDsthatemitlight.These LEDs can be integrated into various lighting fixtures, such as bulbs, luminaires, or panels.
2. Data Encoding: Information is encoded into the LED light by modulating its intensity at a very high speed. Different modulation techniques such as on-off keying (OOK), variablepulsepositionmodulation(VPPM),ororthogonalfrequency-division



ISBN:978-81-957858-1-0

multiplexing(OFDM)canbeemployed.

3. Light Propagation: The modulated light propagates through the surrounding environment, similar to traditional lighting. LiFi signals can be confined within a specific area or can be directed using optical elements such as lenses or reflectors.
4. Photodetection: LiFi receivers, equipped with photodetectors, receive the modulated lightsignalsandconvertthembackintodigitaldata.Thereceivercanbeintegratedinto devices such as smartphones, laptops, or specialized LiFi receivers.
5. Data Decoding:The received optical signals aredemodulated, and the encoded data is extracted.Signalprocessingtechniquesareappliedtoretrievetheoriginalinformation.
6. DataTransmission: Once the data is extracted, it can be used for various applications, including voice transmission, internet connectivity, or other data-based services.

**2.2Key Components ofa LiFi System:**

ALiFi systemtypically consistsof thefollowing key components:

1. LED Transmitters: High-speed LEDs or LED arrays are the primary transmitters in a LiFisystem.TheseLEDsemitlightsignalsthatcarrydataencodedthroughmodulation techniques.
2. Photodetectors: Photodetectors are used in LiFi receivers to detect themodulated light signalsandconvertthembackintoelectricalsignals.Differenttypesofphotodetectors, such as photodiodes or phototransistors, can be employed.
3. Modulation and Demodulation Circuitry: To encode and decode data, LiFi systems utilize specialized circuitry to perform modulation and demodulation. These circuits ensure accurate transmission and reception of data.
4. SignalProcessingAlgorithms:Advancedsignalprocessingalgorithmsareemployedto extract data from the received optical signals. These algorithms handle noise, interference, and other factors affecting signal quality.
5. Networking Infrastructure: LiFi systems can be integrated with existing networking infrastructure, such as routers or switches, to enable seamless connectivity to the internet or other networks.
6. Control and Management Software: Software systems are employed to control and manage the LiFi network. These systems handle tasks such as network configuration, device pairing, and data routing.

**2.3Comparison withRFTechnologies:**

LiFi technology offers several advantages and differences compared to traditional radio frequency (RF) technologies, such as Wi-Fi or cellular networks. Some key points of comparison include:



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1. Speed: LiFi can achieve significantly higherdata transmission speeds compared to RF technologies. With the use of high-speed LEDs and modulation techniques, LiFi can potentially reach speeds of several gigabits per second, whereasWi-Fi typically offers lower data rates.
2. Bandwidth: LiFi utilizes the visible light spectrum for data transmission, providing a vast amount of unlicensed bandwidth. This abundance of available spectrum enables LiFi systems to support high-capacity data communication.
3. Security:LiFioffersinherentsecurityadvantagesduetothe nature.

**VoiceTransmissionConsiderations**

**CharacteristicsofVoice Communication:**

Voice communication has specific characteristics that need to be considered when using LiFi technology for voice transmission. Some key characteristics include:

1. Real-TimeTransmission:Voice communication requires low latency to maintain real-timeinteractionbetweenparticipants.Delaysintransmissioncancausecommunication disruptions and affect the user experience.
2. Continuous Transmission: Voice communication is continuous in nature, and interruptions or packet loss can result in distorted or unintelligible speech. It is crucial to ensure reliable and uninterrupted transmission of voice data.
3. Bandwidth Requirements: Voice communication typically requires lower bandwidth comparedtodatatransmissionapplications.However,thequalityofvoicetransmission can be affected by limited bandwidth or congestion in the network.
4. Voice Compression: Voice signals can be compressed using various audio codecs to reduce bandwidth requirements. The choice of codec can impact the quality of voice transmission and the overall network performance.

**LiFiModulationSchemesforVoiceTransmission:**

LiFi systems employ different modulation schemes to transmit data, and specific schemes can be used for voice transmission. Some commonly used modulation schemes for voice communication over LiFi include:

1. On-Off Keying (OOK): OOK is a basic modulation scheme where the LED is turned onorofftorepresentbinarydata.Itissimpleandefficientforlowdatarateapplications, such as voice transmission.
2. Variable Pulse Position Modulation (VPPM):VPPM modulates the position of pulses within a predefined time slot to represent data. It can achieve higher data rates than OOK and is suitable for voice transmission with moderate data rates.
3. OrthogonalFrequencyDivisionMultiplexing(OFDM):OFDMdividestheavailable



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spectrumintomultiplesubcarriersandmodulateseachsubcarrierwithdata.OFDMcan support higher data rates and is suitable for voice transmission with higher bandwidth requirements.

The choice of modulation scheme depends on factors such as the required data rate, bandwidth availability, and desired trade-off between complexity and performance.

**Quality ofService(QoS)Requirements:**

VoicecommunicationdemandsspecificQualityofService(QoS)requirementstoensurea satisfactoryuserexperience.WhenconsideringLiFiforvoicetransmission,thefollowingQoS factors should be taken into account:

1. Latency: Low latency is crucial for real-time voice communication. The total delay introduced by the LiFi system, including encoding, transmission, decoding, and processing, should be minimized to maintain conversational flow.
2. Jitter: Jitter refers to the variation in packet arrival times. Excessive jitter can cause voice packets to arrive out of order, leading to voice quality degradation. Jitter should be minimized to maintain consistent voice transmission.
3. Packet Loss: Packet loss can result in gaps or distortions in voice transmission. To ensure high voice quality, the LiFi system should aim for minimal packet loss and employ error correction techniques to recover lost packets if necessary.
4. BandwidthAllocation:Adequate bandwidth should be allocated to voice transmission tomaintainvoicequalityandavoid congestion.Qualitydegradationcanoccurifvoice packets compete with other data traffic for limited bandwidth.

**NoiseandInterference Mitigation:**

LiFisystemsforvoicetransmissionneedtoaddresspotentialnoiseandinterferenceissues to ensure reliable communication. Some key considerations include:

1. AmbientLightNoise:Ambientlightsources,suchassunlightorartificiallighting,can introduce noise in the LiFi communication channel. Techniques such as adaptive modulation,equalization,andbackgroundnoiseestimationcanbeemployedtomitigate the impact of ambient light noise.
2. Interference from Other Light Sources: Interference can occur when multiple LiFi systems or light sources operate in close proximity. Techniques such as frequency hopping, spatial filtering, or interference avoidance algorithms can be employed to minimize interference effects.

**Workingof li-fi:-**



ISBN:978-81-957858-1-0

Since LEDs operate at speeds of less than 1 μs, they can be turned on and off quicker than the human eye can notice, giving the impression that the light source is always on. Binary coding are used for data transmission through this stealthy on-off process. Binary "1" denotes turning on an LED, while binary "0" denotes turning it off. By changing the rate at which LEDs turn on and offto produce distinct strings of 1s and 0s, it is feasible to encrypt data in light. Humans are unable to detect modulation because of its rapidity. The signal is subsequently captured by a photo detector, which transforms it back into its original form.

**Existingsystem**

OurIRRemoteshavebeentransmittingdatathroughphotodiodesforaverylongtime. The IR LED in the television remote pulses rapidly every time we push a button, transmittinginformationthatissubsequentlydecodedbythetelevisionwhenithasreceived it.However,thisantiquatedtechniqueisextremelyslowandcannotbeusedtotransferany valuabledata.Thetworeliablewide-rangesourcesutilisedbymanyapplicationsnowadays are Wi-Fi and Bluetooth. The signal noise in these methods, which utilise radio frequency spectrum,isextremelyhigh.Thesetechniquesalsorequirespecialisedequipment,usealot of power, and are expensive. Here, secure data transfer is not possible. Since WPS uses radiowavecommunication,itisunhealthyandmayeasilybehacked.WPSkeyencryption is available.

**Proposedsystem**

Anovel formof datatransmission usesvisiblelight.

Li-Fi uses light intensity modulation to send data, which is subsequently picked up by a photo-sensitive detector. A light source serves as the transmitter for VLC, and a detector servesasthereceiver.TheLEDwillshinemorethenthevoiceislouder.Thesolar-powered lightisinterpretedbythereceiverportion,whichthenusesaspeakertotranslatethesignal into audible sound. Therefore, employing many LEDs and transmitting multiple data streams at once with Li-Fi makes this system more complicated. By doing this, more information can be transmitted, which allows for faster data exchange.

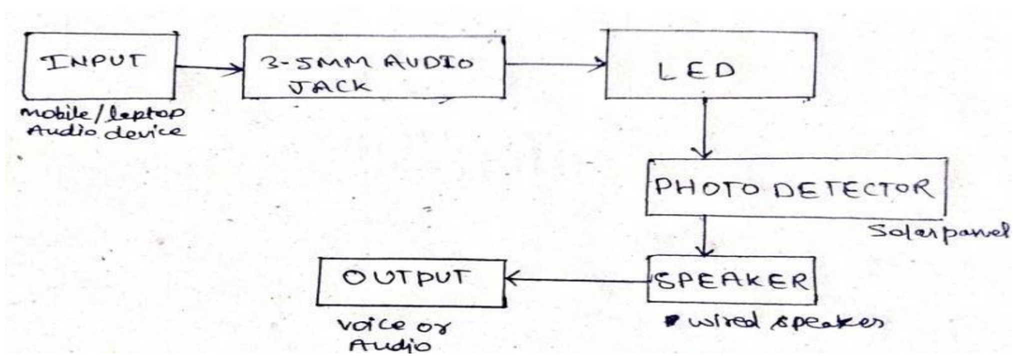


*Fig1: Blockdiagram ofproposed system*



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**Hardware requirements**

**1. INPUT:-**

Analogsignalsareusedasinputandaretypicallyobtainedthroughtheaudiooutputof a mobile device, laptop, or other musical instrument.

**2. AUDIOJACK:-**

Itis amobileconnectorthatisusedto linkmobilephonesto audioequipment.Here,it isutilisedtolinkthemobiledeviceoranyotherdevicewithaLi-Fiaudiosignalinput,suchas an IPAD, MP3 player, etc.

*Fig2: 3.5mmAudio Jack*

**3. LEDs:-**

Theability of a light source to repeatedly flip on and off over very brief periods of time is the most crucial prerequisite for Li-Fi transmission (in ns range). Since LEDs have a relatively shortswitchingtime,weusethem.Basedonthepulsesignal,theseLEDsswitchONandOFF in nanoseconds. Since the switching occurs at a higher rate, the human eye cannot see it.

Therefore,eveniftheyareblinking,itwillappeartobelighting.Asaresult,modulatedsignal is conveyed to receiver via visible light.



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*Fig 3: LED*

**4. PHOTO DETECTOR:-**

TheLEDs'sentsignalneedstoberecognised,demodulated,anddetected.Soweutilise aphotocellorasolarcell(whichconsistsofnumerousphotocellsconnectedinseries)todetect the message signal from the blinking LED light.

Sinceblinkingmaybeeasilyobservedandthesolarcell'soutputisananaloguemessage signal, the solar cell simply detects variations in light. Thus, we were able to detect and demodulate the delivered communication signal utilising solar energy.

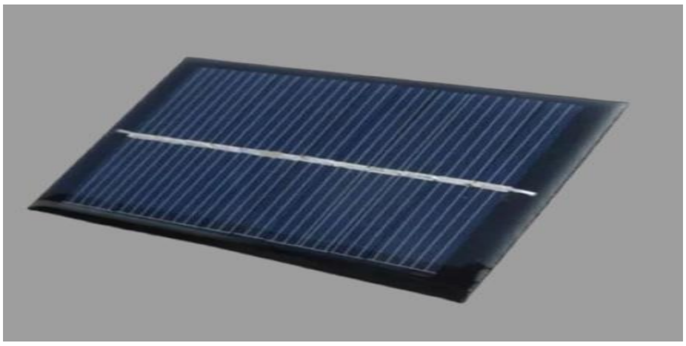

*Fig 4: Solar panel*

**5. SPEAKER:-**

Speakercanamplifythe audiooutput receives fromthesolarpanel thatcaninputtotheLED.



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*Fig5: Speaker*

From speaker to final location, the demodulated audible signal is sent. The message that has been transmitted from the source can now be heard by the audience.

**6. Battery:-**

BatteryisusingtogiveapowertoLEDanditcan helptocompletethecircuitry.Here,weare using a 9 volt battery.


*Fig 6: Battery*

**7. Proposedsystem:-**

Proposedsystemwhichis usingintheexperiment isgivenbelow :

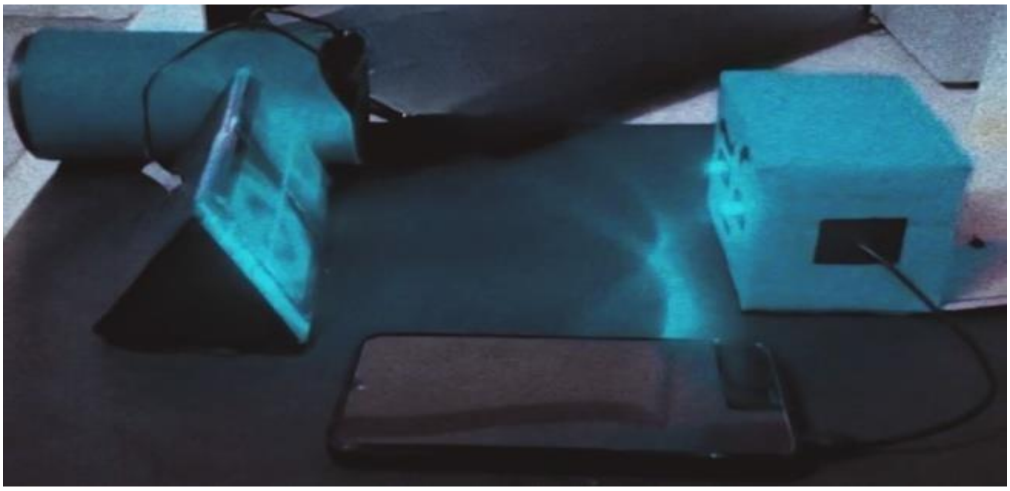

*Fig 7: using system*

**PerformanceEvaluation**

**DataRateandCapacity forVoiceTransmission:**



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The data rate and capacity for voice transmission over LiFi depend on various factors, including modulation scheme, channel conditions, and available bandwidth. While voice communicationtypicallyrequireslowerdataratescomparedtodatatransmission,itisessential toensuresufficientcapacitytohandlemultipleconcurrentvoiceconnections.Thecapacitycan be influenced by the number of users, the modulation scheme employed, and the overall network efficiency.

**LatencyandDelayConsiderations:**

Low latency is crucial for real-time voice communication to maintain natural conversation flow. The latency in LiFi systems for voice transmission includes encoding, transmission,decoding,andprocessingdelays.Minimizingthesedelaysisessentialtoprovide aseamlessuserexperience.Techniquessuchasefficientmodulationschemes,optimizedsignal processingalgorithms,andnetworkoptimizationscanbeemployedtoreducelatencyanddelay in LiFi systems.

**ReliabilityandLink Stability:**

Reliability and link stability are critical for voice transmission to ensure uninterrupted communication. LiFi systems need to provide a stable and consistent link between the transmitter and receiver. Factors that can affect link stability include variations in light intensity, blockage of the line-of-sight path, and interference from other light sources. Techniques such as beamforming, adaptive modulation, and error correction coding can enhance link stability and improve the reliability of voice transmission over LiFi.

**SecurityandPrivacyConsiderations:**

Security and privacy are significant concerns in any communication system, including voice transmission over LiFi. LiFi systems can offer inherent security advantages due to the physical limitations of light propagation. However, it is essential to address potential vulnerabilitiesandprotectvoicecommunicationfromunauthorizedaccessandeavesdropping. Techniques such as encryption, authentication, and secure key exchange protocols can be implementedto ensurethesecurity and privacy of voicetransmission over LiFi. Additionally, privacy considerations should be given to prevent the leakage of sensitive voice data.

Evaluation of these performance factors requires testing and analysis in real-world scenarios. Through performance measurements, simulations, and user studies, the data rate, latency, reliability, and security aspects of voice transmission using LiFi technology can be assessed and optimized for different applications and environments.

**IntegrationandDeployment**

**IntegrationwithExistingInfrastructure:**

IntegratingLiFitechnologyforvoicetransmissionwithexistinginfrastructureinvolves several considerations. LiFi can be seamlessly integrated with lighting infrastructure, as it utilizesLEDluminairesfordatatransmission.Thisintegrationallowsforcost-effective



ISBN:978-81-957858-1-0

deployment, as the existing lighting infrastructure can be leveraged for both illumination and data communication.

In addition to lighting fixtures, LiFi systems can be integrated with networking infrastructure, such as routers, switches, or access points. This integration enables the connection of LiFi networks to the internet or other networks, facilitating seamless communication between LiFi-enabled devices and the broader network ecosystem.

To achieve integration with existing infrastructure, coordination and collaboration among different stakeholders, including lighting manufacturers, network infrastructure providers,andsystemintegrators,arenecessary.Standardizationeffortscanalsoplayacrucial roleinensuringinteroperabilityandcompatibilitybetweendifferentLiFisystemsandexisting infrastructure.

**LiFiDeploymentScenariosforVoice Transmission:**

LiFitechnologyoffersseveraldeploymentscenariosforvoicetransmission,dependingon the specific requirements and use cases. Some potential deployment scenarios include:

1. OfficeEnvironments: LiFicanbedeployedinofficespaces,providinghigh-speedand secure voice communication. LiFi-enabled luminaires can be installed in conference rooms, meeting areas, or workstations, enabling seamless voice transmission for enhanced collaboration and productivity.
2. Healthcare Facilities: LiFi can be beneficial in healthcare settings, where reliable and securevoicecommunicationiscritical.LiFisystemscanbedeployedinhospitalrooms, operating theaters, or patient care areas, facilitating real-time voice communication between healthcare professionals.
3. Public Spaces: LiFi technology can be deployed in public spaces, such as airports, shopping malls, or stadiums, to provide voice communication services. LiFi-enabled access points can be installed in these areas, offering high-speed voice transmission to users within the coverage range.
4. Smart Homes: LiFi can be integrated into smart home environments, enabling voice communicationbetweendifferentdevicesandoccupants.LiFi-enabledbulbsorfixtures can act as communication nodes, providing voice connectivity throughout the home.

**Challenges and Considerations:**

ThedeploymentofLiFitechnologyforvoicetransmissionalsopresentsseveralchallenges and considerations:

1. Coverage andRange: LiFitechnologytypicallyoperates withintheline-of-sight range of the light source. Ensuring adequate coverage and range for voice transmission in different deployment scenarios requires careful positioning of LiFi transmitters and receivers.



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2. Mobility and Handover: Voice communication often involves mobile devices or users moving within an environment. Efficient handover mechanisms need to be implemented to maintain seamless voice transmission when users transition between different LiFi coverage areas.
3. Interference and Coexistence: Coexistence with other wireless technologies, such as Wi-Fi or Bluetooth, should be considered to avoid interference. Coexistence mechanisms and spectrum management techniques need to be implemented to ensure reliable voice transmission without significant performance degradation.
4. Scalability and Network Management:As the number of connected devices increases, the scalability and network management of LiFi systems become important. Efficient network management protocols and techniques are required to handle a large number of devices and ensure optimal performance.
5. Standards and Interoperability: Standardization efforts are essential for ensuring interoperabilityandcompatibilitybetweendifferentLiFisystems.Establishingindustry standardscan facilitatetheintegration andwidespread adoptionofLiFitechnologyfor voice transmission.

Addressing these challenges and considerations requires ongoing research, collaboration, and innovation to optimize LiFi deployment for voice transmission in various environments and scenarios.

**ApplicationsofLiFiVoice Transmission**

**TelecommunicationsandMobileNetworks:**

LiFi voice transmission can find applications in telecommunications and mobile networkstoenhancevoicecommunicationcapabilities.LiFicanprovidehigh-speedandsecure voice transmission in areas with limited cellular coverage or high network congestion. It can be deployed in indoor environments, such as office buildings or shopping centers, to offer reliable voice communication services. LiFi can also complement existing wireless technologies by offloading voice traffic and reducing network congestion.

**HealthcareandMedicalApplications:**

LiFi voice transmission can be beneficial in healthcare and medical applications. In hospitals or healthcare facilities, LiFi can enable secure and reliable voice communication between healthcare professionals, ensuring clear and real-time communication for efficient patient care. LiFi can also be used in telemedicine applications, enabling remote voice consultationsanddiagnosticsbetweenhealthcare providersandpatientsindifferentlocations.

**SmartCitiesandInternetofThings(IoT):**

LiFitechnologycanplayaroleinsmartcitydeploymentsandInternetofThings(IoT) applications.Insmartcityenvironments,LiFicanprovidevoicecommunicationservicesin



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public spaces, improving safety and convenience. LiFi-enabled streetlights or public infrastructure can act as communication nodes, allowing voice communication between residents and city services. In IoT applications, LiFi can facilitate voice communication between IoT devices, enabling voice-controlled smart homes, smart offices, or industrial automation systems.

**OtherPotentialApplications:**

LiFivoicetransmissioncanhavevariousotherpotentialapplications, including:

1. Education: LiFi can enhance voice communication in educational settings, enabling interactive voice-based learning experiences and facilitating communication between teachers and students.
2. Hospitality: LiFi can provide reliable voice communication services in hotels, resorts, or hospitality venues, ensuring seamless communication between guests and staff.
3. Entertainment and Events: LiFi voice transmission can be deployed in entertainment venues,suchasstadiumsorconcerthalls,toprovidehigh-qualityvoicecommunication services to attendees.
4. Public Safety: LiFi can be utilized in public safety applications, enabling clear and secure voice communication for emergency responders, law enforcement agencies, or disaster management teams.
5. Transportation: LiFi voice transmission can enhance voice communication in transportation systems, such as airports, train stations, or public transit, improving passenger information systems and coordination between staff members.

ThepotentialapplicationsofLiFivoicetransmissionextendacrossvarioussectorsandcan contribute to improved communication capabilities in diverse environments. The specific application areas will depend on the requirements, infrastructure, and objectives of each industry or domain.

**FutureTrendsandResearch Directions**

**LiFiStandardization andInteroperability:**

One of the key future trends in LiFi technology is the standardization and interoperabilityofLiFisystems.StandardizationeffortsbyorganizationssuchastheIEEEand the LiFi Consortium arecrucial to ensure compatibility and interoperability between different LiFiproductsanddeployments.StandardizationwillfacilitatethewidespreadadoptionofLiFi technology and enable seamless integration with existing infrastructure and devices. Future research will focus on developing comprehensive standards and protocols for LiFi communication, including interoperability with other wireless technologies.

**AdvancementsinLiFiTechnology:**



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LiFi technology is still evolving, and future research will focus on advancing various aspects of LiFi systems. Some areas of advancement include:

1. Higher Data Rates: Research will aim to increase the data rates of LiFi systems to supportnotonlyvoicetransmissionbutalsohigh-bandwidthapplicationssuchasvideo streaming and augmented reality.
2. Extended Range and Coverage: Future LiFi systems may incorporate technologies to extend the range and coverage area of LiFi networks, enabling wider deployment in various environments.
3. Mobility Support: Research will focus on developing efficient mobility management techniques in LiFi networks to enable seamless voice transmission while users move within a coverage area or transition between different LiFi networks.
4. Enhanced Security: Continued research will address security challenges in LiFi systems, including improving encryption methods, authentication protocols, and privacy protection mechanisms to ensure secure voice communication over LiFi.
5. Energy Efficiency: Future advancements in LiFi technology will explore energy-efficient designs and techniques to reduce power consumption, prolong device battery life, and optimize energy usage in LiFi-enabled systems.

**EmergingResearch Areas:**

AsLiFitechnologycontinuestoevolve,severalemergingresearch areasarelikelytogain attention. These include:

1. LiFifor5GandBeyond:ResearchwillexploretheintegrationofLiFitechnologywith 5G networks, enabling efficient voice transmission and seamless handover between different wireless technologies.
2. LiFi in Intelligent Transportation Systems: Research will focus on utilizing LiFi technology for voice communication in vehicular environments, enabling reliable and secure communication between vehicles and infrastructure.
3. LiFiforSmartGrids:ResearchwillinvestigatetheuseofLiFitechnologyinsmartgrid systems to enable voice communication for energy management, control, and monitoring applications.
4. LiFiLocalizationandPositioning:ResearchwillexplorethepotentialofLiFiforindoor positioningandlocalizationapplications,enablingvoicecommunicationwithlocation-based services and context-aware applications.
5. LiFi in Edge Computing: Research will investigate the integration of LiFi technology with edgecomputing architectures, enabling efficient processing and analysis ofvoice data at the network edge.



ISBN:978-81-957858-1-0

Overall,futureresearchinLiFitechnologywillfocusonstandardization,advancementsin core technology, and exploring new application areas, leading to improved performance, increased adoption, and a broader range of use cases for voice transmission and other communication applications.

**Conclusion**

**Summaryof Findings:**

In this comprehensive research study on voice transmission using LiFi technology, several key findings have emerged:

1. LiFi technology, which utilizes light for wireless communication, offers a promising solution for voice transmission in various applications and environments.
2. The principles of LiFi communication involve modulating light signals to carry data, withkeycomponentsincludingLEDluminaires,photodetectors,andsignalprocessing units.
3. LiFi technology provides several advantages over RF technologies, including higher data rates, lower latency, and reduced electromagnetic interference.
4. Voice communication characteristics, such as data rate requirements and quality of service considerations, can be effectively addressed using LiFi modulation schemes optimized for voice transmission.
5. Mitigating noise and interference is essential for ensuring reliable and clear voice transmission over LiFi, which can be achieved through techniques like adaptive modulation and error correction coding.
6. Performance evaluation of LiFi for voice transmission includes considerations such as datarate andcapacity,latencyanddelay,reliabilityandlinkstability,andsecurityand privacy.
7. Integration of LiFi with existing infrastructure, such as lighting and networking systems, can facilitate the deployment of voice communication services using LiFi technology.
8. LiFi deployment scenarios for voice transmission include telecommunications, healthcare, smart cities, and IoT applications, among others, offering enhanced voice communication capabilities in these domains.

**ImplicationsandRecommendations:**

Basedonthefindingsofthisresearchstudy,severalimplicationsandrecommendations can be made:

Standardizationandinteroperabilityeffortsshouldbeprioritizedtoensurecompatibility between different LiFi systems and facilitate seamless integration with existing



ISBN:978-81-957858-1-0

infrastructure.ContinuedadvancementsinLiFitechnologyarenecessarytoimprovedatarates, extend coverage range, enhance mobility support, strengthen security measures, and optimize energy efficiency.Research and development should focus on emerging areas, including LiFi for 5G and beyond, intelligent transportation systems, smart grids, localization, and positioning, and LiFi in edge computing.Collaboration among industry stakeholders, researchers, and policymakers is crucial to drive the adoption and implementation of LiFi technology for voice transmission in various sectors.Further research should be conducted to validate the performance of LiFi systems for voice transmission in real-world scenarios, considering different environmental factors, user requirements, and network conditions.Pilot deploymentsandfieldtrialsshouldbeundertakentoassessthepracticalfeasibility,scalability, and user experience of LiFi-based voice communication systems.

In conclusion, LiFi technology holds significant potential for voice transmission, offering advantages in terms of data rates, latency, interference mitigation, and security. Continued research, standardization efforts, and collaboration among stakeholders will pave the way for the successful integration and deployment of LiFi-based voice communication systems in diverse applications and environments.

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ISBN:978-81-957858-1-0

**Artificialintelligenceservinginelectricalnetworks**

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**Abstract**

Electricity networks are generating a growing amount of data, due to the deployment of smart meters and increased measurement and communication capabilities. Supported by expanding computingcapabilities,datamanagementtechniquesopenconsiderableopportunities,butalso bring great challenges. Processing these large volumes of data, which are generally inhomogeneous, will require capacities that defy those of human operators. In this context, it seems worthwhile to look at techniques that are designed to handle such levels of complexity and benefit rather than suffer from this volume of data. We are talking here about Artificial Intelligence (AI) techniques. These can adapt to uncertainty, linking scattered information, detecting anomalies and simplifying the modeling of complex systems, or anticipating their future state. Often based on artificial neural networks, they are able to quantify and classify data. Obtaining relevant results depends on the availability of a large amount of quality data, high computing capacity at low cost and adequate learning algorithms.

**Keywords:**AI,smartmetering,privacy,scheduling,virtualpowerbank,adjusted-averagedaily deman

**Introduction**

AI is an interdisciplinary field that combines theory and practice. It is about assisting human activities, mainly via software, and in some cases even replacing them. AI involves the use of informationsystems,datawiththeirmanagementsystemsanddedicatedalgorithms.Thereare of course solutions adapted to different types of data and problems. The available algorithms offer a wide range of technical possibilities, including implementations where the understanding of the results can be limited. One example is deep neural networks. In addition to the end use, several criteria determine the selection of AI methods (type of data available, expected results, available skills, etc.). Because of their potential power (ability to maximize theusemadeoftheavailabledata,howevervaried)andtheirautomaticity,othernon-technical aspectscomeintoplayregardingthesemethods,oneofwhichisuseracceptability.Beyondthe enthusiasm linked to the sometimes-spectacular successes in certain fields, AI faces a certain number of obstacles, which are part of broader and generally transdisciplinary issues.At the heart of AI is data, and its collection and quality represent both a strong challenge and a set of socio-technicalobstacles.Theseincludeissuesof bigdataandcybersecurity,butalsotheuse madeoftheinformationcollectedaswellastheroleofintermediaries,datastorage,associated costs, consent to its processing, etc. The use of AI and related decision-making also raises important issues concerning explicability (and therefore indirectly acceptability), but also ethics, in relation to the verification and validation of results (unbiased, non-intrusive, etc.). Finally,theenvironmentalfootprintofAIalsofiguresprominentlyinthedebatesitraises. The



ISBN:978-81-957858-1-0

associatedtechnicalchallengesaresevere,especiallyconcerningtheabilitytoremainrelevant while being energy efficient. For example, the increase in the volume of data and the training calculations linked to the regular updating of technical objectives are hardly compatible with energy consumption reduction targets

Collected, stored, exploited, transformed, data is present everywhere, especially in the field of electrical networks. An error in data processing can have serious consequences on industrial performance,securityorevenimageandreputation.AccordingtoastudybyMIT1,non-quality of data results can cause an estimated loss of between 15% and 25% of a company's total turnover. The notion of quality here describes both the characteristics of the data (accessible, complete, reliable, relevant, up-to-date, consistent, etc.) and the set of processes that ensure theyarerespected.AIalgorithmsareprogrammedtolearnnewrulesandgenerateamodelthat can solve a problem from a large and varied volume of data. Their relevance and performance are therefore directly dependent on the availability and quality of the data, both during the learning phase and during their exploitation. Thus, the first two challenges to be met are data inventoryandcollection,whichrequireavailability,persistenceandintegrationofdata,butalso compliance with the governance of the various sources and the General Data Protection Regulation (GDPR). The associated issues are wide-ranging, including anonymization to guaranteeacceptabilityandtrust,butalsotheinteroperabilityorgeneralityofmanagementtools that will enable the collection of data from various sources, and finally, the issue of the maintenance of such tools Data is a major challenge for AI, with technical, sociological, environmental and economic barriers. It would be desirable to systematically organize discussions between the various fields concerned in order to harmonize the responses to industrial and societal issues. This harmonization effort should take place upstream of the definition of regulatory limits for AI and its uses.

## AFEWEXAMPLESOFAISOLUTIONSFORELECTRICITYNETWORKS

Due to the amount of data available and the abundance of use cases, the energy sector offers many opportunities for AIreal-time operation, maintenance, planning, optimization, etc. AI-based solutions are already contributing effectively to the performance of power grids, while still presenting broad development prospects

## GRIDMANAGEMENT,OPERATIONANDPLANNING

The energy transition is characterized in particular by increasingly diffuse and intermittent energyproductionsystems.TheFrenchlawontheenergytransitionforgreengrowthhasseta target of 40% of renewable electric energy in national production by 2030. Managing these additional variability elements increases the complexity of the control and operation of distributionandtransmissionnetworks.Newtechniquesarerequiredtodealwiththem,notably AI-based techniques

## VOLTAGE MANAGEMENT



ISBN:978-81-957858-1-0

On the network, the voltage varies continuously. It is impacted by slow variations linked to seasonal, weekly and daily consumption cycles. It is also subject to rapid variationslinkedtomultiplehazards:randomfluctuationsinloads,changesinnetwork topologytripping of thermal generation units, variations in RE production, etc. However, the voltage must be maintained within a range that ensures the proper functioningofthepowersystemandguaranteesthesafetyofthesystem,itsequipment anditsusers. Forthis, adaptedand coordinatedcontrolsolutionsarenecessary.Atthe interfacebetweenthetransmissionanddistributionnetworksinFrance,2,300primary substations impose a set voltage that guarantees the proper functioning of the system. To date, this set point voltage is fixed for each primary station and should only be changed intheeventofmajorwork inthesector.With theincreaseofREproduction, it is no longer possible to find a fixed set point voltage applicable all year round. The solution is to switch to a dynamic voltage that would adapt several times a day to the realstateofconsumptionandproduction.Todothis,itisnecessarytohavearealtime image of the voltage on the network. This is provided by a sample ofthe 800,000 MV-LV substations that cover the territory. Knowledge of the voltage on these substations is the key to a dynamic management of the grid. As soon as a voltage anomaly is detected, for example an energy input from photovoltaic panels, a second algorithmissetinmotiontoinstantlyrecalculatethenewsetpointvoltagetobeapplied to the source station. Considering the volume of data to be processed, classical optimization algorithms are no longer adapted to this task. Deep learning algorithms have demonstrated significant performance gains in this area, both in terms of speed andaccuracy.Afterthetrainingphase,thistypeofalgorithmcantakeintoaccountreal timedataandadaptitsvariablestothechangesobservedonthenetwork.Thistoolwill be deployed progressively.

## ANTICIPATINGTHEIMPACT OFNEWUSES ONPOWER QUALITY

Thedevelopmentofusescontainingpowerelectronicsgeneratesparasiticcurrentsthat can impact the quality of the power supplied. This is particularly the case for electric vehicles, photovoltaic panels and heat pumps. Estimating the risk of harmonic disturbances on the network using conventional approaches would require decades of simulations. Indeed, for each of the 800,000 distribution substations, there are about 30 parameters to consider, which must then be compared with the hypotheses of the progression of the deployment of these different infrastructures until through 2035.

Afterdevelopingalearningbaserepresentativeofthetypesofdistributionsubstations and reducing the list of parameters to those that have a real impact on harmonics, Machine Learning algorithms are used to model the behavior of the network as a functionoftheequipmentpenetrationrate.Theresultisa“mapofFranceofharmonic risk” where the state of each point of the network appears according to a color code characterizingtherisk.Thismapcanbeenhancedandworkisunderwaytoimprove



ISBN:978-81-957858-1-0

the modeling of the behavior of new uses, in particular electric vehicles. Over time, thismapwillallowustoadjustthelocationandtimingofinvestmentstoreinforcethe network

**NETWORKDEVELOPMENT STUDIES**

Digitization and the increasing complexity of the electrical system are a major challenge. This has led to a growing need for stability studies, changes in business lines, new asset management policies to be implemented, etc. This ever-increasing needforanalysisisduetothemultiplicationofuncertaintiesanddecisioncriteriatobe taken into account (connection of RE, heritage constraints, environmental footprint, etc.).AIhas thequalitiesrequiredtofacilitatethe realizationofnetworkdevelopment studies, while offering designers the possibility of integrating more constraints, such as wear and tear on equipment or environmental constraints linked to a specific geographical area, thus guaranteeing amore robust forecasting oftheevolution ofthe electrical network For their design, analysis and understanding of multi-situation powersystem planning studies,networkengineers can also rely on datafrom apower system simulation tool and on AI. Upstream of a network development forecasting study,ablockbasedonnaturallanguageprocessingallowsresearchmanagersnotonly to analyze the economic or environmental context of a given territory, but also to identify the projects in progress in this geographical area through a unified database and to capitalize on previous studies. Another block will facilitate the understanding of increasingly voluminous simulation data, by helping to explore it and using advanced data analysis algorithms, in order to allow the re-evaluation of decisions taken to adapt infrastructures.

**FROMPREVENTIVEMAINTENANCETOPREDICTIVEMAINTENANCE**

The learning capacity of AI and more particularly of data mining allows us in some cases to move from a preventive maintenance logic, based on the respect of manufacturer recommendations and/or on operator feedback, to a predictive maintenance logic taking into account a large number of available information or measurements related to the equipment installed on the network. In this context, task automation enables asset management which, coupled with AI techniques, significantly increases the availability of equipment and opens up prospects for cost reduction, bet it economic or environmental. In low voltage, for example, France has two million electricity outlets. Based on the history of replacements, but also on a number of exogenous variables (humidity, work in the vicinity, etc.), a machine learning algorithm can calculate the probability of a cable's failure according to its characteristicsandenvironment.Similarapplicationsarebeingdevelopedformedium voltage cables and transformers in substations.



ISBN:978-81-957858-1-0

AI techniques of another kind are also used on overhead cables. This is the case, for example, for overhead lines inspected every year by helicopter or drone. In this case, image recognition is used to optimize the scheduling of the renovation of technical equipment. Instead of spotting defects using the naked eye and expertise of field agents, the programmed renovation of networks is now triggered by automatic diagnostics based on image analysis. This work is carried out in France by an AI supported by nearly half a million integrated photos.

**CUSTOMEREXPERIENCEANDEMPLOYEESUPPORT**

AIistransformingtheday-to-dayoperationsandtasksperformedonthepowergrid.It is augmenting certain capabilities and is now able to support operations and maintenance technicians, customer advisors, support function employees and even customers. In the field, for example, deep learning tools, combined with image analysis, are capable of recognizing equipment and providing technicians with all the characteristics they need for their work. Combined with other IT tools, such as relocation,thesesolutionsmakeiteasierandmorereliabletocollectandqualifyasset data during visits to the 2,300 primary substations and 800,000 MV-LV substations. Over time, they could even detect faults and provide an initial analysis to help technicians make the right choices. The most recent developments have made it possibletotaketheergonomicsofthesetoolsastepfurtherbyreducingtheircomputer footprint, thus making them available in Edge mode on a telephone or tablet. On the other side of the network, for customer advisors, AI technologies improve customer reception and complaint processing. Based on the fine semantic analysis of verbatim, AIsolutionscanautomaticallycategorizeandsynthesizecomplaints.Thesecomplaints canthenbedirectedtotheappropriatedepartments,whichcanalsobesupportedbyan AI capable of suggesting

answers. Thus, the average time for processing complaints is reduced and employees can focus more on customer relations. Innovative deep learning methods could also analyzethecontentofcomplaintsandquicklydetecttheemergenceofnewsourcesof dissatisfaction. This detection would then enable the rapid implementation of a responsepolicy adaptedto newsituationsIn terms ofcustomerexperience, let'snot forget to mention chatbots, which can personalize customer relations by considerably improvingtheaccessibilityofinformation.Advancesintextmining,machinelearning and the power of machines have enabled chat bots to make enormous progress in natural language recognition. They are able to handle digressions and lack of information.Inparticular,theycanaskquestionstoobtaindetails.Customerscanthen "converse"withchatbots,whicharerealsearchengines,andthusbecomeautonomous in solving problems and simple or frequent requests.



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## THECHALLENGESOFINDUSTRIALIZINGAIINTEGRATIONINTOTHE IS AND PROCESSES

The industrialization of AI solutions is confronted with the usual problems in the information system (IS), such as data availability, performance, lack of instability, securityormaintenance,sometimesevenaggravatingthem.CompaniesinwhichAIis integrated are often confronted with an abundance of experiments and have difficulty making the transition from experimentation, or proof of concept, to an AI tool integrated into the company's business IS, in other words, the transition to scale. Accelerating the industrialization of AI processing and its integration into core information systems has now become one of the major challenges facing companies, particularly in the electrical system. Moreover, the inclusion of AI solutions necessarilyinfluencesthegovernanceofbusinessprocesses,whichmustbeadaptedto takeintoaccountthelifecycleofsuchsolutions.Initialvalidationfunctionsmustoften be rethought and the control of AI algorithm performance requires special attention and dedicated monitoring tools.

## IMPACTONCOMPUTING RESOURCES

In addition, one of the challenges of AI is to manage to capture and process large volumes of heterogeneous data, some of which are technical in nature, others more functional. The amount of data and the complexity of the algorithms involved push computer systems to their limits, whether in terms of data storage and access or in terms of computing power. For example, the execution of certain algorithms is facilitatedbytheuseofspecificprocessorssuchasGPUs(GraphicProcessingUnits), optimizedforparallelcomputing.Thesenewtechnologiesevolvereallyfastrequiring recurrent and important levels of Investment

## NEEDFOR NEW SKILLS

Finally,AItechnologiesarecomplexandrequirespecificandrareskills.Theexplosion in the deployment of this type of

technology in companies has created a recruitment bottleneck that is not finding enough candidates and, as a result, is holding back the adoption of AI. In 2021, 57% of European companies cite the difficulty of recruiting profiles with the right skills 45% cite the lack of in-house skills.

## AREGULATORYFRAMEWORKINPREPARATION

AI techniques cover issues that go far beyond the conventional technical framework. Its developments will eventually have to be subject to precise standardization and operational constraints, on a scale that goes beyond the national framework. In early 2020, the European Commission published a white paper to define the priorities for thefutureframeworkofartificialintelligence1.Thisledtothedraftingofaregulation



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to guaranteea“Trustworthy AI”, which is expected to comeinto forcein 20232. This new legal framework will aim to protect the fundamental rights of users, define the safetyofAIuseandtheresponsibilityofstakeholders,withanumberof requirements in terms of transparency, robustness, fairness and environmental impact. Energy production and distribution are among the use cases identified as critical by the Commission and strong financial penalties will apply in case of non-compliance with these requirements. In parallel, the ISO and IEC standardization bodies are also preparing a specific framework

**RECOMMENDATIONSFORDEVELOPINGAIFOR NETWORKS**

ForeachtoolusingAItechnologies,in-depthworkneedstobecarriedoutonthedata involved and its quality must be guaranteed. A number of questions relating to organization and technical solutions must be asked upstream of the project. Is dedicated governance required? How to manage data ownership, beyond data collection? A clear definition of roles and responsibilities is essential. Data Lake or Data Warehouse types of data architectures can be relevant solutions, but will not be suitable for all stakeholders or all use cases. In addition, feedback and evaluation are still needed for more recent approaches such as Data Mesh.

**HYBRIDIZETECHNIQUESANDIMPLEMENTMULTIDISCIPLINARY APPROACHES**

Deriving intelligible knowledge from heterogeneous and unstructured data requires hybridizing AItechniques between themselves or with more traditional methods. The implementation of multidisciplinary approaches should also enable progress to be made in terms of performance as well as acceptability and inclusiveness

**EXTENDSTANDARDIZATION**

Thedevelopmentofstandardswouldfacilitatethedesignandindustrialdeploymentof AI-basedsolutions.StandardizationshouldcoverthefieldofdataaswellasAImodels and control references. This standardization should extend to the processes of data storage, information exchange (in particular between all the stakeholders of electrical systems - grid operators, producers, consumers, energy market players, service providers), but also to the analysis and perpetuation of data. Finally, the management of user consent shouldbe the subject of specific treatment

**BETWEEN RISKS AND OPPORTUNITIES, THE PROSPECTS FOR THE DEVELOPMENT OF AI FOR ELECTRICITY NETWORKS**

AI techniques are already regularly used in French electricity networks, whether for transmissionordistribution.Combinedwithhistoricalbusinessknowledge,theyhave proven their effectiveness and are a valuable addition to the tools used by grid operators.Theissuescoveredarevaried,involvingtheentirespectrumfrom



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operational to long-term planning, asset management and userexperience. In orderto goevenfurther,agrowingnumberofresearchprojectsareattemptingtoovercomethe scientific and technical barriers identified, and the prospects for development are significant

**RISKSAND CONCERNS**

As with any technical system, the prospects of AI are linked to scientific and societal issues.

The collection, quality and ownership of data remain important issues at the heart of any AI-related development. On these aspects, there are technical barriers on the measurement, exchange, storage, analysis and durability of data, but also socio-economicbarriersonownership,consenttodisseminationandpossibleremuneration.
Because of its complexity, AI remains difficult to understand and explain. Often perceived as a "black box", it sometimes arouses a certain amount of mistrust. In this context, decision making, which could be biased or be perceived as unacceptable depending on the culture, represents a considerable challenge and carries ethical implications.

On a related note, AI raises issues of inclusivity, directly exposing the existence of digitaldividesinthepopulation.TobenefitfromAI,peoplemusthaveaccesstodigital tools and be able to understand how they are used and how they work. Finally, there areecologicalissues.Calculationslinkedtodataanalysisarecostlyintermsofenergy, but also in terms of raw materials, due to the need for powerful calculation resources and large data storage capacities. In this context, the issues of centralization/decentralization of intelligence take on their full meaning. The end of lifeofthisequipmentalsoraisesquestions.Westillneedtofindacompromisebetween the use, security, costs and environmental impacts of AI techniques.

**BENEFITSOF AI FOR ELECTRICITY NETWORKS**

The challenges of AI can be measured by the opportunities it offers. The major advantage of AI techniques is to embrace the complexity of systems that could not otherwisebeunderstood. Thisabilitytoaggregate largevolumesofdatacanfacilitate decision making, whether in the planning phase or for operational management, but also to better manage the user experience for customers or employees. The ability of AI to aggregate historical data also creates links between scattered, exogenous and endogenous information, in order to better forecast the evolution of a system. Prediction is one of the major capabilities of AI for networks, whether for renewable productionorforconsumption.TheclassificationcapacityofAIalsogreatlyfacilitates the detection of anomalies, by detecting anything out of the ordinary,



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# Technicaloverviewofcompressednaturalgas(CNG)asatransportationFuel

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*Institute of Technology, Dehradun* **Abstract**

Increasing urbanization and industrialization have led to phenomenal growth in transportation demand worldwide, coupled with a concentration of vehicles in metropolitan cities. With regard to increasingly stringent emission legislation, natural gas is gaining interest as a transportation fuel with worldwide over 19 million natural gas vehicles in operation. This paper presents the worldwide background, prospects and challenges of natural gas fuel and natural gas-fueled vehiclesalongwithenvironmentalandeconomicaspectsofcompressednaturalgas asatransformationalfuel.Technicalaspectsofcompressednaturalgasproperties, storage, safety problems and their effect on engine performance, efficiency, emissions and barriers to natural gas vehicles adaptation are discussed in detail. The main indicators selected for the comparative assessment of natural gas as vehicularfuel areeconomic, emissionperformance andsafetyaspects. Theresults showed that CNG has several advantages over both diesel and gasoline fuel, including considerable emission and cost reductions.

**Keywords:**AI,smartmetering,privacy,scheduling,virtualpowerbank,adjusted-averagedaily deman

## Introduction

Intheworldtodayatotalof12,730Mtoeofenergyisconsumed,ofwhich7205Mtoeare oil and natural gas (Fig. 1). Transport sector with over one billion light-duty motor vehiclesinoperationisamajorconsumerofoilworldwide[1–4],increasingfrom45.5% in1973to59%in2011mainlyintheformofgasolineanddiesel[5].Itiswellknown thatoilreservesarebeingdepletedatanalarmingrate.Inaddition,theburningofthese conventionalfuelsbythetransportsectorcontributes greatlytoatmosphericpollution thatthreatenstheverysurvivaloflifeonthisplanet[1,6,7].ThefunctionofcurrentIC enginesneedstobereviewedtoday,fromtheperspectiveofthesetwomaincrises.The energycrisisandseriousenvironmentalpollutionaroundtheworld havetriggeredthe developmentoflow-emissionandhighfuelefficientvehicles to become amajorresearch objective[8]. Various alternative fuelshavebeenintroducedintothetransportsectore.g. LPG,propane,bio-diesel,hydrogen,and fuel cells. Out ofthese available alternate fuels, compressed natural gas (CNG) is the one that is meeting the maximum needs of countriesworldwide,thatwanttoswitchovertoalternatefuels[9–12].CNGhasbeen considered as one of the best solutions for fossil fuel substitution because of its inherentcleannatureofcombustion[13–15].Ithasnowbeenrecognizedworldwideas



ISBN:978-81-957858-1-0

environment-friendlyfuel[16,17].Thefollowingarethemainfeaturesthat conduced to an increased interest to use natural gas as a transportation fuel:

1. Wideavailability
2. Ecofriendly
3. ConventionalSIandCIenginescompatibility
4. Low operational cost.

CNG as fuel

The natural gas used in natural gas vehicles is the same natural gas that is used in domestic sector for cooking and heats. CNG is produced by compressing the conventional natural gas (which is mainly composed of methane –$CH_4$) to less than 1% of the volume it occupies at standard atmospheric pressure. It is stored and distributedinarigidcontaineratapressureof200–248barv(2900–3600psi), usually incylindricalshapesmetallic cylinder Table 1 represents the comparisonbetween thephysiochemicalproperties of CNG to that of diesel and gasoline.

WorldNGVmarket

Worldwide quantities of natural gas vehicles are increasing so speedily that the statistics lag behind and no consistent sources of information are available. However, as per the recent authentic sources, the world leader in NGVs (for the moment) is Iran, with 4.07 million NGVs [18]. Following closely behind Iran is China,with3.99millionNGVs.Fig.2showsthatinthelasttenyears,worldwidethe NGVspopulation has escalated speedily at an annual rate of 24%with the biggest contributioncomingfromtheAsia-PacificandLatinAmericaregions(Fig.3).This trendisprojectedtocontinuewithanaverageannualgrowthrateof3.7%upto2030, with amajor fraction ofgrowth contributing by non-OECD countries.

Todaythereareover18millionnatural gas vehiclesdistributed throughmorethan 86 countries of the world with major concentrations in Iran, China, Pakistan, Argentina, India, Brazil, Italy and Colombia [18]. The majority(93%)ofCNG vehicles are light-dutycarsandcommercialvehicles.Besidesthese,therearemore than26,677CNGrefuelling stations throughout the world. Fig. 4 shows thetop 10 countries of the world with the highest number of NGVs.

HistoricalbackgroundofCNG

TheuseofCNGasavehicularfuelwasdiscoveredbackinearly1930inItaly[19], butthefirstretrowhichexperiencedconsiderableactivitystartedinthe1970swhen natural gas was witnessed as a promising fuel aftermath of the oil crisis. When oil



ISBN:978-81-957858-1-0

pricesroseduringthelate1970sandearly1980s,themarketforCNGvehicles becamemoreattractive.However,thesubsequentperiodupto

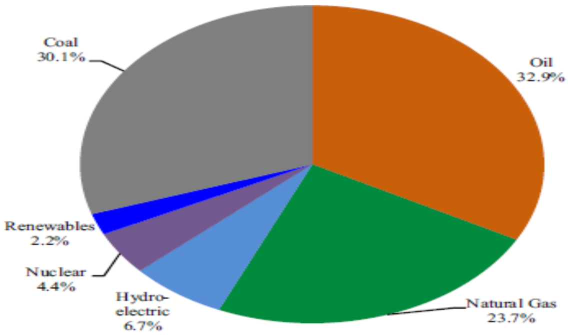


**Fig. 1.** World primary energy consumption.

**Table 1**
Physiochemical properties of CNG vs gasoline and diesel.

| Properties | CNG | Gasoline | Diesel |
|---|---|---|---|
| Octane/cetane number | 120–130 | 85–95 | 45–55 |
| Molar mass (kg/mol) | 17.3 | 109 | 204 |
| Stoichemetric $(A/F)_s$ mass | 17.2 | 14.7 | 14.6 |
| Stoichemetric mixture density (kg/m$^3$) | 1.25 | 1.42 | 1.46 |
| L.H.V. (MJ/kg) | 47.5 | 43.5 | 42.7 |
| L.H.V. of stoichemetric mixture (MJ/kg) | 2.62 | 2.85 | 2.75 |
| Combustion Energy (MJ/m$^3$) | 24.6 | 42.7 | 36 |
| Flammability limit in air (vol% in air) | 4.3–15.2 | 1.4–7.6 | 1–6 |
| Flame propagation speed (m/s) | 0.41 | 0.5 | – |
| Adiabatic Flame Temp. (°C) | 1890 | 2150 | 2054 |
| Auto-ignition Temp. (°C) | 540 | 258 | 316 |
| Wobbe Index (MJ/m$^3$) | 51–58 | – | – |

2000,hasmadeitchallengingforCNGtostriveasvehicularfuel.Butafter2000s,the oil prices rose once again very sharply and owing to this CNG vehicles got an opportunity to prove itself as a cheap and cleanest fuel. Since that time, Natural gas vehicleshave entered andleftthetransportationmarketofseveralcountries/regionsat differenttimes, with the advancement of technology.

TheOrigenofNGVswithdedicatedCNGenginesroutestoItaly.Thefirstnaturalgas vehicleusingpressurizedgascontainerwas observedinItalyin1936asshowninFig. 5[20], but the first promisingperiod that observed any considerable activity dated to 1970, when CNG was recognized as cheap and stable fuel after the oil crisis.

Demandfornaturalgasasatransportationfuel

Natural gas is becoming one of the most important resourcesofenergyandcurrently shares 23% of the world’s primary consumption [21]. As reported by Cedigaz [22], theworld’sprovennaturalgasreserves are7080.3TCFasofJanuary1,2014,which correlatestoover60-yearsupplyatcurrentannualconsumption levelsof118.20TCF [23].Fig.6illustratestheglobalprimaryenergydemandbyfueltypefrom1980to



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2035. It can beobserved that natural gas willsurpass coal before2030 and will cover 25% of the total energy demand in 2035. An IEO2014 projection of future energy demands shows that natural gas is the fastest-growing primary energy source in the future and its consumption is forecasted to double between 2020 and 2040 [24]. The reportprojectedthatthegrowingproductionofnaturalgasfromtight shale reservoirs will keep the prices of natural gas to

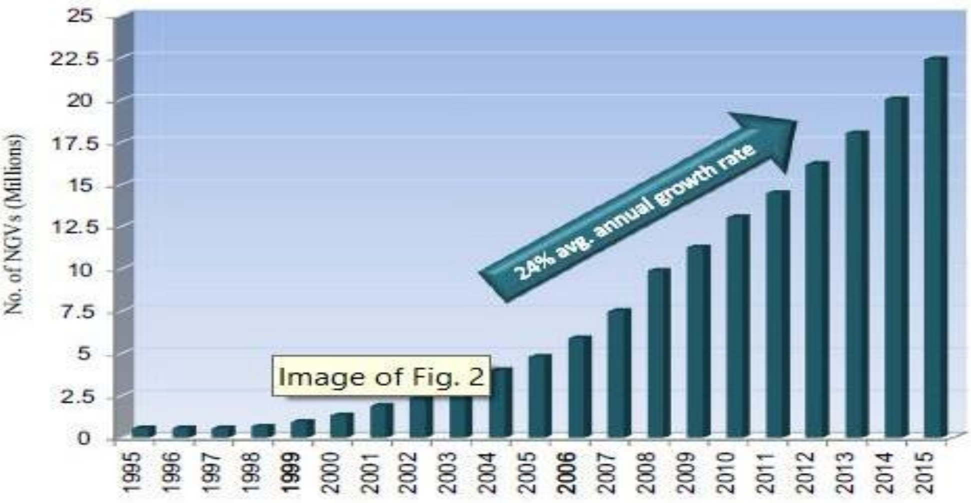


Fig. 2. Worldwide NGVs growth.

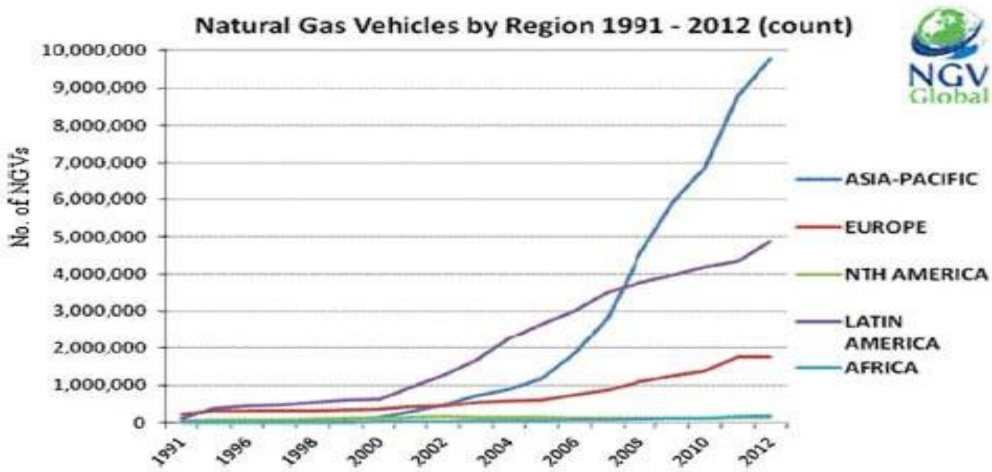


Fig. 3. Worldwide NGVs growth by region.

customers under the price levelof2005–2008through2038. This has led to a growing interest to use natural gas as a transportation fuel. The current annual consumptionofnaturalgasastransportationfuelis1.205TCF,onlyaccountsfor



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1.01%oftotalglobaldemandfornaturalgas.

TypesofNGVs

Intermsoffuelsupply,therearethreetypesofNGVs:

i. DedicatedCNGengine
ii. Bi-fuelretrofittedgasolineengine
iii. Dual-fueldieselengine.

DedicatedCNGvehicle

Dedicated CNG vehicles have SI engines that are operated onlyon natural gas. Thecompression ratio of these engine are



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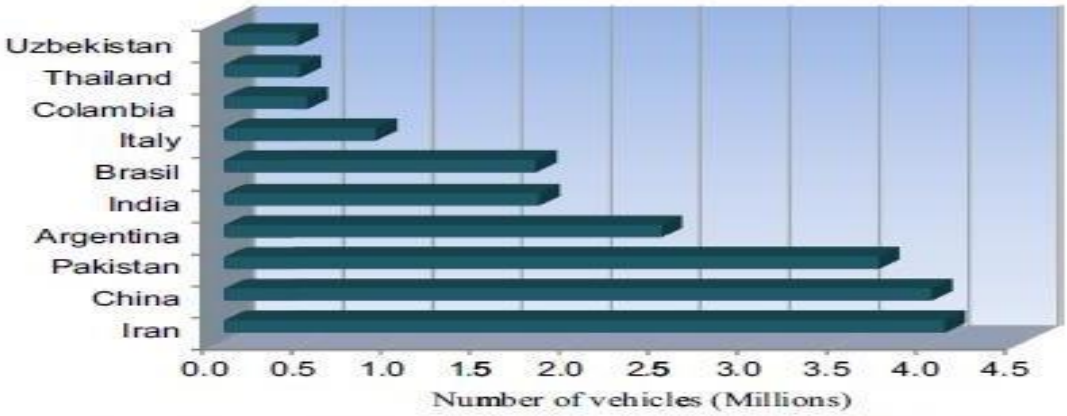


Fig. 4. NGVs adoption by country (number of vehicles in millions).

Fig. 5. Natural gas inter-urban with 40 seats on FIAT chassis 635 RL of 1936.

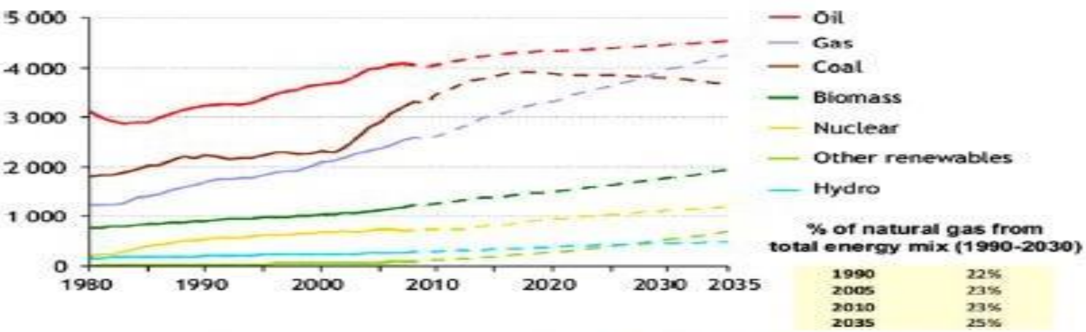


Fig. 6. World primary energy demand by fuel [23].

optimized to utilize the advantage of high-octane number of natural gas and are designed keeping the combustion properties of natural gas, so that the vehicle produce very less emission pollutant.



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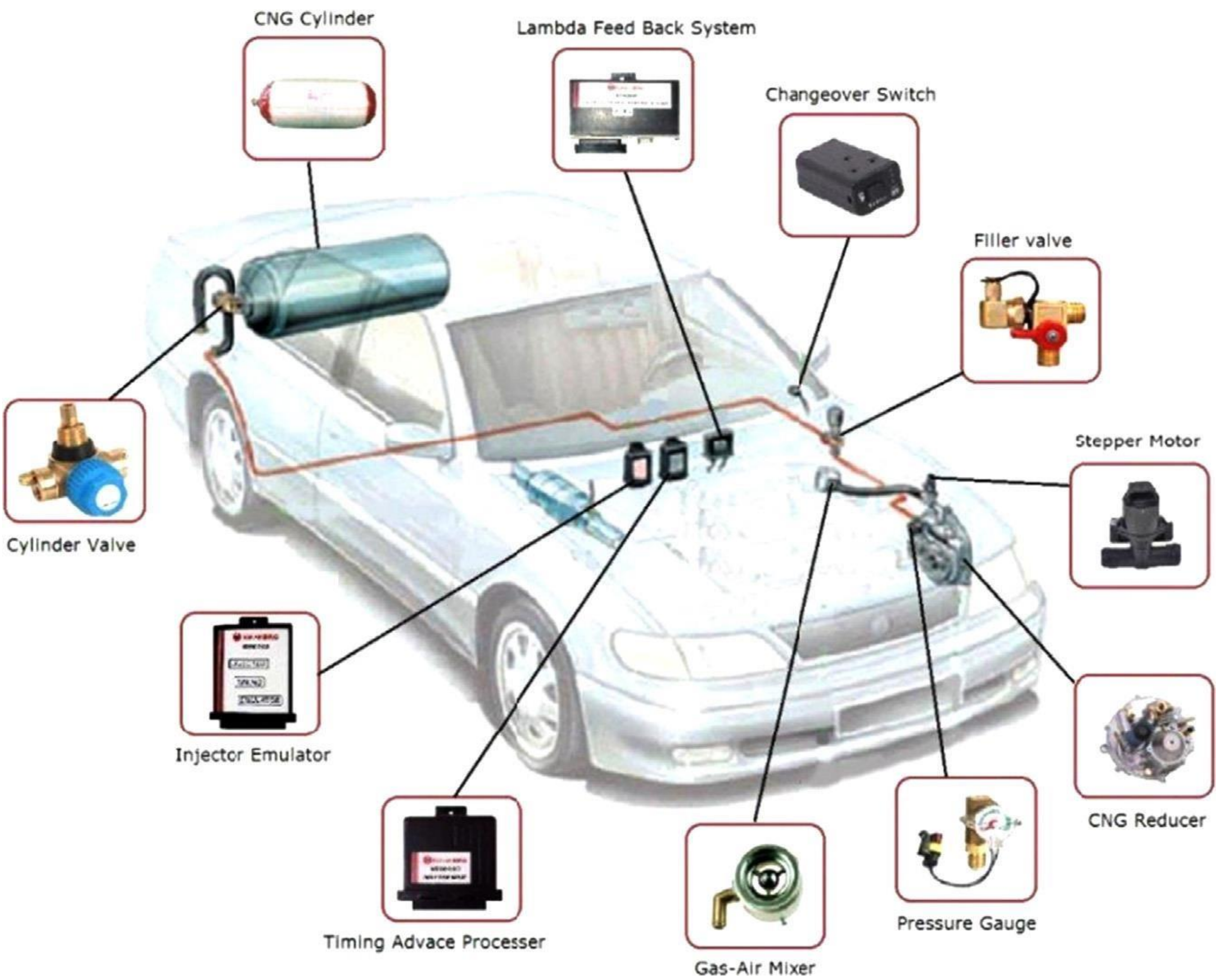


Fig.7.Schematicofretrofittedbi-fuelvehicle.

Bi-fuel

Bi-fuelvehiclecanrunoneithernaturalgasorgasoline.Theenginetypetheyusedisa regulargasoline IC engine. Thedriver can selectwhatfueltoburnbysimplyflipping aswitchonthedashboard.Anyexistinggasolinevehiclecanbeconvertedtoabi-fuel vehicle. Most ofthe CNG vehicles operated today are retrofitted from the gasoline engine[25].InPakistan,the2ndlargestconsumerofCNGalmosttheentireNGVfleet comes under bi-fuel vehicle category [26].

Thecombustionpropertiesofnaturalgasaresignificantlydifferentfromregularfueli.e. diesel and gasoline. As compared to diesel and gasoline CNG has a longer ignition delay time due to low flame propagation speed. Thus using the same gasoline-fueled engineforCNG,thecombustiondurationbecomesrelativelylongeranditrequiresmore advanced spark timing. Hence, retrofitting is necessary for conventional gasoline-fueled enginestorunwithCNG.Thebi-fuelenginesaregenerallyoptimizedfornaturalgas, with the ignition timing rather advanced to accommodate the slower burning rate of



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methane.Fig.7depictsaschematicofaconventionalretrofittedbi-fuelCNGvehicle.

Dual-fuelvehicle

Dual-fuelvehiclearebasedonCIenginetechnology.Theyruneitherondieselonly orutilizeamixtureofnaturalgasanddiesel,withthenaturalgas/airmixtureignited by a diesel “pilot”. During idle conditions, these engines tend to operate only on diesel.Asthevehiclestartstopickuptheload,thenaturalgassubstitutesthediesel fuelupto60–90%.However,like bi-fuelvehicles,directconversionisnotpossibledue totheverylowcetanenumberofnaturalgasasaresultofitsveryhighauto-ignition temperaturewhich necessitates either conversion tospark-ignition or adoption of a dual-fuelsystem.Duetothehighignitiontemperatureofnaturalgas,itneedsavery highcompressionratioforauto-ignitioni.e. about38:1.Owingtothis,itshould be ignited with another fuel (diesel)—pilot injection. The diesel fuel is introduced directly into the combustion chamber, while gas is injected into air intake by carburetion. The gaseous fuel is then compressed in the compression stroke of the engine.Dieselfuelistheninjectedneartheendoffcompressionstroke.Withashort ignition delay, the combustion of diesel fuel happensfirst, resulting intheignition ofthe natural gas andinstigationofflamepropagation. An important factorforthe dual fueloperation is the replacement rate, which is defined as the portion of the energy content of the fuel which is supplied by natural gas. The replacement rates varydependingontheengineload.Amaximum replacementrateofupto90%can beobtained with thecurrently availabledual-fuel engines. Substitution rate affects both engineperformance and emission. Egúsquiza et al. [27] found that brake specificfuelconsumptionincreasedasthepercentageofsubstitutionincreased.They also observed that at higher loads and with the increase of substitution ratio, the hydrocarbonconcentrationsshowedatendencytoincreasewhileCOconcentration firstincreaseduptoasubstitutionrateof70%andthendecreased.$NO_x$wastheonly emission factor that showed decreasing trend with the corresponding increase in substitution ratio.

Theduel-fuel vehicleprovides30–40%higherengineefficiencywhich subsequently reduces fuel consumption by 25% [28].In both cases, there is an incremental cost relative to conventional diesel and gasoline vehicles and this extra costto be reimbursedby the saving in operating costs due to fuel cost [29].

CommercialstatusofCNGtechnology

ThetechnologyofCNGenginedevelopmentandengineconversioniswellestablished and suitable conversion equipment is readily available. Worldwide various manufacturers offer natural- gasengines either as dedicated (mono-fuel) Otto-cycle



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engines or as duel fuel diesel-cycle engines. In theUSA, CumminsWestport Inc. is a leading supplier of high-performance CNG engines for the automotive market. It designs,engineers,and markets6to12l (195–400hp)dedicatedCNGSIenginesfor commercialtransportationapplications such as trucktrucks and buses. TheCummins Westport ISX12 G (298 kW) is a CNG engine suitable for various types of heavy heavy-articles including waste collection trucks and transit buses. The ISX12 G is a stoichiometricCNG engine thatemploys proven Stoichiometric Cooled Exhaust Gas Recirculation (SEGR) combustion technology, turbocharging and aftertreatment through a TWC to achieve U.S. 2014 EPA emission standards.

IVECO is the European leader in the production and sales ofCNG engines and vehicles.Since1994IVECOisofferingawiderange of NGVs and one of the leading researchers and manufacturers ofnatural gas vehicles and engines in Europe, with thousands of vehicles in operation with both public and private authorities. IVECOiscurrentlyofferingthreemaintypesofCNGenginesi.e.IVECOSofim 3 l (100 kW), IVECO Tractor 6 l (kW) and IVECO Cursor8 l (200 kW). All IVECO natural gas engines use a dedicated CNG SIengine operating on stoichiometric combustion coupled with TWC.Volvo, Sweden is the third largest manufacturer of CNG buses in Europe. They offer both dual fuel and dedicated CNG engines since 1992. The Volvo FM Methane-Diesel D13C-Gas engine is a13-l(460 hp) dual-fuel engine,withacompressionratioof17.8:1andpowered by up to 75% natural gas or bio-methane. The engine technology is based on a conventional diesel engine equipped witha gas injector. Under the dedicated CNG engines category they offer, G9Awhich is a 9.4-l six-cylinder (260 or 300hp) gas engine withacompression ratio of 10.25:1. The engine easily meets the EU’s requirements for exhaust emissions according to Euro 5 and EEV.

Since2006Mercedes-BenzismanufacturingM447hLAG(185kW)dedicatedCNG engine used in the Mercedes-Benz Citaro urban buses rated as a Euro4/EEV vehicle. Recently they introduced an M-936G six-cylinder (302 hp) dedicated CNG engine. Similarly to amodern gasoline engine,the new dedicatedCNG engine M-936G operates with a stoichiometric combustion ratio of lambda¼ 1,i.e. it employs neither excessairnorarichmixture.Thisresultinparticularlycleancombustioncoupledwith highoutputpowerandlowexhaustemissions.Theenginecomplieswith the emission standards of Euro VI.

TEDOM,aleadingbusmanufacturerfromtheCzechRepublic,offersdedicatedCNG-fueled buses that comply with Euro 5 EEV levels of emission standards. TEDOM produces turbo or naturally aspirated 12 l, 6-cylinder CNG combustion engines Equipped with OBD-II (Onboard diagnostics) technology. The engines are manufactured in vertical or horizontal layouts with a horse-power range of 241–348 HP and a compression ratio range of 11:0 to 13:1.



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Mostavailablelight-dutyNGVsarebasedon bi-fuel CNGtechnology. There arefew manufacturers who are producing dedicated light-duty NGVs e.g. Car, Van etc. A listingofthelight-dutynatural gas vehicles available worldwide is provided in Table 2.

TechnicalaspectofCNGengine

Thermalefficiency of the engines is function of various parametersbut perhaps most importantis the compression ratio of the engine.Higher the compression ratio higher would be theoretical and also actual efficiency. The octane number of natural gas is ranging from 120to 130, which means that the engine could function at compression ratioup to 16:1, without knocking. The high octane value allowing adedicated CNG engine to use higher compression ratio to enhance enginethermal efficiencyof about 10% above than that of gasoline engine [30]. Therefore, the dedicated CNG engines may have the efficiency up to 35% in contrast to 25% for that of gasoline engine. Incidentallyretrofitgasolineengineswillnothavetheadvantageofahighoctanevalue ofCNGasthecompressionratiowillbesettothelevelrequiredforgasoline.Thebenefit ofhighefficiencyquotedabovecanbeachievedindedicatedCNGengines.Following arethemajorattributesconnectedwithCNGengines

**Table 2**
Light duty dedicated NGVs manufacturer.

| S.N. | Manufacturer | Model | Engine Dis. |
|---|---|---|---|
| 1 | Opel (Germany) | Combo CNG | 1368 |
| 2 | Opel (Germany) | Zafira Tourer | 1578 |
| 3 | Volkswagen (Germany) | Touran EcoFuel | 1984 |
| 4 | Honda (USA) | Civic GX | 1798 |
| 5 | General Motor (USA) | GMC Savana Cargo Van | 4700 |
| 6 | FIAT (Brazil) | Siena 1.4 | 1368 |

Mixingadvantage

The molar mass of gasoline (114.23 g/mol) is much higher than natural gas (16 g/mol). Being light weight fuel, natural gas canproduce much better homogeneous air–fuel mixture [31]. On the other hand, liquid fuel needs time for complete atomization and vaporization to form a homogeneous air–fuel mixture [25]. CNG being a gaseous fuel at normal atmospheric conditions has theinherent advantage of high level of miscibility and diffusion with gaseousair,whichisessentialforgood



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combustion[32].

Maintenanceadvantage

NGVs have lower maintenance cost as compared to conventional fueled vehicle. Chandler et al. [17] conducted 12 months comparative analysis between CNG and dieseltransitbusesoperatedby Washingtonmetropolitanareatransitauthority. They found that themaintenance cost ofCNG-powered buses was 12%lowerthan diesel-fueled buses. CNG does not contaminate or dilute engine oil, which subsequently enhancestheusefullifeofthelubricant.CNGcomesintotheengineingaseousform, unlike gasoline which enters the engine as spray or mist and washes down the lubricating oil from the piston rings region which subsequently enhances the wear and tear of the engine. Therefore, CNG cuts maintenance costs and prolongs the engine's useful life. But as compared to diesel and gasoline engines, CNG engines requirelowsulfated ashoil.Sulfatedashisacharacteristicofnatural gasengineoils that gives an indication of the oil's ability to neutralize acids from the combustion process. Because of its gaseous nature, CNG is dry and provides absolutely no lubricantvalueconducetosulfatedashdepositsonexhaustvalvesthatcontainmetal sulfates, including barium, calcium, magnesium, zinc, potassium, sodium and tin. Largequantitiesofthisremnantcanresultinreducedheattransfer,detonation, valve burning and ring sticking or breaking.

The absence of lead concentration in CNG contributes to avoiding lead fouling of sparkplugs,thusextendingthelifeofpistonringsandplugs[33].Theintervalbetween tune-ups for natural gas vehicles extended up to 30,000 km. Similarly, the interval between oil changes for natural gas vehicles can be extended from 5000 to 10,000 additional km depending on how the vehicle is used.

Brakespecificfuel consumption:

Brake specific fuel consumption (BSFC) is a very important characteristic for comparingtheperformanceofICenginesfueledwithdifferentfuels.Variousstudies confirmedthattheBSFCofCNG-fueledengineswas12%to20%lowerthanthatof gasoline throughout the speed range [14,34–39]. This can be attributed to the following two factors:

i. HigherheatingvalueoftheCNG(47.5MJ/kg)ascomparedtothatof



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gasoline(43.5MJ/kg)

ii. Leanandslow-burningofCNGascomparedtogasoline

LifecycleemissionsofCNG

Themethodologyusedtoassessdifferentvehicletechnologies fromvariouspointsin their life cycle is often referred to as life cycle assessment (LCA). The life cycle can beclassifiedintotwomajorcategories:thefuelcycleandthevehiclecycle.TheGHG emissions impacting the CNG life cycle are predominately the result of production-phasefuelleakagemainlyintheformofmethane.Manyresearchershavemadegreat efforts to understandthe total impact of GHG Well-to-Wheels (WTW) life cycle analysis (LCA)ofCNGas atransportationfuel. Well-to-WheelsGHG advantages of CNG over diesel and gasoline have been confirmed through various studies [109– 111].

ComparingCNGanddiesellight-dutyvehicles, Weissetal. [112]havedoneanLCA studyshowing higher efficiency and reduction of$CO_2$emissions for CNG compared togasoline.Similarly,ArgonneNationalLaboratory'sGREETmodel[113]estimates the life cycle petroleum use and greenhouse gas (GHG) emissions of light-duty vehicles running on CNG. The results of the model revealed that CNG emits approximately 6–11% fewer GHGs than gasoline throughout the fuel life cycle. In 2007,astudy[114]fortheCaliforniaEnergyCommission(CEC)foundthatbothCNG and LNG reduce life cycle GHG emissions in both light- and heavy-duty vehicles comparedto their gasolineand diesel counterparts. Roseet al. [115] concluded thata 24%reductioninGHGemissionsmayberealizedbyswitchingfromdieseltoCNGfor refuse collection vehicles based on the real-time operational data obtained from the CityofBritishColumbia,Canada.Karmanetal.[116]foundsignificantreductionsin $CO_2$emissionsforvehiclesinthecityofBeijing,China,whenswitchingtoCNG.Few studies[117]statedthataCNGcanemitalittlemorethandieselfuelinrealsituations. Thekeycomponentofnaturalgasismethaneandthisemissionfactorassociatedwith natural gas-powered vehicles can be significantly reduced bytheinstallation of an exhaust catalyst which covers unburnt methane fuel (i.e. fuel slippage) to $CO_2$and water.Therefore, the global warming potential of NGVs is reducedrelative totheirdiesel and gasoline counterparts.



ISBN:978-81-957858-1-0

Table 3
Retail fuel prices (US $) in top 15 CNG user countries.

| Rank | Country | Gasoline | Diesel | CNG per liter gasoline equivalent | CNG per liter Diesel equivalent |
|---|---|---|---|---|---|
| 1 | Iran | 0.42 | 0.17 | 0.30 | 0.34 |
| 2 | Pakistan | 1.02 | 0.79 | 0.72 | 0.80 |
| 3 | Argentina | 1.44 | 1.44 | 0.33 | 0.39 |
| 4 | Brazil | 1.72 | 1.11 | 0.92 | 1.05 |
| 5 | China | 1.05 | 0.98 | 0.56 | 0.63 |
| 6 | India | 1.38 | 0.85 | 0.60 | 0.69 |
| 7 | Italy | 2.03 | 1.85 | 0.85 | 0.95 |
| 8 | Colombia | 1.31 | 0.96 | 0.80 | 0.92 |
| 9 | Uzbekistan | 1.03 | 0.98 | 0.30 | 0.34 |
| 10 | Thailand | 1.25 | 1.06 | 0.27 | 0.32 |
| 11 | Bolivia | 0.83 | 0.66 | 0.30 | 0.29 |
| 12 | USA | 1.02 | 1.12 | 0.60 | 0.68 |
| 13 | Armenia | 1.31 | 1.19 | 0.49 | 0.56 |
| 14 | Bangladesh | 0.79 | 0.56 | 0.27 | 0.29 |
| 15 | Egypt | 0.33 | 0.20 | 0.07 | 0.09 |
| Average | | 1.13 | 0.93 | 0.49 | 0.56 |

## EconomicsaspectofCNG

One of the chief benefits of CNG is that it provides a source of affordableenergy. Astheworldcontinuestooperatewithcostlyfuelssuchasdieselandgasoline,thelow cost CNG provides a spark of hope. Although the environmental aspects and emission control of using CNG was the prime objective of natural gas application in road transport,especiallyinsidebigcities,inrecentdayswithsharpriseinoilprices,the increasinglysignificanteconomicadvantageof usingCNGhasbecometherealprime considerationforlotofnewusers[32].Inmostcountries,CNGismuchcheaperper equivalent gallon than gasoline and diesel, even after considering the costs associated with compression and so even taking into account its lower thermal efficiency to diesel and gasoline there are considerable economic advantages of usingCNGasatransportationfuel.Inordertomakeitsuitableastransportationfuel, naturalgasrequiresveryslightprocessingfromproductionfieldtovehicle.Whileon otherhanddieselandgasolinemustbesegregatedfromcrudeoilandpassedthrough complex refining process. Furthermore is less vulnerable to price fluctuations and itsresourcesaremoreevenlydistributedovertheearthascomparedtooil[118].The priceadvantageofnaturalgasoverdieselandgasolinehasoftenbeenconsideredas



ISBN:978-81-957858-1-0

the most crucial parameter to attract consumers to switch their vehicles from conventional fuel to CNG [26,74,107,108,120].

Table3comparestheretailfuelpricesinUS$forthefiscalyear2011–2012inthetop 15CNGusercountries.ItcanbeobservedthatCNGpumppricesonaverage50%less than the gasoline and diesel price in most countries that have had successful NGV penetration. The rapid growth of CNG vehicles in the last decade especially in the Asia-pacific region was mainly because of the less fuel price of CNG with regard to gasoline/diesel.

TheeconomicsofrunningtheCNGvehiclesvis-à-visitsoperationonpetrol/Diesel hasbeenworkedoutattheaverageglobalfuelpriceforthefiscalyear2011–2012. The results are presented in Fig. 8 and Table 4.

The US Department of Energy Alternative Fuel Comparison reports that for Jan–Mar2011CNGremained1/3timeslessexpensivethangasolinefuel.Basedonthe reports released bythe U.S. Energy Information Agency, CNG on average, costs 42% lessthan diesel on an energy equivalent basis and is projected to touch this figure to 50% by 2035. Similarly, Republic Services, the second largest waste managementservicescompanyintheUSA,hasachieved 50%fuelcost reductions throughCNGdeploymentacrossmultiplefleets[121].RecentlyUSDepartmentof Energy conducted a surveyabout alternative transportation fuel and found that in contrasttoconventionalgasolinefuelfleetscansavearound50%onfuelcostswith CNG [122]. In 2004, NREL (National Renewable Energy competition) USA conducted a comparative evaluation of the emissions of transit buses operated by WMATA (Washington Metropolitan Area Transit Authority). In addition to establishing the emissions benefits of CNG buses, this project revealed significant fuel economy outputs for CNG buses compared to diesel buses [96]. In those regions, where the government intends to sub- statute diesel with CNG, explicit strategies are established to maintain a cost benefit of CNG to diesel (e.g. in Pakistan)ortoban diesel usage in city buses(e.g. in India) [19–26]



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Table 4
Cost comparison of CNG vs other fuel.

| Description | CNG | Gasoline | Diesel |
|---|---|---|---|
| Vehicle type | Bus | Bus | Bus |
| km travelled per annum per vehicle | 80,000 | 80,000 | 80,000 |
| Total annual consumption of fuel in liters (consider unit of 'N m$^3$' in case of CNG) | 36,184 | 39,400 | 32,000 |
| Retail fuel price per liter US $ (consider unit of 'N m$^3$' in case of CNG) | 0.52 | 1.02 | 0.92 |
| Annual fuel cost (US $) | 18,816 | 40,188 | 29,440 |
| % Fuel cost saving CNG vs gasoline | 113% | | |
| % Fuel cost saving CNG vs diesel | 57% | | |

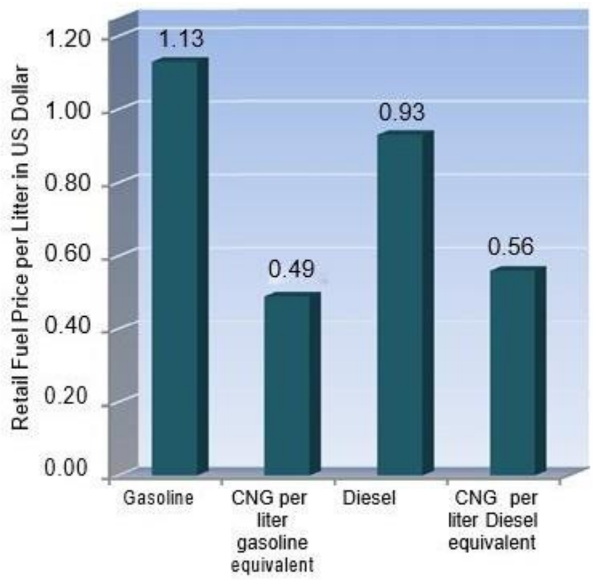


Fig. 8. Cost advantage of CNG fuel over gasoline and diesel.

SafetyaspectofNGVs

Safety of CNG vehicle is a very important aspect. It comes as a surprise to many to feel that natural gas is one of the safest transportation fuels available. Natural gas is safer than gasoline in many respects [83]. Natural gas vehicles are a safe alternative withaproventrackrecord.A1992AGAsurveyofmorethan8000vehiclesfoundthat with more than 278 million miles traveled, NGVs injuries rates per vehicle mile traveledwere 34% lower thanfor gasoline vehicles. There were no fatalities reported even though these vehicles were involved in over 1800 collisions.

The physical properties of CNG offer some safety benefits over diesel and gasoline. PhysicalpropertiesofCNGwhichmakesitaninherently safer than diesel or gasoline are as follows:

- Incontrasttogasoline/dieselfuelCNGhasanarrowrangeofflammability,4.3%to



ISBN:978-81-957858-1-0

15.2%by volume in air, which means thatinconcentrationsinairbelow4.3%and above15.2%,naturalgaswillnotburneveninthepresenceofaspark.

- CNG has a high auto-ignition temperature of 540 1C compared to 258 1C of gasoline and 316 1C of diesel. The auto-ignition temperature is the lowest temperatureatwhichafuelwilligniteatwhichafuelwilligniteduetotheheat only, without any external spark or flame. The high ignition temperature and narrow flammability range of natural gas lessen the chance of accidental ignition and combustion of the fuel.
- Naturalgasislighterthanairsoincaseofaccidentalleakagetheverylowdensity of CNG at atmospheric pressure, 0.68 kg/ $m^3$ compared to air, 1.202 $kg/m^3$, meansthatCNGwouldriseanddisperseintotheairrapidlyinsteadofforming poolson the ground as in the case of diesel and gasoline, which reduces the probability of a fire if the tank is breached.

CNGcylindersaredesignedandfabricatedofspecialmaterials toresistthehigh pressures,withasafetyfactorwhichisusuallygreaterthantwo[123],therefore, safer than ordinary petrol tanks. There are four types of cylinder designs (Table 5).Fig.9 illustratesthe safetyattribute of the CNGcylinder where the CNG cylinder remained safe after a car has been totalled by10,000 using tanker.


Fig.9.HondaCivicGXCNGvehicleaccident—NewYorkState.

The above physical properties do not guaranty that CNG vehicle are safer than diesel fuel. ForinstanceinPakistan,2ndlargestconsumerofCNG,severalCNGvehiclesrelated accidenthas been observed for thelast few years [26]. But this is mainly because of low quality of CNG system material e.g. CNG cylinder, CNG design & installation, main-tenancesystemetc.,driver'serrorsandlackofstrictgovernmentCNGvehicle



ISBN:978-81-957858-1-0

safetyregulationsinPakistan[26].Similarly,in2002,investiga-tors[124,125]matched thefire-safetyrisksassociatedwithdieselandCNGschoolbussesandfoundthattotal fire-fatalityriskfromCNGbuswas2.5timeshigherthanthedieselbuses.Asawhole, CNG is not more or less dangerous than diesel [126]. NGVs safety is highly reliant on the CNG system design, installation, materials, preventive maintenance, operating conditions and driver awareness not only the fuel cylinder or other components in isolation.CNG consumershouldbeprovided sufficientsafetyinformationregarding safetyissuesassociatedwiththeNGVssuchasgasleakages,preventiveandinspection methods and emergency response in the event of vehicle collision and fire.

BarrierstoCNGvehiclesadaptation

CNG now have a firm foothold in global transportation markets,but there are still many hurdles to their widespread use. Some of the problems related to Compressed Natural Gas Vehicles are illustrated below:

1. One of the most important issues pertinent to Natural Gas Vehicles is the Driving Range, which is defined as capability of aNGV to travel a certain distanceaftereachrefueling.Onvolumetric basis, 1m$^3$ of natural gas roughly correspondsto1.0l ofgasolineor1.1l ofdiesel. Becauseofthislower energy densityofnaturalgasascomparedtogasolineordiesel,takes3–4.5timesmore space for storage than gasoline or diesel which consequently reduced the vehicle range. The Driving Range is a major hurdle in the development and growth of CNG as transportation fuel [127].

Table 5
Types of CNG cylinder.

| Type | Construction | Weight (%) | Cost (%) |
|---|---|---|---|
| Type-1 | All metal (aluminum or steel) | 100 | 40 |
| Type-2 | Metal liner reinforced by composite wrap (glass or carbon fiber) around middle (hoop wrapped) | 55–65 | 80–95 |
| Type-3 | Metal liner armored by composite wrapping (carbon fiber or glass) around the complete cylinder (fully wrapped), | 25–45 | 90–100 |
| Type-4 | Plastic gas-tight liner reinforced by composite wrap around entire tank (full wrapped) | 30 | 90 |



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2. Another problem with NGVs especially light duty NGVs is the loss of cargo space.CNGcylindersarelargeandoccupyalotofstoragespaceandgenerally havetobeplacedinthebootofthecar.Owingtothisitsignificantlydecreases the cargo space by almost 50% as compared to conventional fuel vehicle. But this deficiency has nowbeen fixedbydedicated CNGvehicle which equipped with 2 to 3 cylinder all under the vehicle so no luggage space is lost either.
3. Refueling time for NGVs is longer than either diesel or gasoline vehicle and sometimes user have to wait for hours in long queues to get their vehicle refueled due to insufficient number of refueling stations in the areas where share of NGVs ishigh than conventional fuelvehiclee.g. Pakistan, Iran, India etc. Refueling is considered to be the ‘least safe’ moment of its use. The inadequate number of CNG refueling stations is a barrier tothe embracement of NGVs by consumers. Similarly, the lesser number of NGVs required CNG refueling stations makes establishment and operation of a CNG station uneconomical. Janssen et al. [118] studied the effect of the concentration of CNGfillingstationandotherproblemspertinenttoNGVs.Theycomparedthe experience of NGVs in Brazil, Argentina, India, United States and New Zealand.Theresultsoftheirworkrevealedthatforthesustainableuseof CNG as transportation fuel two conditions must be addressed. First, for the CNG stations to be profitable there should be at least 1000 natural gas vehicle per CNGrefuelingstation.Second,tominimizetherefuelingtimeandfacilitatethe motorists,theminimumrangeofCNGrefuelingstationsshouldbeatleast10– 20% of the number of gasoline/diesel stations.
4. For heavy-duty vehiclesmoving through the countryside,the conversion to CNG presents several challenges, including the lack of rigorous Refilling infrastructure,higher vehiclecapitalcosts andlimitedengine offerings. Until a competitive natural gas refueling infrastructure evolves, this alternative fuel is problematic for long haul, irregular-route trucking operations.
5. Anyaccidenttothenaturalgastransmissionpipelinecancutoffthefuelsupply of thewhole city orofaspecific region.

## Conclusion

Themajoroutcomesofthisstudyarelistedbelow:

1. Risingconcernsabouttheharmfuleffectsofemissionsofdieselandgasolinehave made CNG a very promising alternative fuel for the road transportation.
2. TheNGVsectorhasshowntremendousgrowthoverthelast15yearinmostofthe gasproducingcountriestoofferaproductwhichhasbehinditatriedandtested



ISBN:978-81-957858-1-0

technology which guarantees the environment protection, is inexpensive and affordable.

3.CNG is clearly a powerful weapon for the countries in the battle to replace oil in the transportation sector, toreduce air pollution and to address the challenge posedbyclimate change.

4.Worldwide CNG vehicle technologies are well established and commercially available for all type of road transport vehicle.

5.Tokeepthetorqueandbrakehorsepower,ofCNGvehiclescomparabletotheir diesel or gasoline counterparts, dedicated CNG engines research should be accelerated.

6.CNG has several advantages over both diesel and gasoline fuel, including considerable emission and cost reductions, and making the countries more energy sovereign by reducing the dependency on oil.

7.The placement of the high-pressure storage system especially inrather small transport vehicles must be improved concerning transport volume and accessibility but always with respect to the economic effort.

8.Keeping in view the results obtained and the study of literature, it can be established that the use of natural gas as a transportation fuel can contribute towardsurbanairimprovement,andreduceharmfulhealtheffectsandsocialcosts of ambient airpollution.

Nomenclature

*A*/*F* air–fuelratio

AGAAmericanGasAssociation

BSFC brake specific fuel consumptionBTE brake thermal efficiency

BTUBritishthermalunit$CH_4$ methane

CI compression ignition CNG compressed natural fasCO carbon monoxide

$CO_2$ carbondioxide

DOEDepartment of EnergyGHGs greenhouse gases

HC hydrocarbon

kg kilo gram

kJ kiloJoule



ISBN:978-81-957858-1-0

LCAlifecycleassessment

L.H.V. lowerheatingvalueLPGliquefiedpetroleumgas m meter

$m^3$ cubicmeter

MBTmaximumbraketorqueMJ megaJoule

MTOE milliontonsoilequivalent$N_2$ nitrogen

NGV’s natural gas vehicles$NO_x$ nitrogen oxides

OBDon-boarddiagnostics

OECD organization foreconomic cooperation and development

PAH polycyclic aromatic hydrocarbons second

SI sparkignition

TSP total suspended particleTCF trillion cubicfeet

WOT wide open throttle

TSP totalsuspendedparticlesVOC volatile organic compound

WMATA Washington Metropolitan Area Transit Authority

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ISBN:978-81-957858-1-0

## E-wastemanagement

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**Abstract**

The rapid growth of the production of electrical and electronic products has meant an equally speedy growth in the amount of electronic waste, much of which is illicitly imported to India, fordisposalpresentingaseriousenvironmentalchallenge.Thenaturaleffectduringe-squander reusing was researched and metal as well as different poisons [e.g. polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs)] were tracked down in unnecessary levels in soil, water and other natural surroundings. The most e-squander is managed as broad or roughly frequently by open consuming, corrosive showers, with recuperation of a couple of materialsofsignificantworth.Ascomeaboutoftheseinteraction;dioxins,furans,andweighty metals are delivered and unsafe to the general climate, drew in laborers, and furthermore occupantsinhabitingclosetothedestinations.Theinformale-wastesectorsaregrowingrapidly inthedevelopingcountriesoverthaninthedevelopedcountriesbecauseofcheapestlaborcost andweekordainsystems.Ithasbeenconfirmedthatcontaminatesaremovingthroughthefood chainviarootplanttrans-locationsystem,tothehumanbodytherebythreateninghumanhealth. We have suggested some possible solution toward in which plants and microbes combine to correct highly contaminated sites.

**Keywords:**AI,smartmetering,privacy,scheduling,virtualpowerbank,adjusted-averagedaily deman

**Introduction**

With rapid global procession and an exponential growth rate in the electrical and electronic industries in the 21st century has come a comparable change in consumer lifestyles, resulting in the generation of a huge amount of end-of-life electronics, known as electronic waste (e-waste). It has been estimated that approximately 42 million tons (Mt) of e-waste is produced globally per annum. Around 80% of e-squander from created nations is unlawfully sent out to non-industrialnationsparticularlyChina,India,Nigeria,GhanaandPakistan,duetothelower work expenses and absence of legislative guidelines (Sthiannopkao and Wong, 2013; UNEP 2005).AsperRajyaSabha'sreport(2011),practicallyallewasteinIndiaisgatheredandreused inthecasualarea,whichhaspromptedseriousnaturalissues(Keller,2006;Needhidasanetal., 2014). E-squander has a high happy of weighty metals, for example, lead and cadmium in circuitsheets,cadmiuminbatteries,andcopperforelectricalwiringandalotoftheseimportant metalsstayaftertheremovalofe-items(Stevelsetal.,2013;Tangetal.,2010a,2010b,2010c; Zeng et al., 2013). Nonetheless, Bart Gordon, who filled in as Director of the U.S. House Council on Science and Innovation from 2007 to 2011, proposed that hardware engineers be expected to be aware of the imminent natural, social and wellbeing impacts of e-waste, and takethisinformationintoaccountwhileplanningnewelectroniitems(Ogunseitanetal.,2009).



ISBN:978-81-957858-1-0

E-waste contains two major types of substances:e dangerous [(Cd, Cr, Pb, Hg, Chloroflfluorocarbon, (PAHs), (PBDEs), (PCDD/Fs) ] and non-hazardous (base metals such as Cu, Se, Zn and precious metals such as Ag, Au, and Pt) both types have negative potential environmental impacts ). In addition, many organic pollutants such as polyaromatic hydrocarbons (PAHs), polychlorinated biphenyl (PCBs), Brominated flflame retardants (BFRs), Polybrominated diphenyl ethers (PBDEs) and polychlorinated dibenzo-p-dioxin furans (PCDD/Fs)) are released into the environment during incorrect e-waste processing . Its impacts have played a major role in ecological risk assessments show that the heavily containandnumberofresidentssubjectingtohighhealthriskdirtsoilbyPAHsisconcentrated in the densely populated.

Thesesubstances arebroadly utilized innumerous electronicitems. Indiais distinguishedas a significant unloading site for e-squander as natural substances from created nations. The vast majority of the e-squander in India is reused in casual studios that perform tasks for example, valuable metals recuperation and the extraction of repairable parts in the ways are speediest and simplest, paying little mind to natural contemplations. Patio family studios in specific frequentlyutilizecrudereusingstrategieswithhighwellbeinggambles(PoisonousConnection, 2014; Sinha-Khetriwal et al., 2005; Streicher-Porteet al., 2005),and these e-squanderreusing rehearses are done all over India (Harmful Connection, 2014; Sepulveda et al., 2010; SinhaKhetriwal et al., 2005). These studios multiply due to the accessibility of incredibly modestworkandtheabsenceofadministrativeguidelineandoversight.Variousexaminations have proposed that the indigenous habitat (soil, air, water, plants, and so on) is polluted by openness to the harmful substances delivered at these studio locales (Jain and Sareen, 2006; Kwatraetal.,2014;PradhanandKumar2014;Stevelsetal.,2013;Zengetal.,2013;Fujimori and Takigami, 2014; Hites, 2004; Tune and Li 2014a; 2014b; Wu et al., 2014). Many distributedexaminationshaverecordedweightymetalpollutioninthedirt,airandwaterclose to reusing destinations in agricultural nations (Leung et al., 2006, 2007; 2008; Sharma et al., 2007; Steiner, 2004; Wong et al., 2007c). Though this informal e-waste recycling technology extracts valuable metals rapidly, the recovery is ineffificient and incomplete .

Furthermore, it produces waste water containing high levels of toxic metals (Cd, Cu, Ni, Pb, and Zn) and other pollutants, which are released into the local environment, causing soil, air, water, and plant pollution . A study in Bangalore, India suggested that informal processing of e-waste is responsible for heavy metals contamination in nearby soil and in human tissues, because of high penetration rates into the soil and thence into plants, where it compiles and is consumed by humans determined that there is a high probability of transfer of heavy metals and PBDEs from contaminated food plant to human beings, where they pose health danger such as lung, liver and kidney damage .

Greenpeace Worldwide's distributed report assessed that defilement from the reusing of electronic waste in China and India is 80% higher than that in the remainder of the world (Brigdenetal.,2005).Thesefamilystudioterracefrequentlyoccurundertheexceptionally



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crude reusing techniques with high well-being risk (Harmful Connection, 2014; Sinha-Khetriwaletal.,2005;Streicher-Porteetal.,2005).Thissurveyincorporatedallthedistributed writing connected with the natural evaluation of metals like chromium (Cr), cadmium (Cd), mercury (Hg), lead (Pb), as well as PBDEs and PCDD/Fs in e-squander handling destinations in India. India is especially helpless to these issues since it is one of the two nations most impacted by ill-advised reusing exercises, as it has both a critical need for material assets and countless individuals able to work for exceptionally low wages. Keller (2006) featured a portion oftheissues thatwas related e-squanderreusing in Bangalore, such as recuperation of gold through compound draining cycles. Due to ill-advised handling, elevated degrees of weightymetalsandotherpollutantswereaccountedforin regionslikeNewDelhi,Bangalore, Kolkata,Hyderabad,TrichirappalliandGaziabad.Kidsareparticularlydefenselessagainstthe destructive impacts of these ill-advised reusing exercises. Notwithstanding, just restricted investigations have been carried on a mission to investigate the natural corruption brought about by weighty metals and different poisons discharged from e-squander the board or handling locales in India.

The objective of this study was to assess pollution levels and to provide comprehensive information on the impact of pollutants released from e-waste recycling sites into the natural environment.Adetailedcomparisonofe-wasterecyclingandmanagementfacilities,andtheir expected impacts on natural environment was carried out for India. In addition China and Nigeriacouldbeconsiderasfurtherprooforreferenceinordertodetermineimpactofinformal e-waste recycling. Through this review, we explored the environmental pollution generated from e-waste recycling in India. Finally, this study strives to outline proposed eco-friendly solution that may be helpful for resolving the problem and can be recommend to the Ministry of Environment, Forestry and Climate Change (MoEFCC) India.

Review methodology

This study examines data gathered from more than a hundred distributed explores covering a few pieces of India, zeroing in on the ecological effect of weighty metals and other poisons from e-squander handling. This study is like the work of Melody and Li (2014a), however incorporatessomeofextracontaminations,andadoptsamorehealingstrategytotheissue.The concentrates on explored here incorporate those from peer-investigated diaries,specialized reports, postulation reports and meeting procedures published up through the finish of May 2015. Some extra manuscripts from the e-squander reusing segments of surveys by Melody andLi(2014a)andZhengetal.(2012)wereadditionallythoughtof.Theprincipalpointofthis study was to assess the e-squander reusing exercises especially in various chose urban communities of India. These chose urban communities are exceptionally overwhelming by casualreusingexercises asaresultoftremendousquantitiesofpeoplegroupsarerelocatedfor work into these urban communities and furthermore accessibility of e-squander as vocation choice.Accordingtoaccessibleexplorationpapers,reportsandnews,thecasualareasare



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efficiently coordinated in the vast majority of these urban communities of India. These casual area helpfully offers types of assistance for assortment, isolation, destroying and reusing of e-squander. Curiously such units are spread in little bunches around or all around these urban communitieswhat'smore,practically95%ofe-squanderreusingbythesecasualareainIndia. We likewise looked through a few changed data sets like Science Direct and find out about Researcher,utilizingthewatchwords'e-squander','electronicsquander'and'WEEE',aswellas thenamesofdifferentweightymetalsandotherreferredtopoisons,forexample,'PBDE','PCB' and 'organochlorien'.

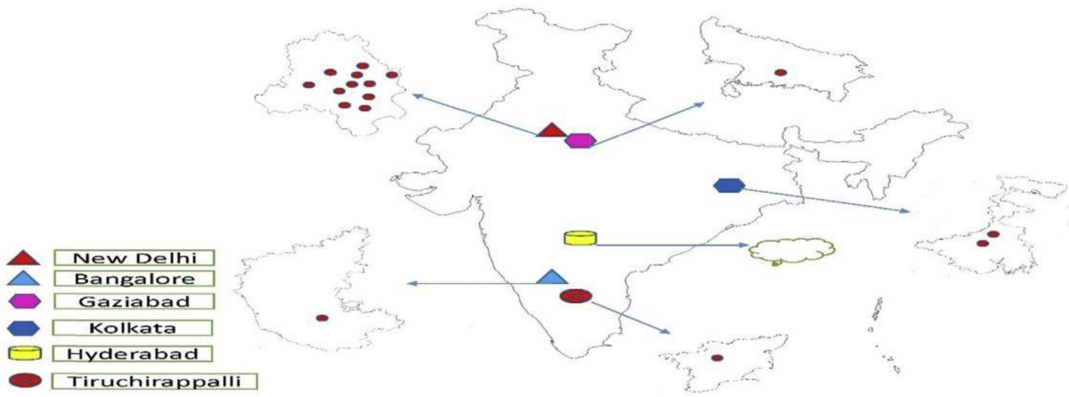


Figure1Locationofmap withdifferentcitiesandImpactofe-waste recyclinginIndia

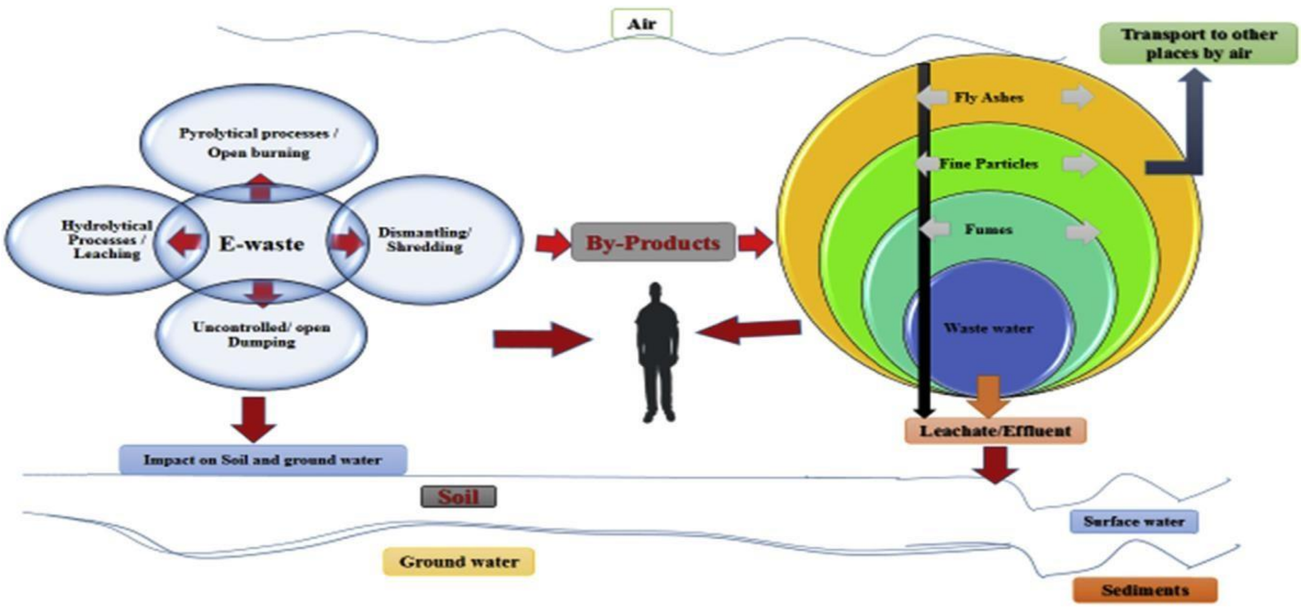


Figure 2Diagrammatical Illustration between environmental medium and e-waste recycling process.



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## AnalysisandDiscussion

### Overviewofcross-relationshipbetweenenvironmentalmediumande-wasterecyclingprocess

Mainly three kind of substances discharged during recycling (a).The substances used in manufacturingofelectricalandelectronicequipment(b)Thosesubstanceareusedinrecycling process (auxiliary substances) (c) By products which are formed during the transformation of primaryconstituents.Thedetailsdiagrammaticalrepresentationofenvironmentalmediumand e-waste recycling.

The present foundation survey investigates the ecological contamination impacts of weighty metals and different poisons from e-squander handling studios in India. We just assessed the conceivableopennesscoursesandhumanwell-beingriskbecauseofimpactsofweightymetals to comprehend the proof of causality between openness to weighty metals from e-waste and human well-being outcomes. As indicated by Poisonous Connection report (2014) different metals' including mercury, lead, and zinc are delivered during the e-squander reusing process and dirty close by soil and water sources.

Albeit many investigations have proposed that e-squander reusing activities influence on indigenous habitat (Orlins and Guan, 2015; Wang et al., 2011a). This paper consequently investigatedtheeffectsofe-squanderreusingrehearsesonsoil,air,water,vegetation,andother environment components close to e-squander handling destinations.

### Heavymetalcontaminatesin dustand air

The residue tests gathered from battery destroying studios in New Delhi were found to have high metal fixations (Brigden et al., 2005). The weighty metal focus in residue and air announced from various districts of the country. The normal degree of weighty metals (Cr) in dust were, in diminishing request: Zarfarabad > Mayapuri > Brijgang (Residue stockpiling shed) > Shastri Park (Sheperation studio) > Shastri Park (Weld studio) > Buradi > Kailash NagarandSafouring>Brijgang(Groundcapacityshed)>Shastripark(WeldcircuitBoard)> Zarfarabad(patchedcircuitboard).Cadmiumlevelsindustwentfrom200,000mg/kginBuradi and Kailash Nagar to <0.5 mg/kg in Safouring. High groupings of Pbd37,000 mg/kg furthermore, 20 mg/kgd were tracked down in fastening studios in Shastri Park furthermore, Safouring,separately.AgroupingofCuover6805mg/kgwasseenindustinapartitionstudio inZarfarabad.Znfixationlevelsranupto21,100mg/kginBrijgang(dustcapacityshed)and <10mg/kginZarfarabad(patchedcircuitboard).LevelsofHgwentfromahighof48.2mg/kg in Buradi (floor dust from a battery studio) to a low of <0.2 mg/kg in Gaziabad, Shastri Park and Brijgang. Zhu et al. (2012) and Bi et al. (2011), reported elevated degrees of metal focus in dust from the e-squander reusing area (Leung et al., 2008). Tooth et al. (2013) viewed that as the centralizations of Pb in studio dust were higher than those from different investigations (Leungetal.,2008).MelodyandLi(2014a)dissectedecologicalcontaminationinferablefrom weightymetalsfromane-squanderhandlingsiteChina.AnexaminationbyTuneetal.(2015a)



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tracked down the most noteworthy convergence of weighty metals in the air and residue of a CRTstudiowasofPbd2.3mg/m3and10.53mg/gincorrelationwithtwootherweightymetals contemplated: Cu and Cd.

Air is one of the most important source mediators for the survival and movement of e-waste dustpollutantsreleased duringrecycling.Excessamountsofthesepollutants,includingheavy metals into the air contaminate the natural environment and inflictlife-threatening effects on humans reported that, metals contaminating the air near e-waste recycling sites, the levels of Cr(1.161lg/m3)andZn(1.038lg/m3)weretheenrichedmetalswiththehighestleveloftotal suspendedparticulates(TSP),higherthanCu(0.483lg/m3),Pb(0.444lg/m3),orMn(0.0606 lg/m3 ). In addition, a comparative studyfound the concentration of heavy metals in formal recycling sector were lower than those in Guiyu, China. A studyfound that the open burning of used electronic product released heavy smoke with a variety of both organic and heavy metals which contaminated the air.

Heavymetalcontaminatesinwastewater(effluent),waterand sediment

Waste water is another important conveyor of contaminants . The level of heavy metals in effluent, water and sediment attributable to wrong e-waste processing. Several studies have examinedheavymetalpollutionfrome-wasterecyclingsites.Nearbywaterisdirtywithheavy metals due to different acidification activity resulting from e-waste recycling activity on site. Thelevelsofheavymetalsine-wasterecyclingareawaterwereasfollows:Cr(0.60mg/l),Cu (0.70 (mg/l), Cd (0.05), Fe (0.46 mg/l), Pb (0.040 mg/l, Zn (1.89 mg/l), Al (3.67 mg/l) inside the unit, while levels found inside a residential area, 500 m away from the recycling site were at: Cr (0.02 mg/l), Cu (0.05 mg/l), Cd (0.002 mg/l), Fe (0.32 mg/l), Pb (0.002 mg/l), Zn (1.46 mg/l), Al (61 mg/l). A reported concentrations of Pb (0.06 mg/l) in groundwater samples; this isattributabletooldtechniqueandthefactthatfewermeasurementsweretakeninthee-waste workshop. Likewise, a report concerning the level of heavy metals in water from an informal e-waste processingsiteinKolkata foundthatthe levelof Fe (0.9 mg/l)inthepond adjacentto a picnic area had the highest levels of all the heavy metals, and lower than those of other investigations. These studies showed that New Delhi and Bangalore were changing improper e-waste processing in heavily polluted regions.

Heavymetalcontaminantsin soiland ash

Weighty metal defilement in soil is a difficult issue attributable to its harmfulness to both the climateandhumanwellbeing.Levelsofweightymetalsinthedirtofe-squanderreusinglocales are displayed in and uncover massive contrasts among Mandoli and Bangalore. The typical groupingofCuwashigherintheMandolimodernregion(136,000mg/kg),than intheformal recycling area of Bangalore (22.8 mg/kg). A few specialists have currently analyzed and detailed that ill-advised reusing of e-squander creates more elevated levels of metal (Lopez et al.,2011;TuneandLi,2014a).ThefocuslevelofCrmetalindebriswasnoticedtobemost



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noteworthy in Ibrahimpur at 293 mg/kg, and least at 11 mg/kg in Kanti Nagar. The most extremeconvergenceofPb(20,500mg/kg)andleast(22.8mg/kg).Bethatasitmay,elevated degreeofweightymetalsreportedinsoilofe-squanderhandlingsiteinNewDelhi.Brigdenet al. (2005) recommended that the e-squander handling utilizing crude strategies is an essential justification for soil tainting in India (Pradhan and Kumar 2014). The weighty metal profiles wereuniquebetweeneveryoneoftheexaminations.Haetal.(2009)concentratedontheeffect of weighty metals pollution on surface soil in casual e-squander processing destinations has harmed natural quality (Guo et al., 2009; Orlins and Guan, 2015; Wong et al., 2007b). Additionally, the metal pollution surface soil close to e-squander handling region was higher contrastedwithuncontaminatedsoil(PradhanandKumar2014).Manetal.(2010)madesense of about human wellbeing chances related with soil debased by e-squander reusing process.

Heavymetalincontaminatedplants

Theroottoshoottransportationofmetalisasignifificanthyperaccumulater.Thepeckingorder is a significant pathway for the transportation of these toxins into individuals (Mama et al., 2007). Singh et al. (2010) made sense of that the immediate admission of harmful toxins presents high wellbeing gambles to people (Bai et al., 2011). Plants filling in sullied soil can possiblygatherweightymetal(Sharmaetal.,2007;Singhetal.,2011).Palmgrenetal.(2008) contendedthatthisvehicleframework'scapacitytogatherharmfuldegreesofcontaminations, forexample, weighty metals might be risky in food crops. Sandalio et al.(2001) proposed that the weighty metals caused other negative effects like decreased plant development (Di Salvatore et al., 2008; Lux et al., 2011). Plants are straightforwardly presented to weighty metalsaswellasnaturalcontaminationsduringtheconsumingofe-squander.Baietal.(2011) researched theimpact of weighty metals from e-squanderreusing destinations on farming and paddysoilsfrome-wasteandtrackeddownconcentrationsofCu(663.08mg/kg)andCd(3.15 mg/kg)whichsurpassedstandardcutoffpoints.GarciaandMillan(1998)saidthatunnecessary weighty metals in plants can adversely affect food quality. Weighty metal pollution of food is an arising issue for food well-being and quality confirmation (Sharma et al., 2009). Pradhan and Kumar (2014) tracked down that plots of arable land, 50 m, 100 m and 500 m away from a reusing site, were defiled with Cu (23.07 mg/kg), Zn (78.18 mg/kg), Fe (106.37 mg/kg), Zn (68.48mg/kg),Pb(0.76mg/kg),Album(0.049mg/kg).Cropsfilledincontaminatedsoilscan amass possibly destructive degrees of harmfulsubstances or weighty metals (Sharma et al., 2006, 2007). The exorbitant statement of such materials in agrarian land may unfavorably influence ordinary soil cycles and cause weighty metal uptake by crops, prompting injurious impacts on food quality and security. Thusly, a human wellbeing risk is presented by dietary admission of vegetables filled in polluted soils (Singh et al., 2010). To some degree, this high exchange factor is because of low soil pH; higher pH can balance out soil and lessening the draining of harmful components (Li et al., 2004; Zheng et al., 2012).



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ConcentrationofPBDEsandPCBs

Openlandistheprimaryobjectivefore-squanderdisposedoffromreusinglocalesinthewake ofdestroyingandcorrosivehandling,andthecorrosivehandlingmakesitdrainvarioustoxins like PBDEs (Luo et al., 2009a, 2009b; Tang et al., 2010b). Mama et al. (2009) detailed that vegetablesareimpactedbythecyclescompletedinadjacente-squanderreusinglocales(Chan et al., 2013; Wang et al., 2011a, 2011b, 2011c).The groupings of PBDEs and PCBs at the Mandoli modern region furthermore, Shastri Park were higher than that of the division studio at Shastri Park (Brigden et al., 2005). Many investigations show that dirt tainted with PCBs and PBDEs might adversely affect the common habitat (Luo et al., 2009a, 2009c; Wu et al., 2009;Zhaoetal.,2008).What'smore,aninvestigationbyRenetal.(2015)foundthatdegrees of PCDD/Fs were 3.2e31.7 pg/m3; 0.063e0.091 pg/m3 furthermore, 5.8e12.4 ng/kg in the air at a foundation site and farmland soil, separately close to an e-squander site.

Discussion

Incorrect handling and management of e-waste is one of the main reasons of environmental pollutionandhumiliationofseveralcities,particularlyindevelopingcountries,becauseoflack of regulations and proper treatment facilities. According to the many researchers, it can be known that the heavy metal pollution of e-waste in India has been spreaded from the casual activities to the surrounding environment (soil, air, dust and plants. Therefore, some efficient measuresshouldbecarriedouttorelievetheenvironmentalpollutionofheavymetals.Inorder to betterbelievethepotential environmental and health risk ofheavy metals pollution,along-termriskassessmentneedstobecarriedoutontheleachabilityandmigrationpotentialofthese toxic metals at the contaminated sites. Due to higher level of heavy metals in the informal e- waste recycling sites, especially forthe two place; Mandoli Delhi and Bangalore, the engaged workersandresidentsarefacingapotentialhigherrevealingofthesesubstanceoverthecontrol areas.Fangetal.(2013)estimatedthat,duringtheserecyclingprocesses,dustcontainingheavy metals will be released into the air to impact the environment and the health of the engaged unprotected workers. And also suggested for special masks for filtering PM2.5 are needed to mitigate the direct oral inspiration of these pollutants. Meanwhile, Zeng explored the impacts of gaseous emissions and pollutant impact on environmental and human health in China .

Thesurfacesoil,air,andgroundwaterclosetoe-squanderreusinglocaleshavebeeneffectively dirtiedwithnaturalsubstances andweightymetals(Cu,Albumfurthermore,Pb)(Wonget al., 2007a; Yu et al., 2006). Ha et al. (2009) demonstrated that e-squander handling locales are profoundlydefiledwithweightymetals.Huangetal.(2011)foundthatPBDEssetfreefrome-squanderhandlingsitedebasedthelandandweremovedtopeoplethroughplanttake-upinthe pecking order. Likewise a few specialists have proactively investigated soil plant affiliation (Huangetal.,2010;Zhaoetal.,2008;Muelleretal.,2006).Hence,itiscriticallyimportantto determinethisissueinaneco-friendlyway.Becauseoftherestricteddistributedwriting,we



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wereunabletoutilizemeasurableinvestigation.Thecurrentexaminationproposedthatsurface soil,air,dust,water,profluentandplantsofIndiaweretrulycontaminatedbydifferentweighty metals and different toxins during e-squander proceessing, which could cause pessimistic impacts on individuals related with these exercises.

Comparativeenvironmentalpollutionresultedfrom e-wasteinsomedeveloping countries

AnUNEP-basedreportrecommendedthatdegreeofmetalsintheclimatearehighernowthan in the past attributable to its anthropogenic exercises broadened exorbitantly like mining (squanderrockfurthermore,following),extraction(watercontamination)(Liuetal.,2014),and energyuseinrefifining(asfarasdieselorcoalfifiredforpower)reflflectedasclimaticoutflow followed by metal reusing may be impacted to climate separately (van der Voet et al., 2013). In thetwo nations China and India afewoffices havebeen worked to empowerthelegitimate innovationfore-garbageremoval.Amongthesenations,Chinabasicallyhasimmenseamount insuchthingsastheneedmighthavearisenforreusingnonferricmetal.Chinaishenceviewed as the enormous scope overseer of e-squander that, with the assistance of cooperating and innovationmove,hasthepotentialforbuildingofficesfortakingcareofasignifificantmeasure of it appropriately (UNEP, 2009).

Today's Asian countries (India, China) and African countries (Nigeria, Ghana) are fifirst the choice for the e-waste disposal/ movement from developed counties, leading to rapid environmental deterioration. Wenotedthat theconcentrations ofpollutants in e-waste discard yardsandrecyclingsitesintheseselectedcountriesarepotentiallyhigh.Ogungbuyiestimated that0.1Mtwasdirectlyimportedoutof0.36Mtofe-wasteisrecycledusinginferiorstandards in Nigeria. Similarly, a study conducted by Atiemeo tested samples from e-waste dismantling & burning sites in Accra and Ghana and found high concentrations of heavy metals (Zn, Cu, PbandCd)withlevelsof28,957mg/kg&30,384mg/kg;16,318mg/kg&16,627mg/kg;3162 mg/kg 1321; 52.1 mg/kg 71.6 mg/kg, respectively fordismantling and burning site. However, many studies already documented the need, in China, for monitoring of environmental pollutants owing to its heavy metals and brominated flame retardants inhabitant in soil and plant.Thesestudieshaveprovedthattheinformalrecyclingsectorsarestilloperatingin Africa with primitive methods and tools with negative consequences for the natural environment . These studies and reports concur that air, soil, dust, water and waste water are major sites of pollutants. The level of heavy metals and pollutants in India, China, Ghana, and Nigeria far exceeded the standard limit for levels of pollution in all countries. This scenario directly reflflects the huge quantity of e-waste long processed in these countries.



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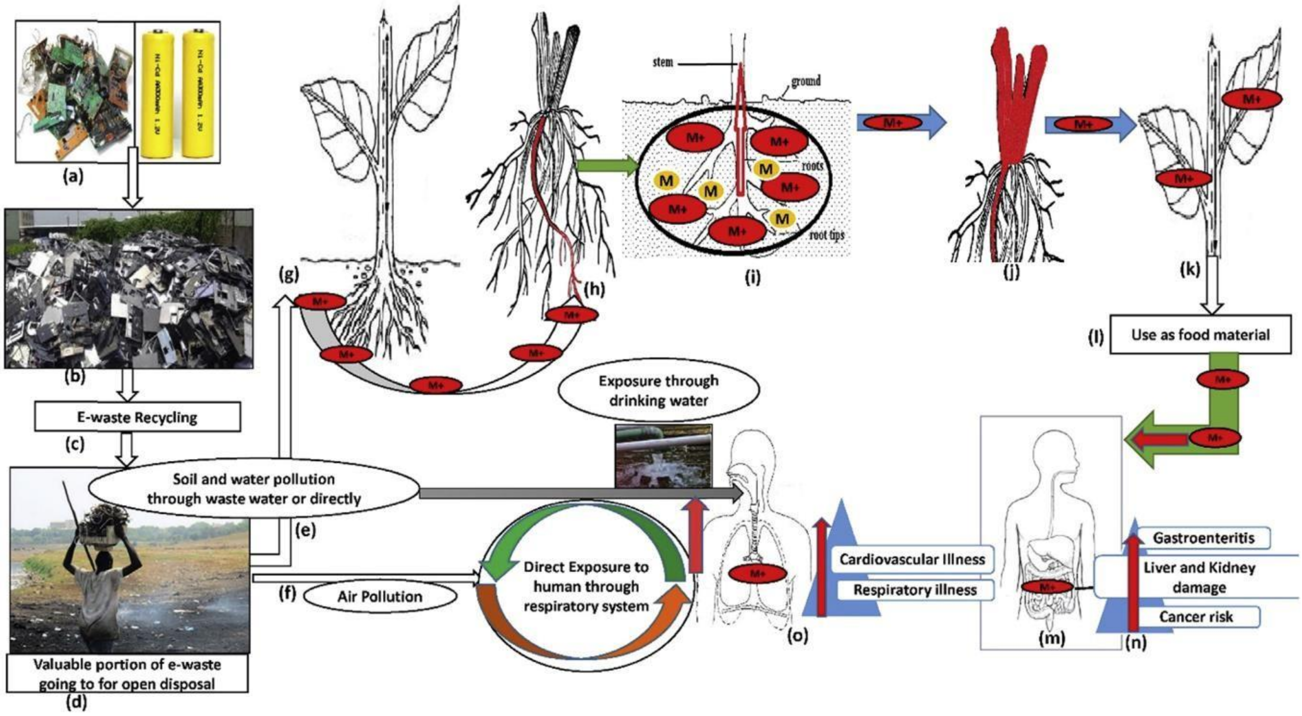


Figure3Flowofe-waste contaminant viadifferentpathwaysintothehuman body

Mechanismofsoilcontaminationandanexpectedremedialsolution

Metalscaninfiltrateintothedirtandsaturategroundwater.Rahmanetal.(2012)proposedthat the possible measure of weighty metals are moved from the surface soil through precipitation and drainage to the lakes in the stormy season. Yuan et al. (2011) madesense of that, because of low level of the innovation used to treat e-waste, and to the industriousness of weighty metals,enormoussumsaremovedfromthedirtsurfacebymeansofprecipitationanddrainage intolakesduringtheblusteryseason,taintingtheamphibianenvironment,anduncoveringclose by laborers and inhabitants to potential harmfulness. It is likewise gives the idea that plants fillingindebasedlandstraywithregardstotheirdevelopmentandadvancement,andarranged ewastemaypromptconceivableadverseconsequencesonpeople,forexample,cardiovascular ailment, respiratorydisease, gastroenteritis and liver,kidneyharm(Brigden et al., 2008). This is because of the presence of over abundances convergence of weighty metals and different toxins (Fig. 3). Accordingly, the above chance might be controlled through different forestalling estimates like orderly assortment frameworks and proper reusing e-squander offices.

This paper is principally focused on India, and is very similar to a study carried out bySong and Li but we have taken an extensive approach to solve this problem with phytoremedial technology Fig4. The metal and PBDEs, PCBs and organochlorine in air, water, soil and dust were differently distributed at different



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sites, but we used only the mean concentration of pollutants. Due to certain limitation it was not feasible for us to apply the statistical methods. However, direct exposure might be prevented through regular use of mask and gloves . Our study also covered additional pollutants.

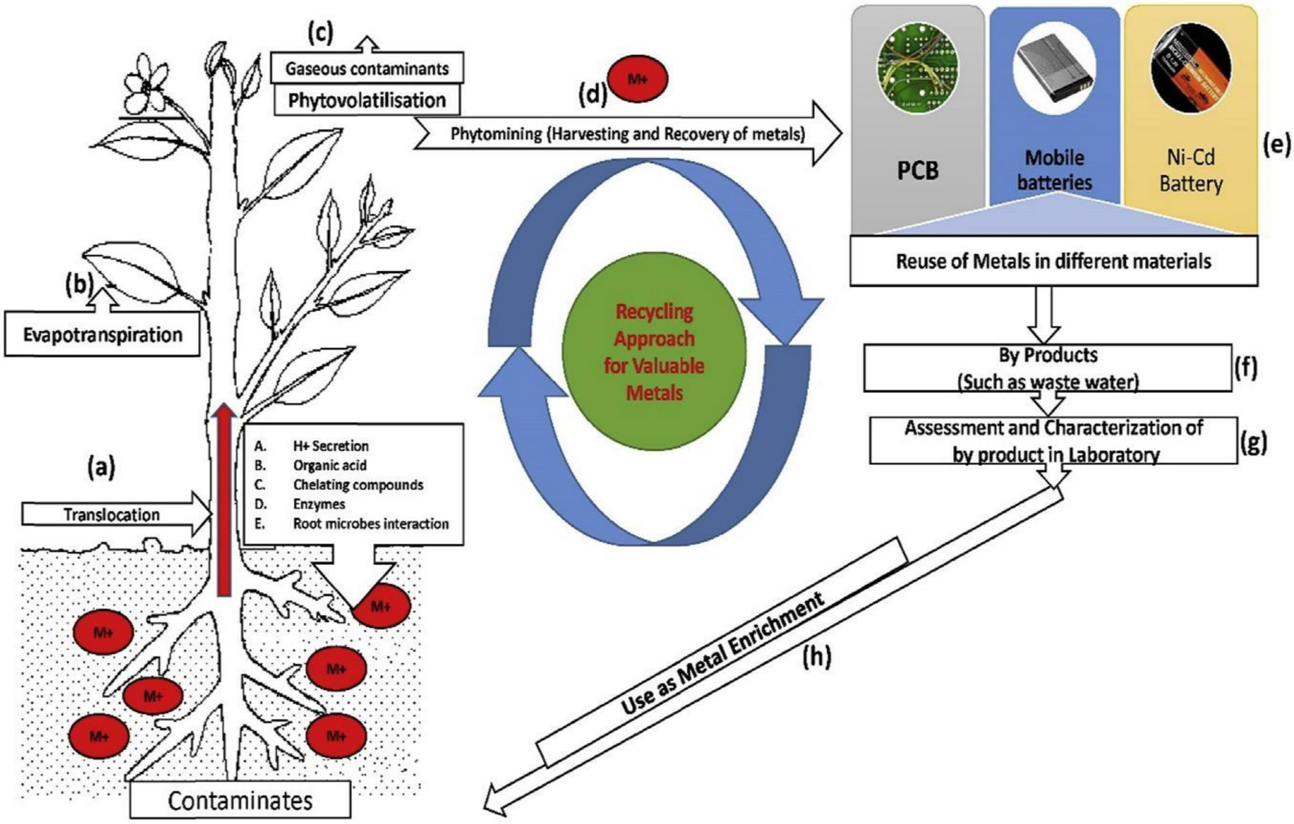


Figure4 Remedialapproach formetals contaminatedsoil and recycling

## Conclusions

This paper investigates the natural contamination from e-squander reusing at numerous little formal and casual studios in India. The customary e-squander handling through ill-advised diverts in India has brought about the colossal amount of weighty metal and other toxins into the indigenous habitat which has a negative influence on regular environments (soil, water, residue and plant). Therefore, this study intends to give a reasonable picture of natural contamination from e-squander handling by a casual area well laid out in numerous Indian peoplegroup.Asperthissystematicapproach,thecasualareaoughttobecoordinatedwiththe formal area at assortment channels, normal checking ought to be completed and e-squander reusingofficesoughttobetakencareofinapreventiveway.Thetaintedsoilcanberemediated through incorporated phytoremedial and microbial frameworks, followed by utilization of results as metal improvements to soil. Further examination

is required for better comprehension of long haul effect of substance and coordinated plant-microbial framework application in sustainable the executives.



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ISBN:978-81-957858-1-0

# PresentandFutureEnergyScenarioin India

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**Abstract**

India's energy sector is one of the most critical components of infrastructure affecting India's economic growth, and thus one of the country's largest industries. India has the fifth largest capacity for electricity generation and the sixth largest energy consumer, accounting for approximately 3.4% of global energy consumption. Over the last 30 years, India's energy demand has increased at a rate of 3.6% per year. Energy consumption is inversely correlated withthegrowthofthehumanpopulation,theimprovementoflivingstandardsworldwide,and the industrialisation of developing nations. Recently, smart grid technology has begun to play animportantroleintheenergyscenario.Asmartgridisanelectricpowersystemthatimproves grid reliability and efficiency by responding automatically to system disturbances. The new communicationinfrastructureandschemedesignedtointegratedataarediscussedinthispaper.

**Keywords-**Smartgrid·FACTSdevices·Energyscenario·PlanningCommission·Projected power scenario

## Introduction

Transmission anddistributionlosses continueto riseas aresultofademand-supplyimbalance. As aresult,bothgridfrequencyandplantloadfactordecrease.Fluctuationsinthefrequencyofthe stategridareharmfultoplantequipment.Peakdemandincreasesthestrainonpowergeneration andutilisationequipment,resultinginanincreaseinenergycosts.TheindustrialsectorisIndia's largestenergyconsumer,accountingforapproximately50%oftotalcommercialenergyavailable in the country. Higher specific energy consumption in Indian enterprises is mostly caused by outdated equipment,decreased capacity, utilisation, causalmeteringandmonitoring ofenergy usage, poorer automation, poor raw material quality, and ineffective handling, operating, and maintenance procedures. High economic growth in the Asia Pacific region, including India, is drivingupenergyconsumptionatarapidpace.Forthepastfivedecades,Indiahasseenanincrease intotalenergyconsumption,withashiftfromnoncommercialtocommercialenergysources.Coal has been themost abundant commercial energy sourceoverthelast fivedecades, accordingto trends in primary commercial energy production [1]. Domestic production and supply of petroleumandnaturalgashaveincreasedsignificantly.Becauseresourceadditionandgrowthin energy supply have not kept up with rising demand, India continues to face severe energy shortages.Asaresult,thereisagreaterrelianceonimportstomeetenergydemand.

**Scenarioforgenerationanddemand**



ISBN:978-81-957858-1-0

Thetransmission line's highest voltage in 1947 was 132 kV; it was later raised to 220 kV in 1960 and 400 kV in 1977. 765 kV transmission voltages are being employed more often, and gas-insulated stations are being erected wherever land availability is anissue,inordertodecreasetheright-of-wayrequirementsfortransmissionlinesand get around land availability restrictions for substations. In the year 2000, 500 kV HVDC back to back was introduced. Recognizing the need for National Grid development, emphasis was placed on gradually increasing interregional capacity. Totalinter-regionaltransmissioncapacitywas14,050MWattheendofthe10thPlan, and it is now expected to increase to around 25,650 MW by the end of the 11th Plan.

In India, natural resources for power generation are unevenly distributed and concentrated in a few pockets. The Himalayan foothills and the north-eastern region arerichinhydroresources(NER).Jharkhand,Orissa,WestBengal,Chhattisgarh,and partsofMadhyaPradeshhavesignificantcoalreserves,whileTamilNaduandGujarat have significant lignite reserves. The North Eastern Region (NER), Sikkim, and Bhutan are each thought to have an untapped hydropower potential of about 35,000 MW, 8,000 MW, and 15,000 MW, respectively. In India, coal output increased by 8.17% between April 2009 and January 2010 from the same time the previous year, when it stood at 385.02 MT, according to the annual report of the Ministry of Coal, Government of India (Fig.1).

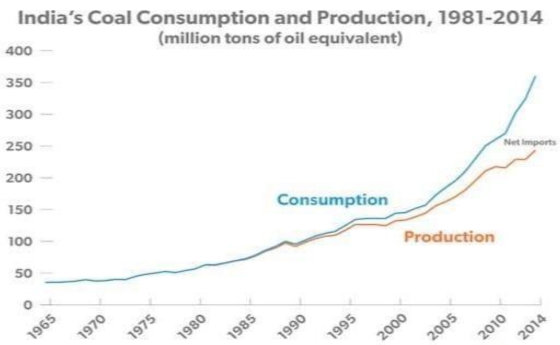


**Fig.1Coalconsumptionandproductionin India**



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**Fig 2: India's top fivecoal consumers, by sector**

According to Fig. 2, India consumes 7% of the world's coal, and 68% of the world's coal is consumed in the generation of electricity.

## ELECTRICITYSUPPLYAND DEMAND

India's electricity sector is rapidly expanding. The current peak demand is approximately1,15,000MW,andinstalledcapacityis1,52,380MW,withgeneration coming from the thermal (63%), hydro (25%), nuclear (9%), and renewable (9%) sectors. Peak demand in 2012 is expected to be around 150 GW, with demand exceeding 200 GW by 2017. The installed capacity requirement in 2012 is approximately 220 GW, and it isexpectedto exceed 300 GWby 2017. In 2007, India had 159 GW of installed electric capacity and produced 761 billion kilowatt hours. Coal, oil, or gas are used to generate nearly all of India's electricity. In 2007, conventional thermal sources generated more than 80% of electricity. In India, hydroelectricity, a seasonally dependent power source, accounted for nearly 16% of totalpowergenerationin2007.Finally,duringthesameyear,nuclearenergyproduced approximately 2% of all electricity, while geothermal and other renewable sources produced approximately 2%.

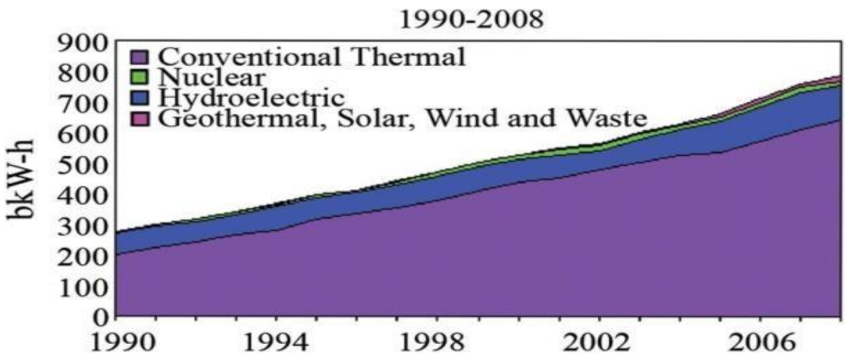




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**Fig.3ElectricitygenerationbytypeinIndia**

## FUTUREOUTLOOKOFINDIANPOWER INDUSTRY

The conditions of Indian transmission, generation, and distribution will be altered through the implementation of new and innovative strategies.

## CLEANCOAL TECHNOLOGY

When used for power generation, clean coal technologies have the potential to significantlyreduceenvironmentalemissions.Thesetechnologiescanbeusedinboth newandexistingplants,makingthemaneffectivewayofreducingemissionsincoal- fired power plants. Several of these systems are not only very effective at reducing SOxand NOx emissions, but theyalso emit less CO2perunit ofpowerproduced due to their higher efficiencies. CCTs can be used to reduce reliance on foreign oil while alsomakinguseofadiverserangeofcoal.Thecombinationofdifferentgradesofraw coal, as well as beneficiation, will ensure consistency in the quality of coal delivered toutilityboilers.Thisapproachbecomesmoreimportantwhenmultiplegradesofcoal are available in different parts of the country, as well as when IPPs import coals of varying quality. The CPCB has established a Steering Committee, which is made up ofmembersfromsomeSEBs,theCPCB,theMinistryofCoal,theMinistryofPower, CEA, and the World Bank, to assess the costs and benefits of using clean coal technologiesaswellastoidentifyandprioritisethemosttechnicallyandeconomically viable improvements to coal quality.

## ENOVATIONOFCURRENTTHERMALPOWERPLANTS

During the early 800s, there was a continuous deterioration in the performance of thermal power plants. As a result, Renovation and Modernization Plans were developed and implemented to improve the performance of existing thermal power plants. During phase-I, 163 units from 34 thermal power plants were covered. These R&M schemes resulted in 10,000 million units of additional generation per year, compared to the target of 7,000 million units. Encouraged by the results obtained, the R&M phase-II programme is currently underway. The total cost of these works is estimatedtobeRs.24billion.ThemajorityofElectricityBoardsandothergenerating agencies are due to financial constraints, R&M activities cannot be carried out. As a result, financial assistance must be prioritised in this area. A massive renovation and modernization programme must be launched to improve the performance of existing oldpowerplants.Theexistingpopulationofthermalpowerplantshasafuelconversion efficiency of around 30% on average. Super-critical boilers can achieve efficiencies ranging from 38 to 40%. No new thermal power plant should be permitted unless its fuel conversion efficiency is certified to be at least 38%.

## CONSTRUCTIONOF ANATIONAL GRID



ISBN:978-81-957858-1-0

The transmission segment is critical to achieving this mission because efficient transmission capacity and network are required to transfer power from generating stations to distribution networks. Previously, transmission planning was done in relation to generation, with the goal of establishing transmission systems capable of safely evacuating power. However, as the scenario changed, the transmission sector begantoshifttowardsintegratedsystemplanning,owingtotheunevendistributionof generation capacities across regions. Thus, integrated system planning has proven to be a viable option. The central transmission utility (CTU), known as the Power Grid Corporation of India Ltd (PGCIL), is in charge of national and regional transmission planning in the central sector, whereas the state sectors have separate State Transmission Utilities (STU). Private sector participation in transmission is minimal, andthereisonlyonepublic-privatepartnershipproject,theTalaTransmissionProject.
Licenses for transmission project development have been granted to four private companies. While three companies have formed joint ventures with PGCIL, one is a privately held company that was awarded independently. The transmission network consists of transmission lines and transmission substations that transport electricity from a generator to a distributor. Up to January 2010, India had over 126,999 circuit/km (ckt km) of 220 kV transmission lines and 188,155 MVA capacity 220 kV substations. National grid development plays an important role in increasing power transmissioncapability.DuringtheEleventhPlanPeriod,newinter-regionalcapacities of 20,700 MW at 220 kV and above are expected to be added.


**Fig.4:ProjectedpowerscenarioinIndia**



ISBN:978-81-957858-1-0

## RENEWABLEENERGY'SPLACEINTHEPOWER SECTOR

The global scenario for dominant energy sources is similar to that of India. The majorityoftheworld'senergyisderivedfromfossilfuels.Itisexpectedthatby2030, fossilfuelswillaccountfor80%oftheprimaryenergymix.Oilwillcontinuetobethe dominantfuel,andcoaldemandwillrisefasterthananyotherfuel.Insuchacase,the realisation that these finite energy sources are also contributing to environmental problems has made renewables a profitable and sustainable option. This has also promptedgovernmentsandindustriesaroundtheworldtoconsideralternativeenergy sources, the need for which was reinforced by the 1973 oil embargo and the 2008 oil priceshock,aswellasever-increasingoilprices.Toincreaseinvestmentinrenewable energy, clear, stable, and long-term support policies must be implemented. A number of national policy measures, which could be implemented concurrently, would significantly improve India's renewable energy framework. They must, however, be carefully designed to work in tandem with existing state-level mechanisms and not undermine their effectiveness.

## SMARTGRID

A smart grid is an automated, widely distributed energy delivery network that can monitor and respond to changes in everything from power plants to individual appliances. Smart grid can also be defined as an electricity delivery system that incorporates communication and information technology. To better understand smart grids, consider the following features:

- Afullyautomatedpowerdistributionnetworkthatmonitorsandcontrolspower flows.
- Electricityandinformationflowsinbothdirectionsbetweenthepowerplantandthe point of consumption.
- Reducedcarbonfootprintandemissions;improvedaccesstorenewableenergy resources (like solar and wind).
- Usingdigital technologyto saveenergy,cut costs,and improve reliability.
- Improvedpowerqualitytomeetthedemandsof thetwenty-firstcentury economy.
- Lessdisruption,higherefficiency,andbetterassetutilization.

## INDIA'SSMARTGRIDPLAN

The impact of Smart Grid on the Indian power sector is promising, with the goal of transforming and developing a secure, adaptive, efficient, and sustainable system by 2027 to provide citizens with reliable and competitive energy by utilising innovative technologiesandpoliciestomeettheneedsandaspirationsofallstakeholders.Smart



ISBN:978-81-957858-1-0

Grid has a broad vision for the future and is working hard to meet the targets and goalsoutlinedinthefive-yearplans.Thesefive-yearplansareclassifiedasfollows:

Near Term Plan (2012-2017)
Mid Term Plan (2017-2022)
LongTermPlan(2022-2027)

TheNearTermPlan (12th5-yearplanfrom 2012to2017)focuses on:

• Accessto'electricityforall'•Transmissionanddistributionreduction

• Powercut reduction

• Powerqualityimprovement•Renewableintegration

• Increasedinter-regionalpowerexchangecapacity

• Wide-areamonitoring

• Efficientpowerexchanges

• Trainingandcapacitybuildinginutilitiesandindustrytobuild, operate,and maintain smart grid systems and applications.

TheMid-TermPlan(13thgiveyearplanfrom2017to2022)hasthefollowing objectives:

• T&D losses in all utilities reduced to less than 10%; end of load shedding; improvedpowerquality;efficientforecastinganddispatchingofrenewables; infrastructure and standards for electric vehicles.

• A1,200 kVacsystem isoperational.

• Appliancesmustmeetmandatorystandardsfor DRreadiness,energyefficiency, and emission.

• Smartgridproductsare exportedtoother countries.

TheLongTermPlan(14th5yearplanfrom2022to2027)willlookat:

• Economicallyviableutilities

• Stable24 9 7powersupply to all

• 33%or morerenewablein power system

• EVinfrastructureleveragedasvirtualPowerPlant(VPP)

• ExportofSmartGridproducts,solutions,andservices overseas.

**FUTUREPOWERSCENARIOSIN INDIA**

India's electricity consumption accounts for approximately 4% of total global electricity consumption, and it is increasing at an annual rate of 8-10%. Total energy shortageinIndiais9%,withapeakshortageof15.2%,andthecountry'spower



ISBN:978-81-957858-1-0

demand is expected to be around 120 GW now, and 315-335 GW in 2017. The study considers two fuel mix scenarios for gross electricity generation in order to estimate the total future requirements of individual fuels of the different sectors, both directly and indirectly through power. In the first scenario, growth in the share of new renewables in total gross generation of electricity is assumed to be business as usual, withsomemoderatechallengestoreducetheshareofcoalinthermalgenerationfrom 70% in 2009-2010 to 60% in 2031-2032. The second scenario, on the other hand, assumes a much higher increase in the share of renewables in power generation, with coalbeingreducedto50%by2031-2032.Duetotheslowpaceoftheiradoptioninthe Indian energy industry, the shares of new renewables in both scenarios have been set significantly lower than what the national action plan on climate change has targeted. Inthescenarioofanacceleratedintroductionofnewrenewable,thesharesofcoaland renewable are 60 and 9.4%, respectively, in 2021–2022, and 50 and 17.7%, respectively, in 2031–2022, while those of all other fuels remain the same as in the base fuel composition scenario. Table 1 shows the fuel composition of electricity generation in the baseline scenario. Rapid development is accompanied by a number of power system problems, including low dependability, large line losses, and subpar power quality. A STATCOM with non-intrusive shunt type active filter arrangement, DSP based controller with IGBT technology, 5 ms reaction time for load changes, reactive and harmonic power correction, and rated at 30-1,000 KVAR was recently produced by Power-one Micro Systems Pvt. Ltd. in India [10](Table 2, 3).

## CONCLUSION

ThispaperdiscussesIndia'scurrentandfutureenergyscenarios.Indiahasbeenobliged toraiseinstalledelectricitycapacityto200GWthisyearduetothecountry'sgrowing GDP.Despitethisincreaseinsupply,thenationstillhasalotofworktodotoprovide electricity to every home and to raise the supply's dependability and quality. Low qualityandinsufficientpowerareproblemsforitspowersystems.Planningstrategies must immediately switch from the conventional method of boosting generation to accommodate restrained consumption to a need-based, resource-based, and conservation-based strategy for the sake of economic and environmental advantages. Given the scope of the target, multiple strategies are being considered. These include removing obsolescence, maximizing the use of existing assets, reducing transmission and distribution losses, demand side management through increased electrical energy conservation, policy changes in pricing mechanisms, a shift and emphasis on renewable energy sources for power generation, total energy systems, new energy storage systems such as Super Conducting Mag- netic Storage Systems as a spinning reserve to meet peak demand, and energy efficiency promotions.

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ISBN:978-81-957858-1-0

# Solar Wind Thermodynamics: Turbulent Heating

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**Abstract**

This paper considers the concept of wave-particle thermodynamic equilibrium in order to improveourunderstandingoftheroleofturbulentheatinginthesolarwindprotonplasma.The thermodynamic equilibrium in plasmas requires the energy of a plasmon—the quantum of plasmafundamentaloscillation—tobebalancedbytheproton-magnetizedplasmaenergy,that is, the magnetic field and proton kinetic/thermal energy. This equilibrium has already been confirmed in several prior analyses, but also in this paper, by analyzing (i) multi-spacecraft data sets along the radial profile of the inner heliosphere, and (ii) representative data sets of a variety of 27 different space and astrophysical plasmas. Recently, it was shown that the slow mode of the near-Earth solar wind plasma is characterized by a missing energy source that is necessaryforkeepingthe energybalanceintheplasmon–proton-magnetizedplasma.Herewe show strong evidence that this missing energy is the turbulent energy heating the solar wind. Inparticular,wederiveandcomparetheradialandvelocityprofilesofthismissingenergyand theturbulentenergyin theinnerheliosphere, also consideringotherminor contributions, such as the temperature of pickup protons. The connection of the missing plasmon–proton energy with the turbulent energy provides a new method for estimating and cross-examining the turbulent energy in space and astrophysical plasmas, while it confirms the universality of the **involved new Planck-type constant that implies a large-scale quantization.**

## Introduction

Spaceandastrophysicalplasmasareaubiquitousformofmatterintheuniverse,nearlyalways found to be turbulent. The turbulence is a chaotic, stochastic process that alters the characteristics of the plasma fluctuations. The entire heliosphere is closely linked to the propertiesofplasmaturbulence.Solarwindprotonsflowthroughoutthesupersonicheliosphere undertheinfluenceofexpansivecoolingandtwo primarygroupsofturbulentheatingsources: (i) the solar-origin large-scale energy fluctuations; and (ii) the excitation of plasma waves by newborninterstellarpickupions(e.g.,Smithetal.2001,2006;Adhikarietal.2015).Thispaper investigates the interplay and partition of these turbulent heating sources in solar wind thermodynamics. In thermodynamically stable space plasmas, the wave-particle thermodynamic equilibrium requires the energy of a plasmon—the quantum quasi-particle of plasmaoscillations—tobebalancedbytheenergyoftheproton-magnetizedplasma,thatis,the fieldandprotonaverageenergy.Thishasbeenverifiedinanumberofanalysesinspaceand



ISBN:978-81-957858-1-0

astrophysicalplasmas(Livadiotis&McComas 2013a,2014a,2014b;Witze2013; Livadiotis2015,2016,2017, Ch.5;2018a; Livadiotis & Desai2016; Livadiotis et al. 2018). However,inthecaseoftheexpandingsolarwindintheinnerheliosphere,adifferencebetween the plasmon and proton plasma energies has been observed, which decreases with the wind speedandtheheliocentricdistanceR(Livadiotis&Desai2016).Wespeculatethatthisenergy difference comprises the turbulent energy, responsible for heating the solar wind proton plasma,whichwasnotconsideredintheplasmon–protonplasmaenergybalance.Inparticular, wemayaskthefollowingquestion:Isthereasolidconnectionbetweenthesolarwindturbulent energyandtheplasmon–proton-magnetizedplasmaenergybalance?Ifyes,then,thesolarwind thermodynamic equilibrium can be used for developing a new method of estimating the turbulent heating of solar wind. The purpose of this paper is to improve our understanding of thefollowingsubjects:(i)thenatureofthemissingenergy,thatis,thedifferenceinthebalance between plasmon and proton-magnetized plasma energies; (ii) the connection of the missing energy to the mechanisms of heliospheric turbulent heating; (iii) the partition of the energies involved in the solar wind thermodynamic equilibrium; and (iv) the thermodynamic equilibrium and the energy balance between a plasmon and a proton-magnetized plasma, interwovenwiththeconceptoflarge-scalequantizationconstant.Thermodynamicequilibrium andlarge-scalequantizationwillbeexaminedandfurtherdevelopedinSection 2.InSection3, we investigate the velocity and radial profiles of the missing energy, while in Section 4, we examine all the components contributing to the missing energy in the plasmon–proton-magnetized plasma energy balance, focusing on the (i) turbulent energy, (ii) temperature of pick-up ions, and (iii) gravitational potential energy. In Section 5, we formulate the missing energy by assembling all the previously discussed components, and then compare the constructed missing energy with the observed turbulent energy. The results lead to rewriting the proton-magnetized plasma thermodynamic equilibrium, and provide a new method for estimating and cross-examining the turbulent energy in space and astrophysical plasmas. Finally, Section 6summarizes the results.

## 2. ThePlasmon–Proton PlasmaMissing Energy

### Plasmon–ProtonPlasmaEnergyBalance

Thewave-particlethermodynamicequilibriuminplasmasrequirestheenergy Eplofaplasmon (energy quantum) to be balanced by the proton-magnetized plasma energy $E_p$, that is, the magnetic field and proton kinetic/thermal energy, namely:

Epl =Ep, with(1a)

PlasmonenergyE$_{pl}$:Energyof quantum(ђ$_{\dot{\omega}}$) (1b)

Protonmagnetizeplasma energy(Ep): Magnetic andthermal energy(1c)

the plasmon energyE$_{pl}$is the energy of one quantum , where the frequency spectrum peaksatthefundamentalplasmaoscillationfrequency$\omega \sim \omega_{\mathrm{pl}} = [n \cdot e^2 \varepsilon_0^{-1}(m_e^{-1} + m_{\mathrm{p}}^{-1})]^{1/2}$(e.g.,Thejappaet



ISBN:978-81-957858-1-0

al.1993,2012).Plasmonswithonly$\omega\sim\omega_{pl}$occurintheapproximationof spatialscalesquite larger than the Debye length. The proton plasma energy density (in the reference frame of the flow) is mainly given by the sum of its thermal energy density for a compressible flow, $[\gamma/(\gamma-1)]nkBT$, and the magnetic energy density, $B2/(2\mu0)$; note that the fraction 1/2 comes from averaging $\sin2(\alpha)$, where$\alpha$is the angle between particle velocity to the magnetic field (e.g., Park et al.2019). This proton plasma energy density, divided by the proton number density, gives the proton plasma energy per (proton) particle, which can be simply referred to as proton energy$E_p$(Livadiotis & McComas 2014a).

In our approximation we will consider solar wind and pickup protons; other particles, such as alphas and pickup helium, are low in density, thus they do not significantly contribute to the total plasma energy density. (Parameter symbols: $m_e$,$m_p$: electron and proton masses; e: elementary electric charge; $\varepsilon_0$: permittivity;$\mu_0$: permeability; $K_B$: Boltzmann constant.) Therefore, we have the energies:

$$E_{pl} = \hbar_* \cdot \omega_{pl}, \quad (2a)$$

$$E_p = \frac{1}{2\mu_0}B^2/n_p + \frac{\gamma}{\gamma-1}k_B T_p + \text{other} ..., \quad (2b)$$

where"other"meanssmallerenergy contributionsthatwillbeexaminedinSection5.

Therefore, the plasma thermodynamic equilibrium in Equation 1(a),$E_{pl}$ =$E_p$, is materialized bythebalanceofplasmonenergyandproton-magnetizedplasmaenergy,givenin Equations2(a) and (b), that is,

$$\hbar_* \cdot \omega_{pl} = \frac{1}{2\mu_0}B^2/n_p + \frac{\gamma}{\gamma-1}k_B T_p. \quad (3)$$

Before describing other smaller contributions to the plasma energy Ep, let us examine the concept of large-scale quantization constant that is unfolded by the star subscript of Planck's constant in Equation (3).

Large-scaleQuantizationConstant

A number of analyses have already confirmed that for space plasmas, the ratio between ion's averageenergy$E_p$andplasmafrequency$\omega pl$isconstant—asexpectedfortheequality of$E_{pl} = \hbar \cdot \omega_{pl}$with $E_p$ shown in Equation (3). Surprisingly, however, the constant value of the ratio$Ep/\omega pl$is not equal to the Planck constant $\hbar = 1.05... \times 10^{-34}$ J $\cdot$ s; instead, it is shown that spaceplasmasleadtoindeedaconstantvalue,but~12ordersofmagnitudelarger,$(1.19\pm0.05)\times10^{-22}$ J·s(Livadiotis&McComas 2013a,2014a,2014b;Witze2013; Livadiotis2015,2016,2017, Ch.5;2018a; Livadiotis & Desai2016; Livadiotis et al.2018); this large-scale analog of Planck's constant is noted by $\hbar_*$.

Figure1demonstratesthelargevariationoftherepresentativeaveragevaluesanduncertainties oftheplasmaparametersof27spaceandastrophysicalplasmas,whiletherespectivevaluesof theratio$E_p/\omega_{pl}$remainalmostconstant(seealsoLivadiotis&McComas2013a,2014a).(Note thatall27valuesforeachparameterarenormalizedtotheirmaximumvalue.)Quantitative



ISBN:978-81-957858-1-0

comparison of the distribution and variance of these values is shown in Figure 2. We observe thatthestandarddeviationofthenormalizedvaluesoflog $E_p/\omega_{pl}$is10–30ordersofmagnitude smaller than the standard deviations of the other normalized parameters. (For details on the data sets used, see Table 1and details in Appendix A.)

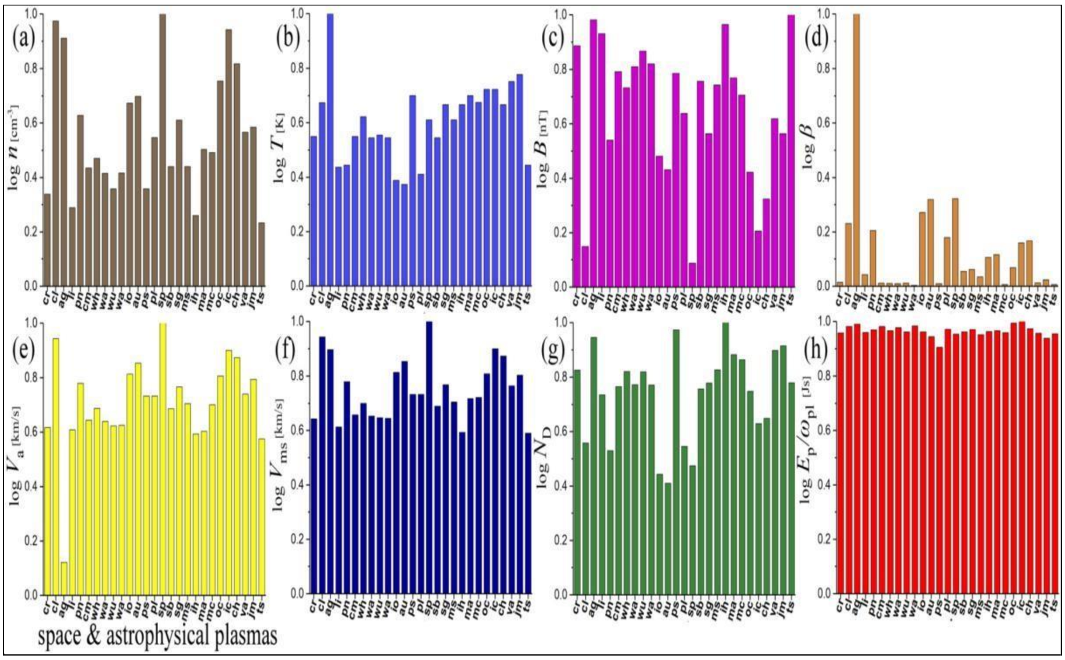


**Figure1.**Averagelogarithmvaluesofvariousplasmaparametersandoftheratio $E_p/\omega_{pl}$for27 different space and astrophysicalplasmas (from leftto rightat each panel):CIRs (cr), coronal loops(cl),AGN(ag),LISM(li),planetarynebula(pn),CMEs(cm),SolarWind—Helios(wh), Solar Wind—ACE(wa), Solar Wind—Ulysses (wu), Solar Wind—1 au average (wa), ionosphere (io), aurora (au), plasma sheet (ps), plasmasphere (pl), sunspot plume (sp), shock example by Burlaga & King (1979) (sb), shock example by Gopalswamy & Yashiro (2011) (sg), magnetosheath (ms), inner heliosheath (ih), magnetosphere—average (ma), magnetosphere—Cluster(mc), outer corona (oc), inner corona (ic), coronal holes (ch), Van Allen belts (va), Jovian magnetosphere—average (jm), termination shock (ts); (for details on thedatasetsused,seeAppendixA).Theplottedcolor-codedparametersare:(a)density(gray),(b)temperature(lightblue),(c)magneticfieldstrength(magenta),(d)plasmabeta(brown),(e) Alfvénspeed(yellow),(f)fastmagnetosonicspeed(deepblue),(g)Debyenumber(green),and (h) the ratio$E_p/\omega_{pl}$(red). All parameter values are normalized to 1 (by dividing each of the 27 valueswiththemaximumbetweenthem).Thevariationofalltheplottedparametersincontrast to the constancy of $E_p/\omega_{pl}$is clear.



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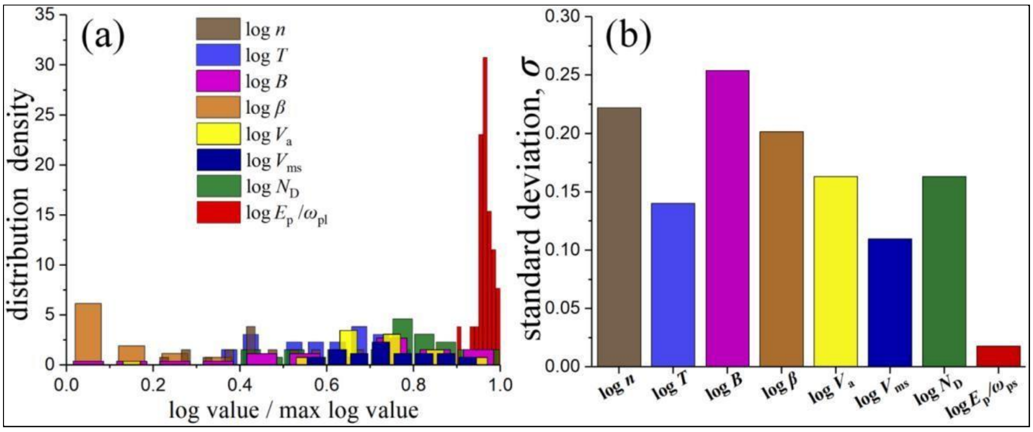


**Figure 2.**(a) Distribution densities of all the normalized values of the parameters shown in Figure1(following the same order and color-coding). (b) Standard deviations of each distribution.

Having verified the small variability of the values of log $E_p/\omega_{pl}$ for the examined 27 types of spaceandastrophysicalplasmas,itisstraightforwardtoapplyEquation(3)toderivethevalue of $\hbar_*$. All the values of log $E_p/\omega_{pl}$and their uncertainties are plotted in Figure 3(a). The correspondingvalueof $\hbar_*$derivedfromtheestimatesoftheaveragevaluesof Ep/ωplforall27 types of space and astrophysical plasmas is log$\hbar_* \approx -21.95 \pm 0.07$or$\hbar_* \approx (1.12 \pm 0.17) \times 10^{-22}$ J s,whichiswithinthe1σofthe abovementioned known value of$\hbar_* \approx (1.19 \pm 0.05) \times 10^{-22}$. The histogram of Figure3(b) is constructed by generating 1000 normally distributed values for each of the original 27 values of log$E_p/\omega_{pl}$ ±δlog$E_p/\omega_{pl}$, according to the technique shown by Livadiotis (2016, see their Figure 8(a)).

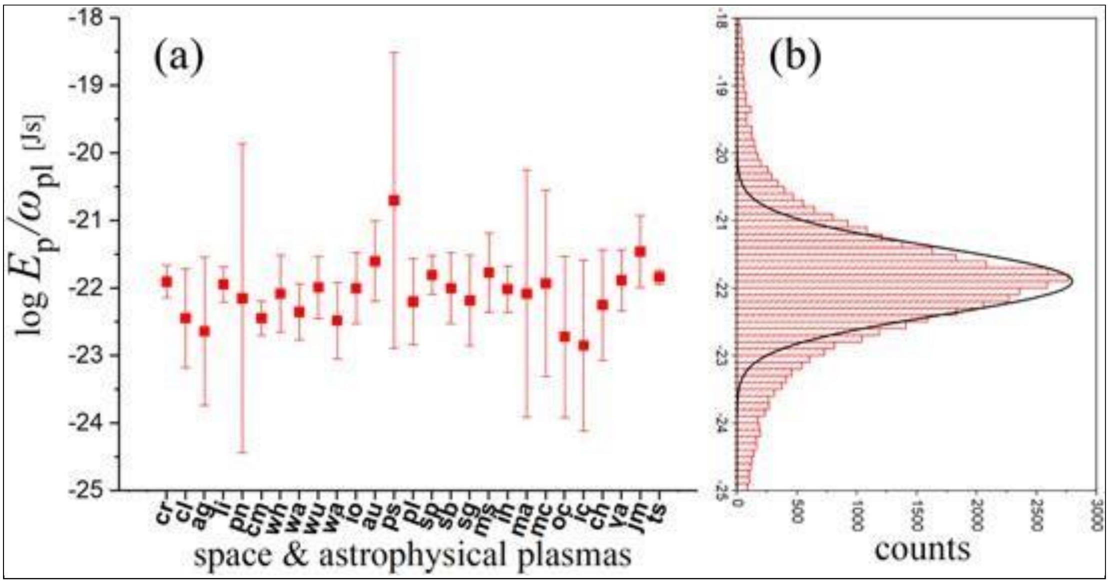


**Figure 3.**(a) Plot of the actual values of log $E_p/\omega_{pl}$ for the examined 27 types of space and astrophysical plasmas, and (b) the corresponding histogram of the log$E_p/\omega_{pl}$values with mode near ∼−21.93.



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We have seen the constancy of the ratio $E_p/\omega_{pl}$ by examining the representative parameter valuesfromavarietyof27spaceandastrophysicalplasmas.Theconstancyofthe ratio$E_p/\omega_{pl}$ can be also shown by examining a single space plasma. As an example we use actualmeasurementsofsolarwindprotonplasmatoagainderivethe ratio$E_p/\omega_{pl}$.Voyager1and2measurements of the solar wind—a largely variant plasma—revealaquasi-fixedvalueoftheratio $E_p/\omega_{pl}$.Figure4plotsthederivedvaluesoftheratio$E_p/\omega_{pl}$ against the heliocentric radial profile from 2 to 10 au. These plots, as well as the histograms on the right side confirm the constancy of the ratio$E_p/\omega_{pl}$.

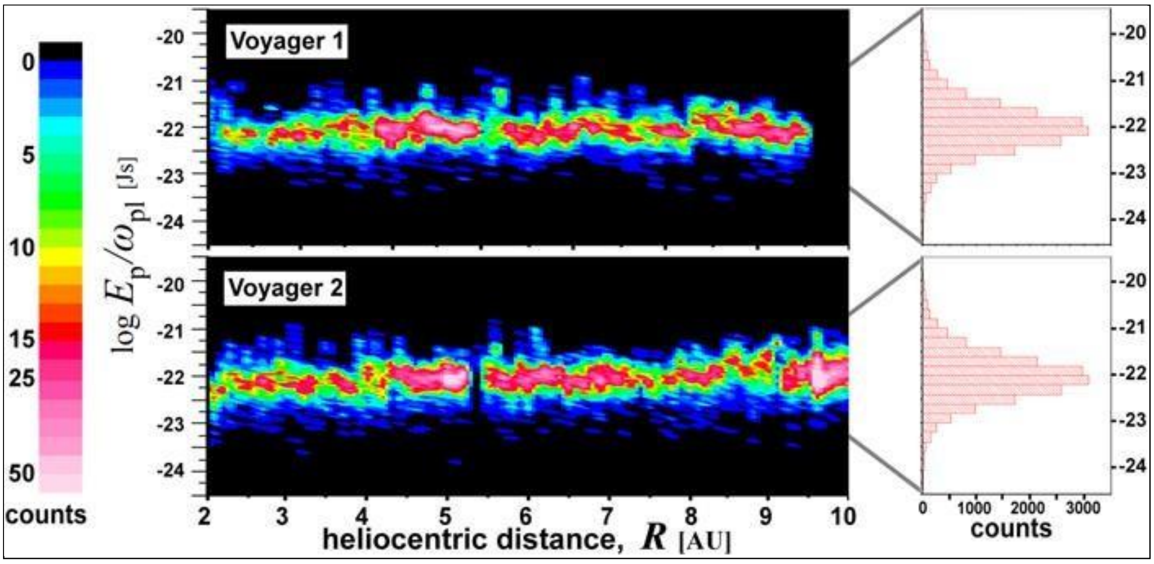


**Figure4.** Illustrationoftheconstancyoftheratio $E_p/\omega_{pl}$intheinnerheliosphere, usingVoyager1 and2measurementsofthesolarwindplasma,andestimationofthevalue of $\hbar_* \sim 10^{-22}$.Left:normalized2Dhistrogramsofthelog$E_p/\omega_{pl}$vs.theheliocentricdistanceR. Right: normalized 1D histogram of the values of log $E_p/\omega_{pl}$.

## 3. Missing Energy

### VelocityProfileoftheMissing Energy

The constancy of the ratio $E_p/\omega_{pl}$, and thus, the plasmon–proton plasma thermodynamic equilibrium, has been confirmed by various space plasma measurements in previous years. Nevertheless,thethermodynamicequilibriumappearstobeviolatedinthecaseoftheslowand near-Earthmeasurements ofthe solar wind (e.g., Livadiotis & Desai 2016). Moreprecisely, it hasbeenobservedthatnear1au,theratiooftheprotonenergyovertheplasma frequency,$E_p/\omega_{pl}$, deviates from the constant value$\hbar_*$that characterizes space plasmas. This deviationislargerforsmallersolarwindspeed;indeed,theratio $E_p/\omega_{pl}$undergoesacontinuous transitionfromtheslowtothefastsolarwind,tendingasymptoticallytowardtheknown value



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of$\hbar$ *(Figure4).Theobserveddeviationoftheratio $E_p/\omega_{pl}$fromtheconstant$\hbar_*$iscausedbya difference between plasmon and proton energies:

$$\text{Missing Energy} = \text{Plasmon energy} - \text{Proton energy}, \quad (4a)$$

$$\Delta E = \hbar_* \cdot \omega_{pl} - \frac{1}{2\mu_0} B^2 / n_p - \frac{\gamma}{\gamma - 1} k_B T_p, \quad (4b)$$

According to Figure5, the missing energy ΔEis larger for low solar wind speeds and smaller for high solar wind speeds, and is actually negligible for speeds higher than VSW>550 km s−1. This dependence of the missing energy ΔEon solar wind speed is similar to the behavior of the turbulent energy in the interplanetary space. Indeed, turbulence is more intense in the slow rather than the fast solar wind (Hadid et al. 2017).

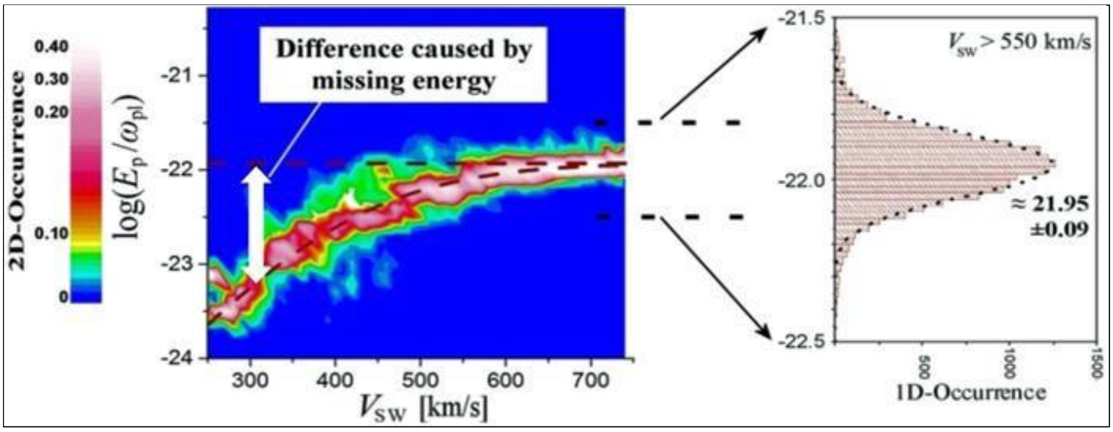


**Figure 5.**Left: 2D histogram of log($E_p/\omega_{pl}$) vs. solar wind speed $V_{sw}$ normalized by the 1D histogram of speeds. Right: 1D histogram of log($E_p/\omega_{pl}$) for $V_{sw}$>550 km s−1; at such large speeds the ratio$E_p/\omega_{pl}$ approaches the value of $\hbar_*$. For lower speeds, $E_p/\omega_{pl}$ differs from $\hbar_*$, becauseofamissingenergy,ΔE,notoriginallyincludedin$E_p$.Theplotsuse~92ssolarwind datafromWindS/Cduringthefirst70daysof1995.(ModifiedfromFigure6inLivadiotis& Desai 2016.)

RadialProfileof theMissing Energy

We examine in detail the plasmon–proton plasma thermodynamic equilibrium, as well as its violationobservedintheslowandnear-Earthsolarwind.UsingEquation 4(b)wecalculatethe missing energy, log $\Delta E/m_p$, and illustrate it as a function of solar wind speed $V_{sw}$and the heliocentric distanceR(Figure6). In panel (a), the logarithm of the missing energy, ΔEper protonmass,asformulatedinEquation 4(b),isdepictedasafunctionofthesolarwind speed $V_{sw}$, for each radial bin of the heliocentric distances R from 0.29 to 5.41 au; each radial bin is color-coded.



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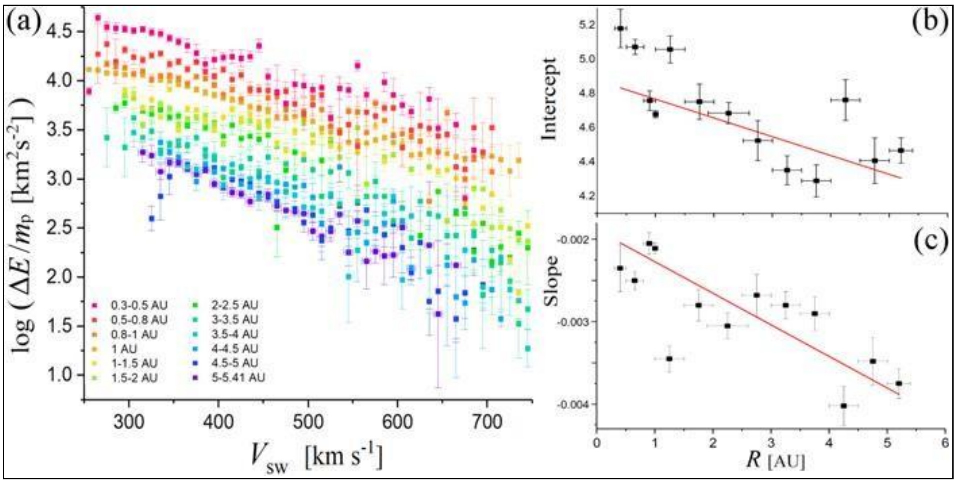


**Figure 6.**Velocity and radial profiles of the missing energy. (a) log $\Delta E/m_p$ is depicted as a functionofthesolarwindspeed,for $V_{sw}$ eachbinoftheheliocentricdistancesRfrom0.29to 5.41au,asshownonthegraph.Themeansandstandarderrorsoflog$\Delta E/m_p$arecalculatedfor eachVSW-bin(=10kms−1).Thelinearfitofeachradialdatasubset{±δ, $V_{sw}$ $V_{sw}$ log$\Delta E/m_p$±δlog$\Delta E/m_p$}estimatestheinterceptandslope—andtheirerrors—correspondingto a certain distanceRplaced on the middle of the radial bin, with δRcharacterizing the half-widthofthisbin;thus,theradialprofilesof(b)interceptand(c)slopeareplotted,indicatinga clear radial decrease. As Rincreases, the intercept decreases, while the slope is negative and becomes steeper.

In particular, for each radial bin, we perform a second binning among the values of the solar wind speed $V_{sw}$ (with constant width of bins $\Delta V_{sw} = 10$ km s−1). Then, for each $V_{sw}$-bin we estimate the mean value and standard error of log $\Delta E/m_p$. The central value and half-width of each $V_{sw}$-bin determine the mean value and error of $V_{sw}$, respectively. Furthermore, weperform a linear fitting of the points {$V_{sw}$± δ$V_{sw}$, log$\Delta E/m_p$ ± δlog$\Delta E/m_p$} within each radial bin. The interceptandslope—andtheirerrors—derivedfromthesefitsareplottedinpanels(b)and(c), respectively, as a function ofR(again, the central value and half-width of each radial bin determinethemeanvalueanderrorofRinthesepanels).Weobservethatonaveragebooththe intercept and slope decrease when R increases.

## 4. Componentsof thePlasmon–Proton PlasmaMissing Energy

### TurbulentEnergy

Therearethreeprimarysourcesofturbulenceintheheliosphere:(1)turbulencedrivenbyshear due to the interaction between fastand slow solar wind streams (Coleman 1968; Roberts etal.1992),(2)compressionalsourcesofturbulenceduetostream–streaminteractionsandshock waves (Whang1991), and (3) turbulence due to pickup ions created by charge exchange between solar wind protons and interstellar neutral hydrogen (Williams & Zank 1994). The sourcescanbedividedintotwogroups:(1)solar-originlarge-scaleenergyfluctuations(stream shearsandshockwaves)driventurbulence,and(2)interstellarpickupiondriventurbulence



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(e.g.,Smithetal.2001,2006;Adhikarietal.2015).Bothofthesegroupsofsourcescontribute to the solar wind heating, but (1) is dominant in the inner heliosphere and (2) is dominant in the outer heliosphere.

Theturbulentenergy,developed alongthesolar wind radialexpansion,isgiven by:

$$E_t^+/m_p = \sigma^2_{z+}, \quad (5)$$

thatis,thevarianceoftheElsässervectorvariable $Z_+$.TheElsässervariablesaredefined by$Z_\pm \equiv V_{sw} \pm V_a$(Tu&Marsch 1995),where $V_a = B/\sqrt{\mu\,\rho}$denotestheAlfvén velocity, ρ ≈ mp · n is the mass density, and mp is the proton mass.

TheElsässervectorvariable$Z_+$correspondstoAlfvénicmodeswithanoutwardradialdirection of propagation (in the solar wind frame). The outward propagating turbulent energy radial profileintheinnerheliosphere, $E_t^+$(R)forR <5.5auwasderivedforHelios 1and2andUlyssesdata sets (from 0.29 to ∼5.4 au) by Bavvasano et al. (2000) and later by Adhikarietal.(2015).Thereissomedifferenceintheresultsofthesetwo analyses,causedby the different lengths of data intervals (hour versus days), thus we use their weighted average. This was performed by (i) binning both thE radius Rand energy$E_t^+$—on log–log scales, and then,(ii)averagingateachbintheresultsofthetwopapers.TheresultsareshowninFigure7.

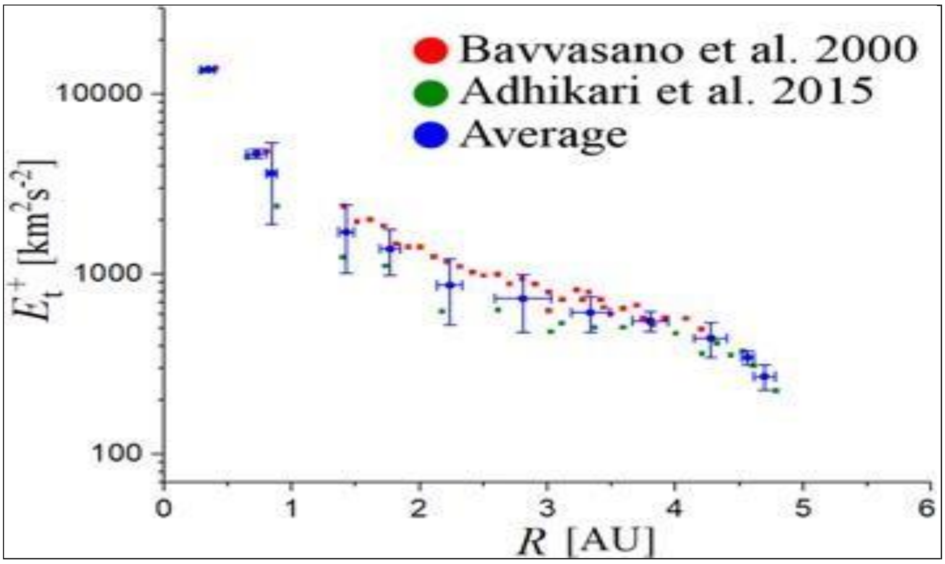


**Figure 7.**The turbulent energy($E_t^+$permp) is plotted vs.RforUlyssesdata according to the results of Bavvasano et al. (2000) (red), Adhikari et al. (2015) (green), and their weighted average (blue).

Note that the other Elsässer vector $Z_-$corresponds to Alfvénic modes with an inward radial propagation direction. The corresponding turbulent energy$E_t^-/m_p = \sigma^2_{z-}$is quite smaller than theenergyoftheoutwardpropagation,$E_t^- \ll E_t^+$,intheinnerheliosphere(seeFigure1in



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Adhikarietal.2015),thusitwasignoredbythepresentedanalysis;however,thetwoenergies have similar values in the outer heliosphere (see Figure 2 in Zank et al. 2018).

TemperatureofPickupIons

Pickup ions (PUIs) play an essential role in the thermodynamic energy balance of the solar wind.TheinternalparticleenergyofthesolarwindisdominatedbyPUIsbeyond∼20aufrom the Sun (McComas et al. 2017), and PUIs are responsible for the majority of the energy dissipation at quasi-perpendicular shocks in the outer heliosphere (e.g., Zank et al. 1996; Kumar et al. 2018; Zirnstein et al. 2018).

The average energy of a proton must take into account the energy of a solar wind proton as wellastheenergyofthe pickupproton.Thus,beforewecomparetheenergymissingfromthe plasmon–proton plasma balance, ΔE, with the turbulent energy, $E_T^+$, we must include the PUI energycontributionintotheprotonenergy$E_p$inEquation2(b).Belowweshowhowwederive the PUI temperature and blend it in Equation 2(b).

McComas et al. (2017) used PUI measurements from the Solar Wind Around Pluto (SWAP) on boardNew Horizons, which utilizes a top-hat electrostatic analyzer with a large field of view (276°×10°) to observe PUIs in solar wind with energy/charge covering 0.023–7.87 keV/q(McComasetal.2008).ThePUIenergydistributionsobservedbySWAParedetermined byforward-modelingananalytic(isotropic)PUIdistributionandderivingitsbestfittothedata (see Figure2 in McComas et al. 2017). The distribution function of speeds in the solar wind frame, $f_{pui}$(u),wastransformedtotheS/Cframeanditsbestfittodatawasdetermined by$\chi^2$minimization. Once$f_{pui}$(u) was derived, the PUI temperature was determined by the second statistical moment $\langle u^2 \rangle$of $f_{pui}$(u), i.e., $T_{pui}$= [mp/(3$k_B n_{pui}$)] · $\langle u^2 \rangle$.

ThePUIaverageenergy$E_{pui}$isderivedasfollows:thetotalprotonpressuresumsthesolarwind and pickup proton partial pressures,

$$P_{\mathrm{p,tot}} = P_{\mathrm{p}} + P_{\mathrm{pui}}, \text{ i.e.,} \tag{6a}$$

$$(n_{\mathrm{p}} + n_{\mathrm{pui}}) k_{\mathrm{B}} T_{\mathrm{p,tot}} = n_{\mathrm{p}} k_{\mathrm{B}} T_{\mathrm{p}} + n_{\mathrm{pui}} k_{\mathrm{B}} T_{\mathrm{pui}}. \tag{6b}$$

Thetotal temperature$T_p$,tot, derived from mixing solarwind and pickup protons, replaces the temperature in Equation 2(b), i.e.,

$$\begin{aligned} T_{\mathrm{p}} \rightarrow T_{\mathrm{p,tot}} &= (n_{\mathrm{p}} T_{\mathrm{p}} + n_{\mathrm{pui}} T_{\mathrm{pui}})/(n_{\mathrm{p}} + n_{\mathrm{pui}}) \\ &\approx T_{\mathrm{p}} + T_{\mathrm{pui}} \cdot n_{\mathrm{pui}}/n_{\mathrm{p}}, \end{aligned} \tag{6c}$$

where weconsiderthat $n_{pui} \ll n_p$ fortheexaminedradialrangeupto6au(asshownin Figures 6–8). Thus, the PUI energy is

$$E_{\mathrm{pui}} = [\gamma/(\gamma - 1)] k_{\mathrm{B}} T_{\mathrm{pui}} \cdot n_{\mathrm{pui}}/n_{\mathrm{p}}. \tag{7}$$

From McComas et al. (2017), we obtain the radial dependence of PUI temperature $T_{pui}$ and density $n_{pui}$, from which we derive PUI energy $E_{pui}$:



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$$T_{\mathrm{pui}}/[\mathrm{MK}] \approx 0.407 \times (R/[\mathrm{au}])^{0.68} \text{ and}$$
$$n_{\mathrm{pui}}/n_{\mathrm{p}} \approx 0.585 \cdot 10^{-3} \times (R/[\mathrm{au}])^{1.22}, \qquad (8a)$$

(seealsoLivadiotis2019),whichcan besubstituted inEquation(7) andconclude as

$$E_{\mathrm{pui}}(R)/m_{\mathrm{p}} \approx 5.045 \cdot [\mathrm{km\,s}^{-1}]^2 \cdot (R/[\mathrm{au}])^{1.9}. \qquad (8b)$$

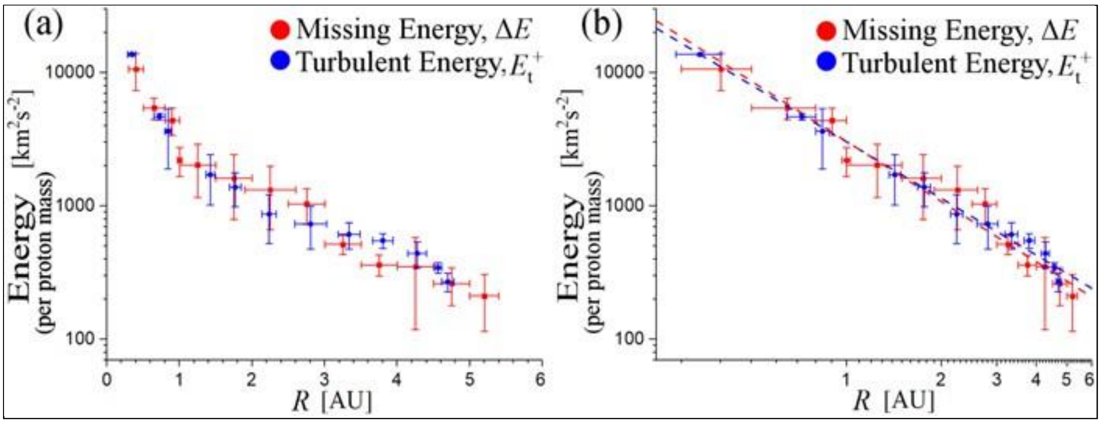


**Figure8.**TheradialprofilesofthemissingenergyΔE(red)andtheturbulentenergy(blue) $E_t^+$ arecoplottedona(a)semi-log,and(b)log–logscale.Thelinearfitsin(b)correspondtosimilar power laws.

GravitationalPotential Energy

Solar wind protons are also subject to gravitational potential energy; that is, another minor contribution in Equation 2(b):

$$\Phi(R)/m_{\mathrm{p}} = -GM_{\mathrm{sun}}/R \approx 887.13 \cdot [\mathrm{km\,s}^{-1}]^2 \cdot (R/[\mathrm{au}])^{-1}. \qquad (9)$$

(Note that gravitational potential energy contributes to the proton plasma energy globally, throughout the heliosphere. In addition, other potential energies may also exist but contribute only locally and/or occasionally to the proton plasma energy, e.g., the electrostatic potential energy; Cuperman & Harten1971; Lacombe et al. 2002; Livadiotis 2018b; Nicolaou & Livadiotis 2019.)

In the next section, we will use the turbulent energy given by Equation (5), the PUI energy given by Equation8(b), and the gravitational potential energy given by Equation (9), in order to improve the proton energy $E_p$in Equation 2(b).

5. Plasmon–ProtonPlasmaMissingEnergyversusTurbulentEnergy

Formulationof the Missing Energy

Having estimated the minor contributions of the PUI energy and the gravitational potential energy, the total proton plasma energy in Equation 2(b) becomes



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$$E_p = E_p^{\text{non-t}} + \text{turbulent energy}, \quad (10a)$$

wherethenon-turbulent partoftheprotonplasma energy is

$$E_p^{\text{non-t}} = \frac{1}{2\mu} B^2 / n_p + \frac{\gamma}{\gamma - 1} k_B T_p + \Phi(R) + E_{pui}(R). \quad (10b)$$

Then,we(i)substitute$E_{pui}$(R)andΦ(R)inEquation10(b),takenfromEquations 8(b)and(9), respectively,(ii)constructthedifference $\Delta E = E_{pl} - E_p^{\text{non-t}}$,and(iii)divideallinvolvedenergies by the proton mass, where we find the missing energy, $\Delta E/m_p$:

$$\begin{aligned}(\Delta E/m_p) \cdot [\mathrm{km\,s^{-1}}]^2 &= 4183.5 \cdot \sqrt{n/[\mathrm{cm^{-3}}]} \\ &- 237.88 \cdot (B/[\mathrm{nT}])^2/(n/[\mathrm{cm^{-3}}]) \\ &- 10318 \cdot (T/[\mathrm{MK}]) + 887.13/(R/[\mathrm{au}]) \\ &- 5.045 \cdot (R/[\mathrm{au}])^{1.9}. \quad (11)\end{aligned}$$

AsshowninEquation10(a), themissingenergyistobe comparedtotheturbulent energy.

ComparisonbetweentheConstructedMissingEnergyandtheObservedTurbulentEnergy

Next, we compare the missing energy $\Delta E/m_p$ with the turbulent energy. We have already plotted the radial profile of turbulent energy in Figure7. Therefore, we need to calculate the radialprofileofthemissingenergy.Then,wewillcomparethetworadialprofiles.Forthis,we calculate the missing energy $\Delta E/m_p$ using daily averages of the solar wind and interplanetary magnetic field data taken from Helios 1and2, Wind, andUlyssesS/C, for the heliocentric distance from 0.29 to 5.41 au. Then, we construct the radial profile of the missing energy ΔE, and compare this result with the radial profile of the turbulent energy shown in Figure 7. Finally, the two radial profiles are shown in Figure 8.

The missing energy ΔE, derived from Equation (11), and the turbulent energy, derived by Bavvasano et al. (2000), Adhikari et al. (2015), and averaged as shown in Figure7, are coplotted in Figure8on a (a) semi-log, and (b) log–log scale; the linear fits in (b) correspond to similar power laws with average energy:

$$\bar{E}(R)/m_p = 10^{3.48\pm0.04} \cdot R^{-1.43\pm0.07}. \quad (12)$$

Thep-value of the statistical hypothesis that the two data sets describe the same statistical population is very high (~0.4), thus the hypothesis is statistically confident.

RewritingtheProton-magnetizedPlasmaThermodynamicEquilibrium

Wehaveshownthattheenergybalancebetweentheplasmonandtheprotonplasmamagnetized energy is written as

$$\hbar_* \cdot \omega_{pl} = \frac{1}{2\mu} B^2 / n_p + \frac{\gamma}{\gamma - 1} k_B T_p + \Phi + E_{pui} + E_t. \quad (13)$$

In addition, the last three minor terms (potential, PUI, and turbulent energies) may be approximated by a radial profile model f (R), namely



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$$4183.5 \cdot \sqrt{n/[\mathrm{cm}^{-3}]} = 237.88 \cdot (B/[\mathrm{nT}])^2/(n/[\mathrm{cm}^{-3}]) + 10318 \cdot (T/[\mathrm{MK}]) + f(R), \tag{14a}$$

with

$$f(R) = -887.13/(R/[\mathrm{au}]) + 5.0450 \cdot (R/[\mathrm{au}])^{1.9} + 3020.0 \cdot (R/[\mathrm{au}])^{-1.43}. \tag{14b}$$

Notethattheradialmodel f(R)isminimizednear R ~ 5.3au,reachingthe value $f_{\min} = 230.72$. Equation 14(b) can be used in future analyses to derive missing measurements of density, temperature, or magnetic field strength (e.g., see Livadiotis 2015).

6. Conclusions

This paper considered the concept of thermodynamic equilibrium between plasmons and proton-magnetized plasma and determined their energy balance in order to quantify the contribution of the turbulent energy. This equilibrium was shown and confirmed in several prior publications, but also in this paper, by analyzing (i) multi-spacecraft data sets along the radial profile of the inner heliosphere (R<10 au), and (ii) representative data sets of a variety of 27 different space and astrophysical plasmas.

Thenear-Earthsolarwindplasma,observedintheslowwindmode,ischaracterizedbyasmall deviationfromtheplasmon–proton-magnetizedplasmaenergybalance(Livadiotis& Desai2016). This is expressed as a missing energy that prevents the plasmon–proton- magnetized plasma energy balance. The paper performed theoretical and space plasma data analysesinordertoimproveourunderstandingoftheoriginandnatureofthemissingenergy. In particular, we investigated the velocity and radial profiles of the missing energy along the innerheliosphere.Wealsoexaminedtheinterplayandpartitionoftheturbulentheatingsources in solar wind thermodynamics, and showed that radial profiles of the missing energy coincide with the radial profile of the turbulent energy.

In addition, the thermodynamic equilibrium and the energy balance between a plasmon and a proton-magnetized plasma are interwoven with the concept of large-scale quantization constant.Recently,strongevidencehasshownthatspaceandastrophysicalplasmasarelinked to a Planck-like constant, but ~12 orders of magnitude larger. The plasmon–proton energy balance is described confirming the universality of this large-scale quantization constant.

The connection of the missing plasmon–proton energy with the turbulent energy provides a newmethodforestimatingandcross-examiningtheturbulentenergyinspaceandastrophysical plasmas.Specifically,instableandstationaryplasmas—wherethethermodynamicequilibrium would have made sense, the plasmon energy, that is, a single quantum of energy, equals the energyoftheproton-magnetizedplasma,thatis,summingalltheappliedenergysourcesinthe proton plasma including the turbulent energy.

**Insummary,thepaperresultsareoutlinedas follows:**



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1. Verified the concept of plasmon–proton-magnetized plasma thermodynamic equilibrium, and the corresponding energy balance.
2. Showed the partition of the proton-magnetized plasma energy into the magnetic field energy, the proton thermal energy, and the turbulent energy, as well as the minor contributions of pickup ion thermal energy and gravitational potential energy.
3. Resolved the plasmon–proton energy balance deviation that characterizes the case of the slow solar wind plasma in the inner heliosphere.
4. Improved understanding of the interplay and partition of the sources of proton turbulent heating in the expanding solar wind in the inner heliosphere.
5. Verified the concept of large-scale quantization constant for space and astrophysical plasmas.
6. Developed a new method for estimating the turbulent energy in space and astrophysical plasmas.

AppendixA:DataSetsofRepresentativeValues ofSpaceandAstrophysicalPlasmas

Information about the plasmas' density, temperature, and magnetic field, as well as their variability, which is represented here by the uncertainty, is taken from the cited references. It isimportanttonotethat alldatawerecarefullyselectedinordertobe(1)representativeofthe majority of bibliographic sources, (2) cross-referenced with various sources, and (3) reliable, with priority, from higher to lower, given to books, referred papers, theses, and other isolated sources/analyses. Notes:

**Table1.**Properties of27 Spaceand Astrophysical Plasmas

| # | Plasma | log(n/[cm−3]) | log(T/[K]) | log(B/[nT]) | $\log(\hbar_*/[\mathrm{J}\cdot\mathrm{s}])$ |
|---|---|---|---|---|---|
| 1 | cr | 5.40 ± 0.20 | 4.95 ± 0.20 | −9.02± 0.20 | −21.91± 0.24 |
| 2 | cl | 15.5 ± 0.5 | 6.1 ± 0.5 | −1.52± 0.24 | −22.4± 0.7 |
| 3 | ag | 14.5 ± 1.5 | 9.0 ± 0.8 | −10.0± 1.0 | −22.6± 1.1 |
| 4 | li | 4.60 ± 0.15 | 3.93 ± 0.12 | −9.48± 0.13 | −21.95± 0.26 |
| 5 | pn | 10.0 ± 1.0 | 4.0 ± 1.0 | −5.5± 1.0 | −22.2± 2.3 |
| 6 | cm | 6.91 ± 0.18 | 4.95 ± 0.28 | −8.06± 0.14 | −22.44± 0.25 |



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| # | Plasma | log(n/[cm−3]) | log(T/[K]) | log(B/[nT]) | $\log(\hbar_*/[\mathrm{J \cdot s}])$ |
|---|---|---|---|---|---|
| 7 | wh | 7.5 ± 0.5 | 5.6 ± 0.3 | −7.5± 0.3 | −22.1± 0.6 |
| 8 | wa | 6.6 ± 0.3 | 4.9 ± 0.3 | −8.25± 0.25 | −22.3± 0.4 |
| 9 | wu | 5.7 ± 0.5 | 5.0 ± 0.3 | −8.8± 0.3 | −22.0± 0.4 |
| 10 | wa | 6.6 ± 0.6 | 4.9 ± 0.3 | −8.4± 0.4 | −22.5± 0.6 |
| 11 | io | 10.7 ± 0.3 | 3.5 ± 0.5 | −4.9± 0.20 | −22.0± 0.5 |
| 12 | au | 11.1 ± 0.5 | 3.4 ± 0.3 | −4.40± 0.10 | −21.6± 0.6 |
| 13 | ps | 5.7 ± 0.8 | 6.3 ± 0.7 | −8.0± 1.0 | −20.7± 2.2 |
| 14 | pl | 8.70 ± 0.20 | 3.7 ± 0.5 | −6.5± 0.3 | −22.2± 0.6 |
| 15 | sp | 15.90 ± 0.20 | 5.50 ± 0.20 | −0.90± 0.09 | −21.81± 0.29 |
| 16 | sb | 7.0 ± 0.5 | 4.9 ± 0.6 | −7.70± 0.04 | −22.0± 0.5 |
| 17 | sg | 9.72 ± 0.45 | 6.0 ± 0.5 | −5.74± 0.26 | −22.2± 0.7 |
| 18 | ms | 7.0 ± 0.5 | 5.5 ± 0.5 | −7.56± 0.09 | −21.8± 0.6 |
| 19 | ih | 4.15 ± 0.25 | 6.0 ± 0.3 | −9.82± 0.10 | −22.0± 0.3 |
| 20 | ma | 8.0 ± 1.5 | 6.3 ± 1.7 | −7.8± 0.5 | −22.1± 1.8 |
| 21 | mc | 7.8 ± 1.5 | 6.1 ± 1.7 | −7.19± 0.20 | −21.93± 1.4 |
| 22 | oc | 12.0 ± 1.0 | 6.5 ± 0.5 | −4.3± 0.3 | −22.7± 1.2 |



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| # | Plasma | log(n/[cm−3]) | log(T/[K]) | log(B/[nT]) | $\log(\hbar_*/[\mathrm{J \cdot s}])$ |
|---|---|---|---|---|---|
| 23 | ic | 15.0 ± 1.0 | 6.5 ± 0.5 | −2.1± 0.3 | −22.9± 1.3 |
| 24 | ch | 13.0 ± 0.5 | 6.0 ± 0.5 | −3.3± 0.3 | −22.2± 0.8 |
| 25 | va | 9.0 ± 0.5 | 6.8 ± 0.3 | −6.3± 0.3 | −21.9± 0.4 |
| 26 | jm | 9.3 ± 0.3 | 7.0 ± 0.5 | −5.8± 0.3 | −21.5± 0.5 |
| 27 | ts | 3.70 ± 0.04 | 4.00 ± 0.22 | −10.18± 0.04 | −21.84± 0.11 |

(1) Abbreviations of examined space and astrophysical plasmas (in order of appearance in Table1): CIRs (cr); coronal loops (cl); AGN (ag); LISM (li); planetary nebula (pn); CMEs (cm); solar wind—Helios (wh); solar wind—ACE(wa); solar wind—Ulysses(wu); solar wind—1 au average (wa); ionosphere (io); aurora (au); plasma sheet (ps); plasmasphere (pl); sunspotplume(sp);shockexamplebyBurlaga&King(1979)(sb);shockexamplewithCME by Gopalswamy & Yashiro (2011) (sg); magnetosheath (ms); inner heliosheath (ih); magnetosphere—average(ma);magnetosphere—Cluster(mc);outercorona(oc);innercorona (ic); coronal holes (ch); Van Allen belts (va); Jovian magnetosphere—average (jm); termination shock (ts).

(2) Datasourcesoftheexaminedspaceandastrophysicalplasmas(inalphabeticalorder):active galacticnuclei(ag)(Liuetal. 2003;Sutteretal.2012);aurora(au)(Berthelier&Sturges1967; Chastonetal.1999);coronaholes(ch)(Doscheketal. 1997;Cirtainetal.2007);corona,inner (ic) (Kivelson & Russell 1997; Gary & Keller2004; Warmuth & Mann2005); corotating interactionregions(cr)(Mannetal.2002);coronalloop(cl)(Fundamenskietal.2007);coronal massejections(cm)(Mitsakou&Moussas2014);corona,outer(oc)(Kivelson&Russell1997; Gary & Keller2004); inner heliosheath (ih) (Livadiotis & McComas 2014a); ionosphere (io) (Daglisetal.1999;Baumjohann&Treumann2006;Sibanda&McKinnell2011;Huba2013); Jovianmagnetosphere—average(jm)(Dessler1983;Divine&Garrett1983);localinterstellar medium(li)(Livadiotis&McComas 2014a);magnetosphere—average(ma)(Palermoet al.2010); magnetosphere—cluster (mc) (Gurnett & Bhattacharjee 2005; Livadiotis & McComas2014b); Magnetosheath (ms) (Sanders et al. 1981; Gosling et al. 1991); planetary nebula (pn) (Zhang et al. 2004; Washimi et al. 2006; Sabin 2009); plasma sheet (ps) (Baumjohann & Treumann 2006); plasmasphere (pl) (Gannon et al. 2005; Baumjohann & Treumann2006); shock example (sb) (Burlaga & King 1979); shock example with CME (sg)



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(Gopalswamy&Yashiro 2011);sunspotplume(sp)(Doyle&Madjarska2003;Solanki2003); solar wind—ACE(wa),—Helios (wh), and—Ulysses(wu) (Livadiotis & McComas 2014a); near 1 au, average (wa) (Foukal 2004); termination shock (ts) (Richardson et al. 2008); Van Allen belts (va) (typical averaged values in Chen 1984, p.14).

(3) Polytropic index γ: it is taken as γ∼ 5/3 (adiabatic; Nicolaou et al. 2014), except for the casesofplanetary/heliosphericsheathswhereγ∼ 0(isobaric)(Livadiotis&McComas2013b).

(4) Temperature liability: in case the temperature is measured either by fitting the energy distribution or by calculating the statistical moments, then the latter is preferred to avoid misestimations (Nicolaou & Livadiotis 2016).

AppendixB:UncertaintiesEstimation

Table2includes the uncertainties formulation for quantities mentioned in the paper, such as theprotonplasmaenergy $E_p$,theplasmonenergy $E_{pl}$,andtheirdifferencethatgivesthemissing energy,ΔE.Thepropagationuncertainty $\delta E_p$ isderivedwithrespecttofourparametersXj:n,T,ν= 1+1/γ,B,with$\delta E_p = [\sum_i(\partial E_p/\partial X_i)^2]^{\frac{1}{2}}$.Theuncertaintyof $E_{pl}$ isthe propagation of $\delta\hbar_*$, $\delta\omega_{pl}$; the uncertainty of ΔE is the propagation of $\delta E_p$, $\delta E_{pl}$.

**Table2.**UncertaintiesofDerivedQuantities

| **X** | **δX** |
|---|---|
| $\gamma_i$ | $\sqrt{\chi^2_{\min}/[N(N-2)\cdot\bar{w}\cdot\sigma^2_{\ln n}]}$ |
| $E_{p_i}$ | $\sqrt{\begin{array}{l}\mu_0^{-2}n_i^{-2}B_i^4[(\ln B_i)^2+\frac{1}{4}(\delta\ln n_i)^2]\\+[(\nu_i+1)k_B\delta T_{p,tot_i}]^2+(\delta\nu_i k_B T_{p,tot_i})^2\end{array}}$ |
| $T_{p,tot\,i}$ | $\sqrt{z_i^2\delta T^2_{p_i}+(1-z_i)^2\delta T^2_{puii}+\delta z_i^2(T_{p_i}-T_{puii})^2}$ where $z_i=n_{p_i}/(n_{p_i}+n_{puii})$ |
| $\omega_{pli}$ | $\frac{1}{2}\omega_{pli}\cdot\delta\ln n_i$ |
| $\Delta E_i$ | $\sqrt{\omega^2_{pli}(\delta\hbar_*)^2+\hbar^2_*(\delta\omega_{pli})^2+(\delta E_{p_i})^2}$ |
| $\log(E_{p_i}/\omega_{pli})$ | $\sqrt{(\delta\log E_{p_i})^2+(\delta\log\omega_{pli})^2}$ |

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ISBN:978-81-957858-1-0

# DesignandExplorationofAutomaticToolChangerDeviceforMultistation Spring Forming Machine

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**Abstract**

Presently, the spring machine device is fixed through manual bracing and situating by bolts. Themechanizationofthedevicechangeislow,andtheexactworthoftheinstrumentposition not set in stone. The programmed instrument change framework for spring machine was planned by utilizing the standard utilitarian pieces of the programmed apparatus change arrangement of the machining focus. It principally incorporates the plan of the programmed free clip gadget and that of the multi-axle programmed apparatus change arm. After static examination,thedeformityoftheprogrammeddevicechangearmis0.153mm,whichfulfills thenecessitiesforuse. Kinematicexaminationoftheplannedprogrammeddevicechangearm was done. After genuine check, the planned programmed apparatus change process for spring machineunderstandstheelementsoftheinstrumentsprogrammedsubstitutionandsituatingof the spring machine, which works on the mechanization of the spring framing gear.

## Introduction

With the persistent advancement of assembling innovation, the robotization in the field of apparatus keeps on moving along. Because of the presentation of the programmed apparatus magazine framework, the metal cutting machine device understands the elements of consequently putting away apparatuses and device change in the programmed machining process. Different machining cycles like processing, drilling, penetrating, and tapping can be finished through the control of the CNC framework. The difference in various apparatuses extraordinarily works on the productivity of parts handling and abbreviates the handling time.Spring is a significant essential mechanical part, and the degree of spring fabricating gadget is the way in to the quality and proficiency of spring creation. The ongoing spring shaping machine with high robotization is the multi-station cam less spring framing machine. Theframing system is that the steel wireis fixed by the fixing instrument and is sent from the shapingboardmandrelbythewiretakingcareofcomponent.Theshapingboardisforthemost part furnished with eight direct movement sliding seats, every one of which is independently constrained by the servo engine. The spring framing is acknowledged by introducing various apparatuses on each sliding seat utilizing multi-hub addition control innovation. As of now, springshapingapparatusisphysicallymountedonthedevicemountingseatontheslidingseat andissituatedandcinchedutilizingbolt.Substitutionoftheshapingitemrequiresalltheeight



ISBN:978-81-957858-1-0

deviceseatstobeeliminatedandsupplantedwithnewones.Thedeviceadditionallyshouldbe physically supplantedwhen it wears,and theoverall placeoftheinstrument, thewire, and the mandrel after manual supplanting of the apparatuses with various capabilities and shapes still up in the air. It requires re-commission of the spring framing program, which is exceptionally badly arranged. The flawlessness ofthe dynamical framework has been certainly standing out [4, 5].

In this way, a programmed device change framework is intended for the multi-station spring shaping machine. It can decide the specific relative place of the device and understand the programmed substitution of the spring apparatus. Consequently, it gives a premise to additionally understanding the computerized programming innovation of the spring and working fair and square of assembling gear of the spring parts.

**<u>Design oftheAutomaticLoose-ClampDeviceof Tool</u>**

***1. Existing Apparatus Mounting Techniques.*** The current apparatus of the spring shaping machine is mounted on the device mounting seat on the straight movement sliding seat, as displayed in Figure 1. The apparatus seat can, individually, change the upper, lower, left and right,andupandaboveplacesofthedevicebybolts.Inthemanualdevicechangeprocess,the administrator needs slackening a couple of screws, eliminating the apparatuses, choosing the proper instruments from the instrument magazine, introducing the devices, and fixing the screws. The device of the machining focus has the applicable public norm, so the instruments of the machining focus delivered by various producers can be utilized all around as indicated bythenorm.However,thespringmachineapparatusesareasyetun-normalized.Byandlarge, producersorclientstweaktheirownhoning,sotheshapecan'tbebroughttogether.Thedevice should be changed in accordance with a reasonable situation being used by different change screws on the instrument seat to work with shaping handling. Subsequent to changing a reasonable position, the administrator needs to continually change the feed of the device until the framed spring meets the necessities. It will require a great deal of investment during machinechangebyphysicallychangingthedevices.Ittrulydiminishesthecreationproficiency ofthespringmachine.Tolessenthechange time andwork fairand squareofcomputerization of spring machine, the plan of programmed device change framework for spring machine is important.

***2. Apparatus Free Clip Gadget Construction Plan***. To understand the capability of programmed apparatus transform, it is important to initially understand the programmed free clipcapabilityoftheinstrument.Asofnow,thistechniqueforinvolvingscrewsforfixingand situating is hard to acknowledge computerization, and it can't be docked with the instrument magazine framework. In the machining focus, the bolt is delivered by driving the hook under the activity of the unclamping chamber, and it is fixed by driving the paw under the pressure of circle spring. The activity of the programmed free clip instrument holder of the axle can be understood,andthehandleisbracedbythetaperedsurfaceandtheshaft[6,7].Hence,drawing on apparatus relaxing and cinching in the machining focus, a gadget for naturally slackening



ISBN:978-81-957858-1-0

and bracing the device is planned on the straight slide of the spring machine framing board utilizing the current normal pieces of the standard CNC machine instrument. The gadget has mostly including parts like a device holder, a bolt, a hook, an apparatus chamber, a device chamber installation, a chamber, a connecter of the chamber and paw, and a chamber associating plate. TheBTstandardis regularlyutilized in theapparatus holder, bolt, and hook inmachiningfocuses[8].Theinstrumentofthespringmachineisrectangulartypically,andin thisgadget,thefinishofthedevicecanbechangedtoaroundandhollowshape,whichcanbe introduced in the apparatus holder utilizing the trama center throw.

***3. FreeCinchRuleoftheApparatus***. Thereleasing and clipping activitiesoftheapparatus is accomplishedbyutilizingthechamber.Atthepointwhenthechamberactivitypolepushesthe hook to propel, the paw can deliver the bolt and the CNC apparatus holder can be slackened and taken out; when the chamber activity bar pulls the paw back, the paw can get a handle on thebolttomaketheconeshapedsurfaceofthedeviceholderpivotallysituatedandbracedwith theconeshapedsurfaceoftheinstrumentchamber.Sincegeneralspringmachinedeviceshave no revolution activity and just move in an orderly fashion, the establishment heading of the deviceisfixed.Thusly,notwithstandingthehubsituating,thedeviceholderadditionallyneeds to keep up with precise circumferential situating. The apparatus holder-coordinating key with bendshapeisplannedandmountedonthedevicechamber.Atthepointwhenthedeviceholder is stacked into the apparatus chamber, the critical score on the instrument holder is consequentlyadjustedalongtheroundaboutcircularsegmentsurfaceofthewaytoaccomplish circumferential situating. The whole instrument chamber is fixed to the straight slide by the installationandtheinterfacingplate.Thechamberislikewisefixedtotheslidebyaninterfacing plate. Eight framing straight slides are undeniably intended to be introduced with this gadget toaccomplishtheprogrammedfreecinchactivityoftheinstrumentsontheeightstations.The device can be straightforwardly utilized for framing handling after it is supplanted.

## 3. AutomaticToolChangeArmDesign

To acknowledge programmed instrument transform, it is important to plan a programmed devicechangearmforthespringmachine.Thenormalapparatuschangeinthemachiningfocus is accomplished through the ATC gadget. In the functioning system, it is predominantly answerable for the trading of the devices on the apparatus magazine with the apparatuses on themachinedeviceshaft.)unpleasantaprogressionofrevolutionandstraightmovement,itcan accomplish the productive and exact trade of the device expected for the following system in the device magazine with the instrument utilized in the past cycle in the machine shaft [9, 10].There is an extremely enormous contrast of the device change process between the multi-station spring machine and the machining focus. In the machining focus, it is by and large coordinated apparatus change between device magazines with the single shaft.

Inthespringmachine,itisone-to-eightdevicechangebetweeninstrumentmagazineswiththe shafts of the eight stations which are disseminated on the board at a 45 degree periphery. Thusly,thedevicechangearmutilizedinthemachiningfocuscan'tbestraightforwardly



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utilized on the spring framing machine. It is important to plan a programmed device change arm that is appropriate for the attributes of the spring machine.

***StructurePlanoftheProgrammedInstrumentChangeArm***.Itembraces thetypeofsingle- arm and single-handle. It incorporates a servo engine, a minimize, and four chambers, which, individually,acknowledgestworotatingmovements,twostraightmovements,andopeningand shutting movements of the clipping jaw. Along these lines, it gives the development of four levels of opportunity for the cinching jaw of the apparatus holder.

## 4. SelectionofToolMagazineTypes

Thenormalkindsofhardwaremagazinesformachiningfocusincorporateroundtype,bamboo- cap type, and chain type.

Various kinds of hardware magazines have various qualities and use situations. Among them, theroundaboutandchaindevicemagazinesbyandlargeutilizeprogrammedapparatuschange system for instrument trade. Since spring machine is as multi-axle apparatus transform, it is appropriatetoutilizeprogrammeddevicechangecomponentATCforinstrumenttrade.Inthis way, roundabout apparatus magazine can be prepared for the most part, and chain device magazine can be utilized when the quantity of put away instruments is huge. The roundabout devicemagazine simply needs the elements of hardware choosing and apparatus caseturning, and the capability of hardware change is acknowledged by oneself planned multi-axle programmed instrument change arm. The construction of the spring machine furnished with a programmed apparatus change framework utilizing the roundabout instrument magazine.

## 5. Physical Test Verification

Tochecktheelementsoftheplannedinstrumentprogrammedclippinggadgetandprogrammed device evolving arm, an actual model is underlying this paper. The open control arrangement of IPC +PMAC movement control card is utilized to fabricate the control arrangement of programmed device change framework. The framework controls the activities of 5 chamber switchingvalvesand1servoengine.IPC,astheupperPC,finisheshuman-PCconnectionand theboardcapabilities.Also,PMAC,asthelowerPC,finishesmovementcontrolandrationale controlcapabilities.Auniquecontrolframeworkforprogrammedinstrumentchangesystemof multi-station spring machine is created on the Windows stage in view of C# language. It understands the elements of programmed device change system, for example, programmed slackeningandclaspingapparatus,programmeddumpingandstackinginstrumentcontrol,and device data the board. )unpleasant genuine activity, the capability of programmed slackening andcinchingoftheapparatusonspringshapingmachineandthecapabilityoftheprogrammed instrumentchangebetweenthemagazineandthespringmachinearecheckedtobelegitimate.

## 6. Conversation



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(1) The component planned in this paper can understand the PC controlled apparatus change process, diminish the manual activity, work fair and square of computerization, and give the establishment to what was in store automated smart assembling.

(2) Afterrealtesting,thequickestdevicechangeofonestationcanbeaccomplishedinaround 1momentviaprogrammedapparatuschange.Also,theapparatuschangetimephysicallyrelies upontheadministrator'scapabilityandworkingvelocity.Asfarasapparatuschangetimealone, the degree of progress might be restricted.

(3) The place of the instrument after the programmed apparatus not set in stone. As indicated bythestateofthespringtobeframed,deducingtheproperfeedofthetoolissimple.Yet,after manual apparatus change, the instrument position is hard to decide; it needs rehashed tests to decide the proper device feed. Normally, the manual investigating spring program needs in some measure thirty minutes.

Starting here of view, the plan of programmed instrument change framework extraordinarily decreases the change season of the program. While the machining objects of spring shaping machine transforms, it very well may be changed rapidly. Contrasted and the technique for manualinstrumentchange,itworksontheextentofgenuinehandlingtime.Itcangivefullplay to the benefits of multi-station spring machine in multi assortments and little clump creation.

(4) Byutilizingtheprogrammedapparatuschangeframework,theinstrumentnormalizationof the spring machine can be advanced, which gives the essential circumstances to the improvement of CAM innovation in the spring shaping cycle.

(5) Basedonprogrammedapparatuschangeofthespringmachine,thePCthinkingofhardware determination and format in light of involvement information can be additionally understood, in order to dispose of the reliance on the experience of administrators.

## 7. Conclusion

(1) Through the programmed device change framework intended for the multi station spring machine, the elements of programmed cinching, programmed substitution, and programmed stockpiling of the spring machine apparatus are accomplished by utilizing the standard parts normally utilized in the apparatus magazine procedure for machining focus, and the dependability is guaranteed.

(2) Thegadgetforconsequentlyreleasingandclippingtheapparatusinboundaryappropriation ofthespringmachineshapingboard isplanned.Theround apparatusmagazineis chosen, and the programmed device change arm of the instrument magazine and multi shaft apparatus change is planned. The working standard of each part is outlined.

(3) Thestaticsinvestigationisledforthemechanicsoftheconstructionoftheapparatuschange arm. The outcomes showed this design meets the necessities of purpose. What's more, kinematicsexaminationisadditionallydirectedforthemechanicsofthedesignoftheapparatus change arm. The kinematics conditions for these components are acquired.



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(4) The planned designs are checked on the real actual model. The outcome shows that the construction of the plan is sensible and the capability of the plan can be understood.

(5) The whole programmed apparatus change framework planned can be applied to the multi stationspringmachine,whichissignificantforfurtherdevelopingthespringproducinggadget, advancing the normalization cycle of spring machine instruments, and understanding the digitization of arrangement of spring.

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ISBN:978-81-957858-1-0

# Valuationofpotentialoffeedstockoilsforbio-dieselandareviewonmuffler geometry

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**Abstract**

Thebiofuelsaredefinedasthefuelswhichbeingproducedwiththehelpofbiologicalmaterials. In this the biomass are being converted to a useful product with the help of biological conversionsand thermochemicalconversion.The biochemicalconversionincludethe process of the aerobic digestions or the anaerobic digestion. The thermochemical include the process ofgasification,liquefaction,pyrolysisthisprocesshelpintheconversationofthebiomassinto the useful fuels in the form of liquid, gaseous. These biofuels are basically carbon neutral in nature since the carbon that is present in the plants is only present and that is converted into different form so the total amount of carbon remains the same that is no change in the carbon percentage in the atmosphere.

**Keywords:** Biodiesel, Bioethanol, Carbon Neutral Fuel, Emissions, Muffler, Generation Of Biofuels,TurboStraightAndEllipticalmufflers, ChamberedStraightAndEllipticalmufflers.

**Introduction**

Thehistoricdevelopment of biofuels is based on the generations of the fuels. Thegenerations are being classified based upon the usage of the raw material being used as the biomass. The generation can be classified as the following:

**Firstgeneration:**Thefirst-generationbiofuelsarethebasiconeinwhichthecropswerebeing usedfortheproductionofthebiofuels.Thecropssuchasthecornswhichwerebeingusedfor the food purpose

**Secondgeneration:** Inthesecondgenerationofthefueltherawmaterialwasbeingshiftedto the lignocellulose material in which the woody crops were used, also in this the use of plant waste, agriculture waste and the agriculture residues were used on the production process

**Thirdgeneration:**Forthistheaquaticspeciescouldbeusedwhicharethealgae-basedspecies.

**Fourth generation:** This include the usage of the Genetically Modified Organisms (GMOs) which can be produced in the laboratory.

Extractionmethods-Thedifferentprocessarethereforefollowedaspertheneedofwhichkind of fuel is need from the biomass. This process can be briefly explained as the following:



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- **Ethanol production:** A simple alternative for the gasoline-based engines. The ethanol production can be done by the process of fermentation of the biomass. The fermentation is followed by the distillation method and later thedehydration of the distillate alcohols is done.

- **Biodiesel production:** The biodiesel is being created by the two different process one is the trans-esterification and the other is the pyrolysis. Both these two processes can help in the production of the biodiesel.

- **Biogas production:** For the production biogas the anaerobic digestion is to be done. In an anaerobicdigestionthebacteriaandthemethogenattacksthebiomassintheabsenceofoxygen.

**Exhaustsystem**

**Introduction**

Theexhaustsystemisthesystemthatisusedtohelptheexhaustgasmoveoutfromthe controlledcombustionchamberthatistheengine.Itusuallyiscombinationofpipeswhichhelp the motion of the exhaust gas to move out of the system. The main components that are the parts of the exhaust are listed as below

- Exhaust manifold
- Turbinepartoftheturbocharger
- Catalytic convertor
- Amuffler
- Tailpipe

**Muffler**

A muffler or silencer is a device for reducing the noise emitted by the exhaust of an internal combustion engine—especially a noise-deadening device forming part of the exhaust system of an automobile. Mufflers are installed within the exhaust system of most internal combustionengines.Themufflerisengineeredasanacousticdevicetoreducetheloudnessof the sound pressure created by the engine by acoustic quieting.

Mufflerscanbeclassifiedonthe basisoftheirworkingprincipleas follows:

- Absorptivemuffler:Absorptivemufflersaredeviceswhichusethesoundabsorptiveproperties of a porous material to absorb the sound on its passage through the device. Probably the simplest absorptive silencer is the common lined duct.
- Reactive muffler: Reactive muffler utilize flow resistance to supplement the reactive silencer qualities. This is obtained by incorporating perforations or ports in the flow passage tubes so that main flow passage resistance is not increased.



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- Combinationreactiveandabsorptivemuffler:Somemufflerscombinewillcombinetheeffect of both absorptive and reactive mufflers in a single envelope. This helps in the increasing the effectiveness or efficiency of the muffler.

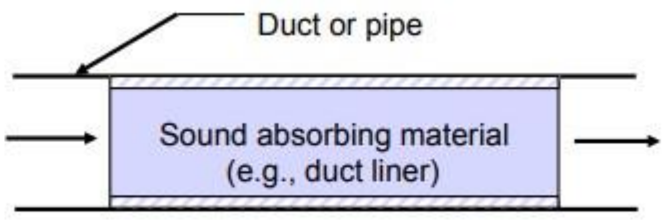


Figure5 Absorptivemuffler

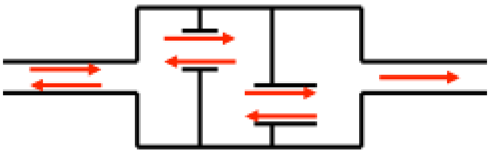

Figure6Reactive Muffler

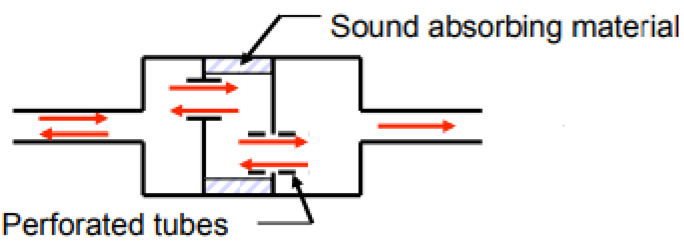


Figure7CombinedAbsorptiveandReactiveMuffler

Design of muffler

The designing of the muffler is very important part in the exhaust system if it is not properlydesignitcoulddecreasetheefficiencyoftheenginewhichisdoneifthebackpressure isveryhigh.Thebackpressureshouldbecontrolled.Amufflersisanoptimizabledevicewhich is need to works o that the amount of sound should be less and the also the back pressure on the engine should be minimum. On the basis ofthe design the muffler can be classified as the following:



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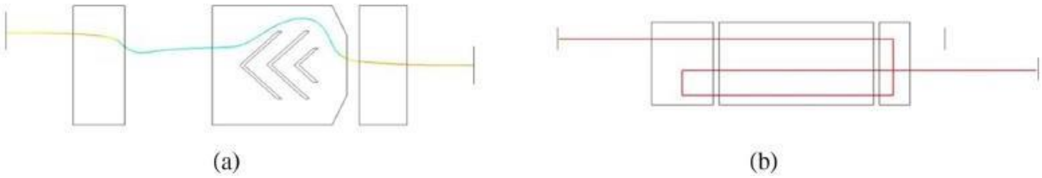


Figure 8 (a) One dimensional stream line (CS and CE). (b) One dimensional streamline (TS and TE).

i. Chambered straight (CS): A straight tube is being used and chambers are being created on the inside of the mufflers which acts as an obstacle in the path of the gas flow and thus absorbing some heat, velocity and pressure.

ii. ChamberedElliptic(CE):Anellipticalshapeboxwithchambersbeingcreatedinit.

iii. TurboStraight(TS):pipearepresentwhichhelpintheflowtobeinthe“S”shaped flowforthatisinstraightboxarrangement.Alsoinsulationmaterialsarebeingused.Perforated tubes are used to have a diffused system so that the air could have a smoother motion and the acoustic could be reduced.

iv. Turbo Elliptic (TE): An elliptical box in which pipe are to regulate the flow in an “S” shape pattern. Also insulation materials are being used.

Figure9Turbo-elliptical



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**Conclusion**

The conclusion that can be made from this can be after this Algae can be a prominent sources oflipidswhichcanbeusedtoproducethetransportationfuel.Algaecanbeartificiallyproduced by the human being weather in the natural conditions or the artificial laboratories conditions. Algae are being produce by the man from many decades. The shifting toward the alternative fuel is due the decrease in the abundance and availability of the natural fossil fuels. These alternativehaveitsgreatdependenceontheproductionofbio-fuelandethanol.Bothofwhich can be obtained by the use of algae. At first we were using the agriculture cultivation crops (such as the corn, maize, etc.) and later we shifted to the use the seeds which were not consumablebythehumanbeingdirectly(suchasthecottonseeds).Butallthesebio-fuelhave a disadvantage that these effect the human consumption and this may lead to the scarcity of resources in the day to day life. All these disadvantages can be overcome by the use algae as biomass for the production of biofuel. Since these algae are not used by human for any consumption value.

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10. Francisco J. Jiménez-Espadafor , Miguel Torres, José A. Velez, Elisa Carvajal, José A. Becerra;Experimentalanalysisoflowtemperaturecombustionmodewithdieselandbiodiesel fuels: A method for reducing NOx and soot emissions

11. R.N. Singh, Shaishav Sharma; Development of suitable photo bioreactor for algae production – A review

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ISBN:978-81-957858-1-0

## IntervalCapacityoftheDalatAtomicExplorationReactor:Radiation Wellbeing Examination

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**Abstract**

Radiation security examination of another break stockpiling of the Dalat Atomic Exploration Reactor(DNRR)forkeepingspenthighimproveduranium(HEU)fuelpacksduringthecenter change to low advanced uranium (LEU) fuel had been performed and introduced. The photon sourceandrotintensityofthespentHEUfuelpacksweredeterminedutilizingtheORIGEN2.1 code.GammaportionpacesofthespentfuelbreakcapacitywereassessedutilizingtheMCNP5 codewithdifferentsituationsofwaterlevelsinthereactortankandcoolingtime.Theradiation wellbeing investigation shows that the maintenance of 106 spent HEU fuel packs at the in-between time capacity along with a center of 92 LEU fuel groups meets the prerequisites of radiation security. The outcomes demonstrate that in the most extreme case, i.e., the total loss ofwaterinthereactortank,theadministratorsactuallycangettothereactorlobbytomoderate themishap insidearestricted time. Especially, in thecontrolroom, theportion paceofaround 1.4μSv/hislittleenoughforindividualstoordinarilywork.

**Introduction**

TheDalatAtomicExplorationReactor(DNRR)isa500kWpool-typeresearchreactor,which is worked by the Dalat Atomic Exploration Organization, VINATOM, situated in Dalat, Vietnam. In the mid-1980s, the DNRR was remade and updated from the 250kW TRIGA Imprint II reactor, which was worked in the mid-1960s and worked on Russian VVR-$M_2$fuel type [1, 2]. The reactor center comprises of 121 hexagonal cells including fuel packs, control poles,lightchannels,andberylliumblocks.Thedynamiccenterhasabreadthofaround46.48 cm and a level of 60 cm. The dynamic center is encircled by a graphite reflector with the thickness of 30.5 cm. The primary center was stacked with 88 high enhanced uranium (HEU) fuel groups with $^{235}$U improvement of 36 wt%. The main criticality of the DNRR was accomplishedonNovemberfirst,1983, andthefullpower activitywas accomplishedinWalk 1984 [2]. Because of the worldwide worries on the utilization of HEU fuel, the center change to low improved uranium (LEU) fuel was begun in 2007. In the structure of the program on Russian Exploration Reactor Fuel Return (RRRFR) and the program on Decreased Advancement for Exploration and Test Reactor (RERTR), the DNRR center was halfway changed over from HEU fuel to LEU fuel with $^{235}$U enhancement of 19.75wt% in September 2007.ThefullcenterchangetoLEUfuelwasperformedduringtheperiodfromNovember,



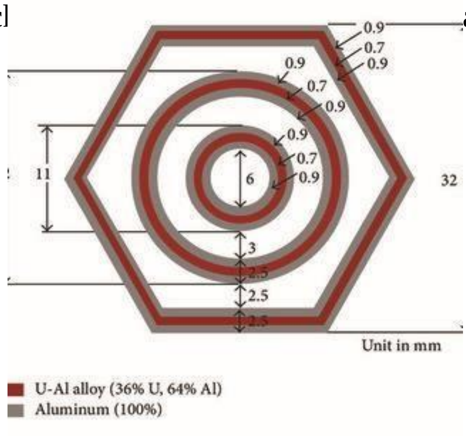
ISBN:978-81-957858-1-0

2011, to January 2012 [2, 3]. During and after the center transformation of the DNRR, one of the significant undertakings is the administration of the spent fuel. Interval wet capacity limit is required for cooling the spent HEU fuel packs for a time of a couple of months to quite a while prior to moving them to a spent fuel pool or returning them to Russian League. The current stockpiling limit ofthe DNRR is skilledto contain 72 fuel packs. ,us, notwithstanding theaccessiblestockpiling,anotherrackwasplannedandintroducedforexpandingthecapacity limit of 106 spent HEU groups during the restart-up of another LEU fuel center. In the plan o f the new break stockpiling, radiation wellbeing and criticality security examination has been directed.

In this paper, we present the radiation security examination of the recently planned break wet capacity of the DNRR. The radiation security was assessed in view of the assessment of the gamma portion rates actuated by the spent HEU fuel group's meanwhile capacity along with thenewLEUcenter.Theestimationswereperformedatdifferentcoolingtimesandwaterpool levels. For the safest case, the HEU fuel groups were expected to have the burn-up of 30% deficiencyof$^{235}$U.TheburnupsubordinatecrossareasoftheVVR-M$_2$fueltypetobeutilized in the ORIGEN2.1 code were created utilizing WIMS-ANL [4-6]. The ORIGEN2.1 code was then used to compute the focus and exercises of the splitting items and actinides, and the rot intensity of the fuel pack. The 18 energy-bunch photon motion at various cooling times got fromORIGEN2.1wasutilizedtodeterminesourceconveyanceintheMCNP5codetoascertain the gamma portion rates at different situations in the reactor corridor including the reactor top cover, safeguarding block, and the control room [7].

## 2. TheDNRRandCalculation Method

***DescriptionoftheDNRR***.Figure1showtheconfigurationandthedetailedparametersof theHEUandLEUfuelbundlesoftheDNRR.Theexternalcylinderhasahexagonalsharp,and the two inward cylinders are barrel shaped. The two fuel groups have a comparative external shape yet with various thickness of fuel meat and cladding. The LEU fuel group has a lower $^{235}$Uimprovement(19.75wt%)yet thethicknessof0.94cm andthethicknessofuraniumfuel meatare morenoteworthythan thatof theHEU pacl ass




of$^{235}$U.

*Figure1.Cross-sectional viewof theHEU andLEU fuelbundles ofthe DNRR.*



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Reactor shows the upward perspective on the DNRR reactor. The center comprises of 121 hexagonal cells including fuel groups, control poles, illumination channels, and beryllium blocks. The reactor center is constrained by seven control poles: two security bars (SR), four shim poles (ShR), and one programmed directing bar (AR). The security and shim poles are made of boron carbide (B4C), while the programmed managing bar is made of treated steel. The dynamic center level is 60 cm. The thickness of the graphite reflector is 30.5 cm. The center and the graphite reflector are put in the reactor pool. More nitty gritty depiction of the DNRRreactorshouldbevisiblein[8,9].Typically,theDNRRisworkedceaselesslyforatime ofaround130hoursoutofeachmonth.Thealloutactivityseasonofthereactorisrough1300- 1500 hours of the year.

**Estimation Technique** Old research depicts the estimation chart of the gamma portion rateutilizingORIGEN2.1andMCNP5.Intheradiationsecurityexamination,theORIGEN2.1 code was utilized to compute the action and photon transition of the spent HEU and LEU fuel packsduringburnupandcoolingtime[5].SincethelibraryofORIGEN2.1doesn'tcontainthe cross-area information of the VVR-$M_2$fuel type, the WIMS-ANL code was utilized for producing the burn up subordinate cross segments of the VVR-$M_2$HEU and LEU fuel groups tobeutilizedinORIGEN2.1[6].AmodelofdifferentconcentricchambersandSUPERCELL choiceofWIMSANLwith69neutronenergybunchesinlightoftheENDF/BVI.8information libraries were utilized to mimic the complicated math and resounding materials of the VVR- $M_2$fuel groups [10]. All variables connected with the fuel math and the neutron ranges have been treated in WIMS-ANL. Burn up estimations of the fuel grid cells were performed from the start up to the burn up of 30% and 40% deficiency of 235U for the HEU and LEU fuel, separately. Then, the burn up dependent minuscule cross segments of weighty nuclides were fallen from 69 energy gatherings to one energy bunch, which are subsequently utilized in the ORIGEN2.1codeforcomputingtheexercises,warmrot,andgammaportionpacesof thefuel groups. In the estimations, the burn up cycles of the fuel packs was dealt with following the authenticactivityofthereactor.Bethatasitmay,becauseofthemuddledauthenticactivityof theDNRR,justtheverifiableactivityofthemostrecent10cycleswasdepictedprecisely.The moreseasonedcycleswerepartitionedinto50daysofactivityand285daysofcoolingtimeon the other hand as the amounts of the activity and cooling time, separately.

Burn up estimations of the HEU and LEU centers were directed independently for getting the typical pivotal burn up circulations of the HEU and LEU fuel groups, separately, utilizing the REBUS-MCNP5 linkage code [11]. In the burn up and center material science computations, the model portrays the itemized reactor center including fills, neutron trap, control bars, light stations,graphitereactor, levelpillarcylinders,andwaterreflector.Thelayeredboundariesof thecentermodelare184.5cminleveland200cminbreadth.Thefuelgroupispartitionedinto five pivotal hubs for getting the typical hub burn up appropriation, which is extensively



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satisfactoryfordecidingthephotonsourcedispersionintheradiationsecurityexamination.



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Then, the burn up profile of the fuel not entirely settled, which is utilized as contribution to MCNP5todeterminethephotonsourceinthepivotalbearingalongwithphotonmotions.The photon transitions with 18 energy bunches got in the ORIGEN2.1 estimations and the photon source dispersion of a fuel pack decided in view of the burn up dissemination in the REBUS-MCNP5 computation were utilized as the info information in the MCNP5 model for working out the gamma portion rate [7]. In the safeguarding examination utilizing MCNP5, the LEU center, the break stockpiling of spent HEU fuel packages and encompassing parts like substantial walls, reactor lobby, and control room were recreated. Study shows the MCNP5 model of the DNRR reactor with the encompassing parts for working out the gamma portion rates at different situations in the reactor lobby, for example, the highest point of reactor tank, middle floors, and reactor corridor and control room. The layered model is extended to the reactor lobby and the control room, i.e., 1517 cm in level and 2630 cm in width. Due to the convoluted design of the DNRR with substantial protecting, no analog MCNP5 estimations wereperformedforgettinggammaportionrate.Weightwindowproceduresrelyinguponspace andenergyforchangedecreasewereappliedforexpandingthephotonpopulaceinthedistricts with low material densities and a long way from the source. In the MCNP5 model, the substantial wall was radials separated into 25 cross sections with an equivalent distance of 10 cm.Thewaterlocaleinthereactortankwasradialsseparatedintofiveequivalentvolumeareas. ThetransitiontoportiontransformationfactorstakenfromANSI/ANL-6.1.1-1977wasutilized to change over the photon motion to gamma portion rate [12].

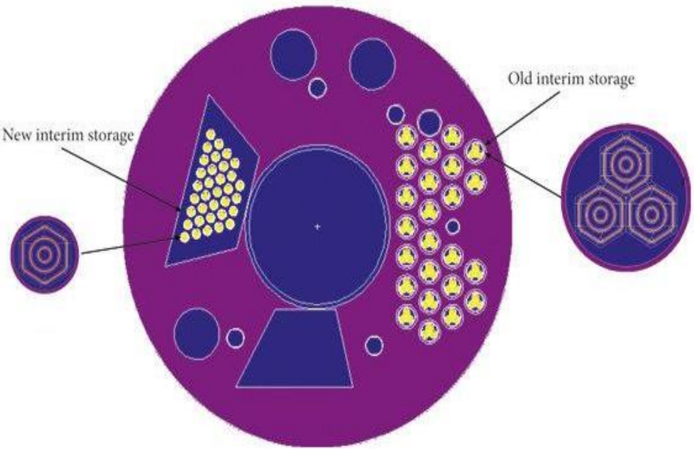


*Figure 2 Configuration of the interim storage containing 106 spent HEU fuel bundles of the DNRR.*

Figure 2 represents the plan of the spent fuel groups meanwhile capacity. To improve on the estimation model, the substantial protecting blocks were depicted as chambers rather than octagonal shapes actually. Since the gamma portion rates at positions near the reactor lobby floor are principally because of the dissipated photons from the rooftop and indoor air, the commitmentofphotonsgoingthroughthesafeguardingconcreteisunimportantlylittle(around 0.1%).,us,thedemonstratedroundandhollowstateofthesubstantialblockswouldn'tinfluence



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essentially to the computation results. In the radiation safeguarding examination model utilizing the MCNP5 code, two photon sources were thought of: the break stockpiling of 106 HEUpackswiththetypicalburnupof30%deficiencyof$^{235}$Uandthecenterof92LEUgroups withthetypicalburnupof40%deficiencyof$^{235}$U.IntheMCNP5estimations,thequantityof narratives of $3 \times 10^9$ was picked so the measurable blunder of the gamma portion rate was inside 1% at the areas of premium.

**EstimationSituations**.ToperformradiationsecurityinvestigationoftheDNRRwiththe newin-betweentimecapacity,itwasacceptedthatthebreakstockpilingcontainedfulllimitof 106 spent HEU fuel packs and the center was stacked with 92 LEU fuel groups. All the spent HEU fuel groups were accepted to have a similar typical burn up of 30% deficiency of $^{235}$U, and theLEUfuel packs had asimilartypical burnup of40%deficiency of $^{235}$U.Theburnsup levels are identical to around 84150 MWd/t for HEU fuel and 61110 MWd/t for LEU fuel, separately.Theburnupof30%deficiencyof$^{235}$UofHEUfuelwasexpectedforthemostsafe case, since the typical burn up of the 106 HEU packs at the hour of center not entirely set in stoneofaround22%deficiencyof$^{235}$U,thoughtheburnupof40%deficiencyof $^{235}$UofLEU fuelwasacceptedinlightofthefactthattheLEUgroupcontainsmore$^{235}$UsumthantheHEU group, and after burn up, the excess 235U sum is estimated that in the spent HEU group. , is impliesthattwosourcesaddingtothegammaportionratesarethoughtof:breakcapacitywith 106 spent HEU fuel groups and the LEU center. The radiation security examination was performedfordifferentcoincidentalsituationsofwaterlevelsinthereactortankandatvarious coolingtimes.Thewaterlevelswereacceptedtodiminishfrom625cmto0cmrelatingtothe fullwatertothetotallossofwaterinthereactortank.Figure3showstheupwardformatofthe DNRR reactor tank showing the hub levels of water. In the radiation protecting examination, two photon sources were mimicked all the while. On account of complete loss of water, extra computations were led with every one of the two sources independently to assess the commitment of the sources to the all out gamma portion rates in correlation between one another. It is on the grounds that when the water in the reactor tank is totally lost, the LEU centerandthe breakstockpilingarepresentedtotheair, andthuslythetwo ofthemcontribute altogetherto theall out portion rates.Thegammaportion ratesat different spots inthereactor corridorwereassessedinthemostseriouscasescomparingtothetotallossofwaterfollowing 1-day and 7-day cooling.



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*Figure3:-Verticallayout ofthe DNRRreactor tankwith axialwater levels.*

**4. Conclusions**

Radiation security investigation has been performed for the new interval stockpiling of the DNRRforkeepingthespentfuelduringthecentertransformationfromHEUfueltoLEUfuel. Thenewbreak stockpilingwasintendedto expand thecurrentlimitwithrespectto containing 106 spent HEU fuel packs in the reactor tank. Estimations of the gamma portion rates at different situations in the reactor corridors and control room actuated by both the spent fuel packsinthecapacityandtheLEUcenterhavebeendirected.Acomputationalmethodhasbeen created to couple WIMS-ANL for producing burn up-subordinate cross segments of the fuel packs, ORIGEN2.1 for working out 18-bunch photon motion, REBUS-MCNP5 for working outpivotalburnupdispersionsofthefuelgroups,andMCNP5forascertaininggammaportion rates. Radiation examination has been performed with the presumption of different situations oflossofwaterlevelinthereactortank.Onaccountofthedeficiencyofwaterlevelunder100 cm,thegammaportionactuatedbythe106spentHEUfuelpacksdoesn'tinfluenceindividuals workinginthereactorcorridor.Inthemostseriouscasethatthewaterlevelinthereactortank istotallylostandthecoolingtimeisoneday,theadministratorsactuallycangettothereactor corridorforfixinginarestrictedtime.Inthecontrolroom,thegammaportionrateisaround 1.4 μSv/h or comparable to 2.8 mSv/y. ,is esteem is not exactly the yearly portion breaking point of 20 mSv/y for word related specialist, and thusly, permitting ordinary activity in the control room. The outcomes show that the maintenance of 106 spent HEU fuel packs in the recently planned break capacity is completely met the necessities of the radiation security at the typical activity state of the new LEU center.

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ISBN:978-81-957858-1-0

## BiodieselbyGrey-TaguchiMethod

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**Abstract**

This study has investigated how piston catalytic coating affects performance and emission.To lower emissions and enhance the performance of an IC engine, the primary performance-enhancing variables—such as load, fuel, and speed—have been favoured. With the use of Taguchi'sexperimentdesignandtheGreyRelationalAnalysisOptimisation(GRA)approach, theseparticularstandardparametershavebeenchangedforcopperalloycoateddiesel engines in an effort to boost performance and cut emissions. When compared to a regular engine with an uncoated piston, the results reveal that a modified copper chromium zirconium (CuCr1Zr) catalyticcoatedpistongenerateslessemissionsandenhancesperformance.Inthisinvestigation cottonseedoilisusedasabio-dieselandthepistonandcombustionchamberwerecoatedwith copper chromium zirconium material with a thickness of 250 microns. Finally, the results of the experiments were compared with un-coated engine and optimized parameters have been identified for catalytic coated modified IC engine using Taguchi with GRA approach. In this study,cottonseedoilhasbeenusedasabiodiesel,andacoatingofcopperchromiumzirconium withathicknessof250micronswasappliedtothepistonandcombustionchamber.ATaguchi with GRA technique was used to identify the optimized parameters for the catalytic coated modifiedICengineaftertheexperimentresultswerecomparedtothoseoftheuncoatedengine. The primary source of power for automobiles is the IC engine. There are several components inanengine,includingapiston,cylinderhead,cylinderblock,etc.Themostcrucial ICengine partsarethepistonandcylinderheadbecausethecombustionthattakesplaceinthecombustion chamberiswhatgivesICenginestheirpower.Itissituatedatthebaseofthecylinderheadand above the piston. The combustion process results in the production of pollutants. Combustion is the process through which fuel and air is burned. In this chemical reaction, fuel like hydrocarbon is mixed with oxygen to generate air-polluting toxic gases. Oxidation does not take place correctly throughout the combustion process. As a result, due to the lean mixture andlightload,carbonmonoxideandhydrocarbonemissionoccur.1,Therefore,theflamespeed duringcombustion maybetoo low orincomplete combustion mayoccur2, and as aresult, the amount of HC, CO, and NOx emissions in the exhaust gas released into the environment throughthetailpipeishigherthanitwouldbeforanenginewithcopper-coatedpistons.These gases have a number of negative effects on society. To solve this issue, a 250-micron coating ofcatalyticmaterial(copper-chromium-zirconium)isappliedtothecombustionchamberwalls andpistoncrown.Thethermalsprayingmethodofplasmasprayingisusedtocoverthepiston and combustion chamber.



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Rameshbabu *et al*. proved that the catalytic coating, reduced the required ignition energy and thefamevelocityisincreased3.WinklerM.F*etal*.statedthatcoateddieselenginegivesbetter performance. Jeyakumar *et al*., state that cotton seed bio diesel can be used as an alternative fuel for control the emissions like CO, HC of a diesel engine.

**Materialsand Method**

TeexperimentalworkswereconductedincatalyticcoatedICengine.Teenginewastestedwith diesel, cotton seed oil blending with diesel fuel with the ratio of 10% to 20% and by varying the engine performance and emissions parameters like load and speed. Te experiments are conducted based on taguchi orthogonal array (OA).

A Minitab ’16 statistical software is used for selection of OA. Based on OA, the design of experiments (DOE) are made. Te experiments are conducted in 150cc kirlosker make multi fueledoperateddieselenginewitheddycurrentdynamometerandgasanalyzersetup.Tesetup enables to find the coated engine emission characteristics like carbon monoxide (CO), hydro carbon (HC) and oxides of nitrogen (NOx) and the important coated engine performance like brakepower(BP),brake thermalefficiencyBothandtorque.Patil.K. R *et al*.investigatedthe dieselengineemissionandconductedtheperformancetestasperISO8178-C1andISO8178-D2procedure6.COismeasuredusingNondispersiveinfrared(NDIR)sensor,HCusingFlame ionizationdetector(FID)andNOxusingchemiluminescentanalyzer.Temainaimofthepaper is to minimize the major diesel engine emissions like CO and HC. In this research, A DC-5 GAS analyzer is used for measuring the emission levels. The measuring probe of DC- GAS analyzerisconnectedto engineexhausttailpipeormufer.Itmeasuresthefiveemissiongases, including hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) in the exhaust gas.

Ponnusamy7 *et al*. investigated the performance evaluation of single cylinder IC engine. Te resultsshowedthatcoppercoatedpistonandcombustionchamberenginereducesHCandCO emissions.Healsocarriedouttheinvestigationfordifferentcatalyticcoatingmaterials.Finally they rated catalysts based on the performance as copper>chromium >nickel>standard or un- coated (aluminum alloy). Krzysztof *et al*. Studied the effects of plasma sprayed zirconium coatings on the piston8 . So, one of the promising technologies for improving IC engine performance and reducing the CO and HC emission is catalytic coating on piston and combustion chamber.

Sincecopperchromiumandzirconiumarelessincostcomparedtoplatinum,andalsothey are is a good catalyst material, these three materials combined in the form of alloys material (CuCr1Zr), and used for coating. So in this investigation, copper -chromium -zirconium material was selected as the coating material is shown in Fig. 1 It is most suitable for internal combustion engines and also good corrosion resistance.

**Methodology.**



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To find the catalytic coated engine performance and emission parameters the following procedure is followed as shown in Fig. 2.

**Plsma coating.** The plasma spray method is basically a thermal spraying coating process. Te materialtobecoatedisconvertedintomoltenstagebymeansofheatandsprayedtothesurface to be coated and produce a coating. It is shown in Fig. 3

The coating material impacts on the substrate surface and quickly cools forming a coating9 . Te plasma coating method has been shown in Fig. 4.

**Piston coating.**

Today's engines uses an exhaust after gas treatment system which is otherwise called as catalytic converter. This investigation intends to implement a similar kind of technology used in catalytic converter in the engine itself. This is achieved by coating the piston and chamber thereby making it possible to reduce a major amount of pollution emitted by the engine. So, thisinvestigationinvolvescoatingofpistonandcombustionchamberwithacatalyticmaterial. Copper-chromium-zirconium alloy is coated on the bottom side of engine cylinder head and the top side of piston crown to a thickness of 250 microns. There are different methods of catalyticcoatingprocessforcoatingthepistonandcombustionchamberwallsasshowninFig. 3. Te plasma spray process is advised by many researchers9–11 because of its performance, economyandecofriendlynature.TepropertiesofcoatingmaterialvaluesaretabulatedinTable 1.The surface roughness of the coating was measured using Mitutyo make Surf test SJ-210 testingmachine.TeaveragesurfaceroughnessvaluebeforecoatingisRa=6.2±0.3µmandafer coatingisRa=5.9±0.4µm.Hencethesurfaceroughnessaftercoatinghasimproved.KadirMert Doleker *et al*. was conducted porosity measurements of thermal barrier coatings. The results showedthatthatthethermalbarriercoatingsexhibithigherporosity12.Das.D*etal*.Conducted investigationonpartiallystabilizedzirconiumcoatedpistonwiththethicknessof250,350and 450 microns. The results showed:

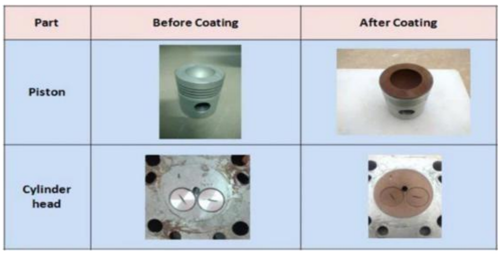


**Figure 1.** Piston, and Combustion chamber coated by plasma coating technique- The figure describe before and after.

**Materialsand Method**

TeexperimentalworkswereconductedincatalyticcoatedICengine.Teenginewastestedwith diesel, cotton seed oil blending with diesel fuel with the ratio of 10% to 20% and by varying the engine performance and emissions parameters like load and speed. Te experiments are conductedbasedontaguchiorthogonalarray(OA).AMinitab'16statisticalsoftwareisused



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forselectionofOA.BasedonOA,thedesignofexperiments(DOE)aremade.Teexperiments are conducted in 150cc kirlosker make multi fueled operated diesel engine with eddy current dynamo-meter and gas analyzer set up. Te setup enables to find the coated engine emission characteristics like carbon monoxide (CO), hydro carbon (HC) and oxides of nitrogen (NOx) and theimportant coated engineperformancelike brakepower (BP),brake thermal efficiency Bth and torque. Patil. K. R *et al*. investigated the diesel engine emission and conducted the performance test as per ISO 8178-C1 and ISO 8178-D2 procedure[6] . CO is measured using Non dissuasive infrared (NDIR) sensor, HC using Flame ionization detector (FID) and NOx using chemiluminescent analyzer. Te main aim of the paper is to minimize the major diesel engineemissionslikeCOandHC.Inthisresearch,ADC-5GASanalyzerisusedformeasuring theemission levels. Te measuring probeofDC- GAS analyzeris connected to engineexhaust tailpipe or mufer. It measures the fve emission gases, including hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) in the exhaust gas.

Ponnusamy[7] *et al*. investigated the performance evaluation of single cylinder IC engine. Te resultsshowedthatcoppercoatedpistonandcombustionchamberenginereducesHCandCO emissions.Healsocarriedouttheinvestigationfordifferentcatalyticcoatingmaterials.Finally they rated catalysts based on the performance as copper>chromium >nickel>standard or un- coated (aluminum alloy). Krzysztof *et al*. Studied the effects of plasma sprayed zirconium coatings on the piston[8] . So, one of the promising technologies for improving IC engine performance and reducing the CO and HC emission is catalytic coating on piston and combustion chamber. Since copper chromium and zirconium are less in cost compared to platinum, and also they are is a good catalyst material, these three materials combined in the form of alloys material (CuCr1Zr), and used for coating. So in this investigation, copper - chromium-zirconiummaterialwasselectedasthecoatingmaterialisshowninFig.1Itismost suitable for internal combustion engines and also good corrosion resistance.

**Methodology.**

To find the catalytic coated engine performance and emission parameters the following procedure is followed as shown in Fig. 2.



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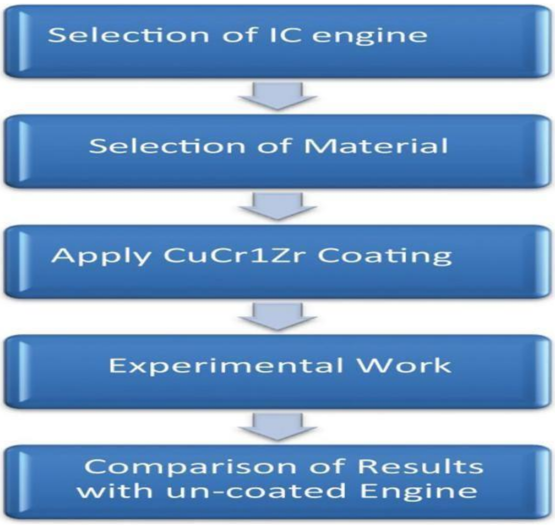


**Figure 2.** Methodology -Te flowchart indicates step-by step process involved in the present investigation

**Plasmacoating.**Theplasmaspraymethodisbasicallyathermalsprayingcoatingprocess.Te materialtobecoatedisconvertedintomoltenstagebymeansofheatandsprayedtothesurface to be coated and produce a coating. It is shown in Fig. 3

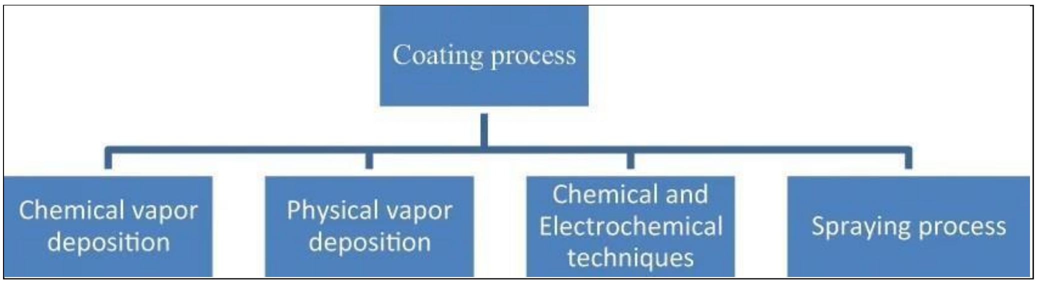


**Figure3.**ClassificationofCoatingProcess-Thefigureshowndifferenttypeofthermalspray coating process.

The coating material impacts on the substrate surface and quickly cools forming a coating9 . Te plasma coating method has been shown in Fig. 4. below.



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**Figure4.** PlasmaCoating Process-TefiguredescribethePiston and head coatedby CUCr1Zr material

**Piston coating.**

Today‘s engines uses an exhaust after gas treatment system which is otherwise called as catalytic converter. This investigation intends to implement a similar kind of technology used in catalytic converter in the engine itself. This is achieved by coating the piston and chamber thereby making it possible to reduce a major amount of pollution emitted by the engine. So, thisinvestigationinvolvescoatingofpistonandcombustionchamberwithacatalyticmaterial. Copper-chromium-zirconium alloy is coated on the bottom side of engine cylinder head and the top side of piston crown to a thickness of 250 microns. There are different methods of catalytic

coating process for coating the piston and combustion chamber walls as shown in Fig. 3. Te plasmasprayprocessisadvisedbymanyresearchers9–11becauseofitsperformance,economy and eco friendly nature. The properties of coating material values are tabulated in Table 1

**Table1Propertiesofcopperchromiumzirconium material.**

| **S. No** | **Parameters** | **Values** |
|---|---|---|
| 1 | TensileStrength | 220–540N/mm2 |
| 2 | 0.2%Proof Strength | 100–440N/mm2 |
| 3 | Elongation | 5–35% |
| 4 | Hardness(HV) | 55–175 |
| 5 | ElectricalConductivity | 80%IAC |
| 6 | ThermalConductivity | 300W/m°K |
| 7 | MeltingPoint | 1080°C |

TesurfaceroughnessofthecoatingwasmeasuredusingMitutyomakeSurftestSJ-210testing machine. The average surface roughness value before coating is Ra=6.2±0.3µm and afer coating is Ra=5.9±0.4µm. Hence the surface roughness after coating has improved.



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Kadir Mert Doleker *et al*. was conducted porosity measurements of thermal barrier coatings. The results showed that that the thermal barrier coatings exhibit higher porosity12. Das. D *et al*. Conducted investigation on partially stabilized zirconium coated piston with the thickness of250,350and450microns.Theresultsshowed4thatimprovementofbrakethermalefciency and reduction of SFC, CO, HC emissions13. In this investigation the piston is coated with CuCr1Zr to a thickness of 250 microns and it does not afect the compression ratio.

**ExperimentalSetup**

Te experimental set up consists of five different elements. The five various elements are catalyticcoatedengine,eddycurrentdynamometer,gasanalyzer,personnelcomputeranddata acquisitionsystem.TheseelementsareconnectedasshowninFigs.5and6.Thissetupisused for conducting the engine performance test and emission test. The engine can be operated by twofuelseitherbypetrolordiesel.Iftheengineisoperatinginpetrolfuel,theelectroniccontrol unit (ECU) is needed. In this research, the engine is run by diesel fuel. Here, it operated with thehelpofinjectorandfuelpump(FIP).Teexperimentsareconductedusingdieselandblended diesel 10% and

20%,asshown inFig. 7.

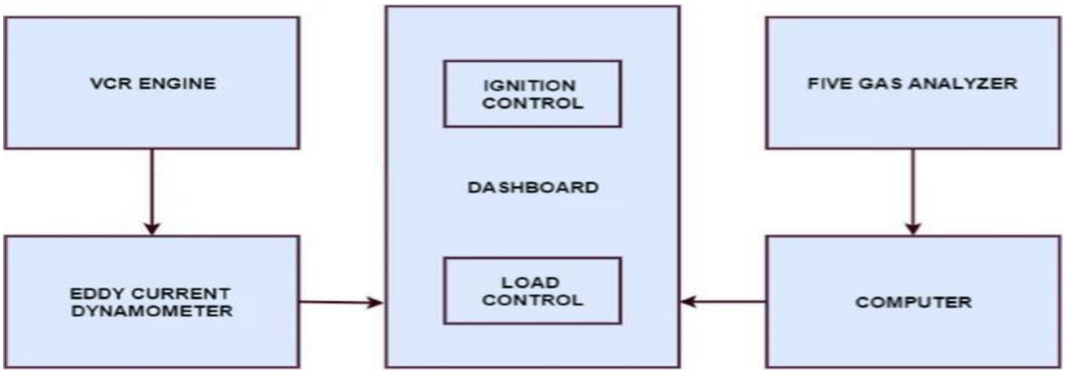


**Figure5**



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**Figure6**


**Figure7**

**Biodiesel preparation.**

In this investigation cotton seed oil is used as blended diesel fuel. Cotton seed oil is produced from the seed of the cotton plant, by crushing or by chemical solvent extraction process. For commercial purpose, cottonseed oil is extracted through solvent extraction process. The properties of cotton seed oil is listed in Table 2.

**Table2Propertiesofcottonseedoil.**

| S. No | Parameters | Values |
|---|---|---|
| 1 | Density | 857Kg/m3 |
| 2 | Flash point | 198°C |
| 3 | Firepoint | 225°C |
| 4 | Calorific value | 35MJ/Kg |



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Cotton seed plant (Gossypium hirsutum and Gossypium herbaceum) is grown by farmers for thepurposeoffeedinganimals,makecottoncloths,andproducecottonoil.Theseedofcotton has a similar shape to sunflower seed. Both seeds contains oil contaminants inside the hull. Usingthechemicalextractionprocess,thecottonseedoilisextractedfromthekernel.Now-a- days due to high demand and shortages of crude oil, the cost of automotive vehicle fuel increases day by day14,15. So the cottonseed oil can be used as an alternative fuel for automotive vehicles. In this investigation cotton seed oil is blending with diesel fuel with the ratio of 10% to 20% (B10, B20) using transesterification process. In thetransesterification process one ester group is converted or interchanged into another ester group. The converting reactionofcottonseedoilintobiodieseliscalledtransesterificationprocessisshowninFig. 8. Inthisprocess,methanolandalcoholcombinewiththetriglycerideoilinthecottonseedunder heat and sodium or potassium hydroxide as catalyst. Bio diesel and glycerol is produced through the chemical reaction. Ayegba, *et al*.14describe, the transesterification reaction as shown in Fig.8. After the sedimentation process, glycerol and bio diesel is separated. The propertiesofcottonseedoiliscomparedwithdieselfuelinTable3.

Figure 8

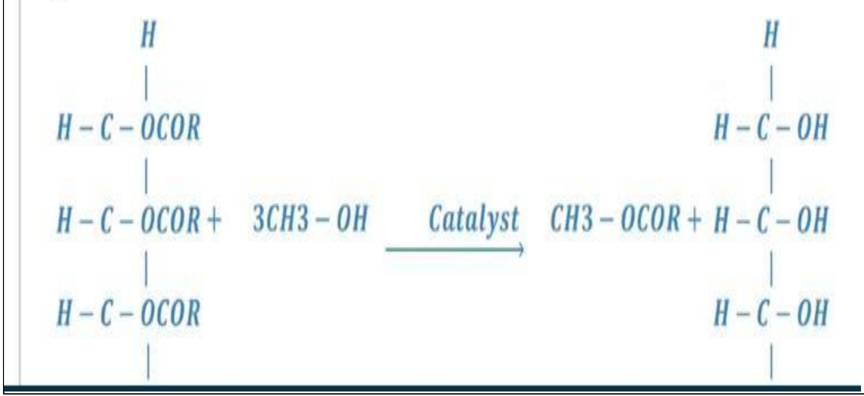


Table3ComparisonofDieselandBiodieselfuelproperties.

| S. No | Parameters | Diesel | Cottonseedoil |
|---|---|---|---|
| 1 | Density(kg/m3) | 830kg/m3 | 857kg/m3 |
| 2 | Flashpoint(°C) | 65°C | 198°C |
| 3 | Firepoint(°C) | 107°C | 225°C |
| 4 | Calorific value (MJ/Kg) | 42.0MJ/Kg | 35.86MJ/Kg |
| 5 | Cetanenumber | 40–55 | 38 |



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## Taguchimethod

Taguchiwithgrey relationalanalysis(GRA)ismostsuitabletechniquefor multi-performance characteristics with minimum experimental work16. In the present investigation, taguchi techniquewithgreyrationalanalysismethodisusedforfindingtheoptimumengineparameters for coated IC engine. To find the optimum solution of a problem with minimum number of trails,taguchitechniqueisthemostpreferablemethod.Thistechniqueusesanorthogonalarray concept. In the present study, three factors and three levels L9 orthogonal array is used. Taguchi`s array selector table used for selecting orthogonal array17. The identified parameter should bein threelevels such as smallest, medium and highest levels. Taguchi techniqueuses a concept known as signal to noise quantitative relation (S/N) for measuring the standard characteristics.

## Greyrationalanalysis(GRA)method

Goutam Pohit *et al*. used the grey rational analysis for multi objective problems18. The intention of the investigation is to optimize seven response parameters for coated piston and headtypeICengine.Outofsevenresponses,fourresponsesrelatedtoengineperformanceand remaining three responses related to emission. In this, higher S/N ratio is preferred for engine performanceandlowerS/Nratioforemissioncharacteristic.Therefore,taguchiisnotsuitable for multi response optimization problem. To overcome this problem, in this investigation taguchiwithgreyrelationalanalysisisusedtofindtheoptimumsolution.PrasantaSahoo *etal*. usedgreyrationaltechnique19.Thefirststepisexperimentalresultsarenormalizedasthefirst step. After normalization, the grey relational coefficients (GRC) are calculated in the second step. In the third step, the overall grey relational grade (GRG) is calculated for each selected response by averaging the grey relational coefficients. Finally, evaluation of the multiple process response is based on the grey relational grade.

## Parametersanditslevels

In thepresent investigation threefactors and three levels areused. Experiments are conducted considering three input parameters such as Fuel, Load (%) and Speed (rpm). Overall nine experiments are carried out. Table 4shows the values of various parameters used for experiments.

Table4Factorsanditslevels.

| **S. No** | **Factors** | **Level1** | **Level2** | **Level3** |
|---|---|---|---|---|
| 1 | Fuel | Diesel | B10 | B20 |
| 2 | Load(%) | 0 | 50 | 100 |
| 3 | Speed (rpm) | 1460 | 1480 | 1500 |



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Minitab-16 statisticalsoftwareis usedin thisinvestigation. The parameter variation levels are updatedin Minitab-16 statistical software, and thesoftwaresuggests that L9(3*3)orthogonal arrayasshowninTable5.Theexperimentsareperformedforthedieselandblendedbiodiesel with the proportion of 10% and 20% bio diesel with 90% and 80% diesel fuel (B10, B20).

Table5-L9OrthogonalarrayDesignof Experiment.

| Exp. No | FuelType | Load (%) | Speed (rpm) |
|---|---|---|---|
| 1 | Diesel | 0 | 1460 |
| 2 | Diesel | 50 | 1480 |
| 3 | Diesel | 100 | 1500 |
| 4 | B10 | 0 | 1480 |
| 5 | B10 | 50 | 1500 |
| 6 | B10 | 100 | 1460 |
| 7 | B20 | 0 | 1500 |
| 8 | B20 | 50 | 1460 |
| 9 | B20 | 100 | 1480 |

## ResultandDiscussion

Theexperimentswereconductedforthedieselandbiodiesel B10,B20onacoatedpiston engine and Table 6shows engine performance results obtained through the experiment.

**Table6PerformanceandEmissionResults.**

| Exp.No | Fuel | Load (%) | Speed (rpm) | BP (kw) | SFC (kg/kw-hr) | BTh (%) | Torque (N-m) | CO (%) | HC ppm | Nox ppm |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Diesel | 0 | 1460 | 0.17 | 2.40 | 3.48 | 1.05 | 0.05 | 0.17 | 98 |
| 2 | Diesel | 50 | 1480 | 1.74 | 0.37 | 22.54 | 11.19 | 0.04 | 12 | 306 |



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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | Diesel | 100 | 1500 | 3.43 | 0.26 | 32.03 | 22.60 | 0.02 | 7 | 332 |
| 4 | B10 | 0 | 1480 | 0.14 | 2.18 | 4.04 | 0.87 | 0.07 | 36 | 89 |
| 5 | B10 | 50 | 1500 | 1.74 | 0.32 | 27.96 | 11.20 | 0.01 | 8 | 182 |
| 6 | B10 | 100 | 1460 | 3.13 | 0.26 | 34.51 | 20.53 | 0.01 | 1 | 212 |
| 7 | B20 | 0 | 1500 | 0.16 | 1.91 | 5.13 | 1.00 | 0.05 | 20 | 55 |
| 8 | B20 | 50 | 1460 | 1.67 | 0.33 | 29.80 | 10.76 | 0.02 | 9 | 173 |
| 9 | B20 | 100 | 1480 | 3.42 | 0.26 | 37.20 | 22.52 | 0.01 | 7 | 225 |

GRAforperformanceand emission

The first step of GRA is normalizing the responses. The important engine performance responses are BP, brake thermal efficiency (BTh), and Torque. These are the important responsesfor coatedengine. When therequired responseis higherthebetter,thentheoriginal sequenceis normalized.TheSFC, CO,HC and NOX are also important emission responsesof coated engine. Rajesh21*et al*. used Smaller the Better, option to normalized parameters.

TheGRAperformanceandemission resultsareshown inTable7

| **Fuel** | **Load (%)** | **Speed (rpm)** | **BP (KW)** | **SFC (Kg/KW-hr)** | **BTE (%)** | **TORQUE (N-m)** | **CO (% vol.)** | **HC (ppm)** | **NOX (ppm)** |
|---|---|---|---|---|---|---|---|---|---|
| Diesel | 0 | 1460 | 0.09 | 0.00 | 0 | 0.08 | 0.33 | 1 | 0.84 |
| Diesel | 50 | 1480 | 0.48 | 0.94 | 0.5 | 0.47 | 0.5 | 0.66 | 0.09 |
| Diesel | 100 | 1500 | 1 | 1.00 | 0.8 | 1 | 0.83 | 0.80 | 0 |
| B10 | 0 | 1480 | 0 | 0.10 | 0.01 | 0 | 0 | 0 | 0.87 |
| B10 | 50 | 1500 | 0.48 | 0.97 | 0.72 | 0.47 | 1 | 0.78 | 0.54 |



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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| B10 | 100 | 1460 | 0.90 | 1.00 | 0.92 | 0.90 | 1 | 0.97 | 0.43 |
| B20 | 0 | 1500 | 0.01 | 0.22 | 0.04 | 0.005 | 0.33 | 0.44 | 1 |
| B20 | 50 | 1460 | 0.46 | 0.96 | 0.78 | 0.45 | 0.83 | 0.75 | 0.57 |
| B20 | 100 | 1480 | 0.99 | 1.00 | 1 | 0.99 | 1 | 0.80 | 0.38 |

GRCandGRGforperformanceandemission

| **Fuel** | **Load (%)** | **Speed(rpm)** | **BP (KW)** | **SFC (Kg/KW-hr)** | **BTE (%)** | **TORQUE (N-m)** | **CO (%vol.)** | **HC (ppm)** | **NOX (ppm)** | **GRG** |
|---|---|---|---|---|---|---|---|---|---|---|
| Diesel | 0 | 1460 | 0.336 | 0.333 | 0.333 | 0.335 | 0.428 | 1.000 | 0.763 | 0.509 |
| Diesel | 50 | 1480 | 0.493 | 0.900 | 0.534 | 0.484 | 0.500 | 0.602 | 0.355 | 0.556 |
| Diesel | 100 | 1500 | 1.000 | 1.000 | 0.764 | 1.000 | 0.749 | 0.723 | 0.333 | 0.799 |
| B10 | 0 | 1480 | 0.333 | 0.350 | 0.337 | 0.333 | 0.333 | 0.333 | 0.802 | 0.402 |
| B10 | 50 | 1500 | 0.493 | 0.940 | 0.645 | 0.489 | 1.000 | 0.695 | 0.521 | 0.686 |
| B10 | 100 | 1460 | 0.845 | 1.000 | 0.862 | 0.839 | 1.000 | 0.955 | 0.468 | 0.860 |
| B20 | 0 | 1500 | 0.334 | 0.390 | 0.344 | 0.334 | 0.428 | 0.474 | 1.000 | 0.473 |
| B20 | 50 | 1460 | 0.483 | 0.938 | 0.694 | 0.478 | 0.749 | 0.669 | 0.539 | 0.653 |



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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| B20 | 100 | 1480 | 0.994 | 1.000 | 1.000 | 0.992 | 1.000 | 0.723 | 0.448 | 0.885 |

Theobtained grey relational rank is presentedin Table 9wherehighergrey relational gradeis ranked high. The obtained higher grey rational grade is very closer to the optimum solution.

| **Fuel** | **Load (%)** | **Speed (rpm)** | **BP (KW)** | **SFC (Kg/ KW-hr)** | **BTE (%)** | **TORQUE (N-m)** | **CO (%vol.)** | **HC (ppm)** | **NOX (ppm)** | **GRG** | **RANK** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Diesel | 0 | 1460 | 0.336 | 0.333 | 0.333 | 0.335 | 0.428 | 1.000 | 0.763 | 0.509 | 7 |
| Diesel | 50 | 1480 | 0.493 | 0.900 | 0.534 | 0.484 | 0.500 | 0.602 | 0.355 | 0.556 | 6 |
| Diesel | 100 | 1500 | 1.000 | 1.000 | 0.764 | 1.000 | 0.749 | 0.723 | 0.333 | 0.799 | 3 |
| B10 | 0 | 1480 | 0.333 | 0.350 | 0.337 | 0.333 | 0.333 | 0.333 | 0.802 | 0.402 | 9 |
| B10 | 50 | 1500 | 0.493 | 0.940 | 0.645 | 0.489 | 1.000 | 0.695 | 0.521 | 0.686 | 4 |
| B10 | 100 | 1460 | 0.845 | 1.000 | 0.862 | 0.839 | 1.000 | 0.955 | 0.468 | 0.860 | 2 |
| B20 | 0 | 1500 | 0.334 | 0.390 | 0.344 | 0.334 | 0.428 | 0.474 | 1.000 | 0.473 | 8 |
| B20 | 50 | 1460 | 0.483 | 0.938 | 0.694 | 0.478 | 0.749 | 0.669 | 0.539 | 0.653 | 5 |



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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B20 | 100 | 1480 | 0.99 4 | 1.000 | 1.0 00 | 0.992 | 1.000 | 0.723 | 0.44 8 | 0.88 5 | 1 |

Sincetheexperimentalplanisorthogonaltheresultsofeveryparameterofgreyrelationalgrade areseparatedintolevel.Forfuelparameter,themeanofthegrayrelativegradeforthevarious levels one, two and three are calculated by averaging the gray relational grade (GRG) for the experiments one to three, four to six and seven to nine. Similarly, the GRG for the remaining parameters load and speed are calculated as shown in Table 10.

Table10GRGPerformanceandEmissionResults.

| **Symbol** | **Parameters** | **Level1** | **Level2** | **Level3** | **Main effect (max-min)** | **Rank** |
|---|---|---|---|---|---|---|
| A | Fuel | 0.621 | 0.649 | 0.670 | 0.0213 | 3 |
| B | Load | 0.461 | 0.632 | 0.848 | 0.2163 | 1 |
| C | Speed | 0.674 | 0.614 | 0.653 | 0.0215 | 2 |

Basedongreypredictionconcept,thehighergreyrationalgradeinputparameter(A3B3C1)is optimum.ThereforeB20fuel,100%loadand1460rpmenginespeedistheoptimumparameter for catalytic coated piston type diesel engine.

ANOVAanalysis

Raggul23*etal*.statedthatthemainintentionofANOVAanalysisistoidentifyandinvestigate the significant factor contribute to the engine emission and performance characteristics of a catalytic coated IC engine. The ANOVA analysis is carried out through the sum of squared deviations of the total mean of the GRG. Based on contribution and error of each factor, the effect of each experimental factor can be separated. The factor that poses the maximum mean square value is identified as the most significant parameter and the factor influences the performanceandemissioncharacteristicsofacatalyticcoatedICengine.TheresultofANOVA isshowninTable11.Patel24*etal*.wherestatedthatthesumofsquarederror(withoutorwith pooledfactor),is thesum ofsquares corresponding to theinsignificant factors. (MSj)is Mean square of a factor found by dividing its sum of squares and degrees of freedom, and (ρ) is the percentagecontributionofeachofthedesignparameters.Degreeoffreedomforeachfactoris 2 (Number of level-1).



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Table11 ANOVAof GRG.

| **Factor** | **Degreesof freedom** | **Sum of Squares** | **Mean Squares** | **F ratio** | **Percentage Contribution ($\rho$)** |
|---|---|---|---|---|---|
| Fuel(A) | 2 | 0.0011 | 0.0006 | 0.11 | 0.777 |
| Load(B) | 2 | 0.0881 | 0.0440 | 6.98 | 0.045 |
| Speed(C) | 2 | 0.0029 | 0.0014 | 0.48 | 0.178 |
| Error | 2 | 0.0041 | 0.0020 | — | 0 |
| Total | 8 | 0.9631 | 0.0480 | — | 100 |

Therefore the ANOVA of GRG analysis conclude that the second factor load poses the maximum mean square value of 0.0455 and hence it is identified as the highest significant factor that contributes and influences the performance and emission characteristics of a catalyticcoatedICengine.TheANOVAmeaneffectplotandresidualplotsforGRGareshown in Figs. 9and 10.

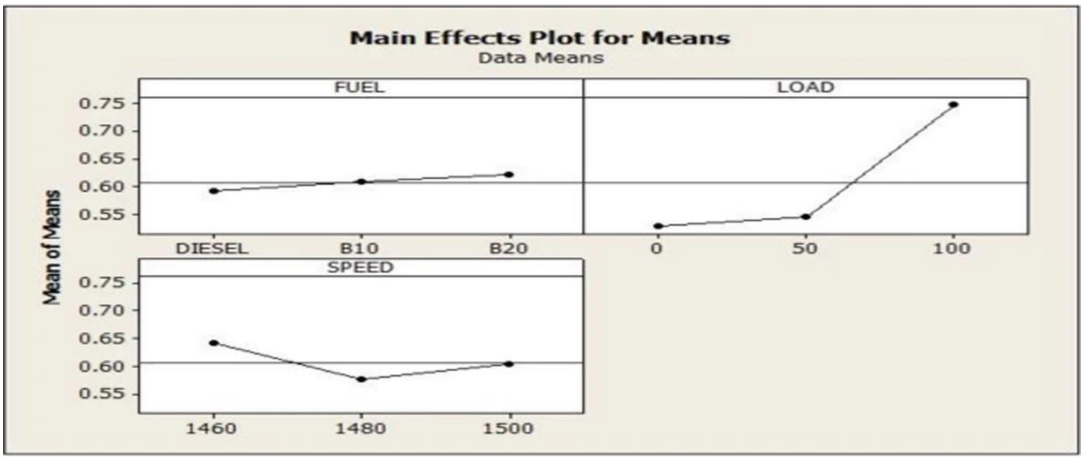




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Figure 9-GRA ANOVA Analysis -The Plot Figure Indicates the GRA Optimum Parameters. (A3B3C1).

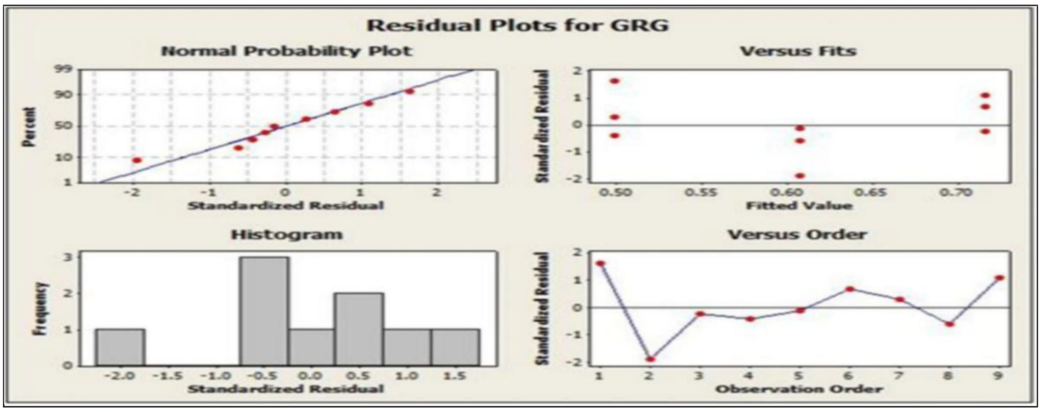


Figure 10-ANOVA Analysis Residual plots for GRG for Indicates the Variations of all the Nine Experiments.

Confirmationtest

The final step of taguchi design technique is confirmation test. It is conducted through experimental work once again to validate the improvement of performance and to reduce emissioncharacteristicsinthecoatedpistonandheadtypeICenginerunbyB20blendeddiesel fuel.TheidentifiedoptimumparameterresponsesBP,SFC,BTE,Torque,CO,HC,NOXobtained through experimental and GRA are presented in Table 12. This shows the comparison of the experimental results using the initial OA, (A3B3C2-experiment no. 9) and optimal Grey theory prediction design (A3B3C1) factor. Based on the confirmation test experimental result comparison, it clearly states that the performance and emission characteristics of a catalytic coated IC engine marginally improved through this study.

Table12ComparisonofOAandGRGOptimumParametersResults.

| **Conditiondescription** | **Greytheoryprediction design parameters** | **Basedon OA Parameters** |
|---|---|---|
| Level | A3B3C1 | A3B3C2 |
| BP in KW | 0.9938 | 0.9940 |
| SFCinKg/kw-hr | 0.321 | 0.3330 |
| BTE in % | 0.9572 | 1 |
| TORQUEinN-m | 0.9982 | 0.9926 |
| CO in %Vol. | 0.9872 | 1 |



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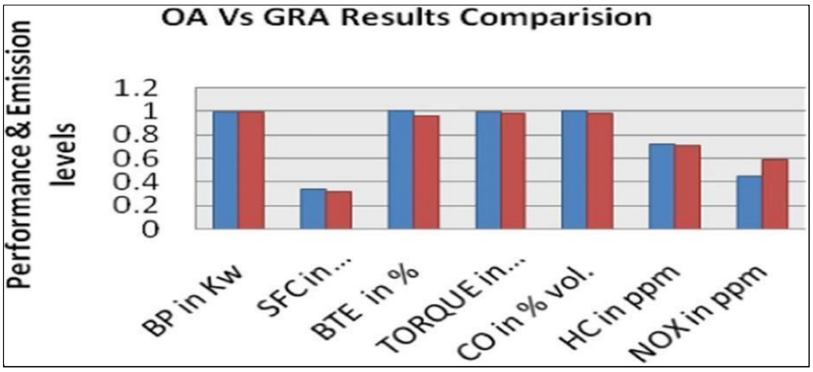
| | | |
|---|---|---|
| HC in ppm | 0.7052 | 0.7239 |
| NOXin ppm | 0.586 | 0.4489 |
| GreyRelationalGrade | 0.8335 | 0.7846 |

ImprovementinGrey relationalgrade=0.0489.

The diesel engine combustion takes place in the combustion chamber in three stages, namely, ignition delay period, rapid combustion and controlled combustion. In that, ignition delay periodimplieshigherinfluenceindieselenginecombustionprocess.Thedelayperiodstageis divedintochemical delayandphysical delay.Thephysicaldelaycanbecontrolledbyvarious factors such as fuel atomization, raise in pressure and temperature etc., The cylinder pressure and temperature rise depends upon speed and load of the engine. So the variation of speed changes from 1480rpm to 1460rpm at same load condition. The power output of engine BP and specific fuel consumption has slightly decreased and it is showed in the grey prediction designfactorlevel(A3B3C1)resultsinFig. 11.Thethermalconductivityofcopperchromium and zirconium catalytic cooper alloy material is higher, so the chemical reaction starts faster andthenfurtheracceleratestohighercombustionratebymeansofcatalystmaterialandhence ignition delay period is reduced and complete combustion takes place in the second stage of rapidcombustion.Thecombustionisfurthercontrolleduptothethirdstagewhenfueldroplets areinjectedtillend.Duetothecompletecombustion,theCOandHCemissionisreducedand NOx increases because of high heat flame temperature.




OA Vs GRA Engine Performance and Emission Comparison Results- It indicated the GRA prediction parameters experiment and showed better results in engine performance in SFC, Torque, CO, and HC emission.

Basedontheconfirmationexperiments,onceagaintheverificationexperimentsareconducted for comparing the results of both coated and un-coated engine. Based on the optimum parameterconditionB20blendeddieselfuel,100%loadand1460rpmwasmaintained,and



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thenewresultsaretabulatedinTable13.Basedontheexperimentaltestcoatingofpistonalong with bio diesel has resulting the reduction of CO and HC emission of a diesel engine because thecoatingandbiodieselleadstoincreasedwallheatlossesandlowerwalltemperaturelevels. Therefore, the objective of the research work has been fulfilled.

**Table13ComparisonofUn-coated-DieselEngine(BaseEngine)WithCoated-biodiesel Engine.**

| **ResponseParameters** | **Un-Coated Engine run with diesel fuel** | **CoatedEnginerunwith biodiesel fuel** |
|---|---|---|
| BP in KW | 3.3 | 3.3 |
| BSFCinKg/kw-hr | 0.36 | 0.38 |
| BTE in % | 23.54 | 26.68 |
| Loadinkg | 11.8 | 11.8 |
| Speedinrpm | 1460 | 1460 |
| CO in %Vol. | 1.01 | 0.01 |
| HC in ppm | 30 | 20 |
| NOXin ppm | 45 | 55 |
| **ResponseParameters** | **Un-Coated Engine run with diesel fuel** | **CoatedEnginerunwith biodiesel fuel** |

Thecylinderpressureandheatreleaseratewasvariesdependinguponcrankangleat1460rpm speed and 11.8kg load of a engine for coated engine as shown in Fig. 12. The maximum cylinderpressuredevelopedincoatedengineis62bar.Thecumulativeheatreleaseforacoated engine is 0.95 KJ and it is shown in Fig. 13.



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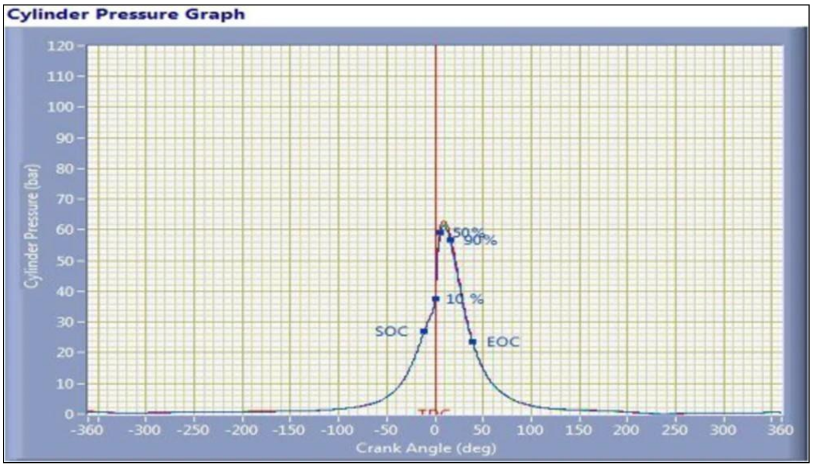


**Figure 12 -** Cylinder Pressure Vs Crank Angle Plot –The image taken through “Engine LV Software” it indicates the maximum cylinder pressure and start and end of combustion with respect to crank angle (p-Ɵ diagram)

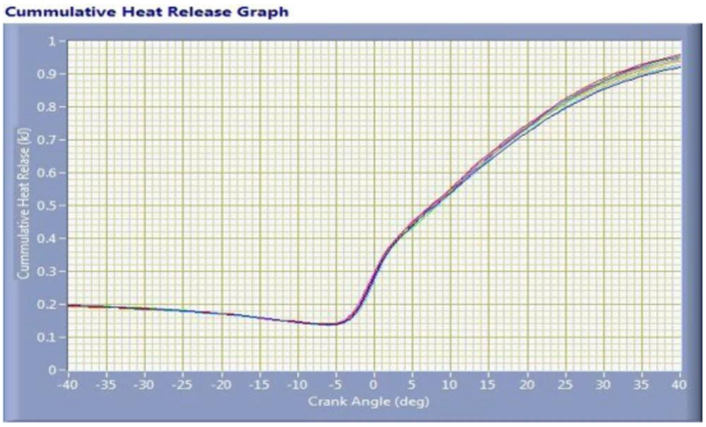


**Figure 13 -**Crank angle Vs Cumulative Heat Release Plot- It Indicates heat release rate with respect to crank angle.

Ponnusamy*et al*.7investigated the effect of copper coating copper gives improved performance and reduces emission, due to rapid flame propagation and catalytic activation of catalyticcoatingmaterialpresentintheenginepistonandcombustionchamberwhichleadsto reduce the CO and HC emission. Similarly in this investigation the coated engine showed reduction of CO and HC emission marginally. It is shown in Fig. 14.



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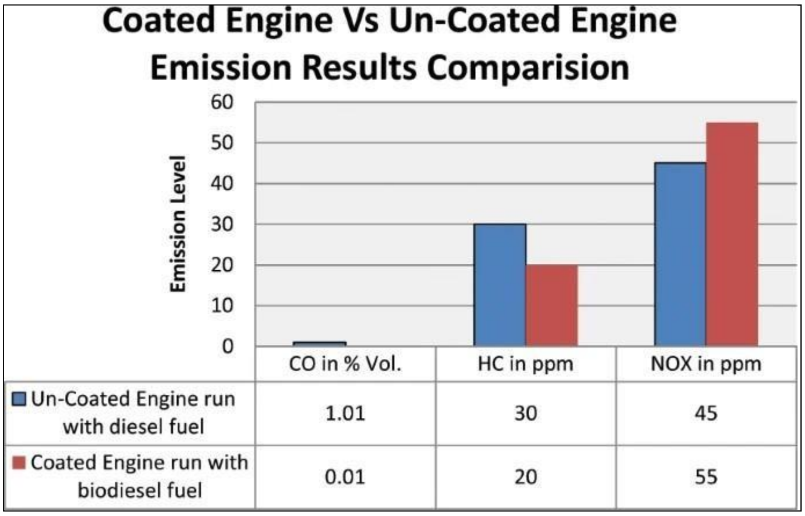


**Figure 14-**Coated and Un-Coated Engine Emission Results Comparison Plot. The plot Indicates CO and HC emission drastically reduced and Nox Increased due to high engine temperature operating conditions.

Microstructureofcoatedpiston

The scanning electron microscope (SEM) piston coating image is shown in Fig. 15. The aboveimageistaken afterrunningtheexperimentaltest.Thegrainstructureisvaryingfrom 10–20μm. In this image, some cracks are noticed on the top surface of piston coating area, anditisindicatestheimpactofthermomechanicalstressesdevelopedduringtheworkingof engine. The presence of carbon particle on the black colored surface indicates the result of combustion and it is also noticed that bond coat and catalytic alloy coating material are attached firmly. There is no indication of peeling or melting of coating of top surface of the piston crown due to high engine temperature induced at the peak of combustion.

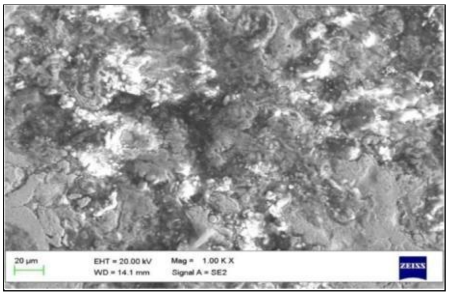


**Figure15-**SEMimageIndicatessomecracksformedaftercombustioninthecoatedpistonand no peeling of coating. Grain structure is varying from 10–20μm, Magnification: 1.00 K X.

Conclusions

Acopper-chromium-zirconiumalloycoatedpistontypeICengine'sperformanceandemission characteristicshavebeenoptimizedextremelywellusingTaguchi'sGRAapproach.Fuel,Load, and Speed are the three variables that enhance performance and lower emissions. The fuel is mixeddieselmadewithcottonseedoil,andtheresultsarecontrastedwiththoseofpurediesel. OnthebasisoftheL9orthogonalarray,experimentsarecarriedout,andtheengineparameters



ISBN:978-81-957858-1-0

are optimised using the Taguchi-GRA experimental design approach.In the current study, the multi response (seven replies) optimization problem is reduced to a single response problem usingtheTaguchi-GRAexperimentaldesignapproach.AccordingtotheGRGresults,theideal conditions for a diesel engine with a copper chromium and zirconium catalytic coated piston are B20 fuel, 100% load, and 1460 rpm (A3B3C1).For both coated and uncoated engines, the seven responses—BP, BTh, torque, SFC, CO HC, and NOX—have been identified. Engines coated in copper, chromium, and zirconium have somewhat increased their braking thermal efficiency (BTh) by 13.33%, while CO and HC emissions have fallen greatly by 98.59% and 33.33%, respectively. The piston coating on the copper, chromium, and zirconium alloy material shows that full combustion occurs inside the combustion chamber. Additionally, the NOx emission increased due to the higher engine temperature, and both engines produced the samebrakepower(BP)and no differencein specificfuel consumption (SFC).Cotton seed oil-biodieselcanbeusedasanalternativefuelforregulatingtheCOandHCemissionsofadiesel engine instead of diesel fuel since it performs better when used in coated engines that are powered by blended diesel (B20) fuel.



ISBN:978-81-957858-1-0

**PowerGenerationSystemforBikefromWasteHeat**

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## Abstract

Theprimarypointofthistaskistofosteralotofcleanercommotionlesssavvydifferentmethod offorce age technique forchargingthebattery as wellastouselegitimatejusttheprerequisite ofutilization,whichservestodecreasestheanEarth-widetemperatureboostaswellasdiminish the power deficiencies, load shedding and furthermore we can move the compact producing unit. In this undertaking the transformation of waste intensity into produce power by utilizing thermoelectricgenerator.Wastemaycoolerintensity,vehicleradiatorheat,PCheat,evenbody intensity can be utilized as an information source as a waste intensity to create power and it tends to be charged straightforwardly portable battery and furthermore put away in a battery-powered lead corrosive battery for additional utilization. And furthermore, squander energy human body movement additionally produce power body weight motion of the energy in to electrical energy by utilizing electromagnetic acceptance standard.

**Keywords**:Heatexchange,SeebeckGenerator,ThermoelectricEffect,ThermalConductivity, Waste Heat Usable

## Introduction

Because of the flood in ecological worries and the expansion in protection efforts, energy reapingresearchhasencounteredaresurrectionsomewhatrecently. Sensationalforwardleaps in accessible materials have additionally set out open doors for new uses of waste intensity energy collecting gadgets. In 1821 Thomas Seebeck found the Thermoelectric, or Seebeck, effect, which expresses that when the intersection of two unique metals is warmed there will beapotentialdeferenceacrossthemgivenby$V=S\Delta T$,whereVisthevoltage,SistheSeebeck coefficient, and $\Delta T$is the temperature deference. Thermocouples are temperature sensors that use this effect by having two different metals fastened together. Related to a different temperature reference, the temperature is then perused by scaling the result voltage. Thermoelectric modules make it a stride further and associate different thermocouples made out of P and N type thermo components together electrically in series and thermally in equal, asshouldbevisibleinFigure1.Thermoelectricmoduleshavefundamentallybeenusedrelated to the Peltier effect, which is something contrary to the Seebeck effect, as cooling gadgets in viewofthelowefficienciesofthemodules.Inanycase,withtheaccessibilityofdopedbismuth telluride for use in thermoelectric modules, the efficiencies have ascended to a level fit for makingreasonablewasteintensityenergyreapingframeworksthatutilizationtheSeebeck



ISBN:978-81-957858-1-0

effecttocreateelectricpowerfromatemperatureslope.Accordingly,thermoelectricgenerators (TEGs) are being tried for use in different applications in efforts to lessen moving parts, increment portability, decline weight, and increment fuel efficiency.

A significant application that has been getting a lot of consideration as of late is the utilization of TEGs as waste intensity energy collectors for gas powered motors. Haidar and GhojeltriedaTEGbuiltonthefumeslineofadieselmotor.UtilizingfourHelloZInnovation, Inc. HZ-14 modules and dynamic fluid cooling they accomplished 42.3W of electric result from a temperature slope of 237 $^{0}$ C.

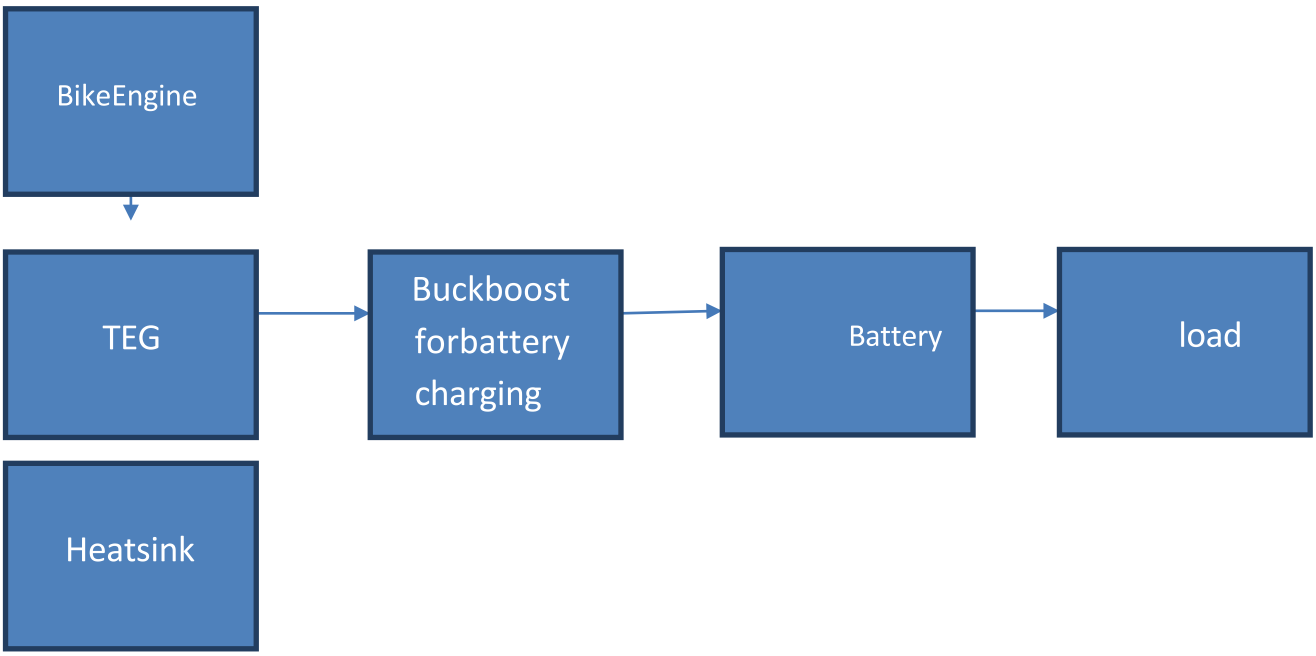
BLOCKDIAGRAM&WORKINGPRINCIPLE

**WorkingPrinciple**:

Power age the intensity at external side up to 100oc in climate so it tends to be utilized aspowerageso weusedtochangingintensityenergyovercompletelytopowerasTEGinthe abovefigTEGonesideputtheintensitysinkandcoolingfanwhichventilatingthetransformer so this fan working the twofold capability first as transformer cooling other one is TEG heat sink temperature marinating.

After the age of power we stepped that energy in the battery through the charged regulatoraschargedregulatorweutilizedthebucksupport.batteryusedtocapacityenergythis battery can supply power to the cooling fan as displayed in block outlineso that can assist the free ventilation power to the transformer no less than 60% energy with canning decreased the transformer cooling waste and furthermore the as per newton regulation energy might not be contorted just it at any point move to one framed to another structure so agreeing decide we planned that venture so it advantageous in future.

Blockdiagram:



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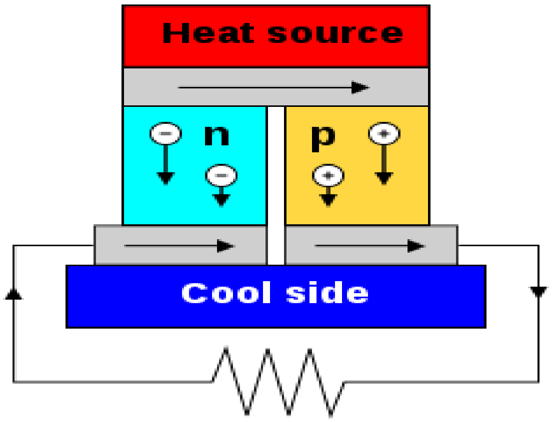
TEG(ThermoelectricGenerator):

**Workingprinciple:**

Athermoelectricgenerator(TEG),likewisecalledaSeebeckgenerator,isastrongstate gadget that converts heat motion (temperature contrasts) straightforwardly into electrical energy through a peculiarity called the Seebeck (a type of thermoelectric impact). Thermoelectric generators capability like intensity motors, yet are less cumbersome and have nomovingparts.Notwithstanding,TEGsareregularlymorecostlyandlessproficient.As




displayedinfig.

Fig:PrinciplediagramofTEG

Thermoelectricgeneratorscouldbeutilizedinpowerplantstochangeoversquanderheat into extra electrical power and in cars as auto thermoelectric generators (ATGs) to increment eco-friendliness. Another application is radioisotope thermoelectric generators which are utilized in space tests, which has a similar system however use radioisotopes to produce the expected intensity distinction.

Thermoelectric materials produce power straightforwardly from heat by changing over temperature contrasts into electric voltage. These materials should have both high electrical conductivity ($\sigma$) and low warm conductivity ($\kappa$) to be great thermoelectric materials. Having lowwarmconductivityguaranteesthatwhenonesideismadehot,theoppositesidestayscold, whichassistswithcreatinganenormousvoltagewhileinatemperatureslope?Theproportion of the greatness of electrons stream in light of a temperature distinction across that material is given by the Seebeck coefficient (S). The proficiency of a given material to create a thermoelectric power is represented by its "figure of legitimacy" $zT = S2\sigma T/\kappa$

For a long time, the really three semiconductors known to have both low warm conductivityandhighpowerfactorwerebismuthtelluride($Bi_2Te_3$),leadtelluride(PbTe),and silicon germanium (SiGe). These materials have exceptionally intriguing components which make them pricey mixtures.

Today,thewarmconductivityofsemiconductorscanbebroughtdownwithout



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influencingtheirhighelectricalpropertiesutilizingnanotechnology.Thiscanbeaccomplished bymakingnanoscaleelementslikeparticles,wiresorconnectionpointsinmasssemiconductor materials. Notwithstanding, the assembling cycles of nano-materials is as yet testing.

A thermoelectric module is a circuit containing thermoelectric materials that produce power from heat straightforwardly. A thermoelectric module comprises of two disparate thermoelectric materials participating in their finishes: a n-type (adversely charged); and a p-type(decidedlycharged)semiconductors.Animmediateelectricflowwillstreaminthecircuit when there is a temperature distinction between the two materials. By and large, the ongoing extent has a corresponding relationship with the temperature contrast. (i.e., the more the temperature distinction, the higher the current.)

In application, thermoelectric modules in power age work in extremely extreme mechanical andwarmcircumstances.Sincetheyworkinexceptionallyhightemperatureangle,themodules are liable to huge thermally prompted anxieties and strains for significant stretches of time. They likewise are dependent upon mechanical weakness brought about by huge number of warm cycles.

Subsequently, the intersections and materials should be chosen with the goal that they endure these intense mechanical and warm circumstances. Likewise, the module should be planned with the end goal that the two thermoelectric materials are thermally in equal, yet electrically in series. The proficiency of thermoelectric modules are extraordinarily impacted by its mathematical plan.

Wastageheatfromindustry:

Itisassessedthataround3,143TBtuofenergyissquanderedeveryyearinhugenumbers ofcyclesutilizedintheU.S.fabricatingarea(barringnearbysteamandelectricenergyageand conveyance losses). A huge part of this energy is depleted into the climate as waste intensity.

A critical part of waste intensity is contained in gases which are released at ~300° F, despite the fact that the heater or cycle conditions that are the wellsprings of the releases might be working at significantly higher temperatures. In countless modern cycles, a lot of weakening airareadded to lessen thetemperatureoftheblended exhaust to decreasecapital and working costsinpipeframeworktasks.Inmanyexamplestheweakeningairisaddedanextremelybrief separationfromtheheaterorcycleexhaustports.Accordingly,high-gradeheatistransformed into poor quality intensity. Successfully, the channel lengths or "home times" for which the exhaust stays a wellspring of excellent intensity are exceptionally short. Temperatures in the scope of 300° F address extremely bad quality intensity and no economically suitable method for recuperating this intensity is accessible (Area momentarily examines a future innovation, piezoelectric age, which might be material at these temperatures).

Many assembling ventures offer a few enormous open doors for energy recuperation. Aluminum, glass, metal projecting and steel, all have interaction heaters releasing high-temperaturesquanderheatburninggasesandsoftenpoolgases,(forexample,aluminum



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~775°Candglass~1,425°C).Incertainbusinesses,thisintensitycanbeutilizedtoraisesteam, preheat unrefined components or burning air, or be coordinated with different cycles at the assemblingsite.However,indifferententerprisestherearerestrictedanopendoortoreusethis nuclear power. This makes TEG power appealing to these enterprises.

The chance to recuperate squander intensity ought to be huge in metals enterprises additionally which utilizes various intensity therapy heaters (with generally clean vent surges of ignition gases just) and in synthetic industry, where process radiators are broadly utilized (direct-terminatedreboilers,reactors,andsoon.).Extrawasteintensityopendoorsexistinlime furnaces, concrete ovens, and so on.

ADVANTAGES

1. Simpletoconstructionandinstallation.

2. Saveenergy.

3. Newrenewablesource generated.

4. Engineefficiencyincreases.

CONCLUSION

1. Thisprojectmeanstotrackdownapotentialmethodforrecuperatingthewasteintensity fromtheexhaustofI.C.motoraswellastoplanandmanufactureonesuchframeworktoserve the point.

2. Experimentally it is found that when two thermoelectric generators are associated in series. This produced power either straightforwardly used to run afew helper gadgets of a car or might be put away in the battery and utilized later.

3. These assistant burdens can be enhanced from battery to this framework consequently lessening load on alternator.

4. The concentrate likewise examines the impact of motor speed on temperature distinction and voltage produced.

5. Themotorexecutionisunaffectedbytheplannedframeworksinceheatextricatedfrom the outer layer of the curve line of the ventilation system which doesn't impacted the working of motor. In the event that higher temperature range is required, TEG module should be changed to higher temperature range (200˚C). Subsequently, the above expressed framework might be effectively executed in various auto motors, with slight changes.

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ISBN:978-81-957858-1-0

**SmartLockFrameworkUtilizingRFIDwithLightComputerization**

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**Abstract**

Astheworldismovingintoshrewdinnovationsrefreshingoursecurityframeworkinabrilliant way is vital. A savvy home is a house or building furnished with an exceptionally organized linkthatpermitsinhabitantstocontrolfromadistanceordriveraprogressionofcomputerized home electronic gadgets by essentially entering a solitary order. So at this point we have so many lock frameworks like conveying the key and setting the secret word for opening the entryway. In the above case on the off chance that we lost our key, we really want break our lock and another thing is we want careful about the burglaries. To beat the downsides of old locking framework for the shrewd home we are presenting the Arduino Solenoid Lock EntrywayutilizingRFID.ThislockframeworkisconstrainedbyArduinoUnoMicrocontroller midway. Microcontrollers recognize the result of Radio Recurrence ID (RFID) and microcontrollerwillgiveareactionwhenitdistinguishestheresultfromthesensors.Areaction givenbythemicrocontrollerwillcontroltheSolenoid.Alongsidelockingframework,utilizing sensorswillgivelightcomputerizationbyrecognizingchangemovingofthebody.Number of sensors utilized relies upon the prerequisite to turn ON lights in various rooms The entryway will open if the information/secret phrase of RFID will be coordinated. The entryway won't open without RF card it will just open by RF card, subsequently it is the main key to open the entryway which implies profoundly got.

**Keywords:**RFID,Arduino,sensor,OLED

## Introduction

A solenoid lock deals with the electronic-mechanical locking component, when the power is applied, DC makes an attractivefield that movestheslug insideand keeps theentryway in the opened position. RFID, Radio Recurrence Distinguishing proof is an essential and reasonable innovation that empowers remote information transmission. Security frameworks will also be integrated with movement sensors to recognize the presence of outsiders in house. sensors utilized IR or ultrasonic sensors. Whereas in proposed framework, will execute the entryway securityframeworkutilizingRFIDtoopenthedoor.Securityframeworklikewisecoordinated with computerizing light frameworks which helps in room lighting. The framework will naturally turn on lights at whatever point an odder goes through it, whose development identified by IR sensor.



ISBN:978-81-957858-1-0

## II. SmartLockFrameworkUtilizingRFIDwithLightMechanization

The well known method of entryway lock framework is utilizing locks followed by keys. In mechanical perspective, Keypad got locks are existed. This framework includes more actual appearance and not successful. Likewise, there is a burden in utilizing Keypad safeguarded lockssince,supposingthatanyindividualnoticesenteringsecretphraseguilefullyuncertainty might emerge. Along these lines, by simply utilizing RFID innovation without Keypad safeguarded lock and by giving access just to RFID cards or labels will increment adequacy with less actual appearance.

**<u>ProposedStrategy</u>**

-  To beat the disadvantages of past lock frameworks and increment the viability of the framework to lock and open. RF card is utilized to confirm the RFID which immediately execute the activity.
-  ARDUINOmicrocontrollerwillcontrolthewholesituationwithenergyreinforcement framework.
-  Additionally, the IR sensor used to turn on the lighting arrangement of the home by recognizing presence of individual.

BlockDiagram:

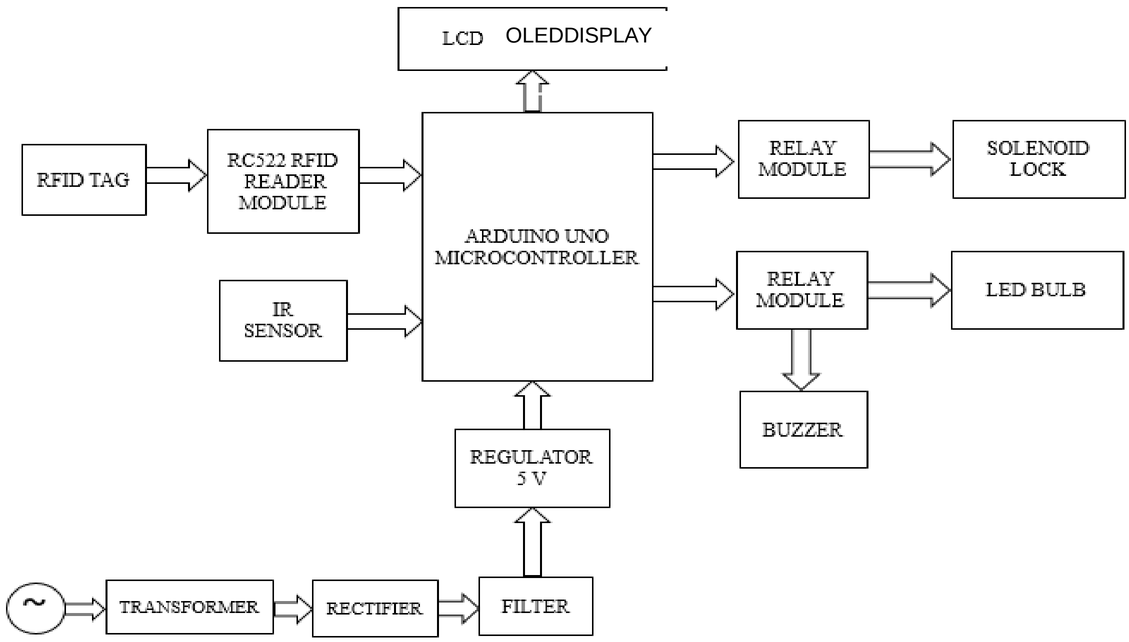


**Fig:1BlockchartofshrewdlockframeworkutilizingRFIDwithlight computerization**

Thisisthestrategywefollowedtokeepthesecurityhigh,whereeveryoneoftheparts



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associatedwithArduinounomicrocontroller,itwillworkthewholesituationandcontrolfrom midway. Thecode is created and composed according to the result prerequisite. In this way, a fewcardsweregivenadmittancebyperusingthecardsclosetoRFIDmoduleandincludingthat object information into codeperforms information match and datais shipped off Arduino uno microcontrollerchecksregardlessofwhetheritisrememberedforthecode,intheeventthatit matchesitwillgiveadmittancetothatcard.ThemessagelikeAccessAllowedwillbedisplayed on the OLED show.

Whole framework is furnished with power supply for working of electronic gadgets. Notwithstanding, when access conceded the transfer module associated with solenoid lock from Arduino uno gets high and assists in working of solenoid with locking. One more hand-off module associated with Drove which will turn ON just when IR sensor associated with Arduinounogets highbydiscoveryofamoreinteresting,inputisgiven fromIR sensorto get transfermodulehigh.IRsensorsisutilizedinviewofprerequisitethatthenumberoflightswe that need to turn ON. This strategy is extremely helpful in conservating energy because of purpose of lights within the sight of people as it were. At long last, on the off chance that an off-base card is put to open lock ringer will blare the sound that we can caution immediately, assuming that we lost our RFID card it tends to be hindered and protest information can be taken out from the code.

SchematicDesignofProposed work

This schematic plan addresses the specific equipment pin to stick associations with draw out the framework function true to form This model can be utilized for the security locking purpose.It can be utilized for home entryway locking, bank storage spaces, inns and condos.

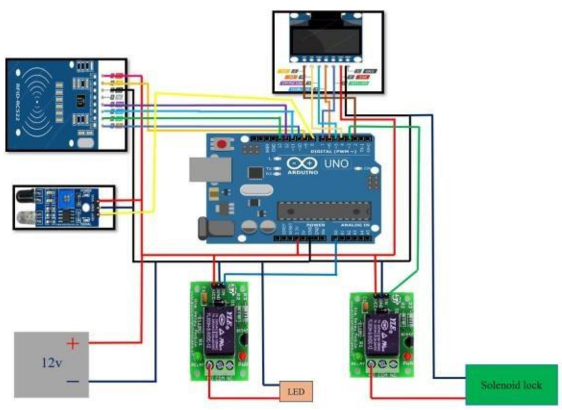


Fig:2SchematicImplementation

## I. DESCRIPTIONOFHARDWARE

ArduinoUno



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Arduino comprises of both an actual programmable circuit board (frequently alluded to as a microcontroller)andapieceofprogramming,orIDE(IncorporatedImprovementClimate)that sudden spikes in demand for your PC, used to write,and transfer PC code to the actual board. ArduinoUnoisthemostfamousandgenerallyutilizedadvancementboard. Itis controlledby an ATMega328P microcontroller. All parts are associated with this Arduino to make each electronic gadget work on required activity and in time span

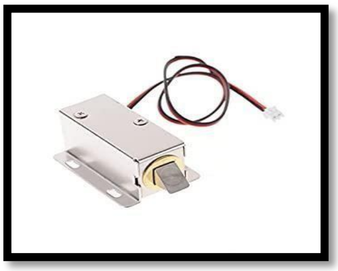
Fig:3ArduinoUnoMicrocontroller

**RFIDReader**

Radio Recurrence Distinguishing proof (RFID) alludes to a remote framework contained two parts: labels and perusers. The peruser is a gadget that has at least one recieving wires that radiate radio waves and get signals back from the RFID tag. The RFIDperuserisanorganizationassociatedgadgetthatcanbeconvenientorforalltime connected. It utilizes radio waves to communicate signals that actuate the tag. When enacted, the tag sends a wave back to the radio wire, where it is converted into information.ThetransponderisintheRFIDlabelitself.ThesesignsmovedtoArduino uno which controls the activity of locking system.

**Solenoid Lock**

The 12V DC solenoid lock is utilized for locking sell-machine, capacity rack, file organizer andsoon.Thesolenoid12Vlockfillsinasthecircuitsdetaches,anditwillopenasthemoment power-on.The solenoid lock includes an enemy of robbery and shockproof plan, the lock is better compared to different sorts of locks.The solenoid entryway lock furnishes a minimal expensearrangementwithanexceptionallyhighlockingpowerofnolessthan1.600N.A



solenoid is a little electromagnet that pushes or pulls an unclogger that can work a capability. Forthissituation,itholdsthestrikeopeningshutorpermitsthestrikeopeningtoopenup,



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subsequentlypermittingtheentryway'slockhook toopenwithout thelockbeing withdrawn.

Fig:5Solenoid Lock

**Buzzer**

Ringer otherwise called a sounder, sound caution or sound pointer, a bell is a fundamental sound gadget that produces a sound from an approaching electrical sign. Ringers come in two essential structures piezo signals and attractive bells. The motivation behind utilizing this ringer to make sound when RFID card is confounded that we can caution.

Fig:6 Buzzer

**OLEDDisplay**

OLEDsareutilizedtomakecomputerizedshowsinthegadgets.Weinvolvedthisshowcasein this model to show the entrance allowed or denied when RFID labels or cards set close to per user module. This is useful to realize that whether the card we utilized is right or wrong. The presentation is associated with Arduino uno which conveys the message information to show either positioned right card or wrong card.

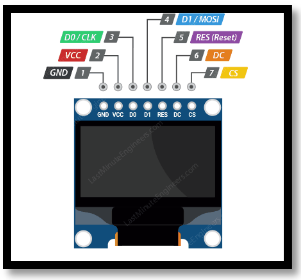


Fig:7OLEDDisplay

**RelayModule**

Hand-offisaswitchwhichcontrols(openandclose)circuitselectromechanically.Theprimary activity of this gadget is to represent the moment of truth contact with the assistance of a sign with practically no humancontribution to turnitONorOFF. It is essentially used to control a powerful circuit utilizing a low power signal. In any case, at the expected activity we make it high to perform essential undertaking which means to make circuit for open and for Drove shine in light of contribution from the Arduino uno



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Fig:8RelayModule

**IRsensor**

To conserve energy this IR sensor is significant on the grounds that it goes about as contribution to lighting framework to turn lights consequently because of presence of an individual it initiates and sends information to Arduino which makes transfer module high which is associatedwithDrovebulb. TheIR sensororinfrared sensoris onesort ofelectronic part, used to recognize explicit qualities in its environmental factors through emanating or distinguishingIRradiation.Thesesensorscanlikewisebeutilizedtorecognizeorgaugethe


intensity of an objective and its movement. In numerous electronic gadgets, the IR sensor circuit is an exceptionally fundamental module. This sort of sensor resembles human's visionary faculties to recognize snags.

Fig:9IRsensor

## II. RESULT

After the schematic plan execution, the gadget was tried for anticipated results. This lock framework is constrained by Arduino Uno Microcontroller halfway. Microcontroller distinguishes the result of Radio Recurrence Recognizable proof (RFID) and microcontroller will give a reaction when it identifies the result from the sensors. A reaction given by the microcontrollerwillcontroltheSolenoid.Alongsidelockingframework,utilizingsensorswill give light computerization by recognizing change moving of the body. Number of sensors utilizedreliesupontheprerequisitetoturnONlightsinvariousroomsTheentrywaywillopen iftheinformation/secretphraseofRFIDwillbecoordinated.Theentrywaywon'topenwithout RFID card it will just open by RFID card, accordingly it isthe main key toopen the entryway which implies profoundly got.

Rightoffthebat,theentrywayopeningframeworkistriedbysettingRFIDcardsclosetoRFID peruser. Weplayoutafewtest results bytaking thecardsunderstanding them andafew them



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enlistedintoArduinounomicrocontrollermemory.Testisfinishedutilizing4RFIDcardsand 1 RFID tag, in that 2 RFID cards and 1 RFID tag were Enrolled in microcontroller memory rest of 2 RFID cards were unregistered. The outcomes from the test acquired as beneath displayed in the table.

TABLE1:RFIDCardsorTagandDoorunlockResponseTestResults

| CardorTagNumber | Response | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Card1 | □ | □ | □ | □ | □ |
| Card2 | □ | □ | □ | □ | □ |
| Tag1 | □ | □ | □ | □ | □ |
| Card3 | x | x | x | x | x |
| Card 4 | x | x | x | x | x |

✓ . Access Granted and Door opensX. Access denied and No response

TABLE2:DetectionDistance RangeofRFIDCardorTagsTest Results

| TagorCards | DistanceRangeofTagorCardsDetection | | | | |
|---|---|---|---|---|---|
| | 1 cm | 2 cm | 3 cm | 4 cm | 5 cm |
| Card 1 | □ | □ | □ | □ | x |
| Card 2 | □ | □ | □ | □ | x |
| Tag1 | □ | □ | □ | □ | x |
| Card | □ | □ | □ | □ | x |



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| | | | | | |
|---|---|---|---|---|---|
| 3 | | | | | |
| Card 4 | □ | □ | □ | □ | x |

This results show that main enlisted tag or cards in the microcontroller memory will justhavetheentrance,unregisteredcardshavenoreactiontowardsopeningtheentrywayand willbedismissed.NexttableshowsthetestresultsaboutthereachrecognitionofRFIDcards or labels and the permitted scope of discovery depends on 4 cm more than this reach RFID peruser can't recognize the card information.

Furthermore,thelightingframeworktestresultswerecheckedand acquired,utilizing 3 sensors and 3 LEDs. Expecting three rooms given by this sensor based lighting framework onesensorisputatclosetoentrywayoflobby,whenentrywayopens,individualenterssensor identifies movement convey messages to Arduino uno which further sends contribution to hand-offmoduletomakeithigh.Theexcesstwosensorsputintheremainderofroomswhen people go into it lights will consequently turn ON.

TABLE 3: LEDs Glow and IR Sensor Input Test Results

| No | IR1 | IR2 | IR3 | LED 1 | LED 2 | LED 3 |
|---|---|---|---|---|---|---|
| | High | High | High | On | On | On |
| | High | High | Low | On | On | Off |
| | High | Low | Low | On | Off | Off |
| | Low | High | High | Off | On | On |
| | Low | Low | High | Off | Off | On |
| | Low | Low | Low | Off | Off | Off |
| | High | Low | High | On | Off | On |
| | Low | High | Low | Off | On | Off |

Finally, the results obtained as shown in above tables were brought from the device by theschematicimplementation. The hardware implantation represents as in below figure.



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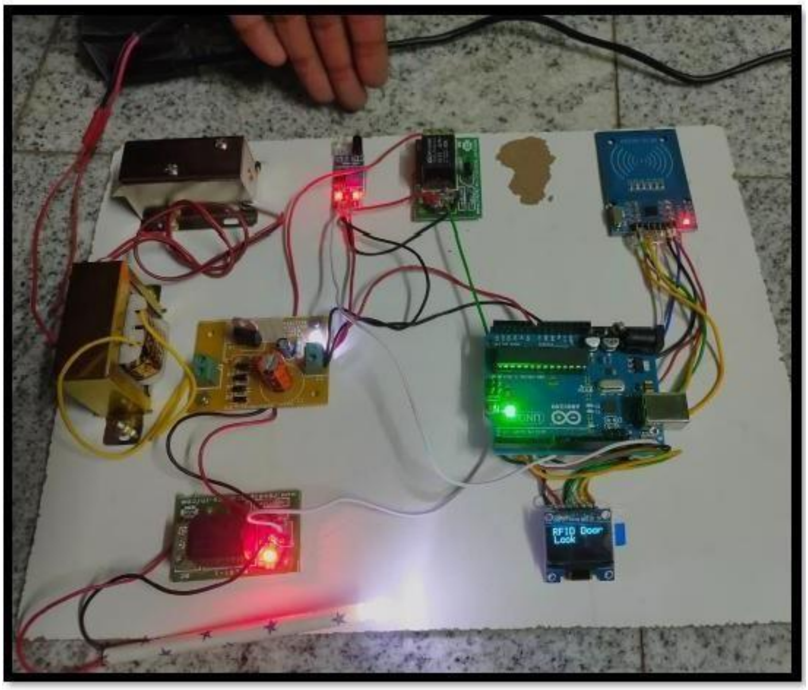


Fig:10SmartlockSystemwithLightAutomationoutput

## CONCLUSION

In this review,wehave carriedout asavvy security frameworkcontains entryway lock framework utilizing detached RFID. A concentrated framework is being conveyed for controlling and exchange tasks. The entryway securing framework capabilities continuously as when the client put the label in touch with the peruser, the entryway openandtheregistrationdataisputawayinfocalserveralongsideessentialdataofthe client. We used RFID innovation to give answer for secure access of a space while keepingrecordoftheclient.TheutilizationoftheArduinoUNOmicrocontrollerinthis venture permits plan straightforwardness, hence, the undertaking can be accomplished in a more limited time than different innovations recently utilized. What's more, this entrywaylockframeworkislikewiseextremelysecureandsavesthedataofRFIDCards or Labels that enrolled in microcontroller memory with the exception of enlisted cards there is no admittance to different cards. Counting a light robotization framework is a mixofsensors,controlsandintendedtoperformlightingcapabilitieswithinsignificant or no human intercession. Adjusting a computerization framework will deliver significant advantages on benefit, energy preservation, creation rate, security, and quality.



ISBN:978-81-957858-1-0

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ISBN:978-81-957858-1-0

# Barkhausen Noise Analysis and its application to analyze the surface integrity after face turning

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## Abstract

Thisthesisworkextendstheunderstandingandtheeffectsofexcitationfieldparametersonthe natureofBarkhausenNoiseprofileinordertoimprovethevalidityofBarkhausenresults.The experiment has been performed on total of four samples of two different steels means two samplesfromeachsteelmaterial.First,allsamplesaresubjectedtoprocessannealingandlater one sample of each steel was face turned in lathe. The Barkhausen test has been performed in two steps; first frequency varies, magnetic field intensity kept constant and second magnetic fieldintensityvaries,frequencyremainedconstant.Thepost-processingBNsignalanalysishas been used to obtain useful profile with zero phase distortion. It has been found that the correlation of noise parameter with frequency has many complications due to eddy current, vibrations and phase lag in applied excitation field, while the nature of Barkhausen signal profile shows correlation with magnetic field intensity and follows an exponential decay function with decay constant depending the material and processhistory. In the second part of the work, Barkhausen noise technique has been applied to analyse the surface integrity of the steelafterfaceturning.Thehighcarbonsteelsampleswerecutintosuitablesizeandsubjected to process annealing. The samples were face turned in lathe by two different tools at four different rotational speeds. The Barkhausen noise parameter depends upon surface residual strainandhardnessonly,sincemicrostructuralchangesarenotexpectedtooccurduringfacing. The hardness and residual strain variation with increasing rotational speeds are unpredictable due to complication involved in machining process. Therefore, the Barkhausen noise parameters obtained on such samples also varied unpredictably. Cutting conditions like tool temperatureandwearfollowinversenoiseparameterforHSStool,whiledirect relationshipforcarbidetool.

## Introduction

Magnetization curves of iron, cobalt, and nickel are shown in figure 1.1. The experimental values of the saturation magnetization $M_s$are given for each metal, but no field values are shownontheabscissa.ThisisdonetoemphasizethefactthattheshapeofthecurvefromM=0 to$M_s$andstrengthofthefieldatwhichsaturationisachieved,arestructure-sensitiveproperties, whereas magnitude of M.



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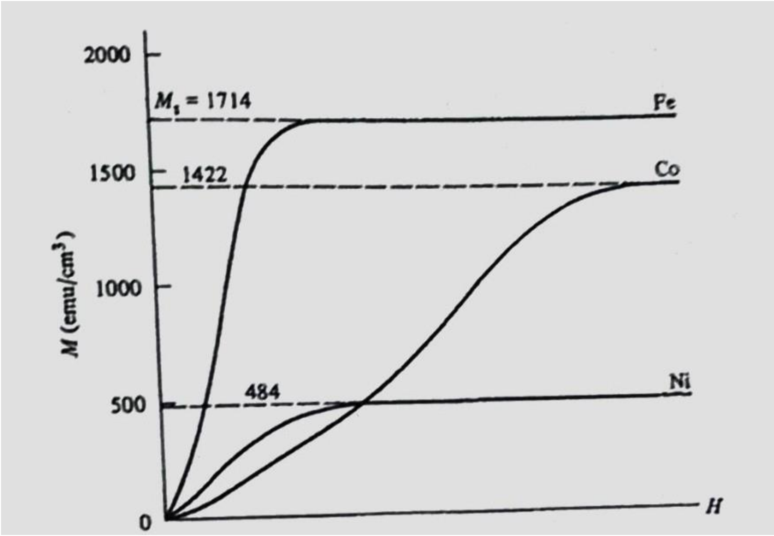


**Figure 1.1:** Magnetization curves of iron, cobalt, and nickel at room temperature (H-axis schematic) [1]

Pierre Weiss in 1906 advanced his hypothesis of the molecular field to better understand the ferromagnetism.Amolecularfieldactsinferromagneticsubstancebelowits Curietemperature aswellasabove,andthatthisfieldissostrongthatitcanmagnetizethesubstancetosaturation even in the absence of applied field. The substance is then self- saturating, or "spontaneously magnetized."

Weiss answered this objection by making a second assumption: a ferromagnet in the demagnetized state is divided into a number of small regions called domains. Each domain is spontaneouslymagnetizedtothesaturationvalue$M_s$,butthedirectionsofmagnetizationofthe various domains are such that the specimen as a whole has no net magnetization. The process ofmagnetizationisthen oneofconvertingthespecimenfrom amulti-domainstateintoonein whichitisasingledomainmagnetizedinthesamedirectionastheappliedfield.Theboundary separatingthedomainscalleddomainswalls.Thismagnetizationprocessisshowninfigure

TheWeiss theory contains two essentialpostulates:

1. Spontaneousmagnetization
2. Divisionintodomains.



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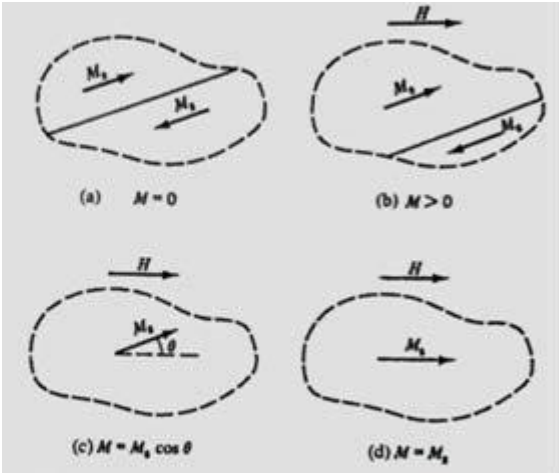


**Figure1.2:**Magnetizationprocessinaferromagneticmaterial.

MagnetostrictionandEffect ofStress

When a substance is exposed to magnetic field, its dimensions change. This effect is called magnetostriction. It was discovered as long ago as 1842 by Joule, who showed that an iron rod increased in length when it was magnetized lenghwise by a weak field. Thus, magnetic inducedstrain:



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$\lambda\lambda = \frac{\Delta l}{l}$

Thevalueofλ measured atmagneticsaturationis calledthesaturationmagnetostriction

$\lambda\lambda_{ss}$,shown in figure 1.3. Magnetostriction occurs in all pure substances.However,eveninstronglymagneticsubstances,theeffectisusually small, typically oforder of$10^{-5}$. IfYoung'smodulus is 30 x $10^6$lb/in$^2$, astrain of $10^{-5}$ would be produced by applied stress of only 2 Mpa.

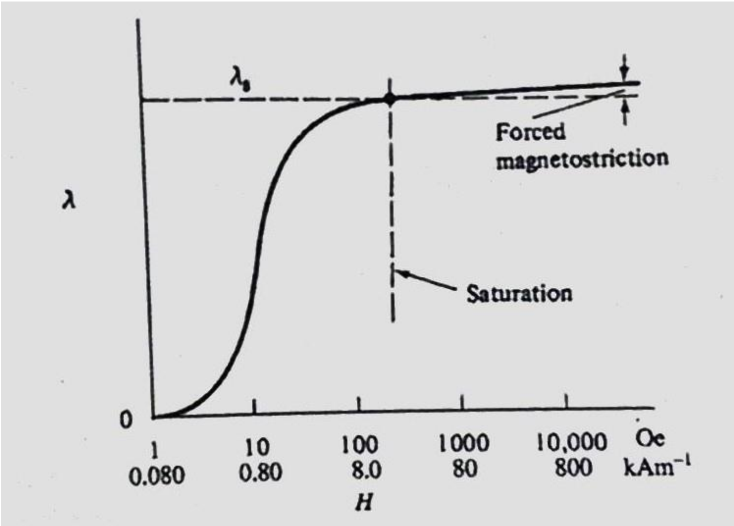


**Figure1.3:**Dependenceofmagnetostrictiononmagneticfield(schematic). Notethat thefield scaleis logarithmic. [1]

Thefieldinducedmagnetostrictioninwhichλchangesfrom0to$\lambda\lambda_{ss}$,iscausedby the conversion of a demagnetized specimen, and made up of domains spontaneously strained in various directions, into a saturated, single-domain specimenspontaneouslystrainedinonedirection.Figure1.4showsonespecial case such conversion, in which the only mechanism of magnetization change is domain wall motion. Magnetization of the iron crystal is accomplished by $90^o$wallmotion,andchangeinlengthofthecrystaldoesoccur.Rotationofthe $M_s$vector of a domain always produces a dimensional change, because the spontaneousmagnetostrictiondependsonthedirectionofthe$M_s$vectorrelative to the crystalaxes.



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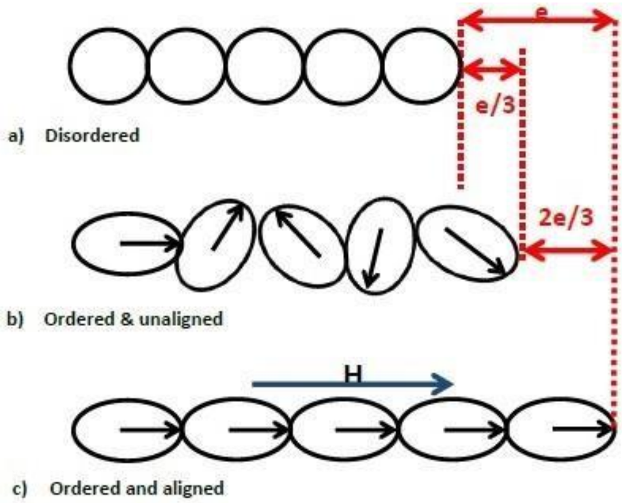


**Figure1.4:** Schematic diagram illustrating the magnetostriction in: a) disordered paramagneticstate,b)demagnetisedferromagneticstate,c)ferromagneticstatemagnetised to saturation [2].

Although the magnetostrictive strain is small in most magnetic materials, the existence of magnetostrictionmeansthatanappliedmechanicalstresscanalterthedomainstructureand creates a new source of magnetic anisotropy. These effects can have a substantial effect on low-field magnetic properties, such as permeability and remanence. For example, if a materialhaspositiveλ,itwillelongatewhenmagnetized:appliedtensilestress,whichtends toelongateit,willthereforeincreasethemagnetization,andappliedcompressivestresswill decrease it. The magnetostriction of polycrystalline iron is positive at low fields, then zero, then negative at higher fields as shown in figure 1.5. As a result, the magnetic behaviour under stress is complicated. At low fields tension raises the B-H curve and at higher fields lowersit.



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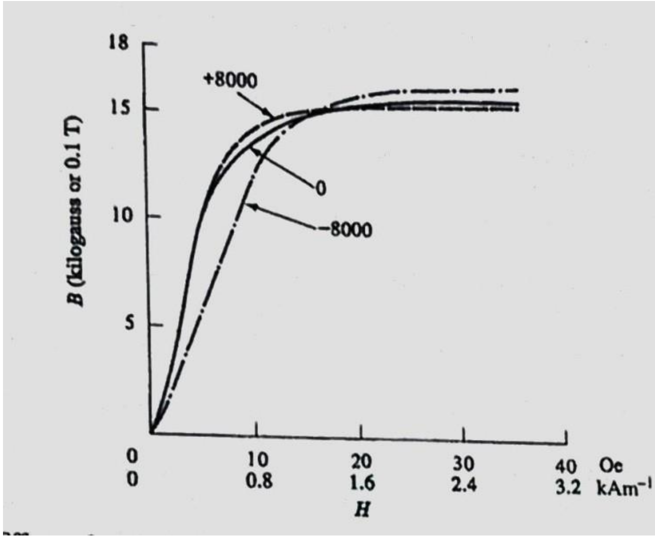


**Figure 1.5:** Effects of applied tensile and compressive stress on the magnetization curve of iron. [1]

When a material is subjected to an alternating magnetic field, the variation of B(orM)withHtracesoutahysteresisloop.Atthesametime,thevariationof λwithHtracesoutanotherloop.Thelatterisactuallyadoubleloop,sometimes calledabutterflyloop,asillustratedinfigure1.6,becausethemagnetostriction strain does not change sign when the field is reversed. The material therefore vibratesat twicethefrequency ofthefield to which it is exposed. Conversely, ifapartiallymagnetized bodyismechanicallyvibrated,itsmagnetizationwill vary in magnitude about some mean value because of the inverse magnetostrictive effect, and this alternating magnetization will induce an alternating emf in a coil wound around thebody.

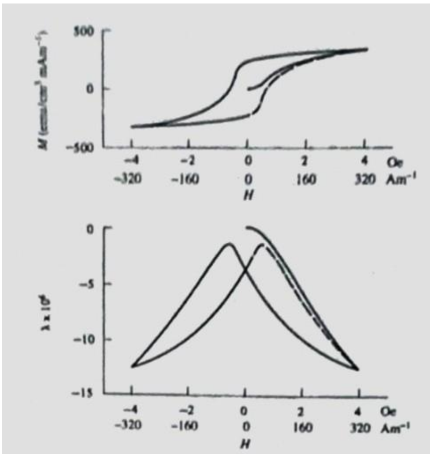

**Figure 1.6:** Hysteresis in the magnetization and magenetostriction of nickel. [3]

DomainWallMotionandBarkhausenEffect



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Domain walls are interfaces between regions in which the spontaneous magnetizationhasdifferentdirections.Atorwithinthewallthemagnetization mustchangedirection,fromoneeasycrystallographicdirectiontoanother.As aresultofthecompetitionbetweentheexchangeenergyandanisotropyenergy, thewallingeneralhasanonzerowidthandadefinitestructure.Also,likeany other interface (such as a grain, twin, or phase boundary), the wall has an energyperunitareaofitssurface,becausethespinsinitarenotparalleltoone anotherandnotparalleltoaneasyaxis.Thefirsttheoreticalexaminationofthe structure of a domain wall was made by F. Bloch in 1932, and domain walls are accordingly often called **Blochwalls**.

Domainwallmovesinresponsetoanappliedfield.Thismotionisobservedto be jerky and discontinuous, rather than smooth. This phenomenon, known as the **Barkhausen effect** [4], was discovered in 1919 and can be demonstrated with the apparatus shown in Figure 1.7(a). A search coil is wound on a specimenandconnectedthroughanamplifiertoaloudspeakerorheadphones. Thespecimen is then subjectedto asmoothly increasing field. Nomatterhow smoothly and continuously the field is increased, a crackling noise is heard from the speaker. If the coil is connected to an oscilloscope, instead of a speaker,irregularspikeswillbeobservedonthevoltage-timecurve,asshown infigure1.7(b).ThesevoltagespikesareknownasBarkhausennoise.Theemf producedinthesearchcoilisproportionaltotherateofchangeoffluxthrough itordB/dt.ButevenwhendH/dtisconstant,andevenonthoseportionsofthe B-Hcurvewhicharepracticallylinear,theinducedvoltageisnotconstantwith time but shows many discontinuous changes. The effect is strongest on the steepest part of the magnetization curve and is evidence for sudden, discontinuous changes in magnetization, shown in figure 1.8(c). The Barkhauseneffectisevidencefortheexistenceofdomains,anditwasthefirst evidenceinsupportofWeiss'hypothesisof13yearsearlier.

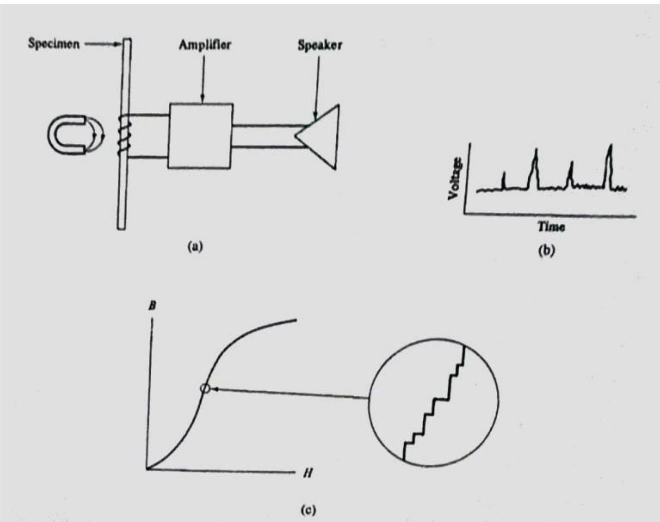




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**Figure1.7:**Barkhauseneffect(a)setup,(b)jerkymotion,and(c)voltage-time graph.

Magnetization can change as a result both of domain wall motion and domain rotation. Wallmotionisthemainprocessuptoabout“knee”ofthemagnetizationcurveshownin figure 1.8. From there to saturation, rotation predominates; in this region work must be doneagainsttheanisotropyforces,andaratherlargeincreaseinHisrequiredtoproduce a relatively small increase in M. This division of the magnetization curve is rather arbitrary, because wall motion and rotation are not sharply divisible process. In fact, at any one level of M, wall motion may be occurring in one portion of a specimen and rotation in another. And in certain orientations of a single-crystal specimen relative to the applied field, wall motion and rotation can occur simultaneously in the same part of the specimen. When magnetization occurs entirely by domain rotation, we expect the processtobereversible,withsameB-Hcurvefollowedinbothincreasinganddecreasing fields. Domain wall motion in real materials is irreversible, leading to different curves for increasing and decreasingfields.

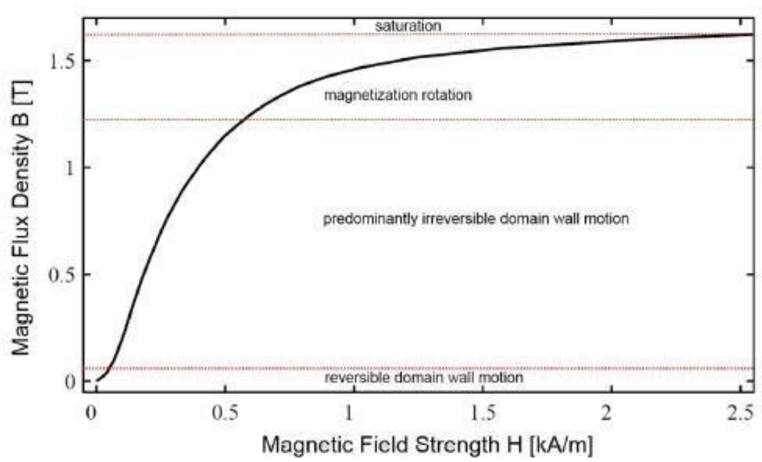


**Figure1.8:**Magnetization processshowing domainwallmotionandrotation. [5]

Factorsaffectingthe Noisesignal

- **Frequency:** The frequency of theAC voltage applied to the magnetizing coil, whichdeterminesthepenetrationdepth.Thesensorissensitivetogreaterdepths ifalowerfrequencyisused.Highfrequenciesinduceeddycurrentsthatdampthe signal as already explained. Higher frequency also causes vibration due magnetostriction.
- **Applied magnetic field intensity:** The sensor varies the amount of electrical current passing through the magnetizing coil, and therefore the strength of the externalmagneticfield.Thefieldshouldbestrongenoughthatthehysteresisloop is relatively large, but not so strong that it saturates thesample.



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- **Materialproperties:** Differentmaterialsreactdifferentlytoanapplied magneticfield. As the part material changes, so does its hardness, grain size, magnetic permeability, and electrical conductivity (figure 1.11 and figure1.12).

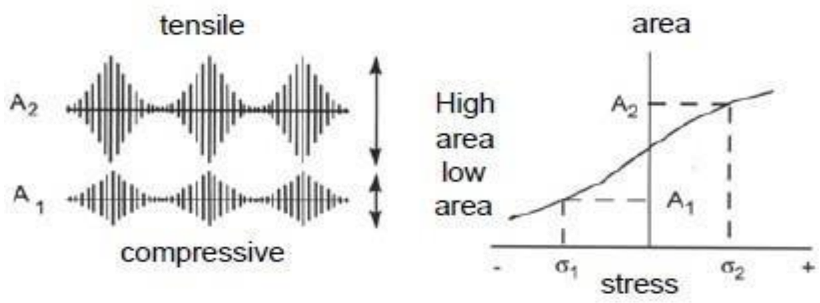


**Figure1.11:**Effectof residualstress onBNA. [6]

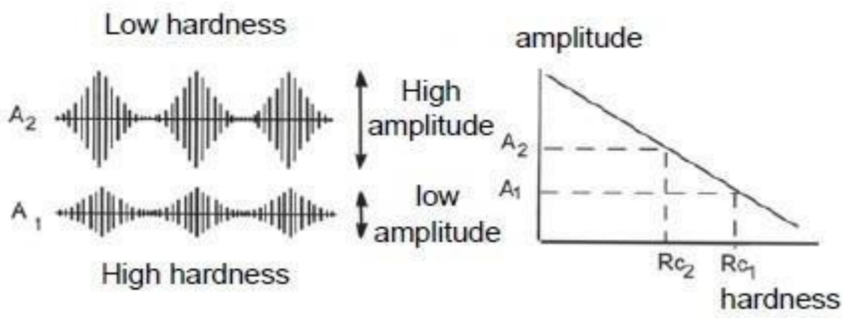


**Figure1.12**:Influenceof hardnessoncharacterof Barkhausennoise.[6]

- **Texture/Surface finish:** The surface finish is usually neglected, because it is similar enough for each of the parts to be considered approximately thesame.
- **Grain size:** Grain boundaries may impede the movement of domain walls, and therefore change the shape of the hysteresis curve.The Barkhausen effect is also responsive to the location, size, and type of carbide precipitates. Typically this is assumed to be aliased withotherfactors,especiallythematerialtypeandhardness.However,fortheseexperiments, itshouldbenotedthatwhitelayergeneratedathigherspeedsiscoarserthanthatgeneratedat



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lowerspeeds.

▪ **Chemical composition:** At high machining speeds, the chemical composition has been showntobethesameasthebulkmaterial,mostlikelybecausethecarbondoesnothavetime todiffuse.Incontrast,atlowermachiningspeedssignificantcementitepresencewasfoundin white layers. These differences are explained by the occurrence of phase transformation at higher machiningspeeds.

▪ **Inclusions:**Inclusionsaffectthesensorresponsebecausetheyhavedifferentpropertiesthan the bulk material. Inclusions may affect the overall permeability, hysteresis loss, and coercivity of thematerial.

**Cutting temperature:** Higher machining speed causes greater thermal loads on the workpiece surface. This alters some of the primary properties that affect the Barkhausen response, especially the grain size and possibly the chemical composition.

Materialand Methods

Process annealing was performed to relieve internal stress on total of four discs of 140 mmdiameterand15mmthicknessundertheconditionshowninTable4.1.Outoffour, twodiscs(PA1andPAM1)areofsteel211BHNandtwo(PA2andPAM2)areofhigh carbon steel 187 BHN. One disc, from each steel type (PAM1 and PAM2), was subjected to facing in lathe, shown in figure 4.1, by tool with CVD coating of **TiN- TiCN-$Al_2O_3$-TiN**(figure 4.2), whose designation is shown in Table 4.2, with experimentalcondition.

**Table4.1:**Process annealing condition.

| Heating | Holding | Cooling |
|---|---|---|
| Heatedinfurnace upto 600$^o$C. | Held at that temperature for 45 minutes. | Cooled in furnace. |

**Table4.2:**Facingcondition.

| | |
|---|---|
| **Tool** | Insert designation: DMMG150608TN200 Holder designation: PDJNR 2020 K15 WIDAX |
| **Operation** | Dryfacingin3 passes. |
| **Cutting parameters** | RPM=1000,feed =0.227mm/rev, DoC = |



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| | |
|---|---|
| | 0.2 mm. |

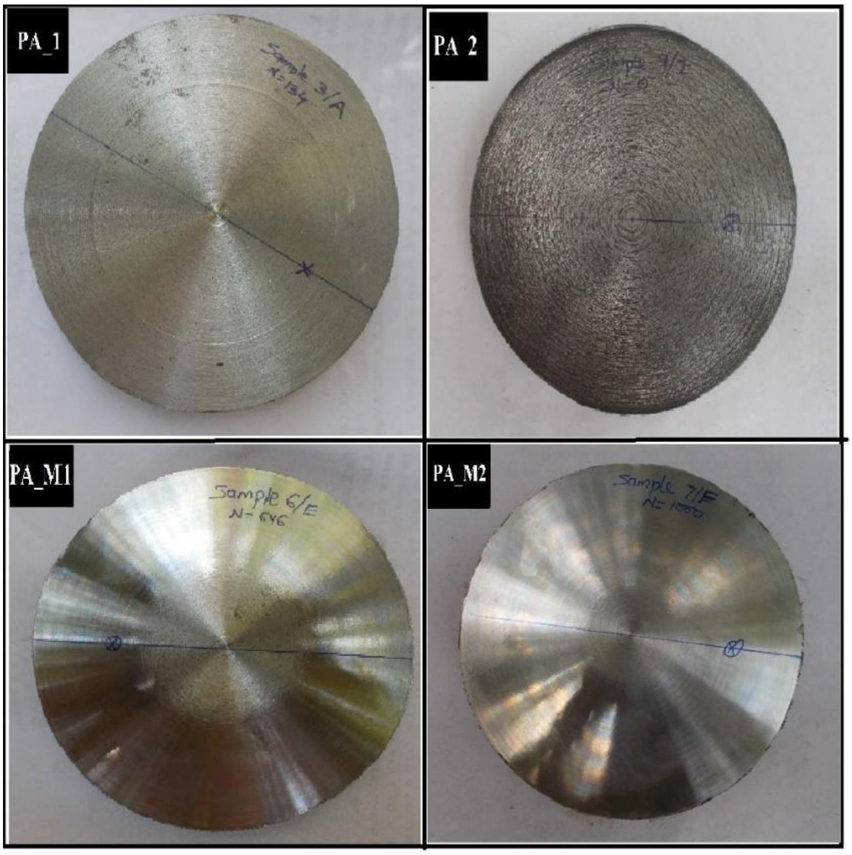


**Figure 4.1:** Disc PA_1 and PA_2 are process annealed only, whereas PA_M1andPA_M2arediscsofrespectivematerialwhicharefaceturned after process annealing.



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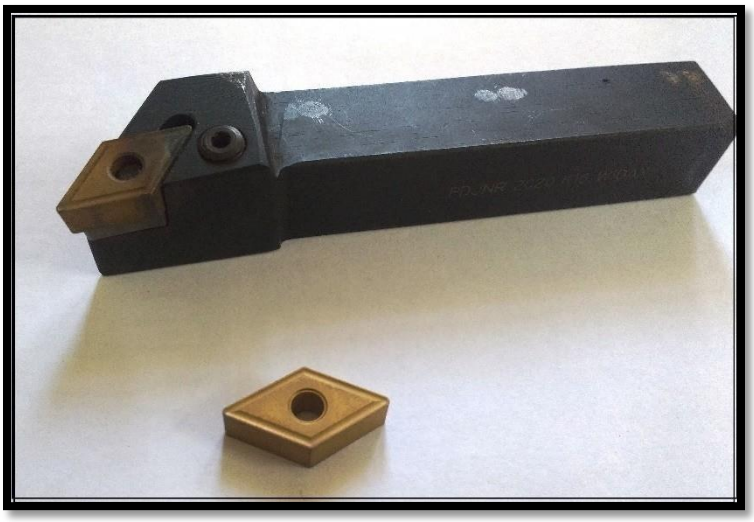

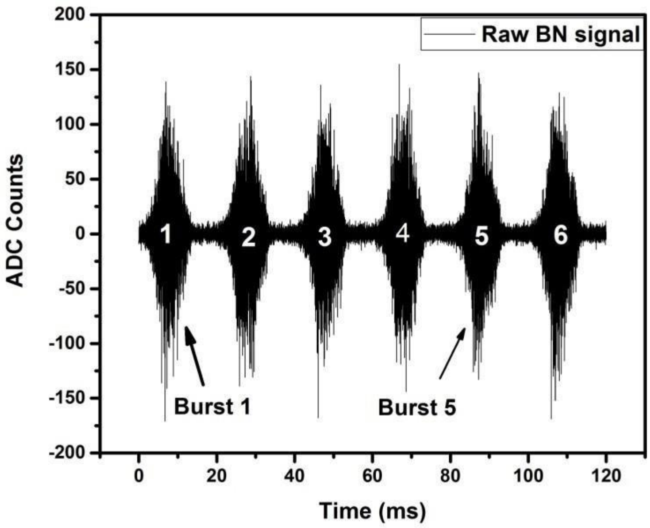


**Figure4.6:**RawBNdataofdiscPA1atfrequency=25Hz,MFI=300Oeand no. of cycle=3

BNTest ofDiscafterFacing

BNtest was performed forall thediscs at 45 mm radius shownin figure4.12, at frequency 10 Hz and MFI = 300 Oe, with 3 number of cycles. As it will be noted from the result of part 1 of this chapter that minute change is better noticed with lower MBN frequency. Before the test, discs were abraded with emery to minimize surface roughness effect on the BN signal. The raw data was extracted from megastar as previous done in part 1 of this chapter, and RMSprofilewasobtainedsimilarly.Thepeakamplitudeandpositionwas



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foundout foreach disc shownin tabular form inTable4.5.

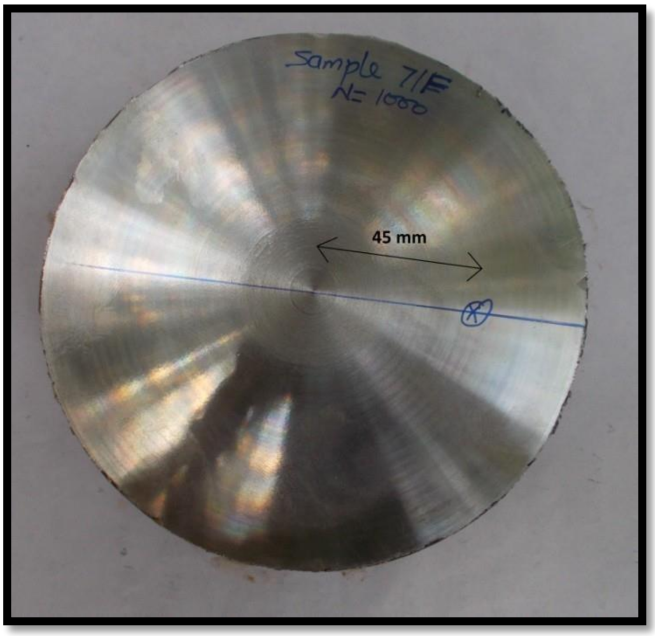


**Figure4.12:**Position ofsensor forBN test.

**Table4.5:**Resultsof BNtest atfrequency =10 Hz.

| S.No | RPM | Peak Amplitude | Peak Position | %change in peak amplitude | %change in peak position |
|---|---|---|---|---|---|
| 1 | - | 37.614 | 11.718 | - | - |
| 2 | 134 | 35.439 | 11.418 | 5.78 | -2.56 |
| 3 | 193 | 34.683 | 12.318 | 7.79 | 5.12 |
| 4 | 282 | 25.844 | 12.568 | 31.29 | 7.25 |
| 5 | 442 | 28.924 | 10.617 | 23.10 | 9.39 |
| 6 | 500 | 16.959 | 13.519 | 54.91 | 15.37 |
| 7 | 646 | 26.605 | 13.219 | 29.27 | 12.81 |
| 8 | 1000 | 34.265 | 12.669 | 8.90 | 8.11 |
| 9 | 1200 | 16.082 | 11.068 | 57.24 | -5.54 |



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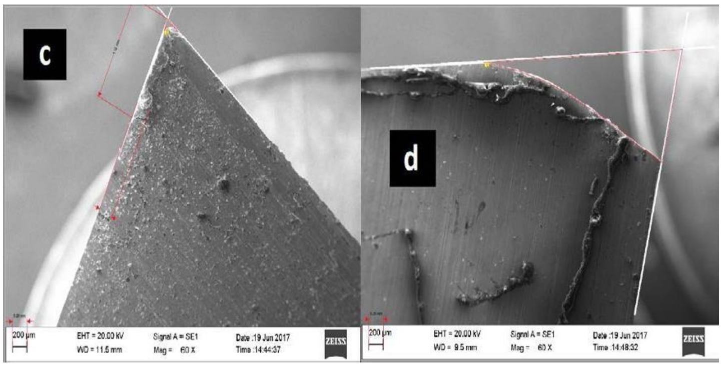
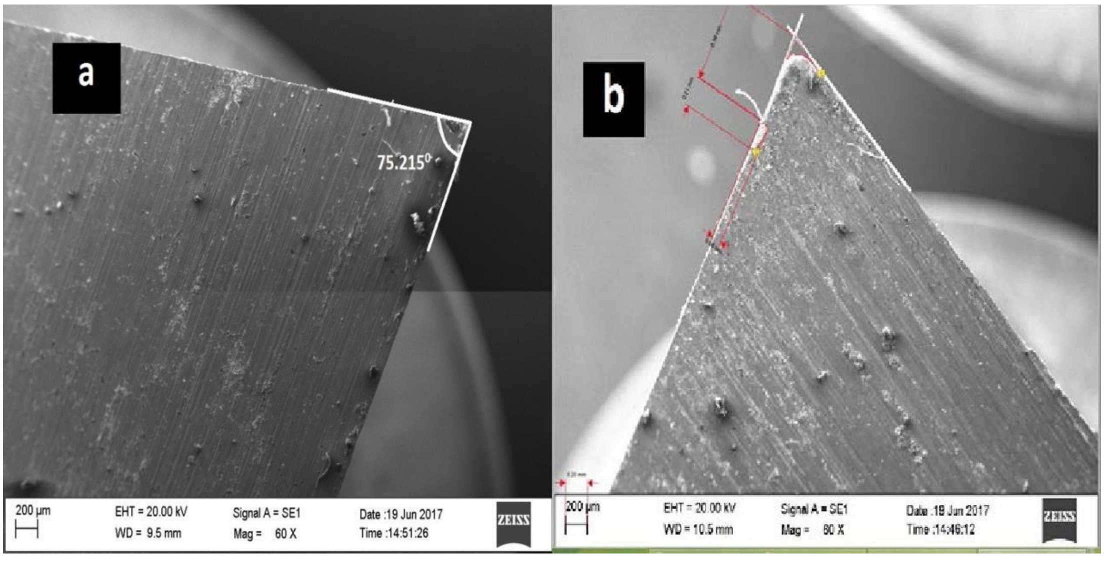



Tool WearMeasurement

Thecriterionforthemeasurementoftoolwearhastobeproperlychosenwhichcaneffectively explain the phenomenon. The SEM of the tool was conducted in two directions with 60X for HSS tool and 50X for carbide tool. One perpendicular to rake face and one perpendicular to flank face. The images were thoroughly analysed. It was found that nose wear occurred in all the HSS tools and flank wear in all the carbide tools, as shown in figure 4.13 and 4.14 respectively. The measurement of the tool wear was takeninAdobereaderDC.Thewearwidth,maximumheightandareaofthewearwere

chosen as the necessary parameter for nose wear and flank wear as shown in figure 4.15. The calculated data is shown in tabular form in Table 4.6 and 4.7.



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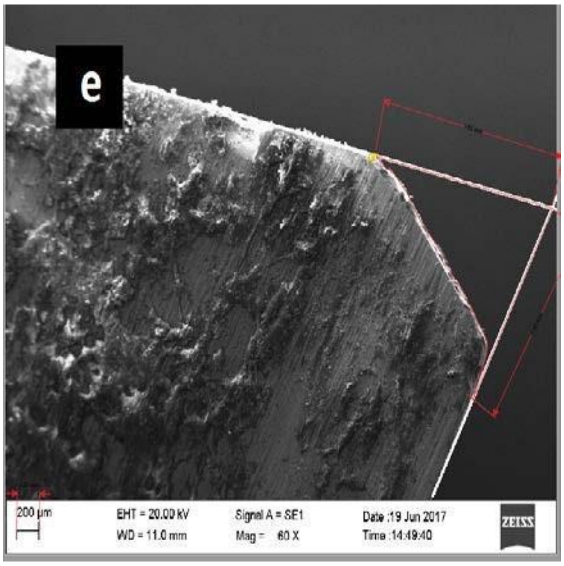
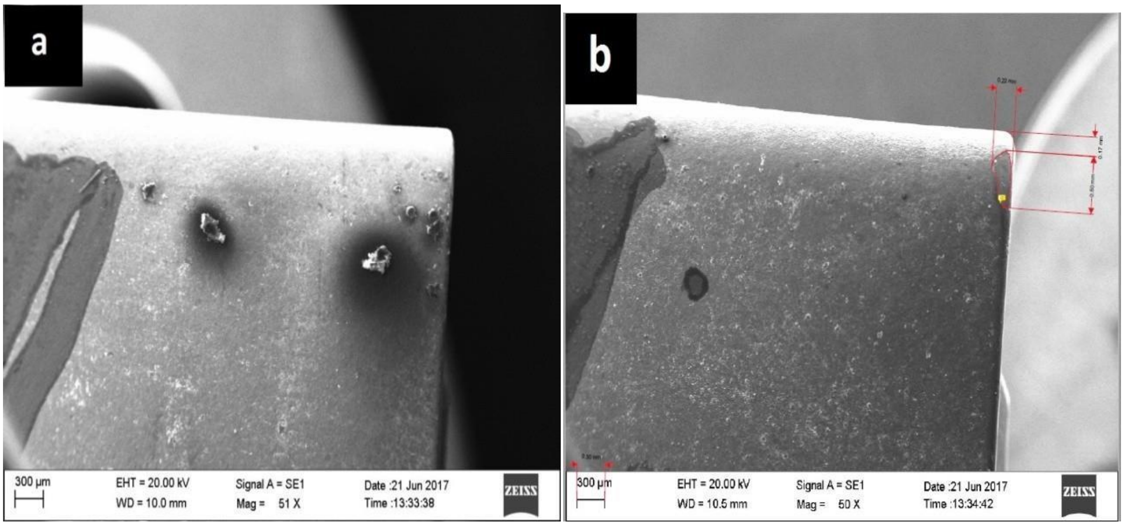



**Figure 4.13:** SEM images of rake face showing HSS tool wear and its measurement at (a) initial condition, and after facing at (b) 134 rpm, (c) 193 rpm, (d) 282 rpm, and (e) 442 rpm.



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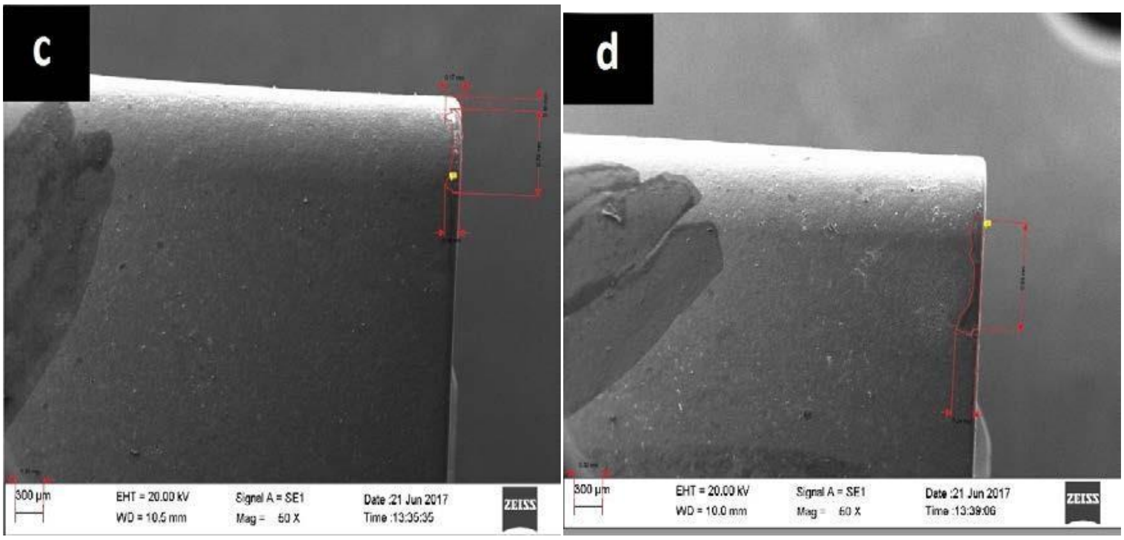


## RESULTS

### **5.1**EffectoffrequencyonRMSprofile.

Since,timeperiodvariesinverselywithfrequency,therefore,asthefrequency ofexcitationfieldchanges,sothusthetimeperiod.TheRMSprofileisplotof RMS BN signal with time along the path e-f-a-b as was shown in figure 4.4. Asexplainedalready, whensinusoidalappliedfieldvariesalongthispath,the fieldincreasestomaximum,andthendecreasestozerotocompleteB-Hcurve on first quadrant. The time taken along this path is half of the time period of theappliedfield.So,themaximumvalueoftimei.ehalftimeperiodonX-axis changes with frequency.

Since, time period (T) for half sinusoidal waveform of applied magnetic field depends on its frequency, therefore, non-dimensionalized time (t*) is introducedtocluballthecurvesofdifferentfrequenciesintosingleplotshown in figure 5.1. Normalized time (t*) is calculated as ratio of actual time (t) to halfofthetimeperiod(T)atthatfrequency. Ast variesfrom0toT/2forhalf cyclesot*variesfrom0to1.Averticallineatt*=0.5separatedthegraphinto two section- on the left when t* < 0.5, MFI increases and on the right it decreases to zero when t*> 0.5, as MFI completes one halfcycle.



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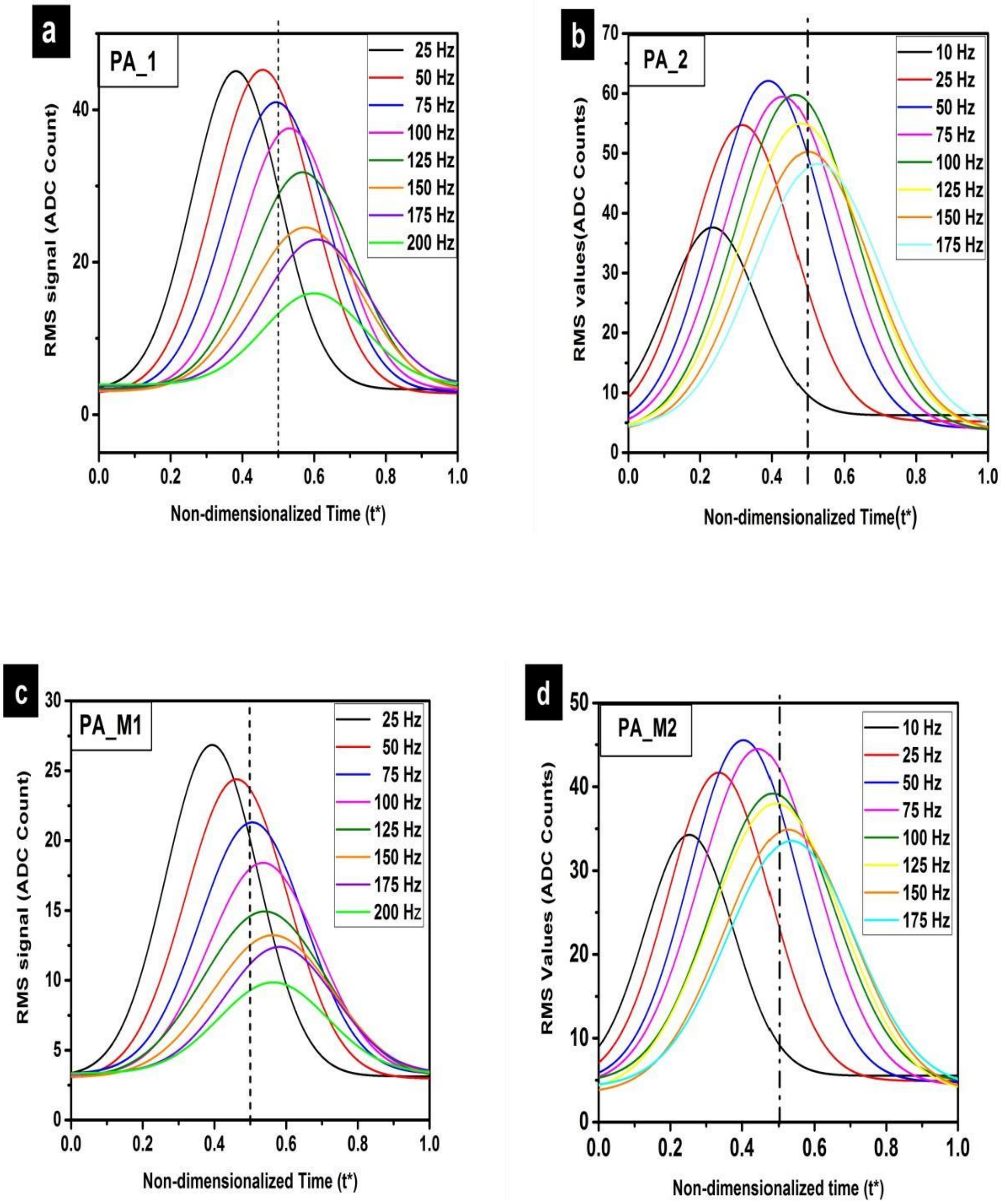


**Figure 5.1:**EffectoffrequencyonRMSprofileondisc(a)PA_1,(b)PA_2,(c)PA_M1,and(d)PA_M2,atconstantMFI=300Oe.

The profiles in figure 3(a), are clearly distinguishable for t*<0.5 depicting the dependencyofjerkymotionofBWonfrequenciesastheappliedfieldincreases,butt heybecomecomplicatedfort*>0.5becauseoftheunpredictable nature of the domain wall rotation in this region. The peak value attenuateswith frequency fordiscs PA_1 and PA_M1, but peak value increases up to 50 Hz and then decreases for discs PA_2 and PA_M2. Generally,thepeakvaluedecreaseswithfrequencybecauseofelectro-magneticskin



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depth decreases due to induced eddy current. This suggests that there is optimum frequency for which signal has maximum strength which mainly depends upon type ofmaterial, not on the facing operation performed. It must alsobepointedoutthatthepeakpositionalsoshifttotherightwithincreasing frequency, and at 75 Hz for discs PA_1 and PA_M1 and at 125 Hz for discs PA_2andPA_M2,thepeakoccursfor$t^*$>0.5.But,itisknownthatBarkhausen jump occurs on the steepest part of the hysteresis curve i.e. around coercivity, therefore, it can be inferred that there is phase lag induced in the RL circuit. Thus, applied magnetic field lags with increasing frequency, so thus the peak position. Apart from the phase lag induced in input RL circuit, this delay in peak position also encouraged due to eddy current, magnetic damping and vibration, whose effect increases with increasing frequency. As mentioned already in the chapter 1 that vibration occurs due to magnetostriction caused byfrequencyofalternatingappliedmagneticfield.Duetothevibrations,noises also add to theBN signal, as can be seen in figure5.2, this is also depicted by the $R^2$value.

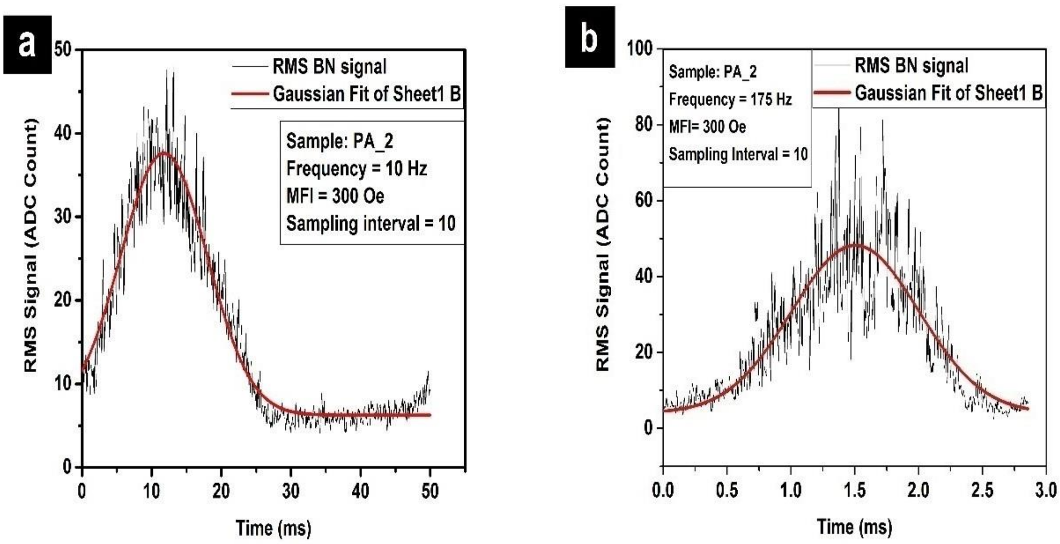


**Figure5.2:**NoisesduetovibrationonBN signalatfrequency(a) 10Hz,and (b) 175 Hz. Due to combined effect of eddy current, magnetic damping, background noises andvibrationontheBNsignal,thecomplicationtocorrelateBNpeakwithfrequencyfurt her

enhanced. As can be seen from the figure 5.3(a), the correlation between BN peakandfrequencycannotbedefinedbysimplemathematicalmodel;ratherit follows polynomialfunctionsuggestingdependencyoncomplimentaryfactors.



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The disc PA_M1 and PA_M2, which undergone machining, their peak value is always lower than the corresponding disc PA_1 and PA_2, because of change in surface characteristic after machining. BN peak position has shown in figure 5.3(b), shows some correlation at first for disc PA_2 and PA_M2. Peak positions for disc PA_M2 are always\shifted to the right with respect to discPA_2,whilethepeakpositionofPA_M1isrightshiftedupto100Hzand beyond it is left shifted with respect to PA_1. So, it becomes complicated to formulate any general correlation with frequency which can explain the phenomenon. Thus, peak shifting of BN profile do not depend only on phenomenon, but also appliedfrequency.

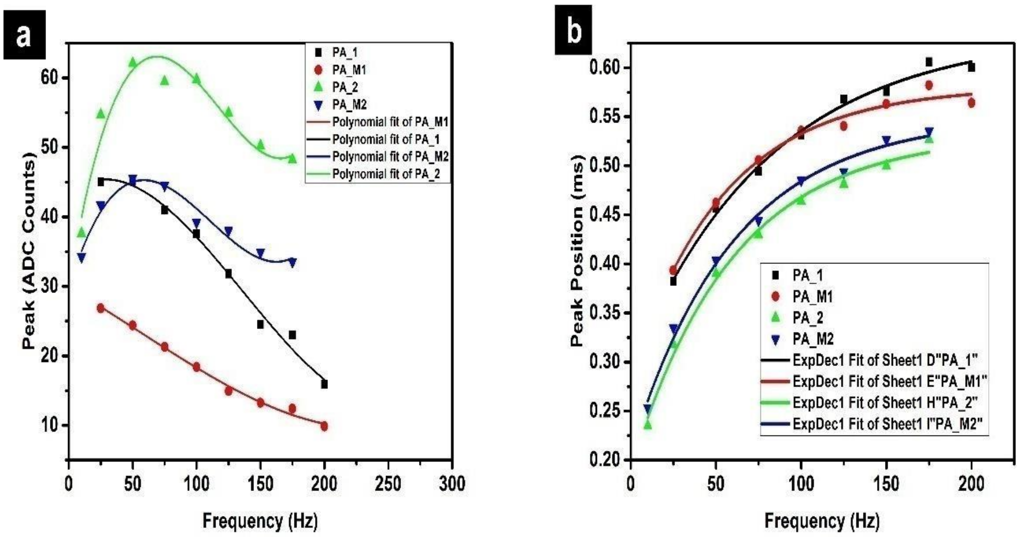


**Figure5.3:**Correlation of(a) BNpeak,and(b)Peak positionwith frequency.

## CONCLUSIONS

- The BN signal is a signature of a material microstructure, but its dependenceonBNmeasurementequipment(pickupcoil,probe,sensor, etc.) and specimen geometry, along with applied frequency and magnetic field intensity, have posed the complexity to decode the necessary information. The noise parameter chosen by applying Gaussian fit to the RMS distribution, has clearly distinguished the nature of BN signal with different parameter ofmagnetisation.
- Ithasbeenobservedthatfrequencyhasmuchpronouncedeffectonthe BN signal, and thus there is complex relationship between RMS peak valueswithfrequencyduetoinducededdycurrent,magneticdamping, shallow electro-skin depth, and vibration, etc. causing phase lag in the primary RL circuit and increase in backgroundnoise.



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- RMS peak follow exponential decay correlation with increasing MFI, frequency remains constant, with different decay constant for different surface condition of the disc material. The BN peaks are obtained much earlier due to easy magnetization with increasingfield.

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ISBN:978-81-957858-1-0

# Human health effects of air pollution

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**Abstract**

Hazardouschemicalsescapetotheenvironmentthroughanumberofnaturaland/or anthropogenicactivitiesand may cause adverse effectsonhuman health and the environment. Increased combustion of fossil fuels in the last century is responsible for the progressive change in atmospheric composition. Air pollutants, such as carbon monoxide(CO),sulphurdioxide(SO2),nitrogenoxides(NOx),volatileorganiccompounds(VOCs),ozone(O3), heavymetals,andrespirableparticulatematter(PM2.5andPM10),differintheirchemicalcomposition,reaction properties,emission,timeofdisintegrationandabilitytodiffuseinlongorshortdistances.Airpollutionhasboth acute and chronic effects on human health, affecting a number of different systems and organs. It ranges from minorupperrespiratoryirritationtochronicrespiratoryandheartdisease,lungcancer,acuterespiratoryinfections inchildrenandchronicbronchitisinadults,aggravatingpre-existingheartandlungdisease,orasthmaticattacks. In addition, short- and long-term exposures have also been linked with premature mortality and reduced life expectancy. These effects ofair pollutants on human healthand their mechanism ofaction are brieflydiscussed.

**Introduction**

Althoughanumberofphysicalactivities(volcanoes,fire,etc.)mayreleasedifferentpollutantsintheenvironment, anthropogenic activities are the major cause of environmental air pollution. Hazardous chemicals can escape to the environment by accident, but a number of air pollutants are releasedfrom industrial facilities and other activities and may cause adverse effects on human health and the environment. By definition, an air pollutant is any substance that may harm humans, animals, vegetation or material. As far as humans are concerned an air pollutant may cause or contribute to an increase in mortalityor serious illnessor may pose a present or potential hazard tohuman health.Thedetermination ofwhether ornot a substance poses a health risk to humans isbased on clinical, epidemiological, and/or animal studies which demonstrate that exposure to a substance is associated with health effects. In the context of human health, ‘‘risk’’ is the probability that a noxious health effect may occur.

**Pollutantcategories**

The main change in the atmospheric composition is primarily due to the combustion of fossil fuels, used for the generation of energy and transportation. Variant air pollutants have been reported, differing in their chemical composition, reaction properties, emission, persistence in the environment, ability to be transported in long or shortdistancesandtheireventualimpactsonhumanand/oranimalhealth.However,theysharesomesimilarities and they can be grouped to four categories:

1. Gaseouspollutants(e.g.SO2,NOx,CO,ozone,VolatileOrganicCompounds).

2. Persistentorganicpollutants(e.g.dioxins).

3. Heavymetals(e.g.lead,mercury).

4. ParticulateMatter.

Gaseouspollutantscontributetoagreatextenttocompositionvariationsoftheatmosphereandaremainlydueto thecombustionoffossilfuels(Katsouyanni,2003).NitrogenoxidesareemittedasNOwhichrapidlyreactswith ozone or radicals in the atmosphere forming NO2. The main anthropogenic sources are mobile and stationary combustionsources.Moreover,ozoneinthroweratmosphericlayersisformedbyaseriesofreactionsinvolving NO2andvolatileorganiccompounds,aprocessinitiatedbysunlight.CO,ontheotherhand,isaproductof



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incomplete combustion. Its major source is road transport too. While the anthropogenic SO2 resultsfromthecombustionofsulphur-containingfossilfuels(principallycoalandheavyoils) andthesmeltingofsulphur-containingores,volcanoesandoceansareitsmajornaturalsources. Thelattercontributeonly~2%ofthetotalemissions.Finally,amajorclassofcompoundsthat fuelcombustionandespeciallycombustionprocessesforenergyproductionandroadtransport arethemajorsourceofemissionaretheso-calledvolatileorganiccompounds(VOCs).Thisis a class of compounds, which includes chemical species of organic nature such as benzene. Even though the majority of gaseous pollutants are inhaled and mainly affect the respiratory system they can also induce haematological problems (CO, benzene) and cancer.

Persistentorganicpollutantsformatoxicgroupofchemicals. Theypersistintheenvironment forlongperiodsoftime,andtheireffectsaremagnifiedastheymoveupthroughthefoodchain (bio-magnification). They include pesticides, as well as dioxins, furans and PCBs. Generally, the generic term ‘‘dioxins’’ is used to cover polychlorinated dibenzo-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs) while polychlorinated biphenyls (PCB) are called ‘‘dioxin-like compounds’’ and can act similarly in terms of dioxin-type toxicity (Schecter et al., 2006). Dioxins are formed during incomplete combustion and whenever materials containingchlorine(e.g.plastics)areburned.Emittedintheatmosphere,dioxinstendtodeposit on soil and water but, being water insoluble, they do not contaminate groundwater sources. Mostdioxinsinplantscomefromairanddustorpesticidesandenterthefoodchainwherethey bio-accumulate due to their ability to be stably bound to lipids.

Heavy metals include basic metal elements such as lead, mercury, cadmium silver nickel, vanadium, chromium and manganese. They are natural components of the earth’s crust; they cannotbedegradedordestroyedandcanbetransportedbyair,andenterthewaterandhuman food supply. In addition, they enter the environment through a wide variety of sources, including combustion, wastewater discharges and manufacturing facilities. To a small extent they enter human bodies where, as trace elements, they are essential to maintain normal metabolic reactions. However, at higher (although relatively low) concentrations they can become toxic (Jarup,2003). Most heavy metals are dangerous because they tend to bioaccumulateinthehumanbody.Bioaccumulationmeansanincreaseintheconcentrationof achemicalinabiologicalorganismovertime,comparedtothechemical’sconcentrationinthe environment.Compoundsaccumulateinorganismsanytimetheyaretakeninandstoredfaster than they are broken down (metabolized) or excreted.

Particulate matter (PM) is the generic term used for a type of air pollutant, consisting of complex and varying mixtures of particles suspended in the breathing air, which vary insize and composition, and are produced by a wide variety ofnatural and anthropogenic activities (Poschl, 2005). Majorsources ofparticulate pollution are factories, power plants, refuseincinerators,motorvehicles,constructionactivity,fires,andnaturalwindblowndust.The sizeoftheparticlesvaries(PM2.5andPM10foraerodynamicdiametерssmallerthan2.5mm



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and10mmrespectively)anddifferentcategorieshavebeendefined:Ultrafineparticles,smaller than 0.1 mmin aerodynamic diameter, Fine particles, smaller than 1 mm,

and Coarse particles, larger than 1 mm. The size of the particlesdetermines the site in the respiratory tract where they willdeposit: PM10 particles deposit mainly in the upper respiratorytractwhilefineandultra-fineparticlesareabletoreachlungalveoli.Sofar,nosingle component has beenidentified thatcould explain most of the PM effects. Among the parametersthat play an important role in eliciting health effects are thesize and surface of particles,theirnumberandtheircomposition.ThecompositionofPMvaries,astheycanabsorb andtransfer a multitude of pollutants. However, their major componentsare metals, organic compounds, material of biological origin, ions, reactive gases, and the particle carbon core. Thereis strong evidence to support that ultra-fine and fine particlesare more hazardous than largerones(coarseparticles),intermsofmortalityandcardiovascularandrespiratoryeffects.In addition, the metal content, the presence of PAHs and otherorganic components such as endotoxins, mainly contribute toPM toxicity.

3. Routesofexposure

Humans enter into contact with different air pollutants primarily via inhalation and ingestion, whiledermalcontactrepresentsaminorrouteofexposure.Airpollutioncontributes,toagreat extent, to the contamination of food and water, which makes ingestion in several cases the major route of pollutant intake (Thron, 1996). Via the gastrointestinal and respiratory tract, absorption of pollutants may occur, while a number of toxic substances can be found in the generalcirculationanddepositedindifferenttissues.Eliminationoccurstoacertaindegreeby excretion (Madden and Fowler, 2000).

4. Healtheffects

Sporadic air pollution events, like the historic London fog in 1952 and a number of short and long-term epidemiological studies investigated the effects of air quality changes on human health. A constant finding is that air pollutants contributeto increased mortality and hospital admissions (Brunekreefand Holgate, 2002). The different compositions of air pollutants, the dose and time of exposure and the fact that humans are usually exposed to pollutant mixtures than to single substances, can lead to diverse impacts on human health. Human health effects can range from nausea and difficulty in breathing

or skin irritation, to cancer. They also include birth defects, serious developmental delays in children, and reduced activity of the immune system, leading to a number of diseases. Moreover, there exist several susceptibility factors such as age, nutritional status and predisposing conditions. Health effects can

be distinguished as acute, and chronic not including cancer and cancerous. Epidemiological and animal model data indicate that the primarily affected systems are the cardiovascular and therespiratorysystem.However,thefunctionofseveralotherorganscanbealsoinfluenced



ISBN:978-81-957858-1-0

(Cohen et al., 2005; Huang andGhio, 2006; Kunzli and Tager, 2005; Sharma and Agrawal,2005).

Effectsofairpollutantsondifferentorgansand systems.

Respiratory system

Numerousstudiesdescribethatalltypesofairpollution,athighconcentrations,canaffectthe airways. Nevertheless, similar effects are also observed with long-term exposure to lower pollutant concentrations. Symptoms such as nose and throat irritation, followed by bronchoconstrictionanddyspnoea,especiallyinasthmaticindividuals,areusuallyexperienced after exposure to increased levels of sulphur dioxide (Balmeset al., 1987), nitrogen oxides (Kagawa, 1985), and certain heavy metals such as arsenic, nickel or vanadium. In addition particulate matter that penetrates the alveolar epithelium (Ghioand Huang, 2004) and ozone initiate lung inflammation (Uysaland Schapira, 2003). In patients with lung lesions or lung diseases,pollutant-initiatedinflammationwillworsentheircondition.Moreover,airpollutants such as nitrogen oxides increase the susceptibility to respiratory infections (Chauhanet al., 1998). Finally, chronic exposure to ozone and certain heavy metals reduces lung function (Rastogi et al., 1991;Tager et al., 2005), while the latter are also responsible for asthma, emphysema, and even lung cancer (Kuo et al., 2006;Nawrot et al., 2006). Emphysema-like lesions have also been observed in mice exposed to nitrogen dioxide (Wegmann et al., 2005).

Cardiovascularsystem

Carbon monoxide binds to haemoglobin modifying its conformationand reducing its capacity to transfer oxygen (Badmanand Jaffe, 1996). This reduced oxygen availability can affect thefunctionofdifferentorgans(andespeciallyhighoxygen-consumingorgansuchasthebrain and the heart), resulting

in impaired concentration, slow reflexes, and confusion. Apartfrom lung inflammation, systemicinflammatory changes are inducedby particulate matter, affecting equally blood coagulation(Riediker et al., 2004). Air pollution that induces lung irritationand changes in blood clotting can obstruct (cardiac) bloodvessels, leading to angina or even myocardial infarction (Vermylen et al., 2005). Symptoms such as tachycardia, increased blood pressure and anaemia due to an inhibitory effect on haematopoiesis have been observed as a consequence of heavy metal pollution (specifically mercury, nickel and arsenic)

(Huang and Ghio, 2006). Finally, epidemiologic studies have linked dioxin exposure to increased mortality caused by ischemic heart disease, while in mice, it was shown that heavy metals can also increase triglyceride levels (Dalton et al., 2001).

Nervous system

Thenervoussystemismainlyaffectedbyheavymetals(lead,mercuryandarsenic)anddioxins. Neurotoxicity leading to neuropathies, with symptoms such as memory disturbances, sleep disorders,anger,fatigue,handtremors,blurredvision,andslurredspeech,havebeenobserved



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after arsenic, lead and mercury exposure (Ewan and Pamphlett, 1996; Ratnaike,2003). Especially, lead exposure causes injury to the dopamine system, glutamate system, and N-methyl-D-Aspartate (NMDA) receptor complex, which play an important role in memory functions(LasleyandGilbert,2000;Lasleyetal.,2001).Mercuryisalsoresponsibleforcertain casesofneurologicalcancer.Dioxinsdecreasenerveconductionvelocityandimpairedmental development of children (Thomke et al., 1999;Walkowiak et al., 2001).

Urinarysystem

Heavy metals can induce kidney damage such as an initial tubular dysfunction evidenced by increased excretion of low molecular weight proteins, which progresses to decreased glomerular filtration rate (GFR). In addition, they increase the risk of stone formation or nephrocalcinosis (Damek-Poprawaand Sawicka-Kapusta, 2003; Jarup, 2003; Loghman-Adham,1997) and renal cancer (Boffetta et al., 1993; Vamvakas et al.,1993).

Digestive system

Dioxinsinducelivercelldamage(Kimbroughetal.,1977),asindicatedbyanincreaseinlevels of certain enzymes in the blood (see following discussion on the underlying cellular mechanisms of action), as well as gastrointestinal and liver cancer (Mandal, 2005).

Exposureduring pregnancy

Itisratherimportanttomentionthatairpollutantscanalsoaffectthedevelopingfoetus(Schell et al., 2006). Maternal exposure to heavy metals and especially lead increases the risks of spontaneous abortion and reduced fatal growth (preterm delivery, low birth weight). There is also evidence suggesting that parental lead exposure is also responsible for congenital malformations (Bellinger, 2005), and lesions of the developing nervous system, causing important impairment in newborn’s motor and cognitive abilities (Garza et al., 2006). Similarly, dioxins were found to be transferred from the mother to the fetus via the placenta. Theyactasendocrinedisruptorsandaffectthegrowthanddevelopmentofthecentralnervous

system of the foetus (Wang et al., 2004). In this respect, TCDD is considered as a developmental toxin in all species examined.

5. Cellularmechanismsinvolved inairpollutants’ actions

Acommoncellularmechanismbywhichmostairpollutantsexerttheiradverseeffectsistheir ability to act directly as prooxidants of lipids and proteins or as free radicals generators, promoting oxidative stress and the induction of inflammatory responses (Menzel, 1994; RahmanandMacNee,2000).Freeradicals(reactiveoxygenandnitrogenspecies)areharmful to cellular lipids, proteins, and nuclear- or mitochondrial- DNA, inhibiting their normal function (Valko et al., 2006). In addition, they can interfere with signalling pathways within cells (Valko et al., 2006). In eukaryotic aerobic organismsincluding humans, free radicals are continuouslygeneratedduringnormalmetabolismandinresponsetoexogenousenvironmental exposures(e.g.irradiation,cigarettesmoke,metalsandozone).Whenfreeradical



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concentrationincreases,duetoanoverwhelmingorganism'sdefence,astateofoxidativestress occurs.Thisoxidativestatehasbeenimplicatedinawidevarietyofdegenerativediseasessuch as atherosclerosis, heart attacks, stroke, chronic inflammatory diseases (rheumatoid arthritis), cataracts,centralnervoussystemdisorders(Parkinson's,andAlzheimer'sdisease),age-related disorders

andfinallycancer.

Furthermore, the toxic effects of heavy metals, apart from inducing oxidative stress, can be also attributed to their ability to substitute diverse polyvalent cations (calcium, zinc, and magnesium) that function as charge carriers, intermediaries in catalysed reactions, or as structural elements in the maintenanceof protein conformation. Indeed, metals accumulate in cellularorganellesandinterferewiththeirfunction.Forexample,ithasbeenobservedthatlead accumulation in mitochondria induces several changes such as inhibition of $Ca2+$ uptake, reduction of the transmembrane potential, oxidationof pyridine nucleotides, and a fast release ofaccumulated$Ca2+$(Chavezetal.,1987).Moreover,metalsbindtoproteins(Goering,1993) and inhibit a large number of enzymes, including mitochondrial ones (Rossi et al., 1993). Nucleic acid binding proteins are also involved, while it has been shown that metals can also bind to DNA, affecting the expression of genes. For example, nickel enters the nucleus, interactswithchromatinandsilencestheexpressionofgenessuchastumoursuppressorgenes, inducing carcinogenesis (Costaet al., 2003). Finally, some metals interfere with various voltage-andligand-gatedionicchannelsexertingneurotoxiceffects.Forinstance,leadaffects the N-methyl-D-aspartic acid (NMDA) receptor, subtypes of voltage- and calcium-gated potassium channels, cholinergic receptors and voltage-gated calcium channels (Garza et al., 2006; Toscano and Guilarte,2005).

Dioxin causes a broad range of adverse effects (Birnbaum, 1994): they alter metabolism by inducing a number of metabolicenzymes (e.g. CYPs, glutathione-transferase, tyrosine kinaseetc.), homeostasis,through hormone modulation (e.g.estrogens, androgens glucocorticoids, insulin, thyroid hormones)and their receptors, and growth and differentiation byinterferingwithgrowthfactors(e.g.EGF,TGFa,TNFa)andtheirreceptors.Atthecellular level, dioxins interact with the aryl hydrocarbon receptor (AhR) (Schwarz et al.,2000) which hasabasichelix-loop-helixdomain,actingasatranscriptionfactorafternucleartranslocation, allowinginteractionofdioxinswithDNA.Thereceptor-ligandcomplexbindstospecificsites on DNA, altering the expression of a number of genes.

As far as cancer is concerned from the data presented above it becomes clear that most pollutants play an important role in the initiation, promotion and progression of cancer cells (Fig. 1).



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6. Naturalprotection

Inourday-to-daylifeweareexposedindifferentkindsofpollutants.Healthimpacts,asalready described above, depend on the pollutant type, its concentration, length of exposure, other coexisting pollutants and individual susceptibility.

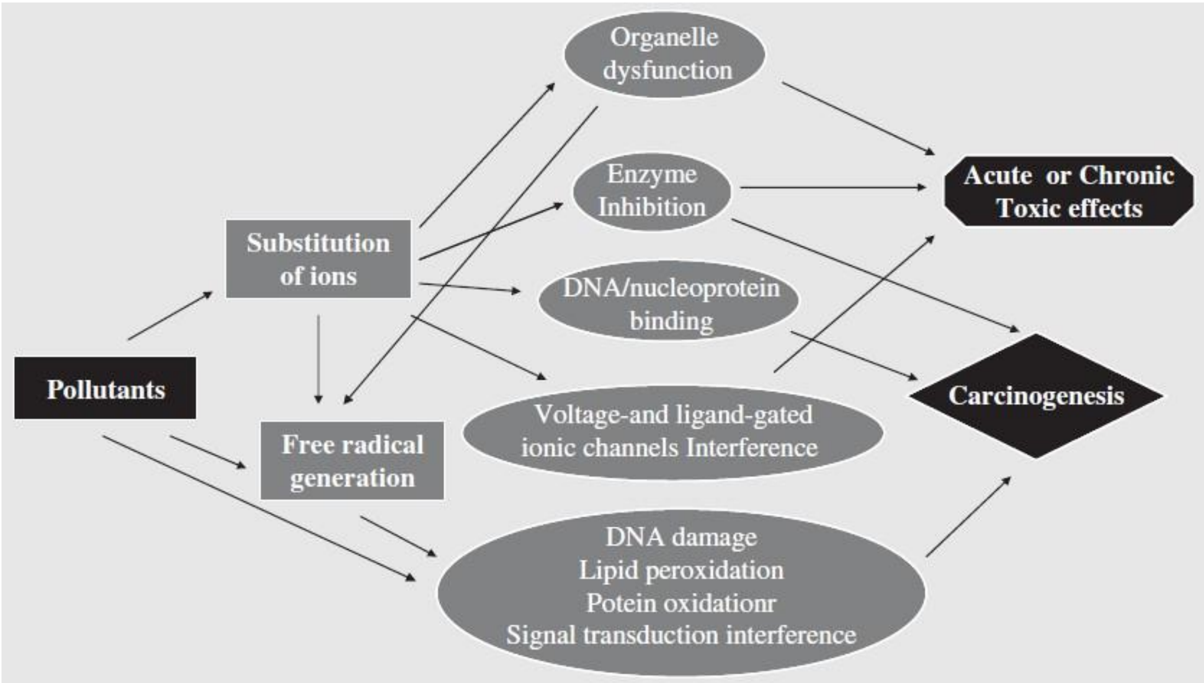


Figure10 Basicmechanisms of carcinogenesis.

People living in cities are exposed to a greater extent, as a consequence of increased industrializationanddemandsforenergyandmotorvehicles.Occupationalexposureisalsoan important factor that should be taken into consideration. During the last decade, the health effects of air pollution are studied

moreindevelopedcountries,whilemoreandbetterenvironmentalmonitoringdataarerequired in order to set up threshold levels. In addition, efforts should be intensified by taking the appropriate measures, in order to reduce the possibility of human pollutant exposure.

The human body, in order to protect itself against the potential harmful insults from the environment,isequippedwithdrugorxenobioticmetabolisingenzymes(DMEsorXMEs)that playacentralroleinthebiotransformation,metabolismand/ordetoxificationofxenobioticsor foreigncompounds,includingdifferentkindsofpollutants.XMEsincludeavarietyofenzymes such as cytochrome P450 (P450 or CYP), epoxide hydrolase, glutathione transferase, UDP-glucuronosyltransferase, sulfotransferase, NAD(P)H quinoneoxidoreductase 1, and aldo-ketoreductase.Theseenzymesmainlyparticipateintheconversionofxenobioticstomorepolar andwater-solublemetabolites,whicharereadily excretedfromthebody. Finally,itshouldbe noted that, in many cases, the chemically reactive metabolites produced during metabolism, areequallyharmfulandthereforeundergo additionalmetabolismtoinactive products.Hence,



ISBN:978-81-957858-1-0

the final outcome of a compound modulating the detoxification enzyme systems is the result of the effects on the different metabolic pathways.

A number of substances of dietary nature are beneficial, protective, and supportive of good health and the body's own natural chelation mechanisms. They include nutrients with natural chelating properties, which may help to detoxify the body, such as antioxidants, herbs, minerals,essentialaminoacids,otherdetoxifyingorprotectiveagents,andfibre(Kelly,2004).
Among them, dietary antioxidants contribute to the organism's antioxidant defence system, which includes a series of antioxidant enzymatic (e.g. peroxidase) and nonenzymatic compounds (such as glutathione, or food-derived like vitamin E, or polyphenols), as well as damage removal/ repair enzymes. Several natural compounds, such as vitamins C, E, and A and polyphenols, found in the majority of plant foods, interfere with or scavenge ROS concentration within cells and subsequently protect the organism from the adverse effects of oxidative stress. Indeed, as it has been shown by our group that the antioxidant activity of plasma in humans following a diet rich in vegetables, fruits and olive oil was increased in comparison to a normal diet (Kampa et al., 2002). This increase can be mainly attributed to polyphenols which exhibit a wide range of biological activities, including anti-tumorigenic, anti-mutagenic, anti-inflammatory, and antiviral actions (Bravo, 1998; Hertog and Hollman, 1996) mainly due to their antioxidant properties and their ability to exert inhibitory effects by affecting basic cellular functions. Indeed the beneficial role of polyphenols in preventing cancer can be in part attributed to their ability to modify enzymes that activate or detoxify environmental carcinogens.

Conclusion

Thisbriefreviewpresentstheadverseeffectsofanumberof(air)pollutantsonhumanhealth. Asshown,majorimpairmentsofdifferentorganscanbeobserved.Themainconclusiondrawn is that, in view of increased exposure of humans to a diversity of pollutants, dietary interventions, rich in plant-derived foods, may protect or decrease their effects on different organs.Thisconclusionissupportedbyanumberofepidemiologicalstudiesonthebeneficial effect of a Mediterranean- type diet on human health.

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ISBN:978-81-957858-1-0

# SixSigma-OverviewofDMAICandDMADV

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**Abstract**

The majority of software development companies use Six Sigma to identify issues with software development and its processes, find the best solutions to those issues, and enhance development processes in order to achieve business objectives. A powerful Six Sigma drive can help an organization to distinguish processes that genuinely add worth and will move everybodyfurthermore,everyactionnearertothe clientandtheclient'sneeds.Inthispaper,a project is chosen to demonstrate that changing the current software development process improves software quality by implementing six sigma.

**Introduction**

A statistical term that measures how far a process is from perfection is this one. The focal thought behind that's what six Sigma is on the off chance that you can gauge the number of "abandons" you have in a cycle; you can methodically sort out instructions to dispense with them and get as near "zero deformities" as conceivable.

Six Sigma is a method with a lot of discipline that helps focus on making and delivering products and services that are close to perfect.

“Six sigma is nota program for improvement. Instead, it is a business philosophy that takes a step-by-step approach to decreasing variation, improving quality, increasing customer satisfaction, and eventually increasing market share”.

In any product improvement, nature of the product is vital to meet the consumer loyalty. The stage of software testing in which flaws are discovered improves software quality. Six sigma is one of many international standards that can be used to improve software quality.

**Advantagesof Six Sigma**

- SinceSixSigmaisdrivenbythecustomer,itsgoalsaretomaximizecustomersatisfaction andreducedefects.Itaimstodelightcustomersandfindnovelandcreativewaystoexceed their expectations.
- Profitability rises and expenses fall as a result of Six Sigma implementation. As a result, the financial outcomes are directly linked to the improvements made.
- Almost all business metrics, including return on investment, employment growth, and stock value growth, are successfully implemented by Six Sigma.



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- Thetop-downapproachensuresthateverygoodthingiscapitalizedonandeverybadthing is quickly eliminated, and training is an essential part of the management system.
- An organization's adoption of the Six Sigma process improvement methodology establishes a method for ongoing process improvement at all levels. The business procedures will continue to improve once Six Sigma is ingrained in the culture of the company. Due to the close monitoring that Six Sigma requires, new issues will also be quickly identified and resolved.
- Six Sigma is based on data. Until the current procedure is fully comprehended, documented, and measured, no adjustments are made. Measurements and verification of the revised procedure are similar. If the Six Sigmaproject doesn't convey what was expected,theSixSigmagroupisstilltheretoaddressnewlydiscoveredissuesorthenagain concentrate on what turned out badly.

### DisadvantagesofSix Sigma

- Qualitystandardsmaybetightenedasproductqualityimproves,ortheprocessmaybeleft in place with close supervision. However, gathering and analyzing data takes time and resources;Thisisreferredtoasthecostofquality,anditisnecessarytoweighthecostof achieving high quality against other business goals.
- Six Sigma ventures can beapplied to businessprocesses that producequantifiable results, forexample,callsdealtwitheachhourorclientstandbytime.Goalslikeraisingemployee morale or increasing customer satisfaction do not work well with Six Sigma projects.
- Implementing Six Sigma always requires skilled personnel. Therefore, if control is not regularly implemented, it is difficult to achieve employee commitment and control.
- The rigidity of the process, which fundamentally hinders innovation and creativity, is emphasized in Six Sigma.

### DMAICProcess

TheDMAICmodelisa methodical approachtoanalyzingandenhancingbusiness processes.

DMAIC is a process-improving data-driven quality strategy. It is an essential piece of a Six Sigmadrive,howeveroverallcanbecarriedoutasanindependentqualityimprovementstrategy or as a component of other interactionimprovement drives.

Therearefivephasestoit. Define

### Phase

Threemajor activities areinvolvedin thedefine phase.

1) ComeupwithaTeamCharter:Thebusinesscase,problemandgoalstatement,projectscope, milestones, and roles are the identified details.



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2) ClientConcentration:Themethodsforgatheringcustomerdata andtranslatingthoseneeds into specific requirements are identified.

3) Mapping aProcess:Beforeconnectingthecustomertotheprocess, first definetheprocess. The benefits and applications of business process mapping are discovered by mapping the existing process.

### MeasurePhase

Thetasksthat arecarriedoutin thisphaseareas follows:

1) Performancestandardsaredefined,whichmeansestablishingspecificationlimitsthatmeet the needs of customers.

2) Makeaplanforcollectingdataandstartcollecting it.

3) Confirmingthemeasurementmethod.

### Analyse phase

Thecollecteddatamustbeexaminedtodeterminethedefects'underlyingcauses. This

phase's steps include:

1) evaluatingthevalueofeachprocess step;

2) inspectingandtransformingthecollecteddataintochartsandgraphs;

3) usingaCause-Effectdiagramtobrainstormthecausesoftheproblem;

4) performingadditionalanalysisontheproblem'scause.

### Improve Phase

Create potential solutions based on the problem's root cause and choose the easiest one to implement.Stakeholdersareinformedofthebestsolutionthathasbeenidentified.Forthepilot solution, process maps and a high-level plan have been created. The final solution's benefits and effects on improvement are determined through its implementation.

### Control Phase

The development of metrics that will assist leaders in monitoring and documenting ongoing success is the goal of the final stage of the methodology.

- StrategiesforSix Sigmaareadaptableand ongoing.
- Whenthisfirstcycleoftheprocessisfinished,changescanbemadeandnewonescanbe implemented.

The initial project is either finished or additional processes are addressed at the cycle's conclusion.



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## DMADV Process

When a client or customer requires product enhancement, modification, or the creation of an entirely new product or service, the DMADV application is utilized. The goal of using these techniques is to make a high-quality product that takes into account what customers want at every stage.

Therearefivephasestoit. Define

### Phase

Projectpioneersdistinguishneedsandneedsacceptedto beconsideredgenerallyvital to clients.

- Needsandneedsarerecognizedthroughverifiabledata,clientinputandotherdata sources.Groups are collected to drive the cycle.
- Testsandmetricsaredevelopedinaccordancewithcustomerdata.

### Measure Phase

Utilizingthespecifiedmetricstocollectdataandrecordspecificationsisthesecondstepinthe process, and it can be used to guide the remaining steps.

- Metrics are assigned to each of the processes necessary to successfully manufacture the product or service for later evaluation.
- Themetricsaretestedandthenimplementedbytechnologyteams.

### Analyze Phase

Internalteamstestthefinishedproductorservicethatcomesoutofthemanufacturingprocess to establish a baseline for improvement.

- Leadersmakeuseofdatatopinpointadjustmentstoprocessesthatwillenhancethequality or manufacturing procedure of a finished product or service.
- Teamsestablishthefinalproceduresandmakeanynecessaryadjustments.

### Design Phase

Customers'wantsandneedsarecomparedtotheresultsofinternaltests.Anynecessary additional adjustments are made.

- Before the final product or service is released to the general public, the improved manufacturing process is put through its paces, and test groups of customers provide feedback.

### VerifyPhase

Themethodology'sfinal stageisongoing.The procedures maybe modified whiletheproduct or service is being introduced and customer reviews are being collected.



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- Tokeeptrackofongoingcustomerfeedbackontheproductorservice,metricsarefurther developed.
- Newinformationmightpromptdifferentchangesthatshouldbeaddressedsothe underlying system might prompt newuses of DMADV in ensuing regions.

Most of the time, these methodologies' applications are implemented over many months oreven years.

Aproductorservicethat completelymeetsthewants,needs,andexpectationsofcustomersis the end result.

## Conclusion

SixSigmaisacustomer-centricmethodologythatimprovesdevelopmentandreducesprocess variation.Acontinuousprocessimprovementknownasa"sixsigmaproject"aimstomeetthe needsofcustomers.Softwarequalityisimprovedby3.4defectspermillionopportunitiesasa result.Thisstudyexplainedthedifferencesbetweenthesixsigmamethodology'sDMAICand DMADV processes as well as when to use which one.

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ISBN:978-81-957858-1-0

# Solarenergy:Potentialandfutureprospects

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**Abstract**

One of the most important ways to meet the growing global energy demand is through the creation of novel solar power technologies. Low solar cell efficiencies and low balance-of-systems(BOS)performancearejustafewofthetechnical roadblocksthatstandinthewayof therapiddevelopmentofsolartechnologies.Otherroadblocksincludefinancialoneslikehigh upfront costs and a lack of financing options, as well as institutional ones like inadequate infrastructureandalackofskilledlabor.Inthisarticle,boththeadvantagesanddisadvantages of solar energy technologies are discussed. Additionally, the beneficial interactions between policy frameworks governing regulation and renewable energy research are brought to light, as are a number of technical issues affecting renewable energy research. A road map for the future of solar research is discussed to help open up new avenues for research and practices related to solar energy.

**Introduction**

For Earth, the sun is a major source of inexhaustible free energy, also known as solar energy. Presently, new advancements are being utilized to create power from collected sun based energy. These approaches have previously been demonstrated and are broadly rehearsed all throughtheworldasinexhaustibleoptionstotraditionalnonhydroadvancements.Fig.1depicts acomparisonof2012'snon-hydrorenewableenergycapacitiesamongnations.Iftechnologies for its harvesting and supply were readily available, solar energy has the theoretical potential to adequately meet the global energy needs. Each year, approximately four million exajoules (1 EJ = 1018J) of solar energy reach Earth. $5 \times 10^4$ EJ of which is professed to be effectively harvest-able. Solar energy still makes a negligible contribution to the global energy supply, despiteitsenormouspotentialandgrowingawareness.Thecurrentpushtoreduceglobalcarbon emissions,whichhavebeenamajorglobalenvironmental,social,andeconomicissueinrecent years, is associated with another significant opportunity for solar research.As a result, issues related to energy security, climate change, unemployment, and other issues would be significantly reduced or eliminated if solar technologies were implemented. Because it does not require fuel transportation, it is also anticipated that its use will play a significant role in thetransportationindustryinthefuture.Asolidfoundationfortheutilizationofthisrenewable energy system has been established by policies, investments, and supports for solar technologies(suchasresearchfunding)fromavarietyofgovernmentalandnon-governmental organizations.Incentivesanddiscountshavethepotentialtospurthegrowthofthesemarkets, but there are also increasing efforts to lessen the financial burden of these policy incentives. However,therehavealreadybeensignificantreductionsinsolarpowersubsidiesinmany



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nations, which may impede industry expansion. Policies arechanging to encourage the use of solar power systems for large-scale power generation in order to avert this potential decline.

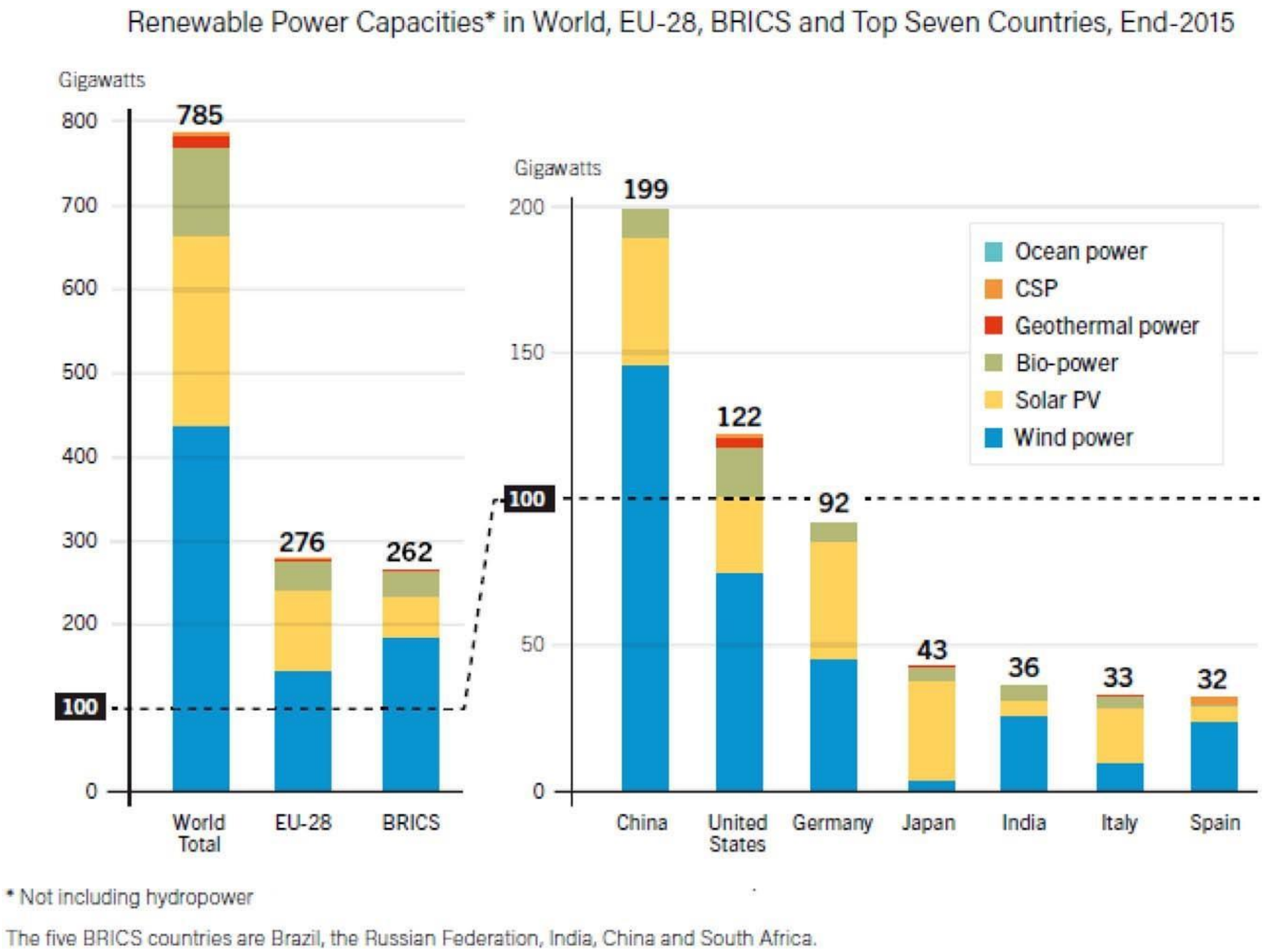


Figure11Comparisonofnations'non-hydrorenewableenergycapacities.

## Potentialofsolarenergy technologiesandcomparisonsbetweenlocations

Togenerateenoughheat energyforpowergeneration,onlythreerenewableenergysources—biomass,geothermal,andsolar—canbeused.Solarenergyhasthegreatestglobalpotentialof the three because geothermal sources can only be found in a few places and biomass is not always available. Various elements (e.g.,scope, diurnal variety, environment, and geographic variety) are largely liable for deciding the power of the sun oriented convergence thatgoes through Earth's climate. The average amount of solar energy absorbed by the Earth's atmosphereisapproximately342Wm$^2$,withapproximately30%isreflectedorscatteredback into space, leaving approximately 70% (239 W m$^2$) of the area is suitable for harvesting and capturing.Aroundtheworld,theannualeffectivesolarirradiancerangesfrom60to250Wm$^2$.

Fig. 2 shows the average annual intensity of solar radiation on Earth's surface. According to research, "black dot" regions have the potential to meet more than all of the world's primary energy needs, even at conversion efficiency levels as low as 8%.



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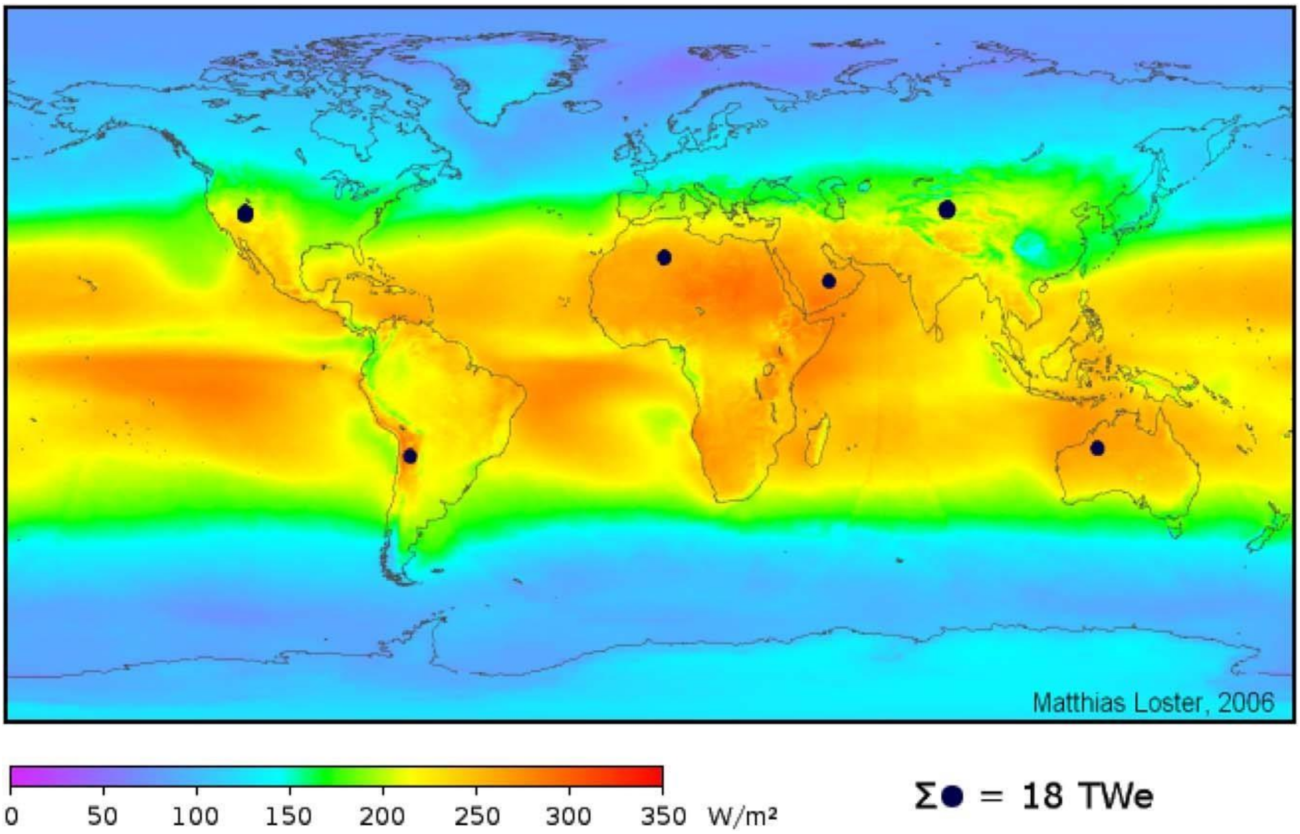


Figure12Yearlyaverage solar irradiance distributionoverthesurfaceofthe Earth.

OutsideofAfrica,suchasthesouthwestUnitedStates,CentralandSouthAmerica,Northand SouthernAfrica,theMiddleEast,andthedesertplainsofIndia,Pakistan,andAustralia,among otherplaces,Thispotentialcanonlyproduce125gigawatthours(GW-h)froma1km$^2$areaof land.

Hang et al. estimated that a wasteland covering approximately 6300 km$^2$ in the northern and westernpartsofChina,wheresolarradiationisamongthehighestinthecountry,hasacapacity ofapproximately1300GWtogenerateelectricity.Incontrast,theNationalRenewableEnergy Laboratory(NREL)intheUnitedStateshasestimatedthatthecountry'ssolarenergypotential can generate 400 zetta watt-hours per year (ZW-h), which is significantly more than the country's current electrical generation capacity (22,813 TW-h) .

One of the largest solar energy projects in the world, with plans to generate 2000 MW (MW) by2020,hasrecentlybeenlaunchedinMorocco,anorthernAfricannationwithapproximately 3000hofsunshineperyear.Dueto thefavorableatmosphericconditions(highaltitudes,low fugitive dust, high transparency, and low humidity), this strategy is ideal.

Australiaisthoughttohavethebestsolarenergyresourceintheworldandhasthehighestsolar radiationpersquaremeterofanycontinent.Arelativelyhighdailysolarirradianceof4–6kW hm$^2$hasbeenobservedontheAustraliancontinent.Similaramountsofsolarradiationwere



ISBN:978-81-957858-1-0

also detected in the deserts of northern and southern Africa, the southwestern United States, Mexico's border regions, and the Pacific coast off South America.

The entire idea of solar energy is thought to be the harvesting and exploitation of the light and/orheatenergyproducedbytheSun,aswellasthepassiveandactivetechnologiesinvolved in achieving these objectives. Figure 3 depicts a classification of current solar energy technologies. Passive technology, by definition, involves accumulating solar energy without converting thermal or light energy into any other form (for example, for power generation). Passive solar technology is exemplified by the collection, storage, and distribution of solar energy in the form of heat for the purpose of heating homes, particularly in the winter.

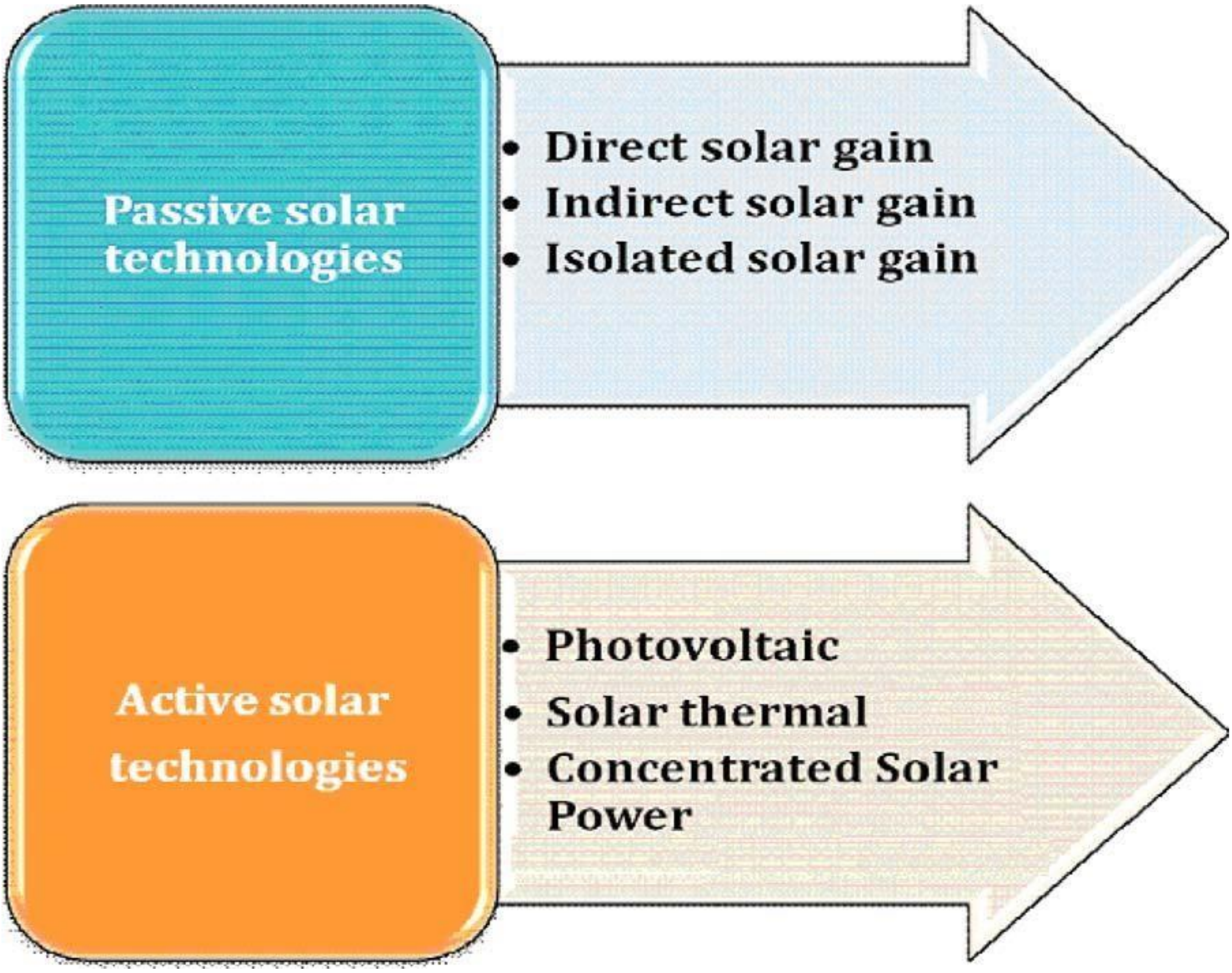


Figure13Categorisationofthepresentsolarenergy technologies.

Active solar energy technology generally falls into two broad categories: solar thermal technology and photovoltaic technology. Photovoltaic technology, which makes use of semiconductors to convert sunlight directly into electrical energy, has emerged as a highly desirableoptioninrecent times.Photovoltaictechnology'sefficiencyhasimprovedasaresult of energy scientists' extensive research into solar options.



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Solar energy is converted into thermal energy insolar thermal technology for use in domestic and/or commercial processes like drying, heating, cooling, and cooking, among other things. However,concentratedsolarthermal(CST)and concentrated solarpower(CSP)technologies are being utilized to generate electricity at the industrial scale to meet these heating requirements. The latter involves concentrating solar energy with high-magnification mirrors before converting it into heat energy to power a steam turbine.

## Currentglobalstatusforsolarenergy

The majority of renewable energy sources (wind, solar, tidal wave, hydro, etc.) are readily available.tendstochangealotfromdaytoday,seasontoseason,andevenfromonelocation to another.In many nations, the use of renewable energy has been pursued concurrently with conventionalenergysources,significantlyincreasingnationalpowergeneration.Forinstance, solar photovoltaics (PV) are thought to account for 7.9%, 7.6%, and 7%, respectively, of the demand for electricity in Italy, Greece, and Germany.

Europe's solar capacity increased by 8 GW in 2015, while only 5.3 GW (75%) was added by the UK, Germany, and France. However, China has excelled, with approximately a total installed capacity of solar power. 43 GW as of December 2015, supplanting Germany, which had topped the global rankings for a long time.

TheAmericanSolarEnergyIndustriesAssociationestimatesthattheUnitedStates'totalsolar photovoltaic(PV)capacitycouldreach45GWby2017.913MWofnewpowerwasgenerated by solar power in Australia in 2015, compared to 774 MW generated by wind power. Interestingly, Australia shut down 1300 MW of coal-fired power in the same year. This was hailedasasignificantpush towardeliminatingconventionalcoal-basedpowergenerationand preserving the environment.

InIndia,thecapacityoftheinstalledsolarpowergridwas3743MWinMarch2015,6762MW in March 2016, and 8062 MW in July 2016. India intends to increase its solar power capacity to a staggering 100,000 MW by 2022 as a result of these developments. In a similar vein, France intends to construct a 1,000-kilometer solar road across Europe, with each kilometer providing sufficient clean energy to power 5,000 homes.

## Regulationand policy frameworks

Global investment in solar energy increased in 2015, particularly in China, the United States, Africa,LatinAmerica,theMiddleEast,andIndia.DespitethefactthatChinaisanticipatedto maintainitslead,theUnitedStatesisanticipatedtoexperiencerobustgrowthin2016asaresult oftheFederalInvestmentTaxCredit(ITC).Additionally,itisanticipatedthattheUnitedStates willsurpassthemuch-anticipated10GWmarkin2016andtakeoverJapanasthethirdlargest solar market.

However, compared to the previous year, 2015 saw a slow increase in investments in solar power in Europe.



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TheRenewableEnergyActof2014establishedfixedpricesforthepurchaseandcompensation of PV electricity in Germany, as well as taxes on self-consumption.

Italy is additionally expecting to shorten all sun oriented power motivators (by10-25%) on comparablegrounds.GreeceandSpainhavealsoimplementedsimilarreductions.PVsystems with capacities between 10 and 100 kW must add excess electricity to the grid without compensation,andsystemswithcapacitiesgreaterthan100kWmustberegisteredinorderto sell electricity on the spot market. These new policies were implemented by the Spanish government. It is possible that governments in some European nations are reluctance to maintain support for the solar power sector is the result of lobbying efforts aimed at securing the fossil fuel energy industry's bulk investments.

## Limitationsand benefitsofsolarenergy technologies

Sun based energy is a consistent power source that could give energysecurity and energy freedomtoall.Thispropensityiscrucialnotonlyforindividualsbutalsoforthesocioeconomic well-being of businesses, societies, nations, states, and countries. Nevertheless, many developed and developing nations are adopting solar power as a natural and significant component of electricity generation to meet their energy needs.

## Limitationsofsolarenergy technologies

Higher initial installation cost is one of the most fundamental weakness of the solar energy system.The value of credits for such systems is also diminished by long payback periods and limited revenue streams. Another drawback of solar technology is that most domestic solar panels only achieve efficiencies of 10–20 percent. However, more effective (around solar panels (> 20%) are also available, but they cost more. the limitations of other components' performance, like batteries and inverters. are additional areas where there is a lot of room for improvement. Another issue with solar energy systems is the safe disposal of spent batteries and short battery lifespans.

Anotherconstraintisalackofskilledlabortomeetthegrowingdemandforsolarpowersystem installation,maintenance,inspection,repair,andevaluation.Theseandotherfactorsarerelated to the maintenance of systems. Besides, an absence of essential specialized expertise on the client's benefit (particularly in country region of the creating scene) with respect to sun based power frameworks can bring about unpredictable utilization, overcharging the battery, extremity inversion, by-passing the charge regulator, and so forth. which may all result in system harm.

In areas where weather or climate conditions are unsustainable, solar energy is probably not themost reliablesource ofenergy. In addition, theeffectiveness ofthesolarcells mayalso be affectedbyairpollutionlevelsattheinstallationsite.Itwasdiscoveredthatsiliconsolarcells' currentsweredecreasedby10%and7%,respectively,whentheywereexposedtoaerosolsand exhaust fumes. Finally, large tracts of land arefrequently required for large-scale solar power generation.



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## Benefitsof solarenergy technologies

Assunorientedpoweris hypotheticallysufficientlyplentiful,itismorethanfitforsatisfying the world's power requests. It is unnecessary to take into account the possibility that solar energy will eventually run out because it is both renewable and sustainable.

Oneofthemostfeasiblesolutionstothecurrentcrisiscausedbyglobalwarmingissolarpower, which,ifleftunchecked,couldhaveveryexpensiverepercussions.Asaresult,switchingfrom coal and gas-based power sources to solar power will eventually benefit society, the environment, and the economy, all while contributing to sustainable development.

Solarpowerisregardedasaclean,dependable,andnon-pollutingenergysource.Incontrastto other forms of energy, its use does not result in the emission of harmful gases.

Solar power is considered to be more labor-intensive than fossil fuel technologies, which are predominantlymechanizedandrequirealotofcapital.Thefactthatsolartechnologiesshould increase employment opportunities is a positive aspect of this idea. Solar energy can, on average, generate more jobs per unit of electricity produced than fossil fuels. In recent years, solar power technologies' efficiency has significantly increased, and their costs have also decreased steadily, and it is anticipated that they will continue to do so.

## Futureprospects ofsolartechnology

Because it is superior to other renewable energy sources in terms of availability, cost effectiveness,accessibility,capacity,andefficiency,solarenergyisoneofthebestoptionsfor meeting future energy demand. Researchers have successfully measured the precise flow of solar energy within and between various parts of a photosynthetic organism for the first time. The result is a first step in research that could eventually lead to the creation of solar energy-using technologies that are significantly more effective than what is currently possible. The GraphemeFlagshipdemonstratedthatusingfew-layer$MoS_2$flakesasanactivebufferinterface layer can significantly increase the lifetime of perovskite solar cells.

It is important to note that when perovskite solar cells first appeared in 2009, their efficiency was only 3.8%. As a result, semi-transparent perovskite solar cells have been developed that are excellent candidates for solar windows because they transmit visible light while blocking infrared light and demonstrate high power conversion efficiency.

Researchers have discovered that a heat-resistant device made of layers of tungsten and alumina can convert broad-spectrum solar radiation into electricity. The dye-sensitized solar cellswerecoatedwithabiowaste-derivedgreenpolymer.Chitosanacquiredfromthebugsand shellfish chitin

was changed to create the phthaloylchitosan electrolyte for the dyesensitized sunlight based cells with effectiveness of over 7%.



ISBN:978-81-957858-1-0

## Conclusionsandremarks

Solar energy technologies are now widely used and well-established all over the world. To overcome the solar industry's current limitations, billions of dollars have been invested and manymoreareanticipatedtobeinvestedinthenearfuture.Inbothdevelopedanddeveloping nations, a number of new large-scale solar power projects, such as CSP, are currently operationalorintheplanningstages.AlthoughCSPismoreexpensivethanPVtechnology, it has been found to be suitable for areas with few clouds or haze. PV technologies may remain the primary means of producing solar power for the time being.

Furthermore, the limited development of supporting policies and institutions means that the potential market for off-grid solar systems remains largely untapped.

Even though thecost ofsolartechnology has dropped quickly in recent years,theoverall cost ofproducingsolarpowerisstillhigh.Itisbecomingincreasinglyclearthatnovelstrategiesare still required to lessen the financial burden of various policy incentives because of the importance of incentives and rebates to the growth of the solar energy market.

However, the solar industry ought to concentrate more on the advancement and quality of its technology. Additionally, researchers ought to concentrate on making solar power more competitive with conventional and other renewable energy sources. In the near future, it is hopedthatmoreresearchwillbedoneonPVtechnologiestomakethemmoreefficient,stable, manufacturer,andavailabletolowerbalance-of-system(BOS)costsandlowermoduleprices. We looked into the global potential of solar energy technologies, their drawbacks and advantages, and their potential for the future in this review. As a result, we came to the conclusionthat,despiteafewdrawbacks,solarenergytechnologyisoneofthemostpromising renewable energy sources for meeting the global energy demand in the future.

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ISBN:978-81-957858-1-0

# ProductionMethodologyusedforBiodieselproductionusingMicroalgae

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## Abstract

\Energyisanessentialforeconomicdevelopmentoftheworld.Theglobaleconomymayruns on the energy. The global economy depends on the fossil fuels but due to limited availability, landandwaterdegradationandhighlypollutedlimitedtheuseoffossilfuels.Biofuelcanbea choice to lessen the reliance on petroleum derivative and help to keep up with climate contamination free and financial reasonableness. Microalgae appear to be the source of renewable biodiesel that is capable of meeting the global energy demands. Microalgae use sunlight and CO2 for their growth. Oil efficiency of numerous microalgae extraordinarily surpasses the oil efficiency of different harvests. In a large scale plant, release of solvent contributestotheproductionofatmosphericsmogandtoglobalwarmingandisclassifiedasa hazardous air pollutant. Subsequently, to decrease the waste water contamination, expanding theDistinctionyields,diminishingthecreationcostsomemorecreationprocedureoughttobe presented.

**Keywords**:Energy,Insitu,transesterification,biodiesel,productionmethodology,microalgae.

## Introduction

Microalgae are termed as micro-organism cell that can convert CO2 to potential biofuels and therefore can be considered to have the potential to serve as feasible process for CO2 mitigation. These photosynthetic micro-organisms are also useful in bio-remediation applications and as nitrogen fixing bio-fertilizers [1-4].The current review is about on micro-algal biodiesel production method from micro-algal oil. Micro-algae can provide several different types of renewable biofuels such as biodiesel, methane and bio-hydrogen. The biodieselfromedibleoilresourcesisimpracticalandinfeasibleasmorethan50%ofedibleoil is imported to meet for food requirement in India. The non edible oil resources like Mahua, Sal,jatropha,pongamiaandneemandmanymoreareviewedinIndiaaspotentialfeedsstocks for biodiesel. Recently, micro-algae is being viewed as the future source of biodiesel as it requireverylesslandarea,lesstime(24hrsto2days)formaturityandgiveabout25timesor more oil yields than terrestrial oil need crops. [5]

## PotentialofMicro-algalBiodiesel

EnormousamountofburningofthefossilfuelhasincreasedtheCO2levelintheatmosphere, whichiscausingglobal warming.Biomassreferredasanalternativeenergysourceto mitigate



ISBN:978-81-957858-1-0

atmospheric CO2 through photosynthesis. Algae usually having a higher photosynthetic efficiency as compared to other biomass. Biodiesel from microalgae appears to be a feasible solutionwithinIndia,asanalternativeofdiesel.TheprojectedannualconsumptioninIndiaof petroleum product is nearly about 130 million tonnes per year & only micro-algae is having thecapacitytoreplacethishugevolume.Ithasbeenexpectedthatlessthan3-5percentoftotal Indian cropping land is sufficient to produce biodiesel to replace diesel currently used in country due to its high yield of oil per acre of cultivation. Clearly micro-algae are superior alternative as a feedstock for large scale biodiesel production as shown in table 1[5]

Table1 Feedstockv/s Oil yield

| **Sr.No** | **Crop** | **LandRequired(Mha)** | **Oil Yield(L/ha/yr)** |
|---|---|---|---|
| 1 | Soybean | 596 | 452 |
| 2 | Oil palm | 47 | 5870 |
| 3 | Jatropha | 145 | 1772 |
| 4 | Corn | 1570 | 185 |
| 5 | Canola | 233 | 1120 |
| 6 | Coconut | 105 | 2560 |
| 7 | Microalgae | 2.3 | 135800 |

The above table obviously shows that the oil yield of microalgae is higher than the other palatable and non-eatable oil seeds and land region required is exceptionally less.

**AlgaeCultivation**

Producing biodiesel from micro-algal biomass is usually expensive than other crops. ThecultivationofalgaerequiresCO2,light,waterandinorganicsaltsandtemperaturesremain within24to35°C.Inordertohavedecreaseexpense,biodieselproductionmustrelyonfreely accessible sunlight. Growth medium must provide the inorganic elements (phosphorus, nitrogen, silicon and iron) that constitute the algal cell. Micro-algal biomass contains approximately 50% carbon by dry weight. Carbon is normally derived from carbon dioxide, producing 100 tonnes of algal biomass fixes approximately 179 tonnes of carbon dioxide. BiodieselproductioncanpotentiallyCarbondioxideduringdaylightshoursandalsousecarbon dioxidethatisreleasedinpowerplantsbyburningfossilfuels[6].Thepracticableapproaches of large-scale production of microalgae are open ponds, Fermenters and tubular photo-bioreactors.



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**HarvestingofAlgae**

Algal collecting consists of recovery of biomass from the culture medium that constitutes about 18-32% of the total biomass production cost. Collecting method include the centrifugation, filtration, combination of flocculation-flotation, ultra-filtration sedimentation. Once the algae is harvested and dried, several methods like

- mechanicalsolventextraction
- andchemicalmethods

Can be applied for oil extraction. Solvent extraction is usually applied to get high oil yields from algae [8].

**OilExtractionTechnique**

Therearevariousapproachestoextracttheoilfrommicro-algaebetweenthemfour methods are well known for oil extraction:

- Mechanicalpress,
- Solvent extraction,
- Supercriticalfluidextractionand
- Ultrasonicassisted.

**BiodieselProductionMethodology**

Biodiesel(FAME)wasreadyfromalgalbiomassthroughtwotechniques:firststrategy is oil extraction from algal biomass followed by transesterification and second strategy is immediate transesterification of algal biomass. For this situation both dry as well as wet biomasses were utilized as feed stocks for biodiesel creation.

**ExtractionTransesterification Method**

Transesterificationofalgaloilwithmodestalcoholhaslongbeenthepreferredmethod for creating biodiesel The Transesterification method is most widely use all over the world. The overall Transesterification reaction is specified by three consecutive and reversible equations as below:

Triglyceride + ROH = Diglyceride + RCOOR

Diglyceride+ROH=Monoglyceride+RCOOR

Monoglyceride + ROH = Glycerol + RCOOR

Inthefirstreactiontheconversionoftriglyceridestodiglycerides,followedbytheconversion of triglycerides to mono-glycerides, and of mono-glycerides to glycerol, yielding one methyl ester molecule per mole of glyceride at each step. The complete chemical reaction of the transesterification method is:



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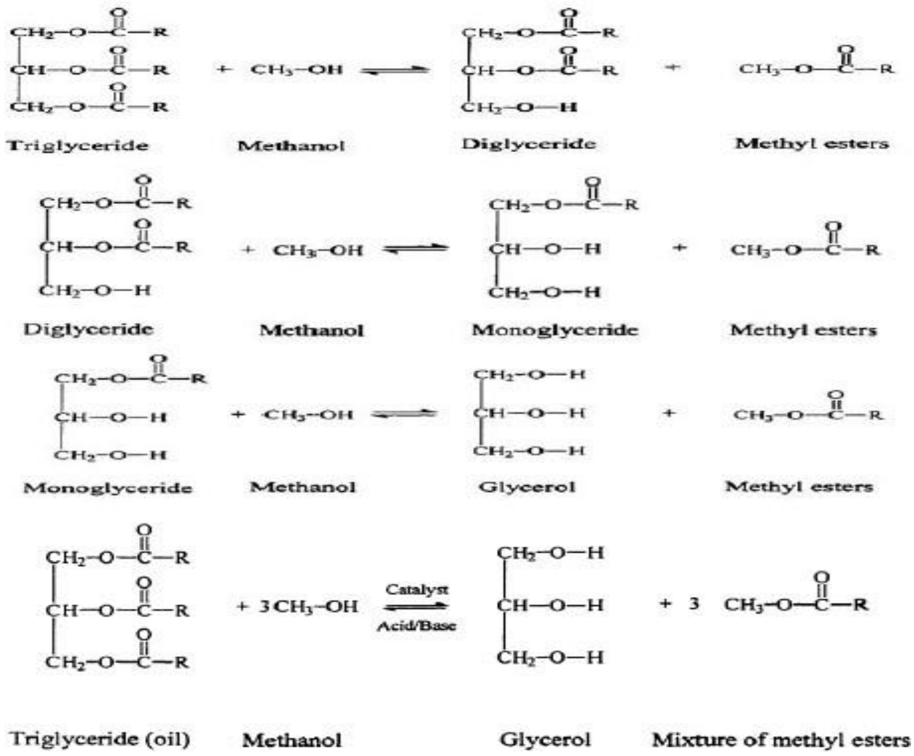


14TransesterificationReaction

Where R is long-chain of hydrocarbons which may be the similar or different with R=CH3/C2H5. As seen above, the transesterification is an equilibrium reaction in which surplus Alcohol is required to drive the reaction close to completion.

**In situ transesterification**

In situ transesterification varies from the conventional reaction in that the oil-bearing materialcontactswithalcoholdirectlyinitsplaceofreactingwithpreextractedoilandalcohol. Thatis,extractionandtransesterificationdoneinsinglestep,thealcoholperformingbothasan extraction solvent and an esterification reagent which improves the porosity of the cell membrane, and would remove the need for extraction: yields found are higher than via the conventional route, and waste is also reduced [9].

**Comparison of *in Situ* Transesterification Method and Traditional Two-Step Reaction Process**

Table2ComparisonofinSituTransesterificationMethodandTraditionalTwo-StepReaction Process

| Sr.No | Extraction-Transesterification | In-situTransesterification |
|---|---|---|
| 1 | Yieldis low | Yieldis high |



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| | | |
|---|---|---|
| 2 | Productioncostisless | Duetoabsenceofextractionand dewateringtheproductioncostislow |
| 3 | Heatingvalueislow | Heatingvalueishigh |
| 4 | Processiscomplex | Verysimpleprocessin operation |
| 5 | Thewaste waterpollutesthe environment | Reducedthewastewater pollutants |
| 6 | Lipid loss during process | Avoidedthepotentiallipid loss |
| 7 | Timeconsumptionis high | Lesstimeconsumingprocess |

**PropertiesofBiodieselfromDifferentOils**

Table3PropertiesofBiodieselfromDifferentOils

| **Oil Ester (Biodiesel)** | **Cetane Number** | **HeatingValue (MJ/kg)** | **Kinematic Viscosity @ 38°C (mm²/sec)** | **Flash Point (°C)** |
|---|---|---|---|---|
| Soyabean | 45 | 33.5 | 4.5 | 178 |
| Peanut | 54 | 33.6 | 4.9 | 175 |
| Palm | 63 | 33.4 | 5.8 | 165 |
| Babassu | 63 | 32 | 3.5 | 126 |
| Sunflower | 48 | 33.4 | 4.5 | 180 |
| Diesel | 50 | 48.3 | 3 | 76 |
| 20% Biodiesel blend | 59 | 41.1 | 4.35 | 165 |
| Micro-algal Biodiesel | 52 | 43.1 | 3.2 | 127 |



ISBN:978-81-957858-1-0

**Conclusion**

It can settled from the above literature is that the oil yield of micro-algae is higher than the other edible and non-edible oil seeds and land area needed is also very less. A comparison betweenthevariouscultivationmethodsisgiventochoosethebestmethod.Releaseofsolvent inextraction-transesterificationprocess,contributestothemakingofatmosphericsmogandto global warming and is classified as a dangerous air pollutant. In situ transesterification techniqueisapromisingmethodwhichreducesthedrawbacksofextraction-transesterification method.Thefuelpropertyofmicro-algalbiodieselissimilartodiesel.Somicro-algalbiodiesel can be an alternative of diesel.

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ISBN:978-81-957858-1-0

**WindTurbineBladeAnalysesofStressandVibration** *Deepak Singh Bisht[1,] Bharat VPS Rawat, Mr. Deepak Saroha [1]Assistant Professor JBIT, Dehradun,248197(UK) INDIA*

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**Abstract**

Theneedtoincreasewindturbineenergyefficiencyandlongevityisgrowingasaresultofthe quick expansion in the energy sector. It is crucial to fully comprehend how wind turbines behaveundervariousloadscenarios.Thisstudyoffersamethodforinvestigatingandanalyzing stressesanddeformationsundersteady-stateconditions.ThevibrationparametersoftheNREL offshore5-MWblade(HAWT)withalengthof61.5mandrotordiameterof126mwerealso studied. SOLIDWORKS was used to generatethe 3Dmodel ofthe wind turbineblade, which was then exported to ANSYS/Workbench19 for the numerical simulation based on the Finite Element Method. At maximum rated power, the steady-state analysis of the chosen wind turbine blade was carried out.

**Keywords-**Windturbineblade,Stressanalysis,vibrationanalysis,finiteelementmethod.

**Introduction**

Renewable energy is produced using non-depleting resources like solar, wind, hydropower, and geothermal energy. The majority of renewable energy is a direct or indirect result of exploitation. In contrast to other energy sources like coal, natural gas, crude oil, and uranium that are harmful to the environment because they produce toxic gases when burned, one of which is carbon dioxide gas which causes a change in climate, renewable energy has two distinct features, one being infinite resource and the second being proving clean energy (zero carbon monoxide emission). Significant environmental effects of climate change include increasing pollution, droughts, rising sea levels, and rising temperatures. Environmental integrationchangesasaresultofhightemperatures.Therefore,thepressingtopicofthedayis whetherornotwecanguaranteeasafeworldforthefuturegenerationinadditiontoproviding enoughenergyforhumanity.Asaresult,findingsolutionsfortheutilizationofalternateenergy sources alongside existing sources should be necessary. Forthisreason, renewableandsustainableenergyisofinterestinthecurrentstudy[1].As a fuel substitute, wind energy is crucial in supplying electricity to the most industrialized nations. Annual additions to and global capacity for wind power are both increasing quickly, as seen in Figure 1. Wind turbines provide wind power, and their blades are the most important part of the entire wind turbine system. Wind loads induced deflection in the wind turbine blades, therefore the blade shouldbestrongenoughandlightenoughtopreventfailure.Theblades'uniquestrengthand



ISBN:978-81-957858-1-0

great stiffness are their defining characteristics. In order to protect the turbine against fatigue failure and decrease the overall weight of the wind turbine system, strong and light materials are needed [2]. The three primary components of a wind turbine are the tower, nacelle, and blades. Tower of wind turbines must be strong and stiff to bear the load so if the the blades, generator,andnacellemustallbeabletowithstandchangesinwindloadsbroughtonbyblade rotation.

The gearbox, shafts, generator, and supporting components are located in the nacelle.Bladescontainmanyairfoilswithoptimumcrosssectionsforaerodynamicefficiencytoprod ucemaximumpower[3,4].Numerous studies have concentrated on understanding the steady-state and dynamic behaviour of various wind turbine blade designs, as well as computing the stresses, deformations, and natural frequencies of blades using both experimental and numerical methods.

Researchers examined the effects of rotational speed and thickness on the behaviour of two types of wind turbine blades (the NREL 5MW offshore HAWT and the WindPACT 1.5MW HAWT) using steady-state and vibration analysis.

(Alloys made of aluminium and titanium) [5]. Utilising the SOLIDWORKS 2016 software, themodelswerecreatedandsenttoANSYSWorkbench2016forexamination.Fortwomodels ofblades,thevon-Misesstresses,overalldeformations,firstfifthnaturalfrequencies,andmode shapes were computed.The dynamic properties and performance of the blade with the NACA 63415 profile were studied by Krishnamurthy and Sesharao [6]. The dynamic behaviour of a horizontalaxiswindturbinebladeexposedtoaerodynamic,centrifugal,andgravitationalloads wasthemainfocusofthestudy.Additionally,theeffectsoftheseloadsonthenaturalfrequency and tip speed ratio were examined.

Small models of blade wind turbines' static and dynamic analyses were examined by Ina [7]. Pro/Engineer and ANSYS software are used to model and analyse the blade. Two different bladematerials—E-glassepoxyandS-glassepoxy—withtwistedanglesof15°and30°arethe subject of analysis. Von-Miss stress and strain analysis of the total deformation data revealed thattheS-glassepoxymaterialissuperiortotheE-glassepoxymaterial.Finiteelementanalysis was used by some rearchers to examine the vibration issue with 1.5 MW wind turbine blades [8]. Thenatural frequenciesand modeshapes werecomputed. Various materials wereused to completethefatigueanalysis.Usingthefluidprogramme,thepressureeffectonthebladewas added.

Four different composite materials were employed and tested by calculating the total deformation, equivalent (von-Misses) stresses, and maximum shear stress in a study of the wind turbine blade's performance parameters [9]. Analyses are performed using ANSYSWorkbench.Accordingtothestaticstudy,Kevlarcreatesthefewestdeformations,



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epoxy carbon produces the fewest von-Misses stresses, and carbon fibre reinforced plastic provides the fewest maximum shear stresses when compared to other materials.To determine the stresses and deflections in the rotor and tower of a wind turbine, Namiranian investigated theeffectsofturbulenceandgravityloads[10].Acomplete3-Dmodelofa5MWwindturbine wasdesignedandsimulatedusingtheANSYSprogramme.Thefindingsdemonstratedthatthe turbulence effect was responsible for the rising fatigue loads on the structural components. It wasadvisedtopaycloserattentiontofatigueloadssincetheyshortenwindturbinecomponent lifetimes and result in component failure

By ANSYS, the analysis of the stress and deformation of the 5MW wind turbine blade was also investigated. A wind turbine blade is a sandwich structure built of composite materials, with PVC foam serving as the core material and Carbonfiber cloth/epoxy compounds as the outerandinnerlayers,respectively[11].Glassfiber/vinylestercomposites'stackingangleand blade skin thickness were altered during the analysis. Vibration analysis is a crucial step in analysing a structure's dynamic behaviour to prevent failure; it will reveal details about the mode shapes and natural frequencies. It should be noted that the natural frequency and mode shapeareconnectedtotheappliedforcefrequency.Thevibrationshouldbekepttoaminimum level to minimise resonance, as this phenomena can cause a catastrophic wind turbine blade failure[12]. This will result in the best possible wind turbine design.

Differenttypesofrotatingbladeswereexploredforbothsteady-stateand dynamicbehaviour. Theseresearchersemployednumericalandexperimentalmethodologiestoprovideresultsthat concentrated on the stresses and natural frequencies of damaged and undamaged revolving blades[13–17].The purpose of this research study is to propose a finite element method approach to designing and analysing a horizontal-axis wind turbine blade. To complete the numericalanalysis,awindturbinebladeexample(NRELoffshore5MWblade)wasprovided. SOLIDWORKS19 software was used to create the model, which was then exported to ANSYS/Workbench19.Two different analysis types, a steady-state analysis and a modal analysis, were accomplished. The total deformations, von-Mises stresses, first tenth natural frequencies, and mode shape of the chosen wind turbine blade are all detailed in the result section.Figure2showstheNRELoffshore5MWblade.

## 2. MODELLINGOFWINDTURBINE BLADE



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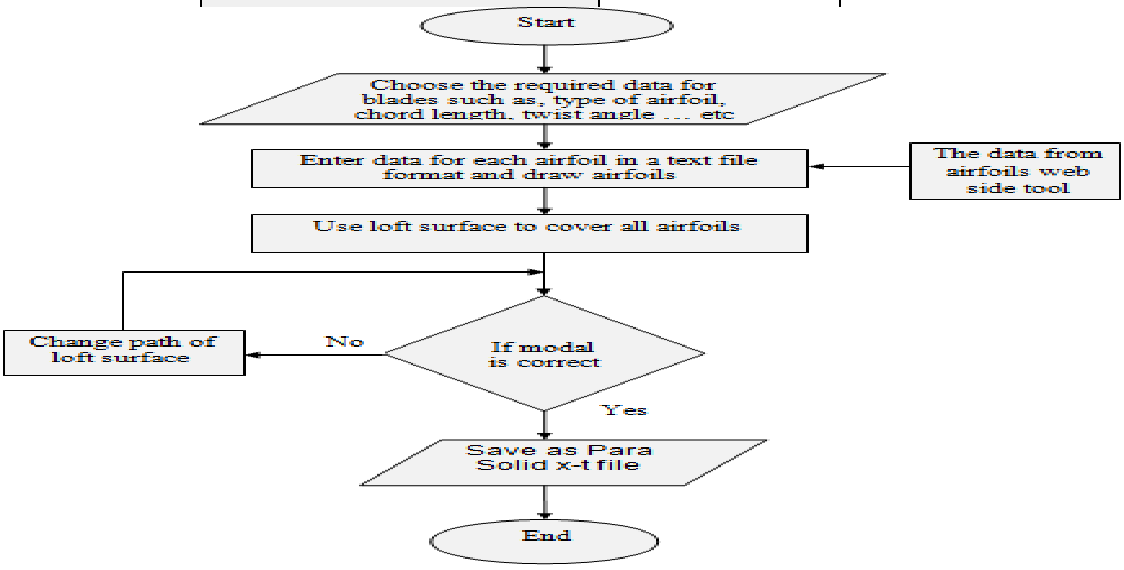
SOLIDWORKS2018softwarewasusedtocreatethe3Dmodelofawindturbinebladeinthis project.Table1[18]displaystheNREL5MWwindturbine'sdimensionsandspecs.Thelength of the NREL 5MW(HAWT) offshore blade, divided into 19pieces,is61.5 metres. The thickness of the blade'souterlayer

| | |
|---|---|
| Ratingpower(MW) | 5MW |
| Rotororientation,confi guration | Upwind,3bl ades |




changes with its length; it starts at the blade root at 40 mm and gradually decreases to 20 mm at the blade tip. In order to build a wind turbine blade successfully, the right airfoils need be chosen.TheDUseriesandNACA64-618airfoilshavebothbeenutilisedinthisdesign,among others[19].Basedonthewebsitefortheairfoiltool,thedataforeachairfoilwasacquired.For the purpose of converting these data from 2D to 3D, EXCEL software might be used.

**Figure3:**Flowchart oftheprocess to build 3D modelof thewind turbineblade

Drawing the other circular and airfoil sections that were chosen for each position of the blade comes after sketching the circular section on the correct plane at the origin point. Lofting of sections needs to be done repeatedly to get a 3D blade model in order to get the final product [20]. The method flowchart for creating a three-dimensional model of the wind turbine blade is shown in Figure 3.The wind turbine blade's airfoil sections are obscured in Figure 4. The NRELoffshore5-MWblade(HAWT)windturbineblade'sfinal3DmodelisdepictedinFigure 5.

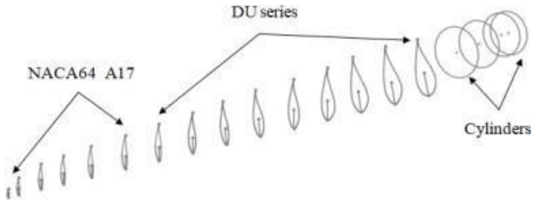





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**Figure4:**AirfoilssectionsfortheNERL5-MWblade

3. FINITEELEMENT FORMULATION

The finite element formulation used to create the numerical models to solve the steady-state and vibration problems is presented in this section.The 3D blade model was exported to ANSYS/WORKBENCH19toexaminethestressesbroughtonbyfreevibrationandcentrifugal effect. The primary goal of this research is to examine how wind turbine blades behave under variousoperatingcircumstances.Itwasthoughtthatthebladeoperatesinitsmostcriticalstate when its output power is at i rpm.

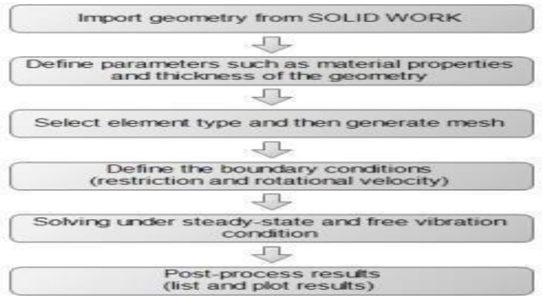


**Figure6:**Themainstepsoffiniteelementanalysis



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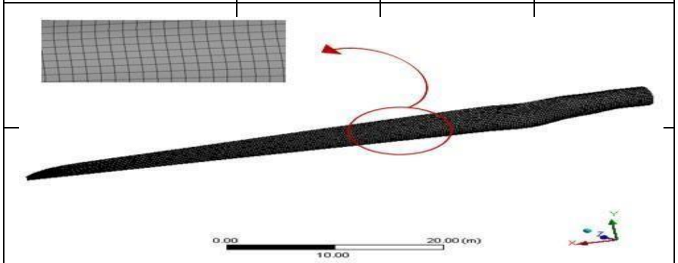
TheflowchartinFigure6showsthemainstepsofthefiniteelementmethodusedtosolvethe steady-stateand modal issues.Thewind turbinebladewas modelled as acantileverbeam with a fixed root end and a free tip. In this examination, three different materials—E-glass fibre, Kevlar,andcarbonfibre reinforcedplastic—wereusedtostudytheimpactofrotationalspeed on the wind turbine blade. Table 2 displays the mechanical characteristics of a few materials.

**Table2:**

Themechanicalpropertiesofthesematerialsare[19],[20]

| Materials | Density(Kg/m^3) | Modulus ofelasticity(GPa) | Poissonratio |
|---|---|---|---|
| E-GlassFiber | 2570 | 72 | 0.2 |



e best mesh was chosen based on the standard mesh test for both steady-state analysisandmodal analysis; the quadrilateraltype of mesh was employed for all parts of the blade, and the number of elements was 10376.Figure7showstheselectedmeshthatusedforthesteady-staeandmodalanalyses.

**Figure7:**Finiteelementmodelof5-MWturbineblade

Theequationthatwasusedtodeterminetheresponseofsteadystateofwindturbinebladescan be stated as follows[21]:

[K]{U}={R}…..(1)

Where[K]isthestiffnessmatrixofthesystemandthe{U}isdisplacementvectorsand{R}isloadvector(centrifugalforce).It was assumed that the damping forces and inertia forces in equation (1) are equal to zero.

Aflexiblestructurecanvibrateharmonicallyifitisputinaproperpositionwithatt=0.Natural frequency is the frequency at which the vibration movement occurs. It follows particular deformationpatternscalledmodeforms[22].Accordingtostiffnessandmass,astructure's



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vibrationandmodeofshapedepend[23].Theequationofthefreevibrationcanbeexpressedas follows,assumingthattheexternalforcevectorRiszero: [M]Ü+[K]U=0…….(2)

And the

harmonicdisplacementis

Ui=isin(it+i),wherei=1,2, etc.DOF ……(3)

Where,thesymbol"i"isavectorofcontractualamplitudefortheithmodeofvibration(mode shape), "i" is the phase angle, and "i" is the angular frequency of mode i. After deriving Equation (3) twice respect to time (t)to obtain the following form,

$\ddot{U}i = -\omega 2 \emptyset i \sin(\omega i t + \theta i)$……. (4)

Thefollowing was obtainedby substituting equations(3)and (4)into equation (2):

([K]2[M])i=0……(5).

Only in the standard model, the symmetric following, Eq. (5)is the most efficient formula for the structural vibration (Eigen Value Problem):

([A]□□i[I])XXi0… ........(6)

Where [A] is a dynamic matrix (symmetric matrix), [I] is an identity matrix, [XXire] is the eigenvector corresponding to the new system of this homogeneous equation, and the symbol denotes the heigenvalue value. Insert matrix [K] or matrix [M] to convert equation (5) into equation(6)usingtheCholeskysquarerootmethod.Thefactthatanymatrixutilisedisasquare matrix,[A],and thattheupper andlowertriangularmatrices [A]can beexpressedas products [24]makeit simpleto solvelinear systems.

## 4. RESULTSANDDISCUSSIONS

In this section the results of steady-state and vibration analyses are presented.The stresses, deformations, natural frequencies, and mode morphologies of the wind turbine blade were shownintheresults.Toproducethemaximumratedpower,thistypeofwindturbine'shighest permittedrotationalvelocityis12.1rpm.Inthisexamination,threedifferentmaterials—E-glass fibre, Kevlar, and carbon fibre reinforced plastic—wereused to study the impact of rotational speed on the behaviour of the blade.The NREL5MW wind turbine blade's total deformations andVon-MisesstresseswhileemployingthechosenmaterialsaredepictedinFigures8through

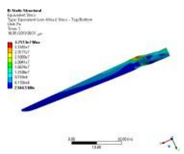

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**Figure8:**Von-MisesstressofE-glassfiber,ratedspeed

## CONCLUSIONSANDREMARKS



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The behaviour of a 5-MW wind turbine blade under a steady-state condition was investigated using finiteelementanalysis.Inaddition,thevibrationcharacteristicsofthebladewereinvestigateddeeply. SolidWorkssoftwarewasusedtogenerateathree-dimensionalmodelofawindturbineblade, whichwasthenconvertedto ANSYS/Workbench19softwaretosimulatesteady-stateand vibrationissues.TheVon-Misesstresses,overalldeformations,naturalfrequencies,andmode morphologiesofthewindbladewereidentified.BecauseCFRPhasthehigheststrength,itwas discovered that stresses are reduced when it is utilised instead of the other materials that were considered.TheCFRP'sresultsaredeemedsatisfactory,althoughthematerialishighlypricey. Additionally, compared to other materials, Kevlar is an excellent material where the level of distortion is acceptable and the total deformations are modest.

Thequalitiesof thematerial and E. determine how stiff the building is. Therefore, Natural frequencies of the structure depend on the ratio because it has a smaller E/CFRP ratio than other materials, it has fewer natural frequencies.Theratio between Kevlarand glass fibrematerial is roughly (1.67),which is also theratiobetweenglassfibrematerialandcarbonfibrereinforcedplastic(CFRP)material.The ratio of each natural frequency in a particular mode and shape of the blade for the three materialsisthesame.Thisratiobasicallyusesthecantilever-beamformulatodeterminenatural frequency.

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ISBN:978-81-957858-1-0

# PVBASEDWATERPUMPINGSYSTEMS

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**Abstract**

Technology in agriculture is evolving quickly. Construction and production infrastructure for farms,aswellasfarmequipment,arecontinuallybeingupgraded.Thereareseveralagricultural applications that photovoltaic (PV) technologies are appropriate for. When utility companies determine that a PV solution is the best option for a remote agricultural necessity like water pumping for crops or livestock, they install systems in these applications, which are a combination of individual installations and utility company systems. There are two fundamentalpartsthatmakeupasolar-poweredwaterpumpingsystem.PVpanelsandpumps arethese. The solar cell is the smallest component of a PV panel. Each solar cell contains two or more layers of semiconductor material that have been properly prepared to generate direct current (DC) power when exposed to light. The wiring in the panel collects this DC current. After that, it is either fed to a DC pump, which uses the power of the sun to pump water, or it is stored in batteries for later use by the pump. This article's goal is to describe how a solar-powered water pumping system operates and how it differs from other energy sources.

**Keywords:**Agriculture, water,solarcell,pump

## Introduction

One of the simplest and most suitable applications for photovoltaic technology is water pumping. A wide range of water needs are met by photovoltaic-powered pumping systems, includinghomeuses,stockwatering,andagriculturalirrigation.Themajorityofthesesystems also have the benefit of being able to store water for usage when the sun is not shining, which eliminates the need for batteries, improves simplicity, and lowers the cost of the system as a whole. The cost deters many people from implementing a solar water pumping system. The actualcost,however,isbetterunderstoodwhenthefeeisspreadoutoveraperiodoftenyears. By contrasting installation costs (labor included),fuelcosts, and maintenance costs over 10 years,youmayfindthatsolarisaneconomicalchoice. One of the simplest and most suitable applications for photovoltaic technology is water pumping. A wide range of water needs are met by photovoltaic-powered pumping systems, including home uses, stock watering, and agriculturalirrigation.Themajorityofthesesystemsalsohavethebenefitofbeingabletostore waterforusage when the sun is not shining, which eliminatestheneed for batteries, improves simplicity, and lowers the cost of the system as a whole. The cost deters many people from implementing a solar water pumping system. The actual cost, however, is better understood when the fee is spread out over a period of ten years. By contrasting installation costs (labor included),fuelcosts,andmaintenancecostsover10years,youmayfindthatsolarisaneconom i calc ho ice. A solar-powered pumping system isge nerally in the same price range as a newwindmillbuttendstobemorereliableandrequirelessmaintenance.Althoughinitiallymore



ISBN:978-81-957858-1-0

expensive than a gas, diesel, or propane-powered generator, solar-powered pumping systems require significantly less upkeep and manpower [4]. Water pumped by solar panels cost between$0.03and$0.15perdayeachcow.Waterpumpingcostspergallonrangedfrom $0.002to$0.007pergallon.

generatedelectricity,calledphotovoltaic(PV).Photovoltaicaresolarcellsthatconvertsunlightto D.C. electricity.

ThesolarcellsinaPVmodulearemadefromsemiconductormaterials.Whenlightenergystrikesthecell,electronsareknockedloosefromthematerial'satoms.Electrical conductors attached to the positiveand negative sides of the material allow theelectrons to be captured in the form of a D.C.current. This electricity can then be used topower a load, such as a water pump, or it canbestored in a battery[2]

It'sasimplefactthatPVmodulesproduceelectricityonlywhenthesunisshining,sosome form ofenergystorageisnecessary to operate systems at night. You canstore the energy as water by pumping it into atanwhilethesunisshininganddistributingit by gravity when it's needed after dark. Forelectrical applications at night, you will need abatterytostore the energy generated duringtheday(**Figure 2**).

***Figure2***.*Atypicalassemblyofsolarcells[3]*

Photovoltaicisawell-established,proventechnologywithasubstantialinternationalindustrynetwork.AndPVisincreasingly morecost-effectivecomparedwitheitherextendingtheelectricalgridorusinggenerators in remote locations. The cost perpeak watt of today's PV power is about $7.Localsupplyconditions,includingshippingcostsandimportduties,varyandmayadd tothecost.

PV systems are very economical in providingelectricityatremotelocationsonfarms,ranches,orchardsandotheragriculturaloperations.A"remote"locationcanbeaslittleas15metersfromanexistingpowersource.PVsystemscanbe muchcheaperthaninstallingpowerlinesandstep-downtransformersinapplicationssuchaselectric



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Fencing, area or building lighting, and water pumping– eitherforlivestockwateringorcropirrigation.

**WATERPUMPING**

One of the simplest and most suitable applications for photovoltaic technology is water pumping. A wide range of water needs are met by photovoltaic-powered pumping systems, includinghomeuses,stockwatering,andagriculturalirrigation.Themajorityofthesesystems also have the benefit of being able to store water for usage when the sun is not shining, which eliminates the need for batteries, improves simplicity, and lowers the cost of the system as a whole. The cost deters many people from implementing a solar water pumping system. The actualcost,however,isbetterunderstoodwhenthefeeisspreadoutoveraperiodoftenyears. By contrasting installation costs (labor included),fuelcosts, and maintenance costs over 10 years,youmayfindthatsolarisaneconomicalchoice. A solar-powered pumping system isgenerally in the same price range as a newwindmillbuttendstobemorereliableandrequirelessmaintenance.Although initially more expensive than a gas, diesel, or propane-powered generator, solar-powered pumping systems require significantly less upkeep and manpower [4]. Water pumped by solar panels cost between$0.03and$0.15perdayeachcow.Waterpumpingcostspergallonrangedfrom $0.002to$0.007pergallon.

Solar-PoweredWaterPumpingSystemConfigurations

Thereare two basictypes ofsolar-poweredwater pumping systems, battery-coupledanddirect-coupled.Avarietyoffactorsmustbeconsideredindeterminingtheoptimumsystemforaparticular application[1].

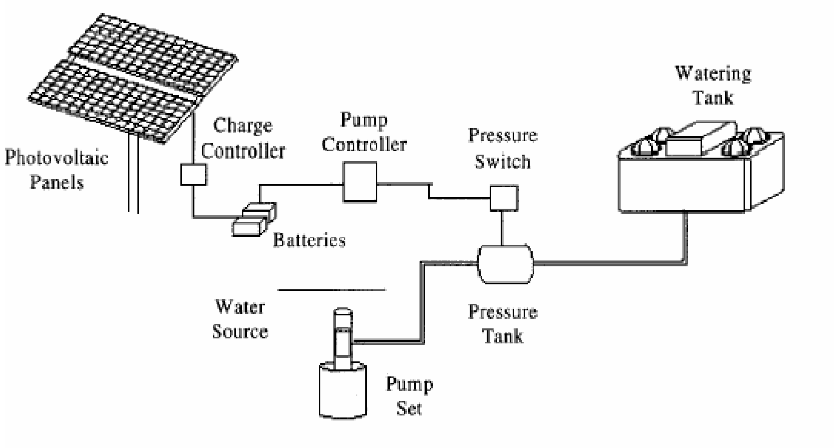


***Figure3.*** *Battery-coupled solar water pumpingsystem[5]*

Battery-coupledwaterpumpingsystemsconsistofphotovoltaic(PV)panels,chargecontrolregulator, batteries, pump controller,pressure switch and tank and DC water pump(**Figure 3**). The electric current produced byPV panels during daylight hours charges thebatteries,andthebatteriesinturnsupplypowertothepumpanytimewaterisneeded.Theuseof batteries spreads the pumping overa longer period of time by providing a



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steadyoperatingvoltagetotheDCmotorofthepump. Thus, during the night and low lightperiods, the system can still deliver a constantsourceof water for livestock.

Battery usage has disadvantages. First off, because the batteries control the operating voltage ratherthanthePVpanels,theycanlowerthesystem'soverallefficiency.Thevoltagesupplied by the batteries may be one to four volts less than the voltage generated by the panels at maximumsunlightcircumstancesdependingontheirtemperatureandhowthoroughlytheyare charged. Thisreducedefficiencycanbeminimizedwith the use of an appropriate pump controllerthat boosts the battery voltage supplied to thepump.

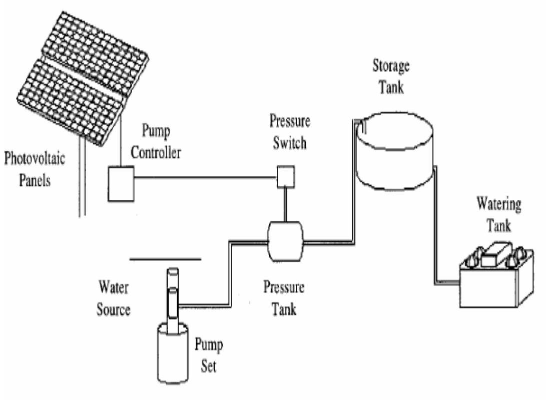


***Figure4.*** *Direct coupledsolarpumping system[5]*

Indirect-coupledpumpingsystems,electricityfromthePVmodulesissentdirectlytothepump, which in turn pumps water through apipe to where it is needed (**Figure 4**). Thissystem is designed to pump water only duringtheday.The type of pump and the amount of sunshine hitting thePVpanels completely determinehow much wateris pumped. The amount ofwater pumpedbythissystem variesthroughout the day as a result ofchangesin the sun's brightness andtheangleatwhichithitsthePVpanel.Forinstance,thepumpoperatesatorcloseto100% efficiency with maximum water flow during the best sunlight times (late morning to late afternoon on bright sunny days). However, pump performance declines in the early morning and late afternoon.

May drop by as much as 25 percent or moreundertheselow-lightconditions.Duringcloudydays,pumpefficiencywilldropoffeven more. To compensate for these variableflow rates, a good match between the pumpandPVmodule(s)isnecessarytoachieveefficientoperation of the system.

Direct-pledpumpingsystemsaresizedtostoreextrawateronsunnydayssoitisavailableoncloudydaysandat night.Water can be stored in a larger-than-neededwatering tank or in a separate storage tank andthengravity-fedtosmallerwateringtanks.Water-storagecapacityisimportantinthispumping system. Two to five days' storagemay be required, depending on climate andpattern of water usage.Storingwaterintankshasitsdrawbacks.Considerableevaporationlossescanoccurif



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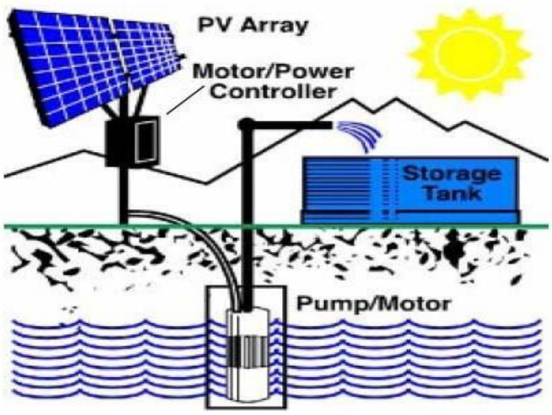
thewaterisstoredinopentanks,whileclosedtanksbigenoughtostoreseveraldayswater supply can be expensive.Also,waterinthestoragetankmayfreezeduringcold weather.

Mainsolarpoweredstockwateringsystemcomponents

Atypicalsolar-poweredstockwateringsystemincludesasolararray,pump,storagetankand




controller[],(**Figure5**).

***Figure5***.*Atypicalsolar-poweredstockwateringsystem[1]*

**SolarModules**

Solarelectricsystemsaresometimescalledphotovoltaicsystems.Theword“photovoltaic”isoften abbreviated PV. Mostsolarpanels,ormodules,generatedirectcurrent(DC)electricity.Agroupofmodulesiscalledan array.

**MountingStructures**

Therearetwowaystomountsolarmoduleseitheronafixedstructureoronatrackingstructure. Fixed mounts are less expensive andtoleratehigherwindloadingbuthavetobecarefully oriented so they face true south (notmagneticsouth).

To make an array portable, it is simple toinstall it on a trailer. The sun is tracked across theskybyan array. In comparisontoafixedarray,atrackerwillincreasethecostof asystem by at least $400 to $800 but, in the summer, can boost water volume by at least 25%.

**Pumps**

In general, DC water pumps consume between a third and a half of the energy of traditional AC (alternating current) pumps. DC pumps can be surface-mounted or submersible and fall into the displacement or centrifugal categories. Water is sealed in a chamber by displacement pumps, which then drive the water through a discharge outlet using pistons, vanes, or diaphragms.Arotatingimpellerusedincentrifugalpumpsgivesthewaterenergyandforcesit into the system. like a water wheel in function. Because they are not exposed to freezing temperatures,donotneedspecialweatherprotection,anddonotrequirepriming,submersible pumps installed down a well or sump are very dependable. Water is generally moved through apipeline by surfacepumps, which arepositionedat or near thewater's surface. Some surface



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pumps have high heads that can be used to transport water across great distances or to veryhigh altitudes.

**Storage**

Batteries are typically not advised for solar-powered livestock watering systems since they lower the system's overall efficiency, increase maintenance requirements, and raise costs. Installing 3 to 10 days' worth of water storage is typically easier and more cost-effective than storing power in batteries.

**ControllerorInverter**

The pump controller maximizes the amount of water pumped under less-than-ideal lighting circumstances and safeguards the pump from high- or low-voltage situations. An inverter is a piece of electronic equipment that transforms DC electricity from solar panels into AC electricity, allowing an AC pump to run.

**Otherequipment**

Afloatswitch activatesanddeactivatesapumpto fillthestocktank. Althoughattached tothe pump controller, it resembles the float in a toilet tank.Lowwatercut-offelectrodesprotect the pump from low water conditions inthewell.

**DesigningandInstallingSystems**

Everysituationinvolvingpumpsandstock-wateringisdifferent.Thenotionofmeasuringand building a solar pumping system is likely to scare the ordinary consumer, hence the majority of people require the help of an experienced solar dealer. Dealers are typically glad to assist. Basedonafewstraightforwardquestionsthatmay beaskedoverthephone, manywilloffera free proposal. You can easily request quotes from other vendors if the asking price seems excessive.

Inordertosizeanddesignasystemcorrectly,thedealerwillwantto know:

- Howmuchwateryouneed;
- Whenyouneed thewater;
- Whetheryourwatersourceisastream,pond,spring,or well;
- Wateravailableallonesperminute(gpm);
- Welldepth;

Howfarthewaterneedstobepumped,andwithwhatelevation gain;

Waterqualityproblems(e.g.,siltorhighmineralcontent)thatmaydamagethepump; How

much volume is available in storagetanksand howthe tanks arearranged.

Installingasolarpumpisacomplextask,combiningelementsofelectricalwork,plumbing,andheavy construction(oftenincludingearthmoving,pouringconcrete,andwelding).Writteninstructions



ISBN:978-81-957858-1-0

are not alwaysas complete as they should be. A backhoe ortractorwithafront-endloadersalmostannecessityfor somelargerprojects.

## CONCLUSION

Whentheirrigationsystemwithwhichitoperateshasalowtotaldynamichead,solarelectricity ismorecostcompetitivebecausethepriceincreaseperincreaseinunitpoweroutputofa photovoltaic system is more than that for a diesel, petrol or electric system. Because of this,using photovoltaic energy to power a micro irrigation system is more cost-competitive thanusingittopoweranoverheadsprinklersystem.Photovoltaicpowerforirrigationiscost-competitive withtraditionalenergysourcesforsmall,remoteapplications,ifthetotalsystemdesignandutilization timing is carefully considered andorganized to use the solar energy as efficientlyaspossible.Inthefuture,whenthepricesof fossil fuels rise and the economic advantagesof mass production reduce the peak watt costof the photovoltaic cell, photovoltaic powerwill become more cost-competitive and morecommon.

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ISBN:978-81-957858-1-0

# SolarPoweredIrrigationSystemIoTBased:PaddyIrrigation

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**Abstract**

In this project, an automatedwatering system forricefields is being innovated. Theold paddy irrigation method was dependent on the seasons of rain. The development of paddy fields will beimpactedbyshiftingrainyseasons.Todrainwaterintothepaddyfield,thefarmerwillutilize awaterpumppoweredbydiesel.Smokefromthedieselwaterpumppollutestheairand harms thefarmer'shealth.Additionally,themanualirrigationsystemcontrolthatisrequiredtorunthe water pump and check the water level wastes time and human energy. Diesel was also a non-renewableenergysource.onthisproject,asolarsystemwaspresentedasameansofpowering the irrigation system, and a prototype was created to replicate an actual irrigation system on a paddy field. The components of a standalone photovoltaic system include a solar panel, a battery for energy storage, a solar charger controller, a water pump, and an Arduino UNO for completeautomationoftheirrigationsystem. In ordertofullypowertheirrigationsystem,the solar-poweredpaddyirrigationsystemmustbesuccessful.Thewaterpumponlyoperateswhen the polypropylene float switch detects a low water level. The proposed project would result in an effective irrigation system, lower air pollution in paddy fields, and improve farmer health.

**Keyword-**Solar,ArduinoUNO,MoistureSensor,irrigation

## Introduction

Because there are rainy seasons in Uttarakhand, farmers will begin dividing the paddy seed in April. When it rains, the water hole in the paddy field will have a greater water level than the ditch. Gravity and water pressure allow a ditch to supply water to a paddy field. The paddy grow will be impacted by the change of the rainy seasons because the water level in the ditch islowerthanthewaterholeinthepaddyfield.Thus,thiswillstopwaterfromenteringthefield. Waterwillbedrainedintothefieldbythefarmerusingawaterpump.Dieselwasusedtopower the water pump, and it was a non-reusable source. likewise it of solar releases smoke into the open environment, contributing toair pollution.However, with consistent water and fertilizer, the paddy will thrive. Solarenergy was a renewablesource that could provide power. Farmers are greatly aided in their work by the usage power in agriculture. The irrigation system at the paddy field may entirely rely on solar energy as their source of electricity. The enormous demandforcropproductionnecessitateshigh-speedinternalcombustionenginesthatgenerally burnlightpetrolordieselandhavedifficultfuelhygienerequirements.Runningthewaterpump on diesel is neither economical nor environmentally good. By releasing a significant quantity of$CO_2$andotherhazardouschemicalsintotheatmosphere,itcontributestoenvironmental



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degradation and noise pollution. Pumps may make irrigation systems more efficient, cost-effective, and healthy for farmers. In addition, solar energy can use an automated method to manage the paddy field irrigation system. In addition to being environmentally benign, photovoltaic (PV) energy also generates electricity .Farmers who manually manage the water pumpandmonitorthewaterlevelsquandertheirtimeandhumanresources.Farmersmanually turn on and turn off the water pump during non-rainy seasons. Farmers must then wait until water levels in the paddy field reach the desired level. This is the primary cause of time and energyloss.Bycreatingawaterpumpthatusesawaterlevelsensortoregulatethewaterpump, farmers willsavetime andenergyoperatingthe irrigationsystem.Toprotecttheenvironment, lessen pollution and global warming, and suggest a system that uses solar energy to power a motor capable of cleaning certain terrains with the aid of a sensory circuit, this study proposes replacingdieselwaterpumpswithsolarwaterpumps.Thephotovoltaicwaterpumpingsystem (PVWP) is determined by comparing solar sources and seasonal water demand. Effective precipitation during irrigation seasons depends on factors such as precipitation volume, intensity, soil moisture, water management techniques, and more. Figure 1 displays the timeframes for paddy growth as well as the water requirements for each stage of the crop.

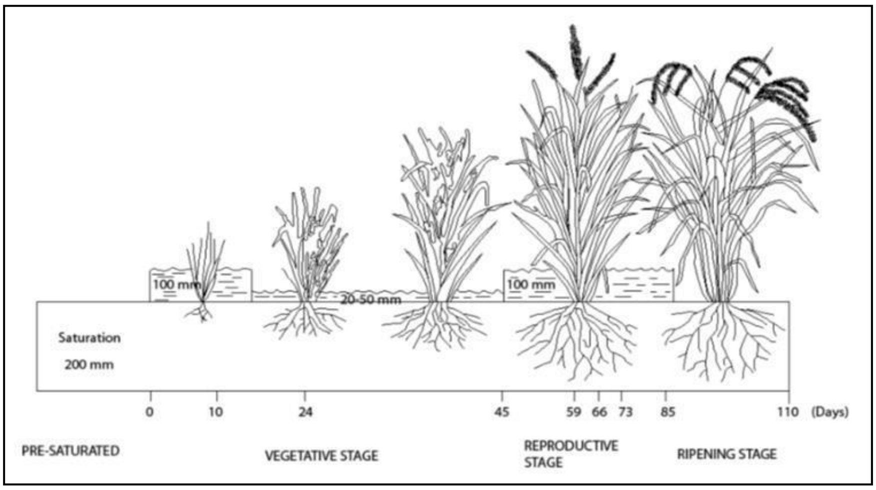


**Figure1**.WaterRequirementofEachStageofriseandTimesfor

## Methodology

The solar panel, solar charger controller, battery, Arduino Uno, polypropylene (PP) float switch, water pump, and LCD display are all parts of this project. The hardware element is implemented in the layout shown in Figure 2. The water pump is powered bysolarenergy,andthebatterychargingandthedischargingaremanagedbyasolar



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chargercontroller.ThewaterlevelatthepaddyfieldisdetectedbythePPfloatswitch. TheArduino UNOreceivesthesignal from thePP float switchand uses it as an input signalforthewaterpump.Whenthewaterlevelfallsbelowthedesiredlevel,thewater pumpautomaticallyturnsonuntilthedesiredwaterlevelisreached.bothatonce.LCD willdisplaythemotorconditionandwaterlevelatpaddyfield.

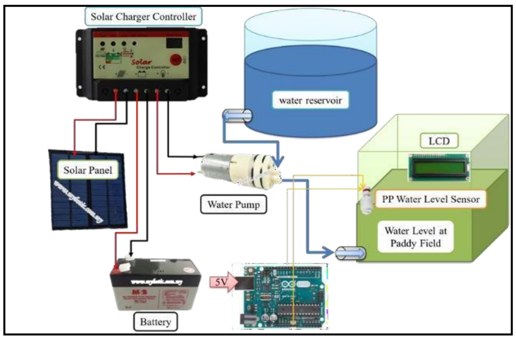


**Figure2**.LayoutofSolarPoweredIrrigationSysteminPaddyField

Figure3.Awaterpumppoweredbysolarenergywillturnonwheninstructedtodoso by an Arduino Uno-controlled water level sensor situated in a paddy field. The water pumpwilloperateuntilthedesiredwaterlevelisreachedwhenthepaddyfield'swater level sensor detects a low water level. When the desired water level is reached, the water pump won't move.



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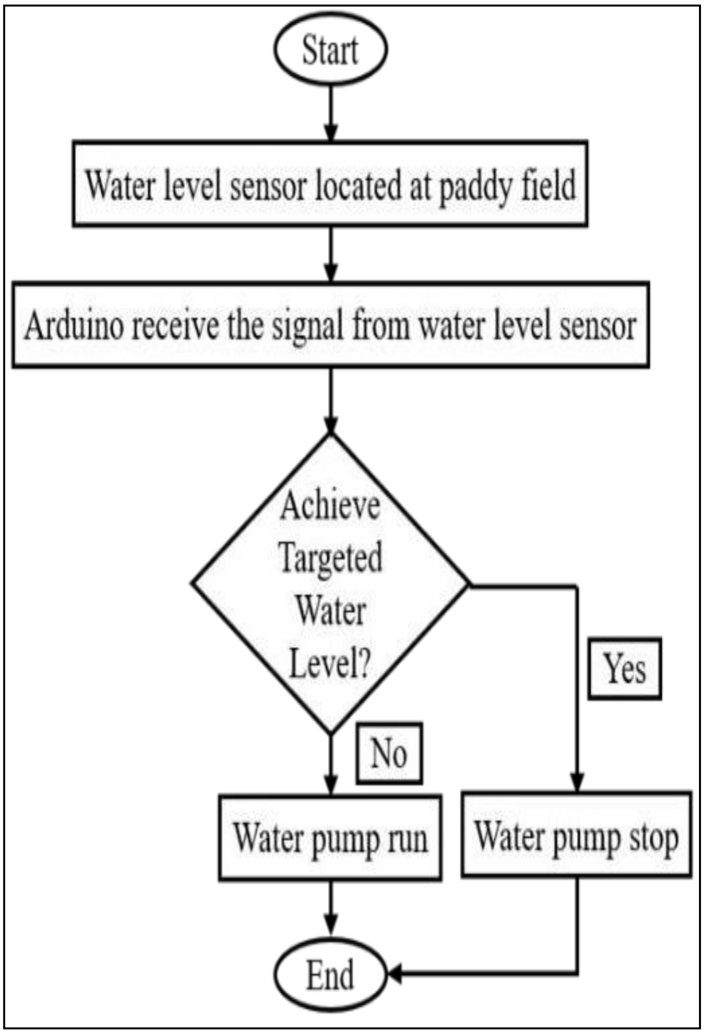


**Figure3**.FlowchartofWaterPumpOperation

**DevelopmentofIrrigationSystem**

The creation of the solar-powered automatic irrigation system circuit is described in this section. Proteus 8 Professional was used to create the schematic circuit for the automated watering system, as illustrated in Figure 4. They do not exist as a PP float switch component in Proteus 8 Professional. The single pole single through switch thereforeservedasarepresentationofthePPfloatswitch.TheArduinoUNOrelieson Arduinocodetofunction.Tomimicsystemfunctioning,Arduinoprogrammerscreate their code in the Arduino IDE and upload it to the Arduino UNO at Proteus 8 Professional to simulate system operation.



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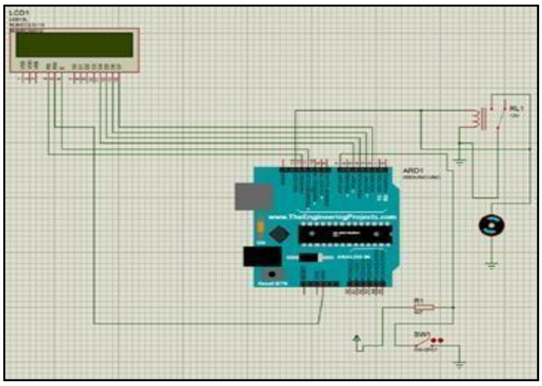

**Figure4**.SchematicCircuitDiagram forAutomatedWaterPumpusingProteusSoftware

AfterthatttherealcomponentwasdevelopasdesignedwithPVsystemtosupplythe powertosystem.Thecomponentconnectioncomplete irrigationsystemshowninFigure5

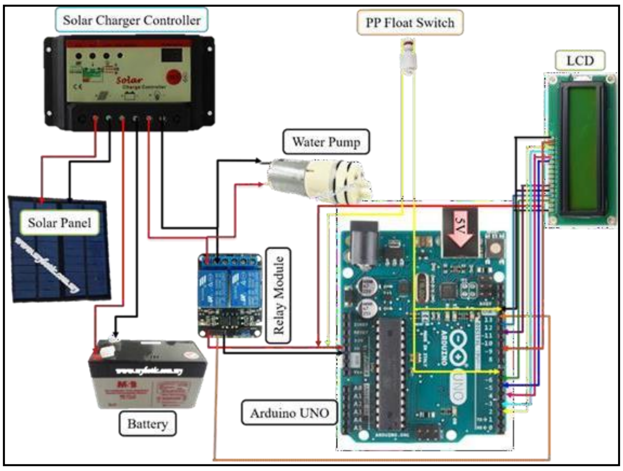


**Figure5**.PrototypeComponentConnectionofFullCircuit

RESULT

Theproject'soutcomeisexplainedinthissection.Itincludedthehardwareand simulation results for the automated watering system.



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### i)Simulation Result

Theplanned circuit for the system configuration makes up the simulation circuit. The controller and water level sensor used by the Arduino IDE to code turned the water pump ON and OFF depending on the status of the situation. A signal is given to the controllerbythePPfloatswitchwhenalowwaterlevelisdetected.Thesignaltostart thewaterpumpwassentbythecontroller.Thisisaccomplishedbysendingasignalto the relay's base, which is attached to the Arduino's pin 13 for this purpose. Until the water level exceeds the PP float switch, the motor will run. Table 1 displays the simulationresultsfortheproject'swholecircuitundertwodistinctconditions.Figures 6 and 7 depict the state of water whenlowwaterlevelandhighwaterlevel.

**Table1**.SimulationResultoftheCompleteCircuitoftheProjectWaterlevelWaterPump

| | |
|---|---|
| <PPfloatswitch | ON |
| >PPfloatswitch | Off |

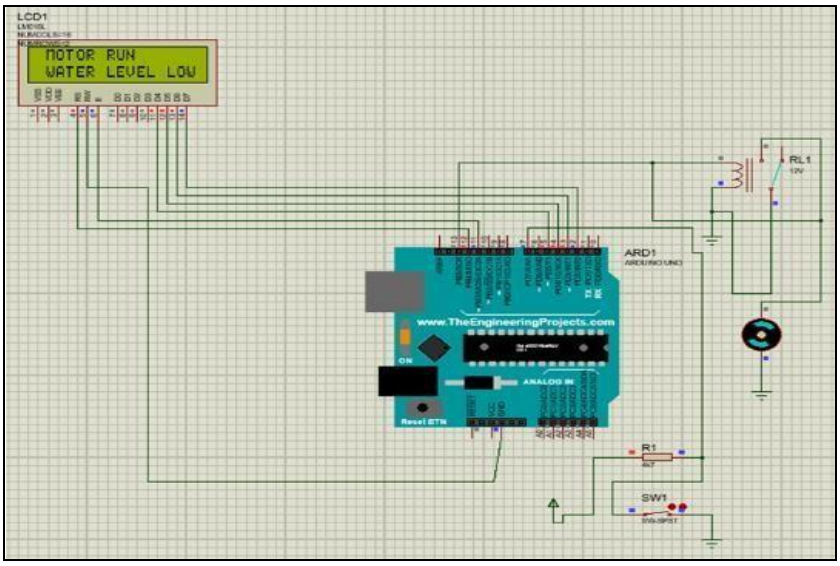


**Figure6.**SimulationResultwhenlowwaterlevel

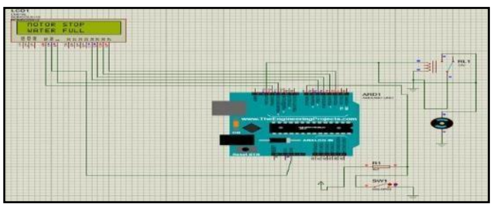



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**Figure7.**SimulationResultwhenhighwaterlevel

**HardwareResultofProposedSystemDevelopment**

Table 2 displays the solar charger controller's indicator light results for various solar, battery, and load conditions.

**Table2.**Indicator Light at Solar ChargerController for Different Condition

| | **Condition** | **IndicatorLight** |
|---|---|---|
| **Solar** | Sunny | Redcontinually |
| | Cloudy | OFF |
| **StorageBattery** | Charging | Greenflash |
| | Full | Green |
| | Middle | Red |
| | Over-discharger | RedflashandOFFtheload |
| **Load** | MotorRun | Greencontinually |
| | Motor Stop | Greencontinually |

**Battery and Photovoltaic Voltage Output**

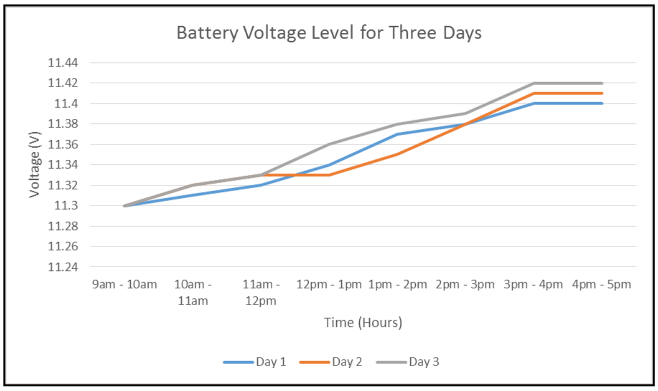
**Performance:**

Thetechniqueis used to study therate at which voltageis charged by solar energyon variousdays.When thetest is conducted,theprototypeisin anidlestate.9 a.m.to 5 p .m. sees theprototype exposed to thesun.therate ofsolarcharging is monitored ever y hour from 9 a.m. to 5 p.m. forthree days.Day 1 begins on September 10, Day 2 on October10, andDay 3on November10,2022.theset11.30V startingvoltageforeac



ISBN:978-81-957858-1-0

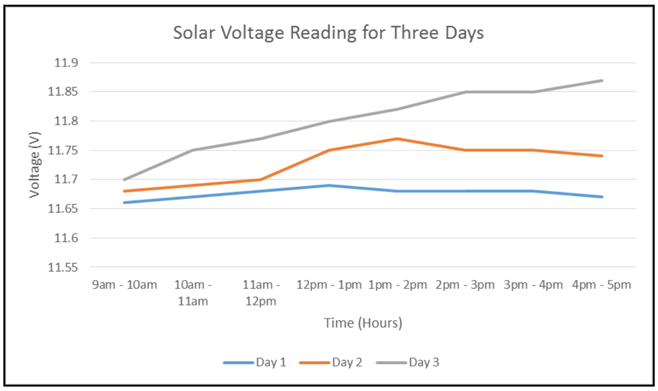
h day.The pace of battery level utilising solar panel charging is shown in Figure 9.Th eexamisadministeredat thesamelocation(**TehriGarhwal,Uttarakhand**)andtime each time. With an initial voltage of 11.30, the battery begins charging at 9 a.m. and continues until 5 p.m. Day 1's battery voltage is increased to 11.40V after eight hours ofcharging.Whilefordays2and3,11.41Vand11.42Vareused.Theweatherhasan impactonthethree-daycharging'svariousendnumbers.Theoutputofsolarelectricity




fromsolarpanelscanbe impactedbytheweather.Thefirstbatteryhasavoltagedrop of 70.83% or 11.30V. The voltage level of the battery is raised to 11.40V, or 74.99% of the voltage loss. The charge rate is 4.16% of the cost for 8 hours.

**Figure9.**RateofBatteryLevelusingSolarPanelCharging

Figure10showstheinputvoltageforsolarpanels.Thevoltagepeakonday1isshown




inFigure10from1p.m.to2p.m.Theweatherconditionmayhaveanimpactondaily variations in peak voltage.

**Figure10.**SolarOutputVoltageforThreeDays

## Conclusion

The solar energy from the solar panel charged to a 12V lead acid battery in this study successfully developed a solar powered paddy irrigation system that can be utilised whenever necessary. The 12V lead acid rechargeable battery is protected from overchargingandreversecurrentatnightbythesolarchargercontrollercircuit.Itwas



ISBN:978-81-957858-1-0

successfultodesignandcreateanautomatedsolar-poweredwaterpumpforpaddyfields utilising a PP float switch, an Arduino UNO, a solar panel, a rechargeable battery, an LCD display, and a water pump. Water level sensors were used to manage the water flow and reduce water waste in the development of an effective irrigation system.

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ISBN:978-81-957858-1-0

## Analysisofphotovoltaicpowerprojections

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**Abstract**

As solar penetration rates continue to climb, the variability of solar resources presents challenges for grid management. Forecasting solar energy is so essential to preserve grid stability, allow for an efficient unit commitment,and enable dispatch. It is possible toidentify a number of forecast horizons, from a few seconds to days or weeks in the future, as well as spatial horizons, from single site to regional projections. Every year, new methods and strategies are developed globally to increase the precision of models with the ultimate aim of lowering the level of uncertainty in the predictions. With an emphasis on the most recent developments and emerging trends, this study aims to compile a significant portion of the knowledge concerning solar power forecasts. First, the case for making an accurate forecast and an examination of potential economic effects are made. An overview of the primary methods utilized to make the forecasts is provided after that. Next, the advantages of regional/point forecasts and probabilistic/deterministic forecasts are examined. It has been noticed that most recent articles emphasize the value of probabilistic forecasts and include a financial analysis of the grid's influence of forecast accuracy. The most recent collection of solarpowerforecastingstudiesisthenprovided,withauthorscategorizedaccordingtoforecast horizons and the source of inputs. In order to provide a fair comparison, all of the researchers' various measurements have been included along with some commentary.

### Introduction

The 2015 United Nations Climate Change Conference (COP21), often known as the Paris Agreement, has recently becomeaturningpoint in thebattleagainst global warming. The196 signatorynationscommittedtotakingstepstokeepglobalwarmingtolessthan2°Ccompared topre-industriallevels,whichcallsforachievingnetzerohumangreenhousegasemissionsby the middle of the twenty-first century. In addition to numerous other efforts, achieving those goals entails electrifying a number of the thermal systems in use today. This Agreement highlights the importance of producing electricity from renewable sources and encourages research on how to manage and incorporate these variable production systems into the grid. If we concentrate on solar technology, photovoltaic has seen tremendous development in recent years, reaching a total installed capacity of around 177 GW globally by the end of 2014 (IEA, 2015), and growth is anticipated to continue at a similar rate in the future. In addition, photovoltaic (PV) prices have significantly dropped, bottoming out at less than $1.5/Wp for fixed-tiltsystems,encouragingmoreinstallations(GTM).Withyearlysolar shareapproaching



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8% in Italy or over 7% in Germany, PV has already established itself as a major player in various power markets. There are currently roughly 20 nations where this proportion is larger than 1% (IEA, 2015). In this perspective, the increasing adoption of PV in electric systems offers several economic advantages but may potentially present a hazard.

ThequantityofsolarradiationimpactingonthepanelsfromthesundetermineshowmuchPV is produced, although this radiation varies throughout time. Most of the issues that need to be resolved to keep the stability of the electricity system are caused by the fluctuation of solar resource availability and the uncertainty surrounding projections. The rotational and translational motions of the Earth with regard to the Sun, which are precisely specified by physics equations, account for a portion of the fluctuations in a predictable manner. The quantityofsolarirradiancereachingtheEarth'ssurfacecan,however,alterunexpectedly.This is mostly due to the occurrence of clouds, which randomly block the Sun's rays and introduce some uncertainty into PV power predictions.

One of the main obstacles to widespread PV integration, according to EPIA (2012) and PV GRID(2014),isthecapacitytoaccuratelyanticipatetheenergygeneratedbyPVsystems.Itis crucial for grid operators because any discrepancies between anticipated and actual energy production must be filled by the other technologies that make up the energy portfolio. The electric system's construction includes certain generators that function as running reserves. Accordingly,agoodPVpredictionwouldbeabletodecreasethenumberofunitsinhotstandby and,asaresult,minimizetheoperatingexpenses.Theadaptabilityandcapabilityoftraditional power plants to handle such variances are shown in Table 1.

Since it lowers costs and uncertainties, an accurate prediction is advantageous not only for systemoperators(and,eventually,forallgridconsumers),butalsoforPVplantmanagers,who may avoid any fines resulting from discrepancies between anticipated and generated energy.

Because of how important the problem is, several research have been conducted all across the world to produce preciseprojections.IndirectanddirectmethodsarethetwoprimarytypesofforecastingusedforPVplantoutput. Indirect predictions first anticipate solar irradiation and then calculate the amount of electricity produced by the plantusingaPVperformancemodel.Theelectricityproductionoftheplantiscalculatedimmediately,incontrast, by direct projections. Since solar irradiation is the hardest element to model and has uses other than forecasting solarelectricity,manyotherstudiesalsosolelyconcentrateonthisaspectofthesun'sirradiation.Similarmethods areusedtoapproachbothpowerandirradiationprojections.Tosetaboundaryinthescopeandsincethatvariable maybeutilizeddirectlybygridoperatorsandplantmanagers;thisreviewstudywasfocusedonthosepublications thatcontainthepowerproducedbytheplantsastheoutput.Thisreview'sinvestigationofcommercialforecasting techniques is outside the purview of this work, which is restricted to the evaluation of scholarly literature.

Thestate-of-the-artmethodsforcreatingpowerprojectionsforphotovoltaicsarefullyreviewedinthiswork.There are some earlier review articles that have a similar broad scope (forecasting methods, inputsources, performance metrics,temporalandspatialcoverage,etc.),suchastheworkproducedbyInmanetal.,2013,IEA,2013,butthe rateatwhichnewstudiesaredevelopednecessitatesthatanewreviewdemonstratingcurrenttrendsbeconducted. Focusingontheeconomiceffectsofforecasting,emphasizingprobabilisticforecasting,andstressingtheneedfor consensus on a set of performance criteria are some of these new developments.In some more recent studies, a



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single forecasting topic—such as ensemble forecasting (Ren et al., 2015) or several forecasting methodologies (Wan et al., 2015]—is the only area of attention.

The article is organized in a way that it addresses some of the concerns that come up when planning a forecast, including theneed toproduceand improve solar power forecasts, the various techniques that can be used, spatial and temporal coverage, information that should be provided, accuracy measurement, and prior research done by other researchers.

Thefollowingishowthepaperisorganized:Somefundamentalideasutilizedintheworkareexplainedin Section 2. The study's key goals and premises are laid out in Section 3, which also discusses the value of forecasting and illustrates the economic benefits of better forecasts. The major methods for predicting power production are then presented in Section 4, which can be either physical, statistical, or hybrid. The advantages and characteristics of forecasting for either a single PV plant or for an ensembleof them are covered in Section 5. The various ways to providetheforecast—asasinglenumberoraprobabilisticterm—arediscussedinSection6.Thepotentialeffects on grid functioning are also covered. The various temporal perspectives that must be adopted are covered in Section 7.

The various time horizons that must be considered for a suitable grid operation are covered in Section 7. Unlike themajorityofreviewpublicationsonsolarforecasting,ourclassificationoftheresearchisbasedontheprediction horizon rather than the methods employed. All the articles regarding solar power forecasts that were identified have been compiled and summarized here. Finally, Section 8 provides a summary of the measures that are employed to assess projections and the usefulness of each one, as well as some suggestions for improving study comparability. The major results and conclusions regarding each issue are also summarised in a brief summary that is offered at the conclusion of several sections and subsections.

**FUNDAMENTALFACTORS**

Theexplanationofcertainfundamentalsolarirradiationandsolarpowergeneratingideasinthissectionwillmake it easier for the reader to understand the text's subsequent sections.

**PREDICTING'SECONOMICS**

The primary goal of increasing solar power prediction accuracy is to lessen the uncertainties associated with this sortofvariableenergysource,whichwouldsubsequentlyleadtosaferandsimplergridmanagement.Alsopossible is a reduction in the curtailment of photovoltaics (Bird et al., 2014). Better projections help plant managers schedule mintenance pauses and create more accurate bids, which motivates them to make them.

**STRATEGIESFORPREDICTING**

There are two basic strategies for forecasting solar power, as was explained in the Introduction. The analytical equation-based modeling of the PV system is the first available strategy. Since irradiance is the primary variable affectingelectricityoutput,themajorityofeffortsareoftenfocusedonobtainingprecisepredictions.Thisstrategy is referred to as the PV performance, physical, parametric, or "white box" approach.

**SINGLE-PLANTANDLOCALPREDICTIONSONTHESPATIALHORIZON**

A single PV system or a group of them can be forecasted. Since regional projections are more beneficial for balancingsupplyanddemandintheelectricsystem,gridoperatorsoftenfavourthem.Weexaminetheshortterm power output variability first in order to better grasp the distinctions between point and regional projections.

AccordingtoMillsandWiser(2010),therearemultipleissueswiththeintegrationofsolarenergybecauseofthe fluctuation of solar resource at various time periods.



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**DECISION-MAKINGVERSUSPROBABILISTIC**

Energy forecasts were used to predict both output and load long before renewable energy sources like solar and wind became commonplace. There are differences in the precision of each domain, and each has its own peculiarities. Solar power estimates are the least developed of the energy forecasts reviewed by Hong et al. (in press) since solar energy has only recently started to saturate the electrical market.

**THEHORIZONOFTIME**

Forecastscanbecategorizedprimarilybasedontheirtemporalhorizon.Predictionsprovidedforthevarioustime horizons are crucial for a number of areas of grid management, including grid stability maintenance, spinning reserve scheduling,loadfollowing, andunit commitment,as will be detailed later.Thecomprehensivetaxonomy of time horizon research is shown below. a broad summaryhighlighting the key features of each research and its most important findings.

**METRICSFORPERFORMANCE**

A number of measures may be used to evaluate a model's performance and accuracy. Metrics allow for the comparisonofvariousmodelsandlocales.Eachoneconcentratesonacertainfeatureofapointdistribution.Asa result,thereisnoonemetricthatisapplicableinallcircumstances;rather,eachoneprovidesadditionalinformation on the model's correctness. Although there are a few measures that are more often used, the bibliography has a number of metrics.

**CONCLUSIONS**

As solar energy starts to play a significant role in the electricity markets, projecting solar power becomes an important responsibility. The estimate of the solar resource is where the majority of the difficulty in making accurate projections comes from. Additionally, the time horizons in which the energy markets operate vary, necessitatingtheneedforuniqueestimatesforeachone.Itseemsthatafewofmodelsprovidepredictionsthatare as precise as feasible.

## ACKNOWLEDGMENTS

The University of La Rioja's ATUR grant 15/03 and FPI-UR-2014 scholarships are acknowledged by J. AntonanzasandR.Urraca.TheUniversityofLaRioja'sFPI-UR-2012fellowshipandATURGrantNo.03061402 arealsoacknowledgedbyF.Antonanzas-Torresinhisletterofappreciation.R.Escobarexpresseshisgratitudeto CORFO(CorporacióndeFomentodelaProducción)foritskindfinancialassistancewithProject13CEI2-21803.

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ISBN:978-81-957858-1-0

# Analysisofpowerqualityimprovementusingactiveshuntfilters

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**Abstract**

Electricity consumption has been increasing so rapidly once in line with the development of the country to achieve its status as the industrial countries. The paper shows the method of improving power quality using shunt active filters which are used in reduction of total harmonics distortion. Paper shows a comparison of reduction in harmonics with and without shunt active filter for nonlinear loads. The analysis is done in MATLAB /SIMULINK. FFT analysis is also carried out and the model successfully reduces the harmonics.

**Keywords-** Power System, Harmonic Distortion, Shunt Active Power Filter, Non-Linear Loads, Total Harmonic Distortion**.**

**Introduction**

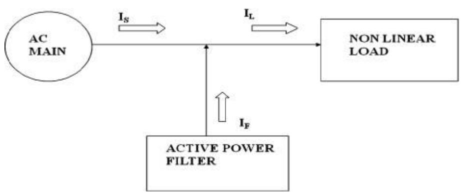
Power quality is important in the distribution system. To provide power supply with good quality is not easy because it depends on the type of load used. Phenomenon that causes an interruption in the electrical system such as overvoltage, voltage sags, voltage surges and harmonic. Harmonic distortion problem has existed in the power system for a long time. it causes a wave of the line current and voltage in the power system to be distorted. In the past, discussions about the existence of harmonics have been discussed. However, at that time, the impact and influence of harmonic distortion is slightly lower than at present, where it only covers in the delta grounded w-ye connection of the transformer and also in some design of power transformer. At present, the creation of modern equipment, especially electronic equipment and also the increased use of non-linear loads in industry has produced harmonic distortion, harmonic distortion in electrical systems became more serious because the use of electronicequipmentareamongthelargestcontributorstotheformationofharmonicdistortion. In recent years, with the increasing use of adjustable speed drives, arc furnace, controlled and uncontrolledrectifiersandothernonlinearloads,thepowerdistributionsystemispollutedwith harmonics. Such harmonics not only create more voltage and current stress but also are responsibleforElectromagneticinterference,morelosses,capacitorfailureduetooverloading, harmonicresonance,etc.IntroductionofstrictlegislationsuchasIEEE519limitsthemaximum numberofharmonics(THD-TotalHarmonicDistortion)thatasupplysystemcantoleratefora particulartypeofload.Therefore,useofactiveorpassivetypefiltersisessential.Tosolvethe current harmonic related problems, passive filters connected in several circuit configurations present a low cost solution. However passive filter implementations to filter out the current harmonics have the following disadvantages:



ISBN:978-81-957858-1-0

- Possibilityofresonanceswiththesource Impedance
- Supplyimpedancedependentsystemperformance
- Fixed compensation

In order to diminish the preceding disadvantages of the passive filters, active power filters(APF) have been worked on and developed in recent years. Elimination of the currentharmonics, reactive power compensationand voltageregulationarethe mainfunctionsofactive filtersfortheimprovement of powerquality.APFshave anumber ofadvantagesover thepassivefilters.Firstof all,theycansuppressnot onlythesupplycurrent harmonics, but also the reactivecurrents.Moreover,unlikepassivefilters,theydonotcauseharmfulresonanceswiththepower distribution systems. Consequently, the APF performances are independent of the power distribution system properties.




On the other hand, APFs havesome drawbacks.APF necessitates fast switching of high currents in the power circuit resulting high frequency noise that may cause an electromagnetic interference (EMI) in the power distribution system.

**INSTANTANEOUSACTIVEANDREACTIVEPOWERTHEORY**

This method offers a good precision and ease of implementation. Its main disadvantage is that it can't be applied in the case of unbalanced grid voltage [13]. In this case, A Self Tuning Filter (STF) can be usedafterthemeasurementofthegridvoltagestoextractthefundamentalbalancedthreephasevoltage components of the distorted unbalanced one. This transformation may be viewed as a projection of the three-phase quantities onto a stationary two-axis reference frame. The Clarke transformation for the voltage variables is given by [14]:

$$\begin{bmatrix} u_{\alpha} \\ u_{\beta} \\ u_0 \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix} \ldots\ldots\ldots\ldots\ldots (1)$$

Similarly,thistransformcanbeappliedonthedistortedloadcurrentstogive

$$\begin{bmatrix} i_{l\alpha} \\ i_{l\beta} \\ i_{l0} \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & -\frac{1}{2} & -\frac{1}{2} \\ 0 & \frac{\sqrt{3}}{2} & -\frac{\sqrt{3}}{2} \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix} \begin{bmatrix} i_{la} \\ i_{lb} \\ i_{lc} \end{bmatrix} \quad \ldots\ldots\ldots (2)$$

Theinstantaneousactivepowerp(t)canbedefined by:

$p(t)=u_a i_{la}+u_b i_{lb}+u_c i_{lc}$…..(3)

Thisexpressionisgiveninthestationaryframeby:

$$p(t) = u_{\alpha} i_{l\alpha} + u_{\beta} i_{l\beta}$$

$p_0(t)=u_0 i_{l0}$…….(4)

Where, p(t) is the instantaneous active power, $p_0(t)$ is the instantaneous homo-polar sequence power. Similarly the instantaneous reactive power can be given by:



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$$q(t) = -\frac{1}{\sqrt{3}}[(u_a - u_b)i_{lc} + (u_b - u_c)i_{la} + (u_c - u_a)i_{lb}] = u_{\alpha} i_{l\beta} + u_{\beta} i_{\alpha} \quad \ldots\ldots(5)$$

Fromeqns.4and5,theinstantaneousactiveandreactivepowercanbegiveninmatrixformby

$$\begin{bmatrix} p \\ q \end{bmatrix} = \begin{bmatrix} u_{\alpha} & u_{\beta} \\ u_{\beta} & u_{\alpha} \end{bmatrix} \begin{bmatrix} i_{l\alpha} \\ i_{l\beta} \end{bmatrix} \ldots\ldots.(6)$$

In orderto separatetheharmonicsfrom thefundamentaloftheload currents,itissufficientto separatethealternatingtermoftheinstantaneouspowerfromthedirect.Aftertheseparationofthedirect and alternating terms of instantaneous power, the harmonic components of the load currents can be given using the inverse of equation (3.6) which gives:

$$\begin{bmatrix} i^*_{s\alpha} \\ i^*_{s\beta} \end{bmatrix} = \frac{1}{v^2_{\alpha\beta} + v^2_{\alpha\beta}} \ldots \begin{bmatrix} v_{\alpha} & -v_{\beta} \\ v_{\beta} & v_{\alpha} \end{bmatrix} \ldots\ldots.(7)$$

TheinverseClarketransformcanbeusedasfollow:

$$\begin{bmatrix} i^*_{fa} \\ i^*_{fb} \\ i^*_{fc} \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & 0 \\ -1/2 & \sqrt{3}/2 \\ -1/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} i_{l\alpha} \\ i_{l\beta} \end{bmatrix} \ldots.(8)$$

Figurepresentstheprincipleoftheactiveandreactiveinstantaneouspower.

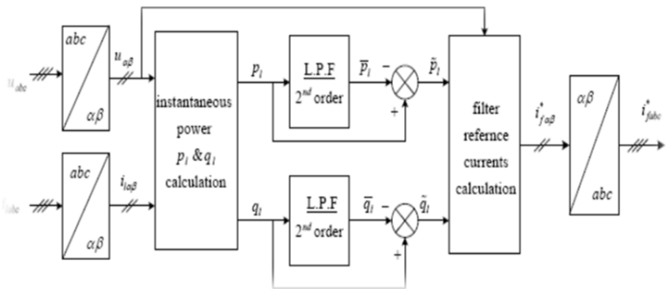


**Fig.2Principleofinstantaneousactiveandreactivepowertheory.**

**MODELLING OF SHUNTACTIVE POWER FILTER**

The simulation modelof system without SAPFis shown in fig 4.1 and the simulation model of system with SAPFisshown in fig 3which shunt activepower filter (SAPF) isconnected across the non linear load. The control of Shunt active power filter (SAPF) is divided in two parts. First part is used for the harmonic current extraction. There areinstantaneous active and reactive power method (p-q method). Second part is used for the generation of gate pulse to control of voltage source inverter. Hysteresis Current Control Method is used.

**SIMULATIONRESULT**

Due to thepresenceof thenonlinear load, so thecurrent waveformisin distortedmanner.The current is taken along the Y-axis and time is taken along the X-axis.



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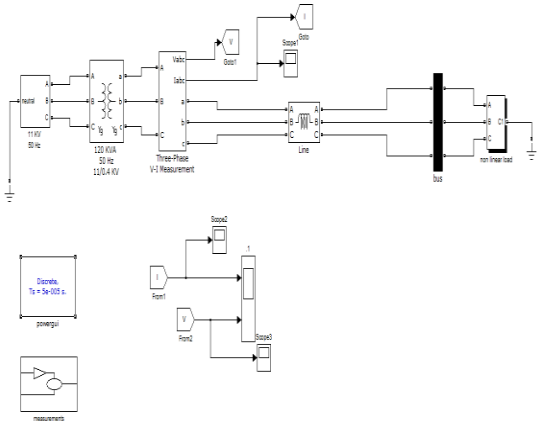

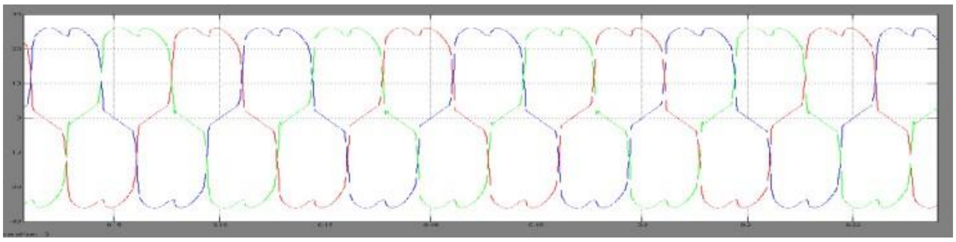

**Fig3.VoltageandCurrentwaveformwithoutfilter.**

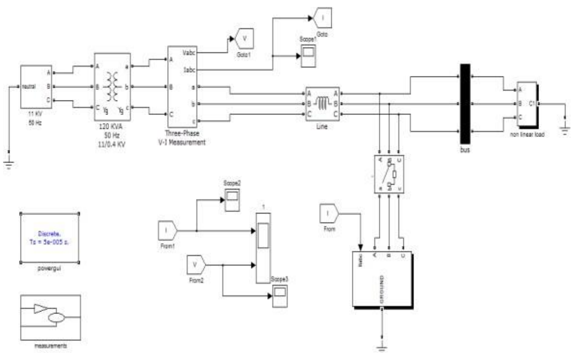

**Fig.4SimulationmodelofsystemwithoutSAPF** **Fig.5.SimulationmodelofsystemwithSAPF**

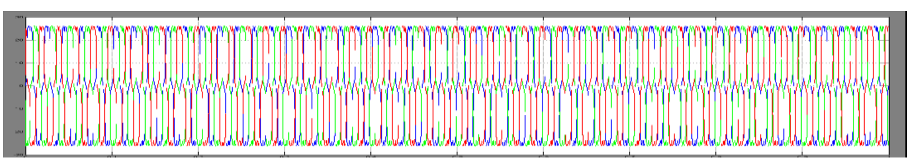

**Fig.6SimulationmodelWvewith SAPF**

**SIMULATIONRESULTS**



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A number of simulations have been performed to check the working of the shunt active power filter under various non-linear loadings (w.r.t connection of the loads at the PCC) and nonideal supply. The analysis of the results show that the working of the active filter is very satisfied to compensate the harmonics and reactive power even under unbalanced and distorted conditions of distribution supply.

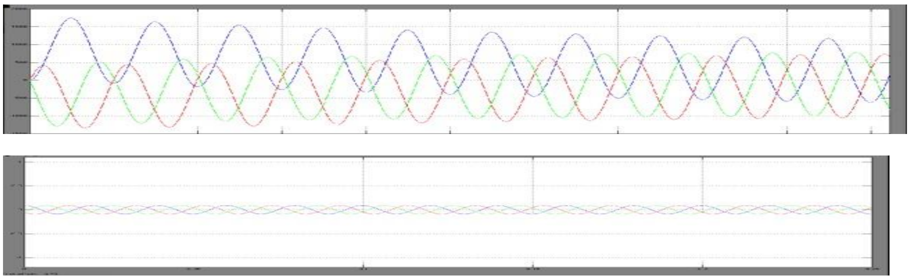

**Fig6.VoltageandcurrentwaveformwithSAPF FFT**

**ANALYSIS**

The following fig.12 shows the THD analysis of source current without SAF. THD is found to be 20.49%respectivelyduetononlinearloadwhichcreatesharmonicsinthethreephasesystem.Inorder to reduce the THD the proposed system is implemented.

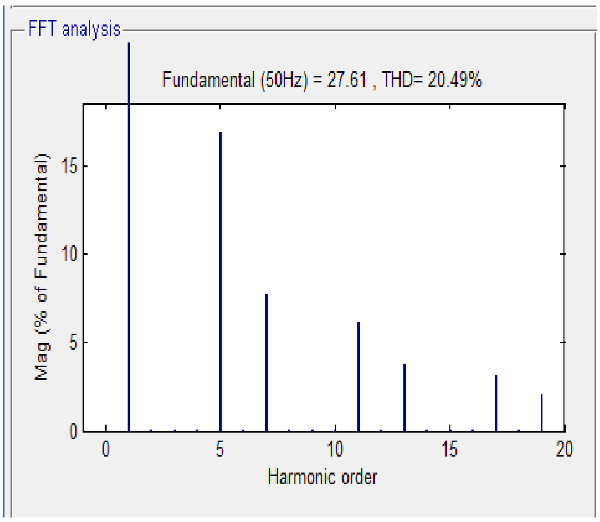


**Fig7.FFTanalysiswithoutSAPF**



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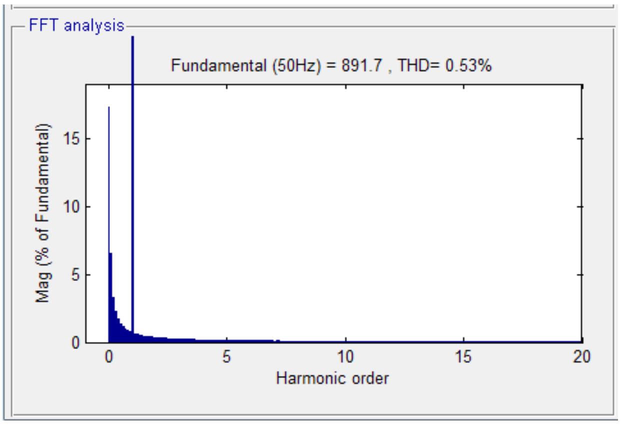


**Fig8.FFTanalysiswithSAPF.**

## SIMULATIONRESULT

TheTotalharmonicdistortion(THD)spectruminthesystemwithoutfilterisshowninfigure8which indicate a THDof 20.49% and THD with active filter is observed to be 0.53%. which is with in allowable limit.

## CONCLUSION

Thethreephasethreewireshuntactivefilterwithcontrollerbasedoninstantaneousactiveandreactive power theory to compensate the problems of the harmonics and reactive power which are encountered frompowerelectronicnon-linearloadsissimulatedinMATLAB/SIMULINK.Theperformanceofthe shunt active power filter is investigated under different scenarios. It is investigated that the p-q theory based active filter manages to compensate the harmonics and reactive power of the power distribution networkevenunderunbalancedanddistortedsupplyvoltages.Theactivepowerfilterisabletoreduce the THD in source current at a level well below the defined standards specified by power quality standards.TheTHDinsourcecurrentaftertheactivefilteringisnot exactlyzero.Itisbecauseinternal switching of the compensatoritself generates some harmonics .Thus SAPFis proved tobeeffective to keep harmonic content in power lines with in permissible limit

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ISBN:978-81-957858-1-0

## WindForecastingTechniques-ReviewPaper

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**Abstract**

An overview of recent and new advancements in wind forecasting is provided in this study, with an emphasis onfundamental ideas and real-world applications. Due primarily to the unpredictablenatureandfluctuationofwindpoweroutput,thehighpenetrationofwindpower in the energy system presents significant issues topowersystemoperators. Whileit'spossible that wind energy won't be completely eliminated, power system operators may lessen the likelihood of an unstable electricity supply by using an accurate strategy for estimatingwind speed and power production. An overview of the various categories and wind forecasting techniques is provided in this study. On the basis of an evaluation of wind speed and power forecasting techniques, a route forfuture progress in wind forecasting is suggested.

**Keywords-**LiteratureReview,CategoriesofWindForecasting,andTechniquesforPredicting Wind Speed andPower

### Introduction

Rising crude oil prices draw attention to the use of renewable energy sources. Due to its excellent efficiency andlittle emissions, wind energy is one of the most alluring renewable energy sources [1]. However, because the amount of power generated by wind energy conversion systems (WECS) varies depending on the weather conditions and wind speed [2–3], unanticipated variations in WECS power generation could raise operatingcosts for the electricity system by increasing the need for primary reserves and pose potential risks to the security of the electricity supply [4]. Power system operators must forecast variations in wind energy output in order to plan for spinning reserve capacity and manage grid operations [4]. Accurate wind speed forecasting is required [5] to lower reserve capacity and enhance the penetration of wind power. Additionally, the forecastingof wind energy is crucial in the distribution of balancing power. In addition, day-ahead scheduling of conventional power facilities and spot market trading of energy both employ wind power predictions [6]. Despite thefactthatloadforecastinghasahigherpredictionaccuracythanwindpowerforecasting,the latteris still superior. To meet the operational issues in the delivery of electricity, wind power projectionscontinuetobecrucial.Theforecastingofwindpowerhasrecentlyusedavarietyof techniques.Researcherswithextensiveexpertiseconductingfieldexperimentshavedevoteda lotofmaterialtoimprovingwindpowerforecastingmethodologies.Numerouswindpower



ISBN:978-81-957858-1-0

forecasting techniques have been created and put into use on wind farms. The six classes that make up the broad classification of wind power forecasting methods are: hybrid approach, persistence method, physical method, statistical method, spatial correlation method, and method usingartificial intelligence. In addition to providing a thorough overview of current technologies for predicting wind speed and wind powerover timescales, this study also discusses potential future advances.

Time-scalesUsedtoClassifyWindPowerForecasts

There are several approaches to wind power forecasting, which may be categorized based on timescales or technique. Various descriptions in the literature classify wind power forecasting techniquesaccordingtodifferenttimescales.However,whenpairedwithvariousliteratures[7- 9], it is possible to categorize the fourdifferent types of wind power forecasting systems into four different time scales.

Forecastingforthevery nearfuture: uptoanhour in advance.

Short-termforecasting:fromafewhoursinadvancetouptoanhour.

Medium-term forecasting: a few hours to a week in advance.

Long-rangeforecasting:aweektoayearormoreinadvance.

The exact time-scale in relation to the functioning of power systems is also shown in Table 1. Different uses ofa certain time scale exist in electrical systems.

wind power forecasting techniquesPersistence Technique

The persistence technique makes the straightforward assumption that the wind speed or wind poweratacspecificfuturetimewillbethesameasitisnow[9].Intheeventwhentheobserved wind speed and wind power at timet are v(t) and P(t), the forecasted wind speed and wind power at time t+t may be expressed as thefollowing term:

$v(t + \Delta t) = v(t)\ldots$ (1)

$P(t + \Delta t) = P(t)\ldots$ (2)

In terms of wind forecasting for the ultra-short period, the persistence approach is somehow moreaccuratethanothermethods.However,aspredictingtimescaleslengthen,thepersistence method's accuracy will gradually deteriorate [10].

**PHYSICALMETHODS**



ISBN:978-81-957858-1-0

Thephysicalapproachisdependinguponnumericalweatherprediction(NWP)orthe lower atmosphere, which usesweather forecast information including temperature, pressure, surface roughness, and obstructions. For

large-scaleareaweatherprediction,meteorologistscreatedtheNWPmodel[5].Wind power is typically

produced by converting the wind speed measured by the local meteorological agency into the wind turbinesat the wind farm [7]. To achieve precise weather prediction, physical approaches are used to raise the true resolution of the NWP model [9]. Due of their extensive computational requirements, physical approaches

arerenderedon supercomputers.

To achievethehighest forecast accuracy, physical systems employ parameterizations thatarebasedonathoroughphysicaldescriptionoftheenvironment.Thewindspeed provided by the meteorological serviceon a rough grid is often converted to the local circumstances at the site of the wind farm [6].NWP wind

predictions are the input data for the commercial wind power forecasting techniques now in use. The

necessary adjustment of these output data (wind speed forecast) to the on-site circumstances is carried outby physical systems employing the input data from NWP using methods that are based on the physics of thelower atmospheric boundary layer [12].

**STATISTICAL METHODS**

In order to determine the link between the online measured power data, statistical approaches are used.

The historical WECS data may be utilized for a statistical model. Comparatively speaking, statistical models are less expensive to construct and easier to model. In general, the statistical approach is effective for briefperiods of time. This method's drawback is that as forecast time grows, prediction inaccuracy also does.

Gray forecasts, the Bayesian approach, the auto regressive (AR), the auto regressive moving average (ARMA), and the auto regressive integrated moving average (ARIMA) are some examples of statistical

procedures. When there is a lot of data and the observations are interconnected, statistical approaches canbe utilized to address issues in engineering, economics, and the natural sciences. An innovative statistical



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approachbasedontheARmodelandindependentcomponentanalysiswasintroduced by Firat et al. in [13].Compared to direct fore-casting, thesuggestedapproach clearly provides superior accuracy, according to thefindings.

It is perfectly suited to utilize an ARMA model of times series to predict wind speed since the wind speedexhibits excellent succession and unpredictability. For the forecasting of the tuple of wind speed and

direction,ErdemandShi[14]suggestedfourmethodsbasedontheARMAmethod. Theresults

demonstrated that, although the traditional-linked ARMA model performs better at forecastingwindspeedthanthecomponentmodeldoesatpredictingwinddirection.In ordertoestimatewindspeed,Lietal.[15]introducedanARMAmodelcombinedwith a wavelet transform. The low frequency components of the overall wind speed are captured using the wavelet transform. The wind speed is predicted using the ARMA model on the softened data. The combination model has the potential to significantly raise forecast

accuracy.

Fortime-seriesforecastincludingmeasurementsofwindspeed,Palomares-Salasetal. [16]employedanARIMAmodel.Theprocedureofmodelvalidationandaregression analysis, both based on actual data, arepresented in the study. According to the findings, the ARIMA model forecasts short time intervals more

accuratelythanthebackpropagationneuralnetwork.

**SPATIALCORRELATION MODEL**

The spatial correlation models consider how the wind speeds at several places relate tooneanother.Theanticipatedpoint'sanditsnearbypoints'windspeedtime-seriesare used in spatial correlation models to

forecast wind speed [5]. For the purpose of forecasting the wind speed at a single location based on spatialcorrelation, a different location for measuring. Using data accumulated over a seven-year period, its

behaviorhasbeenexaminedandsatisfactorilyverified[18].Usingcrosscorrelationat nearby sites, Alexiadiset al. [19] described a method for predicting wind speed and power production up to several hours in

advance. In this study, an ANN method based on spatial correlation models was established. Its predictingaccuracy compared to the persistent forecasting model is much higher.



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A locally feedback dynamic fuzzy neural network (LF-DFNN) was proposed by BarbounisandTheocharis[20]withapplicationtothewindspeedpredictionutilizing spatialcorrelation.Removablemeteorologicalstationsaresetupattworeferencesites in accordance with the base site's location, lining up the three sites' locationswith the direction of the predominant winds. In this study, the LF-DFNN is used to forecast base site wind speed many steps in advance utilizing spatial data from distant meteorological stations. According to simulation data, the LF-DFNN performs better than other network models compared to this application.

Artificialintelligencemethods

Recently,anumberofnovelAItechniquesforpredictingwindspeedandpowerhave been created thanks tothe advancement of artificial intelligence (AI). Fuzzy logic techniques, support vector machines (SVM),neuro-fuzzy networks, and evolutionary optimizationalgorithmsaresomeofthenewlydevelopedapproaches.Artificialneural networks (ANN), adaptive neuro-fuzzy inference systems (ANFIS), fuzzy logic methods,andANFISarealsoincluded.Whenitcomestocategorizationorforecasting, ANN might handle complicated non-linear situations. The training procedure of the ANN models allows them to reflect intricate nonlinear relationships and extract the dependency between variables [21]. Recurrent neural networks, ridgelet neural networks, radial basis function(RBF) neural networks, back propagation neural networks, and adaptive linear element neural networks are

ANN-based techniques. ANN-based methods are a suitable approach to use in the problem of wind powerforecasting.

Sfetsos[22]providedanANNtechniqueforthetimeseriesanalysis-basedforecasting of mean hourly wind

speed data. The suggested technique has an added advantage for utilities that employ hourly intervals for taskslike economic dispatch and unit management and have high levels of wind penetration. A back propagation neural network-based wind power forecasting methodology was described by Chang [23]. A 2400kW WECS on the Taichung coast may use the short-term wind forecasting model that was created with extremely

excellentaccuracyforelectricity supply.

To predict wind speed, Li and Shi [27] looked at three forms of conventional ANN, including adaptive linearelements, back propagation, and radial basis functions. No one ANN model outperforms others consistently



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across all assessment measures, even for the same wind dataset, according to the findings of comparing threedifferent ANN types. The choice of ANN type that will perform the best will also rely on the data sources.

ANFIS was first established by Yang et al. [28] to interpolate the missing and inaccurate wind data. A wind farm in North China provided 12 measured wind data sets,whichweretheninterpolatedandanalyzed.Theseexperimentswereperformed. ResultsofthetestsdemonstratedtheANFIS method'sefficacy.A

comprehensiveinvestigationintooptimizingthemodelparametersforone-stepahead wind speed forecasting was detailed by Zhou et al. in their paper [30]. The implementation includes the use of the linear, gaussian,

andpolynomialkernelsoftheSVM.Themajorityofthetime,itisdiscovered,LSSVM approaches canperform better than the persistence model.

An approach using neuro-fuzzy networks was developed by Xia et al. [31] for forecasting short-term windpower. For the purpose of predicting the amount of wind energy in an actual wind farm in China, the

forecasting methodology is used. According to the test findings, trained neuro-fuzzy networks are effective atmodeling wind farms and predicting wind speed.

**HYBRIDMETHOD**

Utilizing the strengths of both models to achieve a forecasting performance that is globally optimum is thegoal ofhybridmodels [10].Sincetheinformation included in any individual forecasting technique is

constrained, the hybrid approach may make the most use of the benefits of several forecasting methods and can combine the information from different models while maximizingtheinformationthatisnowaccessible[8].Thehybridtechniquesintegrate many methodologies, for example, merging physical and statistical methodologies or combining short- and medium-term models [11]. To forecast wind power, several hybridmodel types were used. Thefollowing areexamples of possiblecombinations:

Physicalandartificialintelligence techniques

Utilizingbothstatisticsandartificialintelligencetechniques

Combining several artificial intelligence models

Zhao et al.'s [33] investigation on a hybrid wind forecasting technique that combines ANN and NWP models. The Weather Research and Forecasting (WRF) system and the Global Forecasting System (GFS) are coupled to create the NWP model, which forecasts meteorologicalparameters. Theamountof windenergypenetrationin China



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may be raised with the use of this hybrid forecasting method. Two hybrid models—ARIMA-ANN

andARIMA-SVM—wereintroducedbyShietal.[34]forforecastingwindspeedand power. Based on twocase studies, one on wind speed and the other on wind power generation, this research thoroughly and methodically examines the applicability of the suggested hybrid models. The findings demonstrate the

viability of hybrid techniques for predicting wind speed and wind power generation timeseries,althoughtheydonotnecessarilyresultinbetterforecastingaccuracyforall the time horizons under study.

Anovelhybridwindspeedforecastingtechniquewaspresentedby Guoetal.[35]and wasbasedonabackpropagationneuralnetworkandthenotionofseasonalexponential adjustment to remove seasonal impacts from real wind speed information.

**THEFUTUREOFWINDFORECASTING**

Theforecastingaccuracyofwindpowerpredictionsystemsisbecomingmorecrucial due to the rising penetration of wind power in the energy grid. Numerous academics have conducted extensive study on wind power prediction in recent years. The forecast'saccuracyhassteadilyincreased,anditisreasonabletoassumethatsignificant research and development activities are now progressing as planned. The following areas are planned for future study in order to further enhance wind power estimates, along with certain literatures [5,9,37,38].

Researchadditionalcutting-edgeAItechniques,andenhancetheirtrainingalgorithms to increase forecastaccuracy. Future study will also concentrate on novel approaches on difficult terrain.

Conductmoreresearchonhybridtechniques,whichcombineseveralwaystoproduce good results in bothlong-term and short-term prediction, including blending physical and statistical approaches. • The current prediction method should be used in actual WECS. Continue your investigation into the methods' actual

applications,notjusttheirtheoretical ones.

Create a framework for more precise evaluations and a benchmark for measuring the effectiveness oftechniques.The input data for wind power forecasting will be strengthenedbyfurtheradvancementsintheNWPmodelsandmoreregularupdatesof the weather predictions.

Conduct further in-depth study on the utilization of online wind measurement data, particularly for windforecasting over the near period.



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Continueyourinvestigationintotheestimateofadaptiveparameters.Themodelscan automatically adjust tochanges in the farms and the environment.

Conduct morein-depth study on the NWPmodelscreated foroffshoreenvironments. To verify NWP outputs for the offshore areas, increase the accessibility of meteorological data.

**CONCLUSION**

Thisstudyprovidedanoverviewofwindspeedandpowerpredictionsatvarioustime ranges.Thereweresixcategoriesofforecastingmethodologiespresented,eachwithits unique traits. Papers were chosen to

emphasizethevarietyofforecastingtechniquesandtheirvaryingtimehorizons.While someofthesesystemsdowellatmakingshort-termpredictions,othersexcelatmaking predictionsatvarioustimescales.Sincethecurrentappsweremadeindifferentways and at different times, it is challenging to compare the performanceof different methodologies. However, the electricity system offers a variety of wind forecasting techniques, making it easier for the owners of wind farms to choose the one that best suits their requirements. The last

sectionproposesfuturedevelopmentdirectionsforwindspeedandpowerforecasting based on the evolutionof wind speed and power prediction.

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ISBN:978-81-957858-1-0

## VehiclebreakingSupportSystem

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**Abstract**

Smart Automatic Braking System may automatically start emergency braking if necessaryandcanadjustavehicle'sspeedbasedonhowcloseitistoanobstruction. This project report introduces the use of an automatic smart braking system. A vehicleprototypeiscreatedandputintoaction.Thesystemwilluseasonarsensor to identify impediments, and an Arduino running pre-burnt code will carry out emergency braking. The device also offers options for speed control. To limit damage or collision from an accident, the vehicle's speed will be decreased or increasedbasedonhowcloseanobstructionistothedrivingvehicle.Consequently, a fully accessible automatic collision avoidance system is suggested. As a result, any automobile may now have an automatic Smart Speed control and Braking system. Proteus was used in this research to create the simulation model.

**Keyword:** Smart Braking System, Smart Speed Control,Sonar Sensor, Arduino, Emergency Braking, Automatic, Prototype**.**

### Introduction

Thebrakingsystemisacar'smostcrucialcomponent.Inmostcases,thedrivermustpress the brake pedal to activate the braking mechanism. Numerous rear-ending car accidents can be avoided or at least have less severe consequences if the driver who is hitting the back of the vehicle applies the brakes with enough force and at the appropriate time. However, most of the time, drivers fail to recognize possible accident conditions in time. Additionally,alagbetweenthedetectionofapossibleaccidentsituationandtheexecution of the remedial procedures that would prevent collisions is frequently brought on by delayed brake activation. Therefore, it is necessary to design an effective speed control system and Automatic Braking System (ABS) in order to prevent accidents. The primary goal of this research is to enable automobiles to automatically stop in response to barriers when a sensor detects any. The automated braking system is a safety feature for cars that helps to avoid or lessen injuries from collisions with other cars, people, or objects. Althoughthereareanumberofcutting-edgeadvancementsandtechnologiesforcarsafety, the number of road accidents is rising daily. Consequently, an automatic collision avoidancesystemissuggestedtosolvetheissue.Antilockbrakes,speedsensors,andother automatedsystemsareonlyfoundinsportscarsandotherhigh-endvehicles.Butnot



ISBN:978-81-957858-1-0

everyone can afford these autos. As a result, any automobile may now have an automatic Smart Speed control and Braking system.

**Smartbrakingtechnology**

Thegoalofthisprojectistodevelopasmart,automaticbrakingsystemthatcanrecognize anyobject,movingornot,aswellasanyobstacleorpersoninfrontofavehicleahead,and adjust the vehicle's speed in accordance with the speed and proximity of the obstruction. The system will also warn the driver of any potential collision damage or accidents. The automated braking system will start the braking system and stop the car if the driving is unable to do so within the safest range that would have been previously specified by the controlunit.Aprogrammelogicisusedtooperatethecontrolunit.Thesafestdistancefor anobjecttobefromamovingvehicleispre-definedinthisprogram'slogic.Inthisproject, an Ultrasonic sensor is utilised to identify the item while an Arduino Mega serves as the control device. The item is detected by an ultrasonic sensor, which then sends the informationtothecontrolunitforprogrammelogicexecution.Thereareanumberofstages before automated braking. If an item is initially spotted, the control unit will display a warning and lower the vehicle's speed. In the second phase, the control unit once more reduces thespeed and warnsthedriver. Ifthe driverdidn't brakeduringthe second phase, the control unit would have done so automatically during the third phase, bringing the speed to a complete stop the vehicle.

## WORKINGPRINCIPLE

A project prototype like this Ultrasonic sensor is utilised to detect objects and gauge distance,withArduinoMegaservingasthecontrolunitdevice.Theobjectdistance,vehicle speed, and warningareshownon a16 x 2 LCD screen. Inthis instance, an LEDserves as awarningindication.Whenanobjectisfound,theLEDblinksasawarning,andtheLCD display also displays the alert status. Theencoded motorutilised in this project prototype. This encoded motor has the ability to convey the RPM value to the control unit. Vehicle speed is measured by the control unit.

### A. EstablishAProgramLogic

Inordertoworkproperlyandpreciouslyaprogramlogicisbuild.

### B. MeasuringDistance

The distance is continually measured by the ultrasonic sensor. It broadcasts a signal throughchirpinordertomeasuredistance,andthissignalisthenreflectedoffofanobject andpickedupbyanultrasonicsensorviaanecho.Lettimetbethedurationoftheentire procedure.Therefore,ifthedistanceisd,thebroadcastsignalwent2ddistanceintime t. The distance is continually measured by the ultrasonic sensor. It broadcasts a signal throughchirpinordertomeasuredistance,andthissignalisthenreflectedoffofanobject



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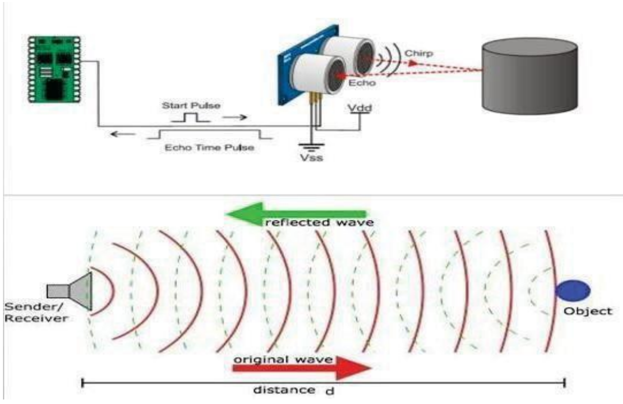


Fig.2:WorkingPrincipleofSonarSensor

Itisknownthat,

$$S=Vt \qquad (1)$$

Where,

S=Totaldistance(2d)

V=Velocityofthesoundwaveofthesonarsensor=340 per meter second

t= Time

So,theequation(1)willbe, 2d

= Vt

$$d = \frac{vt}{2}\ cm$$

Fromtheequation(2)theobjectdistancefrom thevehiclecanbe measure.

## WORKINGPRINCIPLE

The ultrasonic sensor continually detects the item in front of a moving vehicle when it is in operating state. The sensor will measure the distance if it detects any objects. Take into account that both automobiles A and B are in operational condition in picture3below.CarAwillnotbewarnedwhenitisatpointd3,whichisregardedas a safe distance. However, a warning to press the brake pedal will appear and the driver'sspeedwillbereducedby33%whenautomobileAisbetweend2andd3.And when Car A is between D1 and D2, a continual warning will appear, and it will likewise slow down by 66% from its initial speed. f the driver doesn't use the brakes during that period, before point d1, the vehicle will automatically brake at point d3, reducingthespeedofautomobileAby100%andacollisionwillnotoccur.Inthis



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projectprototype,itisassumedthatthereare40cmbetweenautomobileBandd1,50 cmbetweend2andd3,and60cmbetweend1andd3.Therewon'tbeawarningwhen the distance between automobile A and car B is higher than 60 cm. normally, the automobile B will move.

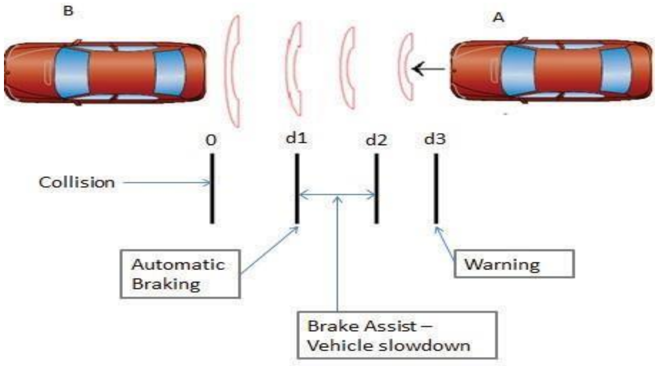


Fig.3:GraphicalIllustrationofWorkingPrinciple ofthisproject

But the warning light will shine when the distance is between 60 cm and 50 cm. Reducethe33%velocitywhenawarningisdisplayedontheLCDpanel.Whenit is between 50 cm and 40 cm, the LCD panel displays a warning and slows down by 66%. However, when it reaches 40 cm, an automated brake will engage and 100% of the velocity will be reduced, or zero. And the car will stop completely.


Fig.4:MeasuredSpeedvsDistancedata

## V. COMBININGWITHCONVENTIONALBRAKE

The Smart brake System may be integrated with a vehicle's standard brake system to function both manually and automatically. It may be used manually, just like any other traditional braking system, but it won't start to stop automatically until the control unit notices a front-facing obstruction. The answer to that is an electric actuator. It can be completely or partially electrically (voltage or current) activated by varying voltage or currentlevels.Asaresult,avehiclecanbesloweddownorstoppedusinganelectricorder from programme code.



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## VI.FUTURESCOPE

Inordertodetecttheinputchangingwheelangularspeedanddeterminethereferenceslipratio withtheprojectedvehiclespeed,theABSsimplyrequireswheelspeedsensors.Fordryroads, the coefficient of friction is 0.7, whereas for wet roads, it is 0.4. The tread pattern is a "all weather" trade-off. On dry conditions, the coefficient can reach 0.9, whereas on wet roads, it may only reach 0.1.

Therefore, the road friction co-efficient, which determines the vehicle deceleration during braking, is an important parameter in estimated vehicle speed.

Allofthedatafromthetyretestbencharereplicatedinthecomputerorseenontheprototype car. Many controllers can handle the nonlinearities and exhibit resilient behaviour when evaluated in simulations. However, evaluating a controller on an actual system allows for a more accurate assessment of its performance. Although a controller's sensitivity to predeterminednoisesignalsormistakesmaybesimulated,anexperimental setupallowsfora morecompleteexaminationduetothemanyimpactsonsignalspresent,suchasdrift,additive noise, delays, and other system dynamics.

Friction of Brake when braking initiates, since it is a time varying variable, depends on the temperature, it is difficult to model. In this prototype we didn't consider it. But actually the estimation precision should be taken into account.

## ONCLUSION

The potential to create systems with more functionality is enormous. These featured systems that could operate safely in a larger variety of accident situations, such as head-on and front-to-sidecollisionsonstraightandcurvedhighways,aswellaspedestrianincidents.Avarietyof sensors, including radar, camera image technology, infrared, far infrared, laser, and sensor fusion, can be used to do this. However, a large body of research indicated that ABS alone would be limited in crashes at intersections due to constrained line of sight and more complicated conditions. Vehicle-to-vehicle communications can be added to improve the functionalityinthiscollisiontype,whichwillsolvetheproblem.Somefullautomatedcollision avoidance systems can be also developed using both vehicle sensors and vehicle to vehicle communication.

## ACKNOWLEDGMENT

We are grateful to our supervisor, Assistant Professor Mr. M. S. Muhit, for his ongoing guidance on our research as well as for his persistence, inspiration, and vast expertise. His advice was invaluable to us throughout the whole project report writing, research, and implementation process. For this Project, we could not have asked for a greater mentor and counsellor

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ISBN:978-81-957858-1-0

# Advancedenergystoragetechnologiesforrenewableenergyintegration

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**Abstract**

Carbon dioxide is released by electric power plants powered by fossil fuels, which aids in climate change. Currently, 87 percent of Nigeria's entire electrical power supply comes from fossil fuels. Renewable energy sources are being accepted globally in order to lessen the environmentaleffectofelectricpowergeneratingsourcesbothlocallyandinternationally.Due to its fluctuation, intermittency, unpredictability, and location dependence, solar energy, one oftherenewableenergy sources that would havebeen theideal replacement forfossil fuels in Nigeria,requiresenergystoragedevicesasabackup.Thisresearchoffersapracticalapproach todealwiththedrawbackofsolarenergysourcebyutilisingintelligentbatteryenergystorage technology. An auxiliary battery was employed in this work to supply power when solar radiationwasinsufficientorunavailabletochargetheprimarybattery.Inordertoautomatically control the functioning of the main and auxiliary batteries, voltage level sensors were also employed.Therateofchargeandstressonthemainandauxiliarybatterieswereloweredwith the introduction of smart operation, lengthening the battery life and improving the sustainability of electrical power generation.

**Keywords**: climate change, fossil fuel, renewable sources, smart battery energy storage technology, intermittency, power generation sustainability.

## Introduction

The contemporary civilization's recent advancements have led to an increase in demand for electrical energy. Increased electrical energy production, transmission, and distribution are requiredtofulfilthedemand.However,theproductionofelectricalenergyfromfossilfuelsis linkedtorapiddepletionoffossilfuelsandadverseenvironmentalimpacts,suchasozonelayer thinning,globalwarming,pollution,thedevelopmentofground-levelozone,andacidrain[1], [2].Globalattentionhasrecentlybeendrawntothefightagainstglobalwarming[3,4].Similar to this, it has been predicted that the known reserves of oil, coal, and natural gas will run out within 34–40 years, 106–200 years, and 36–70 years, respectively [5]. As a result, switching to renewable energy (RE) sources is necessary to meet the rising energy demand, all while addressing concerns about the depletion of fossil fuels and the threat of global warming. [6], [7], [8], [9]. Renewable energy is not only cost-effective but also environmentally friendly, which has led to higher rates of its penetration of the energy market in recent years [10]. Variability, intermittency, unpredictability, and geographical dependence are frequent issues withrenewableenergysources(solar,wind,hydropower,etc.)[11],[12],[13],[14],[15].



ISBN:978-81-957858-1-0

Utilising power from renewable sources, then, necessitates a sizeable amount of backup producingcapacityfromenergystoragedevices[16],[17],[18].Additionally,thereisarising discrepancybetween whenenergyis generatedandwhen itisused as aresultoftheincreased integration of renewable energy sources into power networks [19], [20]. The issues with grid stabilityandbalancearealsorelatedtotheincreasingpenetrationofrenewableenergysources [21], [22]. Storage systems are therefore necessary in order to play the crucial roles of enhancing energy system flexibility, expanding the ability to handle fluctuating renewable energy sources, and managing electrical networks better [23].

Thefollowing arethemain forces influencingthegrowth ofenergy storage[24].

- Increasingtheresourceefficiencyoftheenergy system.
- Increasingtheuseofrenewableenergysourcesthatare variable.
- Increasingself-generation(distributedgeneration)ofenergy(heat,cold, electricity).
- improvementinend-use sectorelectrification(e.g.,electric automobiles).
- improvementinend-usesectorelectrification(e.g.,electric automobiles).
- thenecessityofgridresilience,dependability,andstability.

Several outlets for energy storage. Among these are chemical (gas, liquid, and solid), kinetic, thermal,andelectrochemicalpotentialenergy(pumpedstorage)[25].Energyconversionfrom one form to one that can be stored is referred to as energy storage technology (EST). When required, the energy might be stored in a variety of forms and then transformed back into electrical energy [26]. These procedures are categorised in figure 1 as follows.

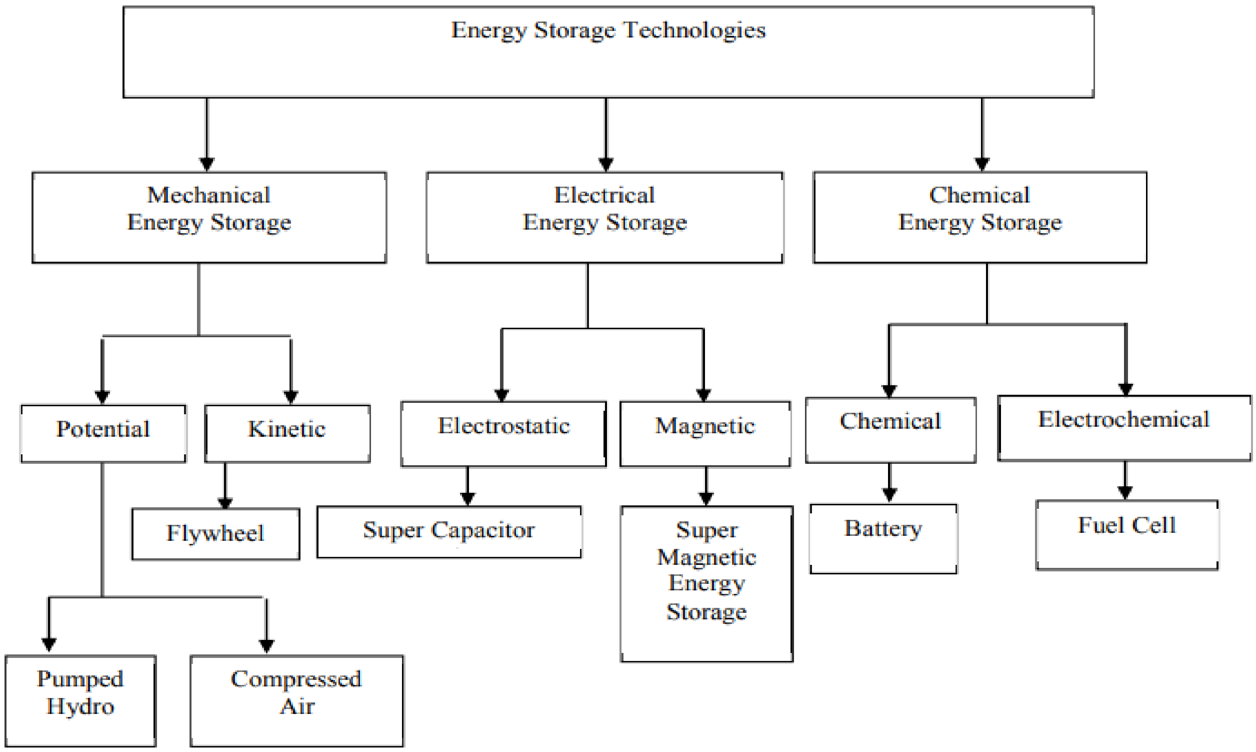


*Fig.1-EnergyStorageTechnologyClassification[41]*



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**A. BatteryEnergyStorageSystem**

There are severalbattery sizes with capacities ranging fromunder 100W to several megawatts [32]. Theelectric grid, portable electronic systems, wireless network systems, maritime and undersea missions, hybrid electric vehicles (HEV), and aerospace operations are among sectors where they are used [30]. There are many different types of batteries, including iron chromium, sodium nickel chloride, sodium sulphur, vanadium redox, lithium ion,zincbromine,leadacid,nickelcadmium,andzincairbatteries[27],[30],[31],[33]. Manystudieshavebeen conducted recently on battery energy storage technologies. For instance, [34] discussed the potential of energy storage systems for integrating renewable energy sources and mitigating intermittency while emphasising the advantages of battery storage technology over competing technologies. According to [35], demand shifting, islanded systems with off-grid rural electrification, houses with solar PV, and short-term power balancing in ancillary markets are the four primary applications of battery energy storage systems for integrating renewable energy.Oneofthemainpurposesofbatteryenergystoragesystemswassuggestedtobetheprovisionofasolution to the issue of intermittent solar PV output caused by sharp fluctuations in irradiance [36].An evaluation of the operationalpowerdispatchwiththeadditionofbatteriesandtherequirementtostoreenergyintheMadeiraisland system were reported in[37].[38] explored the use of a battery energy storage system with a lithium-ionbattery in a mass rapid transit system.

Additionally,aquadraticprogramme(QP)-basedoptimisationalgorithmwaspresentedin[39]forthescheduling ofresidentialbatterystorageco-locatedwithsolarPVinthecontextofPVincentiveslikefeed-intariffswiththe objective of maximising the daily operational savings that accrue to customers while penalising large voltage swings resulting from reverse power flow and peak load.[40] looked on how installed battery energy storage technologies inlow-voltage networks affectedoverlaid gridlevels. Inlow-voltagenetworks, gridbatterystorage systems have positive multiplicative effects on upper grid levels, decreasing local grid demand and reducing powerpeakstress,accordingtosimulationdata. Theconstructionofarepresentativedutycycle,astatisticalstudy of battery energy storage system utilisation, and a preliminary estimation of battery energy storage system deterioration were all provided in [41]. The battery duty cycle was described using five variables: pulse length, pulse strength (current), status of charge swing range, state of charge event ramp rate, and temperature.In this research,manybatteryenergystoragesystemapplicationshavebeenhighlighted. However,thisessaywillfocus more on how battery energy storage technology helps to integrate renewable energy sources for the creation of sustainable electricity.

**B. Thepurposeofthisstudy**

- PossibilityofdeployingbatteryenergystoragesystemsinAfricatoproduceallrenewableenergy.
- Possibilityofusingbatterystoragetechnologytorevolutionizetheelectricityindustry.
- The restriction thatelectricitymustbe generated atthesame rate asitisused willbe liftedifaffordable energy storage is available in sufficient quantities.

**SMARTBATTERYOPERATIONFORTHEGENERATIONOFSUSTAINABLEENERGY**

Usingsolarenergyasarenewableenergysource,thisendeavouraimstogenerate100%sustainableenergy.This decision was made because solar radiation is available in Nigeria, even though the strength varies based on the region, the season, and the time of day. Even in locations where radiation levels are quite high during the day, there is zero radiation at nightbecause to a natural design. For the aforementioned reason,if the energy needs to bemaintainedduringloworzeroradiationtimes,abackupstoragesystemmustbeavailable.Figure2depictsthe block diagram for a sustainable renewable energy generator.



ISBN:978-81-957858-1-0

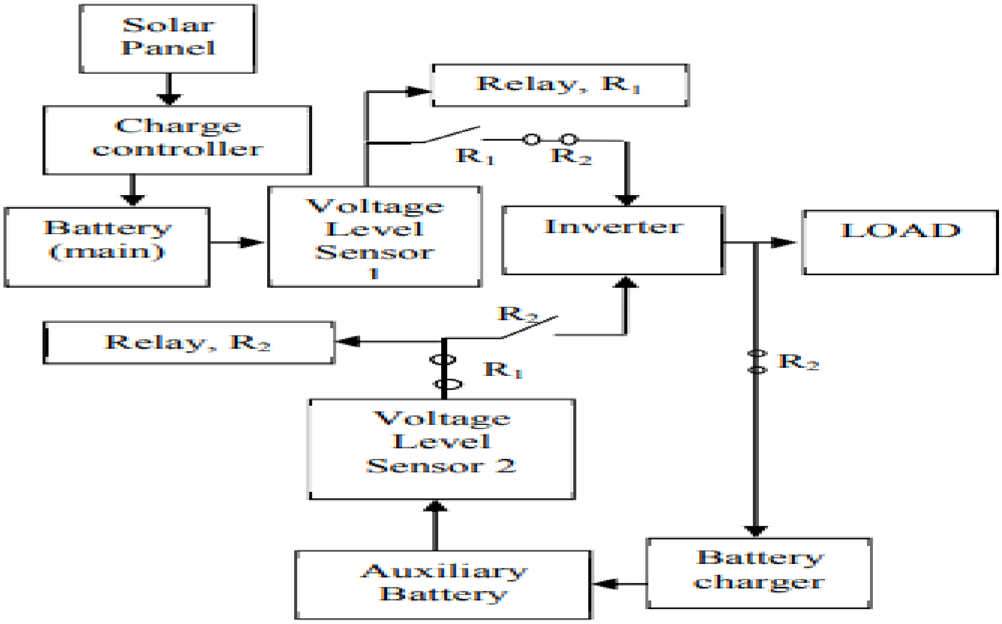


*Fig.2-theproposedsustainablerenewablepowergeneratorblockdiagram[41]*

Because component sizing depends on the anticipated load, it was not taken into account in this study. It should be emphasised, nevertheless, that the load that may be used to determine the size of the primary battery should also include the rating of the charger for the auxiliary battery.

**A. ComponentsutilisedintheProposedDesign'sFunctions**

The addition of an additional battery, voltage level sensors, and relays makes this work innovative. As a result, this section would describe how the three contribute to the development of sustainable electricity generation.

- Theauxiliarybatterywasincorporatedintothedesigntoactasabackupforthemainbatteryintheevent that the main battery is unableto supply the required amount of power due to the intermittent nature of solar radiation. By lowering the pace of charge, it will also help the primary battery last longer.
- Voltage level sensors:These devices sent energizing or de-energizing signals to the relays based on the battery voltage they detected. Due to the limited number of alternate sources in the design, only two voltage level sensors were employed.
- Onlytworelayswereutilisedinthisdesign,muchlikethevoltagelevelsensors.Dependingonthesignal from the voltage level sensors, the relays automatically connect or detach the inverter from the source. Additionally,therelaysactasaninterlockbetweenthetwosourcestomakesurethatonlyonesourceis allowed to operate at once.

**CONCLUSION**

Sustainable power generation from renewable energy source is achievable via careful coordination between the sourceandthestoragetechnologyemployed.Inthispaper,voltagelevelsensorswereusedtosmartlycontrolthe operationofthemainbatterywhich ischargedbythe source andthe auxiliarybattery.Byoperating therelaysat thesetvoltage,powersupplycouldbealternatedbetweenthemainandtheauxiliarybatteriestherebyresultingin sustainable supply of electrical energy to the load.

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ISBN:978-81-957858-1-0

**CurrentDevelopmentsinWirelessPowerTransmission**

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**Abstract**

Because of its potential to bring cutting-edge technology into our daily lives, wireless power transmission (WPT) has attracted a wide range of subjects from a variety of industries and developed into a very active study area. Because this technology makes it possible to transmit electrical energy over an air gap from a power source to an electrical load without any interconnecting wires, it will soon be required to be used. We conduct a pilot study in this paper to highlight the current state of wireless power transmission technology, as well as recent advancements and potential future directions. In addition, we include numerous wireless transmissions uses.

**Keywords:** Wireless power transfer, inductive coupling, Qi standard, A4WP, microwave power transmission.

**Introduction**

To get electricity energy to the distribution lines, cords are required. Power is one of the main problems. Transmission refers to the losses that occur during the transmission and distributionof electrical power as a result of energy loss in the conductor and other transmission-related machinery. Power generation and power loss both rise along with the daily rise in demand. The expenseofproducingelectricityalsoharmstheenvironment.Consequently,loweringtransmission lossisessentialsincetheelectricitysavedcanbeusedinanotherwaytocutcosts.Althoughthere willinevitablybesomepowerlossduringthetransmissionprocess,therearevariouschoicesthat maybeinterpretedtolessenthisissue.Wirelesspowertransmissionhasbeenusedforcenturiesto reduce power losses in the power distribution network using clean sources of electricity.Battery chargingwithwirelesspowertransferisanovelapproach.Butevenforbatterycharging,theidea ofwireless powertransferis not new.Researchers cameup with it, butit hasn't been widely used yet.Wirelesspowertransmissionisrevolutionizingthemodeofelectricitytransmissiontoenable the reliable and efficient wireless charging of millions of everyday electronic devices with integrating a power source to an electrical load without the aid of wires. Such a transmission is used in cases where interconnecting wires are hazardous or inconvenient. In the early period different scientist proved different approaches to transfer power without physical connection betweenthesourceandappliance.Eachtypeofwirelesspowertransferhasitsowncharacteristics



ISBN:978-81-957858-1-0

and applications. To make this idea for familiarize for the new researchers we reviewed the backgroundhistories,recenttechnologiesandfutureadvances[2].Thispaperwillbrieflysurveya varietyofpotentialwirelesspowertechnologyandcomparethemindifferentfeatures.Thisessay hasthefollowingorganizationalstructure.Afteranintroduction,SectionIIreviewscordlesspower transmission. While some power transmission applications are given in Section IV, the most currentwirelesspowertransmissiontechnologiesareclearlydetailedinSectionIII. InSection V, findings are given.

## WIRELESSPOWERTRANSFER (WPT)

Withoutusingcables,wirelesspowertransfer,alsoknownasmagneticpowertransfer,canbeused forshort-range or even long-range applications. Incomparison to earlier technologies, this one is more effective, quick, and minimal upkeep. Additionally, it enables self-charging for portable devices that have never been inserted into a common power outlet.on the other hand, this system losesmuchlesspowerthanwiredenergytransfer.Theprimarygoalofwirelesspowertransmission is to eliminate the restriction imposed by a power cord and enable uninterrupted charging of electricaldevices.Microwaves,resonance,andsolarcellsarethethreeprimarytechnologiesused in WPT.Totransmit electromagneticradiation from apowersource to areceiverin an electronic instrument, microwaves would be used.

First trials involving WPT were carried out by Nikola Tesla, the creator of AC energy. His inspiration stemmedfrom theconcept that theearthis aconductorcapableofdispersing acharge across its complete surface. Tesla's trials merely transferred electricity; they did not create it. Nevertheless, his theories can be used to address the world's current energy problem. Each application has its own disadvantages, but they all have the ability to help this world, which is running out of options for producing energy.

Portable technology is become a commonplace in daily life. However, another issue that arises frommobilityisenergy.Sincealmostallportablegadgetsrunonbatteries,theywillultimatelyall needtoberechargedusingthewiredchargersthatarealreadyinuse.Amobilephone,PDA,digital camera,voicerecorder,mp3player,orlaptopmightnowgetpowerwirelesslyinplaceofrequiring a plug to recharge it [3]. Although wireless power transfer is practical and useful in human everydaylife,thereareanumberoflimitationstothistechnology,includingtheneedforanetwork ofhundredsofsatellitesandinterferencewithotherelectronicequipment.Thenear-fieldtechnique and the far-field approach are the two methods used in wireless power transfer. Near-field approaches often offergreaterfrequency transmission and comprehensive patternmeasurements, whereas far-field techniques typically offer lower frequency transmission and basic pattern measurements [4] [6] [28].

### A. NEAR-FIELDTECHNIQUES



ISBN:978-81-957858-1-0

The appliances are measured using near-field methods that are close to the power source. There are three divisions that may be made: electromagnetic radiation, inductive related to magnetic resonant coupling. These methods can be utilized to solve issues brought on by bad weather and security issues.

**1) ELECTROMAGNETIC(EM)RADIATION**

EmissionviaEMradiationisthemethodoftransferringenergyfromapowersource'stransmission antenna to a receiving antenna using radioactive EM waves. In terms of the direction in which energy is emitted, omnidirectional radiation and unidirectional radiation are the two categories. Byusingomnidirectionalradiation,atransmitterbroadcastselectromagneticwavesinadesignated ISMband,suchas850–950MHzor902–928MHzintheUnitedStates,dependingontheregion. Bothofthesebandshavea915 MHzCentrefrequency.Areceiver,suchas anRFIDtag,tunes to the same frequency band to harvest radio power [1]. Although omnidirectional radiation makes information communication easier and more suited, it also has a severe inefficiency issue with energytransfersinceEMwavesquicklydecayasdistanceincreases.Theexperimentrevealedthat the power transmission efficiency is just 1.5% when a receiver is 30 cm from an RF emitter. [1]

Additionally, omnidirectional radiation for ultra-low-power sensor nodes, such as up to 10 mW with extremely low detecting activities like temperature, moisture, and light, is the only method that is adequate for protecting possible health risks of people from EM radiation. In the case of unidirectional radiation, if a clear line-of-sight (LOS) channel is present, it is possible to achieve high power transmission over a considerably greater distance, for instance, by utilizing a microwave or laser beam, whose range can reach kilometers Wireless power is often transferred using microwave frequencies of either 2.45 or 5.8 GHz, both of which are within the ISM frequency range, in microwave-based systems. The laser-based system, which is currently regardedasbeinglessdevelopedthanthemicrowave-basedsystem,transmitspower,forinstance, in the visible or near-infrared frequency range between a few THz and several hundred THz [1].

**2) INDUCTIVE COUPLING:**

A general definition of inductive coupling is the coupling of two LC circuits whose resonance frequenciesarethesame.Itfunctionsbyutilizingmagneticfieldinduction,anaturalbyproductof current flowing through a wire. For instance, alternating current in a primary coil connected to a source can produce a fluctuating magnetic field that induces a voltage across the terminals of a secondary coil at the receiver. Inductive coupling uses separate coils known as primary and secondary. Due to its ease of use, comfort, and safety, inductive coupling has become a crucial andwell-likedtechniqueforpowertransmissionwithoutwires.Eachofthesedevicesisconnected wirelessly.Numeroustypesofelectricalgadgetshavepreviouslybeencreatedusingthistechnical application.Consequently,ithasbeeneffectivelyusedtoavarietyofgoods,includinganelectric toothbrush,achargingpadforalaptopormobiledevice,andmedicalimplants.Powertransferin



ISBN:978-81-957858-1-0

inductivecouplingsteadilyreduceswhentwocoilsarenotperfectlyalignedorwhentheyare slowly separated from one another.

These types of issues typically arise when it is not utilized correctly. It works best when the device's charging node and the power receiving node are in close proximity to one another, typically less than the diameter of a coil. For example, the range may be measured in centimeters, and the charging direction must be straight. [1]

**3) MAGNETICRESONANT COUPLING:**

Magneticresonantcouplingisthefinalandmostsignificantsubsetof WPTtechnologyunder the heading of near field approaches. By combining inductive coupling and resonance, this technique was created by Kurs et al. and allows for extremely powerful interactions between two separate objects [1].. The magnetic field surrounding the coil and the electric field surrounding the capacitor will also be transferring energy back and forth. The action of magnetic resonance is comparable to that of classical mechanical resonance in that a string tunedtoacertainpitchmaybemadetovibratebyadistantsoundgeneratoriftheirresonance frequencies coincide. In this technology, alternating current in a primary coil (connected to a source) generates a varying magnetic field that induces a voltage across the terminals of a secondary coil at the receiver. This allows energy to be transferred efficiently from a source coiltoareceivercoilwithlittleenergyloss.Anexcellentextraneousoff-resonantobjectisan electrical transformer. This method has a number of benefits, including high efficiency, zero radiationloss,andconsiderablymoredirectionalandrangethaninductivecoupling[1][5][7].

**B. FAR-FIELDTECHNIQUES**

The electrical load is measured using far-field methods at a distance from the power source. Thesemethodsneedlineofsightandaimforgreatpowertransmission.Itmaybedividedinto two groups: laser power transmission and microwave power transfer [10].

**1) MICROWAVEPOWERTRANSMISSION(MPT):**

Withtwopointsinlineofsight,thistechniquetransmitsstrongpowerfromthebasestationto thereceivingstationormobiledevices.Thistechniqueallowstheobjectstoreceiveelectricity fromthebasestationwhileemployingthemagnetron,thankstogeosynchronousreceivingand transmitting satellites. Although MPT offers efficient energy conversion, it might be a little challenging to concentrate the beam in a small area. Additionally, this technology could readilytraversetheatmosphere.Theprocessofpowertransmissionbeginswiththeconversion ofelectricalenergyintomicrowaveenergy,whichisthencollectedviaarectenna.Alternating Current(AC)cannotbetransformedintomicrowaveenergydirectlywiththistechnique.Asa



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result, AC must first be converted to Direct Current (DC), and then, using a magnetron, DC must be transformed into microwaves. Rectennas receive the transmitted waves and more effectivelyconvertthemintoelectricitybyrectifyingthemicrowaves.DCwillbeproducedas the output. The final phase will include converting DC back to AC. [11][13-16]

**2) LASERPOWER TRANSMISSION:**

ThistechniqueisalittledifferentwithMPTsinceitusesamirrortofocus electricityina limited region. Additionally, high powers that are coherent and not distributed are producedbythistechnique.However,asalaserbeamtravelsthroughtheatmosphere,its power is reduced.Additionally, this technique has been applied to a rover to investigate the presence of ice at the bottom of lunar craters where there is no access to sunlight. In contrast, solar energy produced by radiation is transformed into electric energy. This energywillsubsequentlybetransformedintolaserlightandsenttotheroveroperatingat the crater's bottom [2] [12].

## RECENT TECHNOLOGIES

Resonancehasseenasharpincreaseinuseinrecentyearstoimprovetheeffectivenessof wireless energy transfer in a range of applications. In order to hasten the adoption of the technology into specialized applications, electronic businesses are also developing the essential core components of electronic products.This will increase our capacity for creativityandenableustomakemoresignificantmodificationstotechnologythatcanbe appliedtospecific activities.Whilesome of these ground-breakingapps havealready hit the market, others are still in the development stage. For instance, car charging is a revolutionary concept that is not yet commercially available since its charging infrastructurehastobestandardized.Ontheotherhand,aconsortiumbusinesshasalready created a ground-breaking invention for conventional inductive charging in mobile electronics. The Standards Development Organizations (SDOs) are developing mobile deviceinteroperabilitystandardsforhighlyresonantwirelesspowertransmissioninorder to guarantee that multi-vendor goods may charge anywhere in a shared wireless environment.Alloftheseinitiativesarelayingthegroundworkforanewtrendinwireless power technology, which may be used in a variety of applications.

### A. QI TECHNOLOGY

Thismethodsupportsachargingdistanceofonlyafew centimeters atmost andemploys tiny inductors to carry electricity overhigherfrequencies. Asa result, in orderto prevent a lack of a strong magnetic field, portable devices must be positioned very precisely on thedock.Qicomponentscanemployseveralresonatorarraystoproduceagreater



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charging area because to its limited charging area. However, turning on individual coils doeslittletoalleviatetheissueandactuallyconsumesalotofenergy.Usersmusttherefore carefully align their gadgets with the magnetic fields in order to maintain a robust connection [8] [18].

Due to the operating frequency heating conductive materials, the wireless charger can currently grow warm when charging and will heat up a device's back. A restricted communicationprotocolisalsoincludedintheQistandardtoreducetheamountofpower used by several coils. This allows the charging gadget to learn how much power it needs and when it is completely charged. In addition, the charger has the ability to change its poweroutputtoaccommodateanyreceivingdevicesandcangointostandbymodewhen thedevicehasfinishedchargingorifnodeviceisconnected.Althoughawirelesscharger hasnotyetprovenaseffectiveasaconventionalcharger,theQistandardwillsoonbeable to be employed in wireless charging [21–24].

## B. ALLIANCEFORWIRELESSPOWER(A4WP)TECHNOLOGY

The next-generation of wireless power transfer is called A4WP. allowing for effective power delivery to electronic equipment.

Using reference power for transmission and reception, Without the need of connecting wires, resonators [25]. With the help of this technology, several devices with various powerneedsmaybechargedsimultaneouslyfromasingletransmitter.Devicesmaynow be charged without perfectly aligning them with the coil thanks to a new technique that employs a broader electromagnetic field instead of the tiny inductor coils. Electronic gadgets may now be charged in any position, including along the Z-axis, thanks to the presence of A4WP, despite the fact that it has not yet been commercially marketed. The ability of A4WP to embed chargers in items where magnetic fields may still generate energy from the objects is another benefit [19] [26].

## C. PMA TECHNOLOGY

Power Matters Alliance is another modern technology. (PMA). This is the organization that has been collaborating with a number of research group leaders to develop a better powerparadigm forbattery-operatedgadgetsemployingwireless chargingtechnologyin aworldwide,not-for-profitsector.PMAhasexpandedquicklysinceitsfoundingin2012.
Recently, over 100 members operating in a variety of sectors, including telephony, consumer electronics,automotive,retail,furniture, surfaces, andmore,have adopted this new technological standard. The innovative strategy used by PMA to make wireless chargingcommonplacewherecustomersneeditmost,aswellastheeffortand



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commitmentofitsmembers,arecreditedwiththeorganization’sdevelopmentandsuccess [20].

| No. | RecentTechnologies | | |
|---|---|---|---|
| | QiStandard | PMA | A4WPStandard |
| 1. | Magneticinductioncharging | Inductioncharging | Magneticresonancecharging |
| 2. | Lack of largemagneticfield | Enough magneticfield | Huge magneticfield |
| 3. | Charging distancea few centimetersat most | Lessthan10cm | Much largerchargingdistance |
| 4. | Not easy to charge more than one devices at a time | Onedeviceata time | Design allows charging more than one device from a single transmitter |
| 5. | Heat upthe back of the devices | Heat up the devices | Don’theat up the devices |
| 6. | | Small coil | Muchlargercoil |



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| | | | |
|---|---|---|---|
| | Uses small precise inductor coil | | |
| 7. | Need to line up perfectly within the coil | Lineupwiththe coil | Noneedtoline up |
| 8. | 137 member organizationwith 100 products | More than 100 member organization | Very few company workingforthe development |

**TABLE 1. A4WPSTANDARD, PMA, ANDQISTANDARD COMPARISON**

## IV.APPLICATION OF WIRELESS POWER TRANSMISSION

Thefocusofcontemporaryresearchintheareaofwirelesspowertransmissionislikelyto be on the distance between the transmitter and receiver, which has the potential to be a significant factor in a variety of applications in human life. Applications rely on the employment of both high-powered devices in the industrial sector and low-powered devices, such as wireless sensors or other electronic mobile devices, with power ranges (less than 1W). (not more than 3KW).Different charging devices need to be battery or capacitor charge specified wireless charging might be two types of implemented system for devices like led lights where supplying energy is directly associated with load. [27]

### A.FIELDOF ELECTRONICS

The wireless power source is placed behind the corkboard and is used to implement the wireless charging system in electronics, which is the largest application field for it. This device can deliver over 20 watts of power and can charge a device over a distance of 40 cm from the wireless power source because its resonators are angled perpendicularly to one another.



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**Fig.1:Recentapplicationsofwirelesspowerchargingsystem in ourdailylife**

By 2020, analysts predict that highly resonant wireless power transmission will hold a market shareofmorethan 80%ofall wireless chargingsystems dueto theadvantages of charging across distance and with spatial flexibility [27]. The ability of mobile gadgets like smartphones to be charged wirelessly is another excellent application of this technology.Thebiggestutilityofthiswirelesschargingtechniqueforhumansmaybefor charging cameras or other equipment at anytime, anywhere, even in public settings, as indicated in the figure. [8] [17] [22] [23]

## B. MEDICAL DEVICES

Implanted medical equipment such as pacemakers, infusion pumps, and LVAD cardiac supportpumpshaveallemployedwirelesspowertransferextensively.Withtheuseofthis technology, medical gadgets that are deeply implanted into a person's body may be powered effectively. Additionally, it can reduce the necessity for drivelines that pierce human skin and for surgically replacing primary batteries. [9] [17] [25] [27].

## C. ELECTRIC VEHICLES

Wirelesschargingsystemscanbeusedtodirectlypowerrechargeablehybridandbattery electricautomobiles.Overa20cmdistance,thesedevicesdeliver3.3kWwithremarkable efficiency.Thistechnologymakesitpossibletotransmitelectricitytoelectricvehiclesin anefficientanddependablemannerwithouttheuseofwires.Furthermore,itisanticipated that wireless charging would significantly enhance the charging experience for EV owners, increasing the allure of such vehicles to consumers. [27]

## D. LED LIGHTING



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We may immediately charge our gadgets utilising wireless electricity when employing LED(lightemittingdiode)lights,whicheliminatestheneedforbatteriesinunder-cabinet work lighting. Additionally, it can assist architectural lighting designers in developing goods that appear to float in midair without a power cable. [27]

**E. DEFENSE SYSTEMS**

By utilizing wireless charging in defence systems, designers are developing new designs to enhance the dependability, ergonomics, and safety of electronic gadgets. For instance, the wireless charging capability of the Talon tele operated robot will enable it to be recharged while being transferred from one location to another by truck. Another application of the defence system is the use of radio devices and helmet-mounted electronics that can be wirelessly powered by a battery pack worn by the soldier. This eliminates the need for disposable batteries or a power cord that connects the helmet to the battery pack on the soldier's vest. Over the past several years, a number of industry consortia and standards development organizations have been working on developing specifications and standards related to the use and commercialization of wireless power.

Ultimately, a standard for wireless charging of electric and hybrid vehicles, including as automobiles and buses, is being developed by a committee of the Society of Automotive Engineers (SAE). Additionally, outside of North America, other international (International Electro technical Commission, or IEC) and national organizations (DKE German Commission for Electrical, Electronic and Information Technologies and the JapaneseAutomobileResearchInstitute,amongothers)areworkinginthesamecapacity to develop more wireless charging applications. The Consumer Electronics Association (CEA)hasbeenworking oncreatingastandard for theuseof wirelesspowertechnology inconsumerapplicationssince[27].Additionally,anumberofindustryconsortiumshave beensetuptogeneratespecificationsforpartsandsystems(asanexample,themostrecent three standards from the Alliance for Wireless Power (A4WP), Power Matters Alliance (PMA), and Wireless Power Consortium (WPC)). The quickest adoption of wireless power technology for the many wireless space application fields must benefit from these sorts of activities.

**F. SOLARPOWERSATELLITES(SPS)**

The use of satellites equipped with enormous solar arrays and positioning them in Geosynchronous Earth Orbit makes it the greatest use of WPT. These satellites are essential for producing and sending microwave energy to the ground. Wireless sensors, ubiquitouspowersources,andRFPowerAdaptiveRectifyingCircuits(PARC)arefurther uses for WPT [2] [28].



ISBN:978-81-957858-1-0

## CONCLUSIONS

It introduces the idea of wireless power transfer. Recently developed technical applicationsthatimprovehumanlivesinthemodernworldhavebeenhighlighted.When additionalnewstandardsareabouttobereleased,thethreenewwirelesspowertechnology standardsthatarenowinrivalrywithoneanotherwillalsobeahotissue.Whichofthese threewirelesschargingprotocolswillprevailinthecompetitiondeterminedbytheirmost recentoutstandingapplications.usingtheA4WPstandards,whichhaveastrongmagnetic field and a long charging distance, must be maintained, according to a comparison table. Thistechnologyismoreadvancedthanpreviousstandards,whereasQiandPMAarealso developing quickly. Only if wireless power continues to advance will more applications for robots and wireless power charging find their way into our daily lives.

## ACKNOWLEDGMENT

Forproviding thetools and materials forthis research, theauthor would liketo thankthe JB Institute of Technology's teachers and students.

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ISBN:978-81-957858-1-0

## OpportunitiesandResearchonElectricVehiclesinIndiaChallenges

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### Abstract

The need for renewable and eco-friendly products has grown throughout time as a result of the overuseanddegradationofnaturalresources.Theelectricvehicleisoneoftheseitems.Petroleum-basedcarsarebeingreplacedbyelectricones.Theyareanewtechnologythatisalsopracticaland environmentallybeneficial.Electricengineswillbecost-effectiveforcustomersandsignificantly cutpollutionwheninternalcombustionenginesarereplaced.Thistechniquehasbeenadoptedby severalnationsallaroundtheworld,anditishelpingtoimprovetheenvironment.We'llexamine the potential and difficulties associated with introducing electric cars in India.

**Keywords:**Pollution,ElectricVehicle,Eco-Friendly,LithiumBattery.

### Introduction

Environmental contamination has reached a completely new level as a result of the usage of harmful,non-renewableenergysources.Weurgentlyneedtoceaseusingnon-renewableresources andcutcarbonemissionsbecauseofthespeedingupofglobalwarming.Theamountofcarbonin theatmospherehasincreasedsincetheindustrialperiod.Aaveragepassengervehicleproduces 4.7metrictonsofcarbonemissionsannually.Theburningoffossilfuelsisthemainhumansource of carbon emissions. Internal combustion engines have been replaced with electrical engines in cars, which has made way for electric vehicles (EV). Since their invention, EVs have been accepted by several nations, having a good effect on the environment. We will now examine the potential and upcoming difficulties associated with introducing electric automobiles in India.

### BEVs,orbattery-electricvehicles

Batteries are the only source of energy used to power battery electric cars, which are entirely electricandlackeitherinternalcombustionordieselengines,gasolinetanks,orexhaustpipes.For propulsion, they employ electric motors and motor controls. There is no internal combustion engine in them. They are sometimes referred to as "Plug-in Electric Vehicles (PEVs)" since they recharge their batteries using an external charging outlet. BEVs come in a variety of forms, including electric trains, buses, trucks, motorcycles, and scooters. Even less parts are utilized in them than in cars powered by internal combustion engines. Even in comparison to their competitors, they make less noise.

### HEVs,orhybridelectricvehicles



ISBN:978-81-957858-1-0

Since hybrid electric cars employ both internal combustion engines and electric power technologies, they are not entirely electric vehicles. Cars, buses, and trucks are the principal examples of these. The most recent models use efficiency-enhancing technologies like regenerative brakes, which transform a vehicle's kinetic energy into electricenergytochargethebattery,andothersystemslikestart-stopsystems,whichturn offanengineatidleandrestartitwhennecessarytocutdownonidleemissionsandmotor generators. A hybrid electric vehicle runs at optimum efficiency and creates far less emissions than a hybrid powered exclusively by petrol.

Additionally,plug-inhybridvehicles(PHEVs)exist.Evenlessnoiseisproducedbythem than by pure hybrid automobiles.

**INDIA'SDEVELOPMENT IN THEUSEOFELECTRIC VEHICLES**

Byorganisingatransitiontoelectricvehiclesby 2030,theIndiangovernmenthassetout on a quest to revolutionise renewable energy in the nation. Within the next12 years, it is anticipated to reduce its oil purchases by almost $60 billion, cut emissions by 37%, and reduce the demand for road development. India presently has 1.3 billion inhabitants and sells over 21 million automobiles yearly .

**OPPORTUNITIES**

**A. Governmental Programmes**

- To encourage the use of electric cars, the government launched a programme in 2015 called the FasterAdoption and Manufacturing of Hybrid and Electric cars (FAME) .
- The National Electric Mobility Mission Plan was created in 2015 with the goal of achieving fuel security by achieving sales of six to seven million electric and hybrid vehicles by 2020 .
- The nodal organisation has been selected by state-owned Energy Efficiency Services Limited (EESL) to acquire about 10,000 electric vehicles to replace current government fleet vehicles .
- In order to encourage research and development in electric mobility, the Karnataka State Government established a policy that makes it essential to install charging stations and pods in all of the state's main cities .
- TheMaharashtraStateGovernmenthascancelledvarioustariffsforelectricvehiclesever since it became the first state in India to establish an electric mass transportation system.
- As a party to the Paris ClimateAgreement, India is required to reduce its percentage of global emissions by 2030 .
- Under the direction of Bharat Heavy Electricals Limited (BHEL), the government wants to establish a lithium-ion battery manufacturing plant .



ISBN:978-81-957858-1-0

- TheGoodsandServices Tax(GST)Councilestablishedataxrateof12%vs28%for automobiles fueled by petroleum

**B. Battery**

- Approximately22,000electricvehicles(EVs)arenowbeingmarketed,2000ofwhichare four-wheelers .
- Batterycostshavedroppedfrom$600 in2012to$250in 2017andarepredictedto reach $100by2024,makingthemlessexpensivethantheinitialcostofgasoline-poweredcars .
- EVbatteries'storagecapacitycanaidwithgridbalance..

**C. Industrial**

- Aiming to create an ecosystem for electric transportation that includes charging infrastructureandvehiclefleetslikeelectrictaxis,e-rickshaws,andmore,taxiaggregator OLA has started the OLA Electric project.
- Suzukihasrevealedplanstobuildalithiumionbatteryfactoryfor$600million.
- Mahindraplanstoofferelectricversionsofitscarsafterinvestingover60millionrupees in the development of its EV business.
- Anenginemaker,CumminsIndia,islookingintooptionsforelectrictransportation.
- A cooperation betweenAshok Leyland and SUN Mobility to create a battery switching system for electric buses has been announced.
- JSW Energy has made known that it intends to spend $623 million on infrastructure, batteries, and electric vehicle vehicles.
- Volvo, a Swedish automaker, has said that by 2019, they would stop producing internal combustion engines altogether and exclusively produce electric or hybrid vehicles.Businesseswhoinstallcharginginfrastructureareatanadvantage,providedthat the industry is anticipated to be lucrative and reach roughly 90 billion units (BU).

**D. Environmental**

- The majority of big cities have significant levels of air pollution, with vehicle emissions being one of the main culprits.
- Due to high levels of air pollution, Delhi, the capital of India, has begun to experience smog .
- Increased awareness of climate change encourages the manufacturing and sale of EVs. • The use of recycled and used automotive parts in EVs makes them even more environmentally benign.
- GrowingenvironmentalconsciousnessencouragesthedevelopmentandsellingofEVs**.**

**CONCLUSION**



ISBN:978-81-957858-1-0

India's use of EVs intends to lower greenhouse gas emissions and oil costs in particular.The Indian government's goal for 2030 is a challenging and ambitious project. The government needs to take advantage of all of the chances it has and create effective solutions for the problemsthatwillarisefromtheadoptionofEVs.AsaresultofIndia'scommitmenttoseveral environmental agreements, it is now under pressure to carry out Vision 2030.

**ACKNOWLEDGMENT**

We would want to sincerely thank and appreciate everyone who made it possible for us to finishthisstudy.WewouldliketoextendourgratitudetoDirectorMr.CSakthikumarandour Honourable Secretary and Correspondent Dr. P Chinnadurai. We would like to express our gratitude to our department's head, professor S Selvi, as well as professors Stephen Silas, V Devaraj, and B Vijayakumar, who guided us during this research. Last but not least, we appreciatetheprayersandwellwishesfromourparents,employees,andallofoursupporters.

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ISBN:978-81-957858-1-0

# Design of Linearly Polarized Microstrip Square-Patch Antenna for Improved Bandwidth and Low Return Loss

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## Abstract

ThedesignofmicrostripAntennaisachallengeforresearchers.Thispaperproposesthedesignof a linearly polarized Microstrip Square-Patch antenna with enhanced Bandwidth and low return loss. The design of linearly polarized microstrip patch antenna is realized using Quarter wavelengthtransformer.Thedesignandsimulationofthisantennahasbeendonewiththehelpof Ansoft HFSS. The simulation of the Microstrip patch has given different parameters like low returnloss,ImprovedBandwidth,Directivegain,radiationpatternand3-Dpolarplotofradiation pattern. This antenna can be used for many modern communication systems.

**Keywords:**LinearlyPolarized(LP),Bandwidth,DirectiveGain,Square-patch,VSWR,Radiation pattern, Return loss.

## Introduction

Microstrippatchantennashavedrawntheideaofresearchersoverthepastfewdecades.However, the antennas inherent narrow bandwidth and small gain is one of their major drawbacks [1, 2]. This is one of the problems that researchers around the world have been trying to overcome. Throughout the years, authors have devoted their investigations to creating new designs or variationstotheoriginalantennathat,tosomeextent,producewiderbandwidths.Thepatchaerial has been fastly used in various fields like space technology, aircrafts, missiles, mobile communication, GPS system, and broadcasting. Patch antennas are light inweight, tinysize, low cost,simplicityofconstructandeasy integrationtocircuits.Moreimportantisthesecan bemade outintovariousshapelikerectangular,triangular,circular,squareetc.Manytechniqueshavebeen suggested for achieving the high bandwidth. These techniques include: using parasitic elements either in same or other layer [8], utilization of thick substrates with low dielectric constant, and slotted patch.We have used a thick dielectric substrate having a low dielectric constant which provides better efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size. In order to design a compact Microstrip patch antenna, higher dielectricconstantsmustbeusedwhicharelessefficientandresultinnarrowerbandwidth.Hence a compromise must be reached between antenna dimensions and antenna performance.

## Microstrippatchantenna

Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side as shown in Figure 1.



ISBN:978-81-957858-1-0

**Fig1MicrostripPatchAntenna**

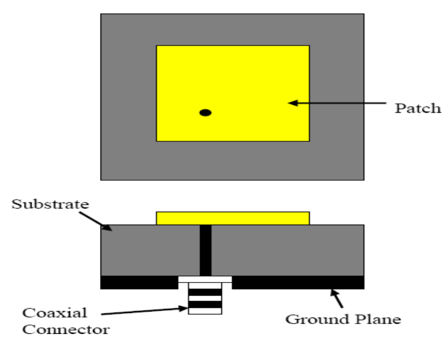
The patch is generally made of conducting material such as copper or gold and can take any possible shape. The radiating patch and the feed lines are usually photo etched on the dielectric substrate [1, 3]. The patch is selected to beverythinsuchthat$t$<<λo(where$t$isthepatchthickness).Theheight $h$ofthedielectricsubstrateisusually0.003 $\lambda o \leq h \leq$ 0.05λo. The dielectric constant of the substrate (εr)istypically in the range 2.2 ≤εr≤ 12 $r$. Microstrip patch antennasareincreasinginpopularityforuseinwirelessapplicationsduetotheirlow-profilestructure.Thereforethey are extremely compatible for embedded antennas in handheld wireless devices such as cellular phones, pagers etc. ThetelemetryandcommunicationantennasonmissilesneedtobethinandconformalandareoftenMicrostrippatch antennas. Another area where they have been used successfully is in Satellite communication.

FEEDTECHNIQUE

Microstrip patch antennas can be fed by a variety of methods [1, 2]. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniquesusedarethemicrostripline(fig.2),coaxialprobe(fig.3)(bothcontactingschemes),aperturecouplingand proximity coupling (both non-contacting schemes).

Thispaperusesmicrostriplinefeedingtechnique.

**Figure(2)MicrostripLine Feed**




**Figure(3)CoaxialFeed**

METHODSOFANALYSIS

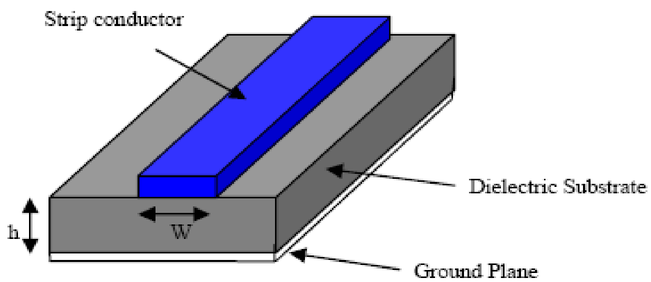
Themostpopularmodelsfortheanalysisof Microstrippatchantennasarethetransmissionlinemodel,cavitymodel, andfullwavemodel(whichincludeprimarilyintegralequations/MomentMethod)[1,3].Thetransmissionlinemodel isthe simplest of all and itgives goodphysical insight,but itis lessaccurate. The cavitymodel ismoreaccurate and gives goodphysical insight but iscomplex in nature. The full wave models are extremely accurate, versatile and can treatsingleelements,finiteandinfinitearrays,stackedelements,arbitraryshaped elementsandcoupling.Thesegive less insight as compared to the two models mentioned above and are far more complex in nature. In this paper Transmission line model is used for designing the patch antenna.

**TRANSMISSIONLINEMODEL**



ISBN:978-81-957858-1-0

This model represents the microstrip antenna by two slots of width *W* and height *h* separated by a transmission line of length L. The microstrip is essentially a nonhomogeneous line of two dielectrics, typically the substrate and air. The formulae used in this model for calculation of the dimensions are discussed in next section.



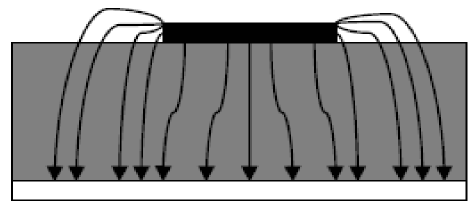
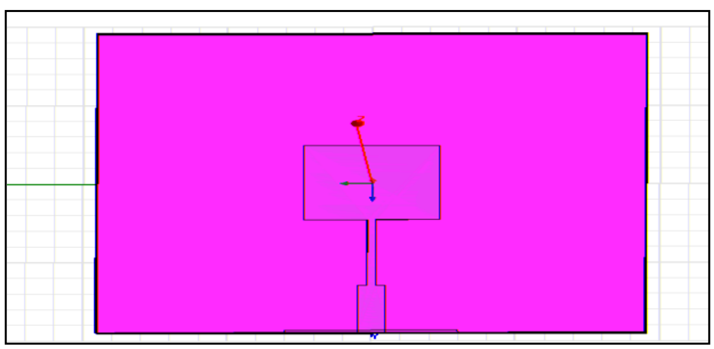



**Figure (4) icrostrip Line Figure** **Figure(5)ElectricFieldLines**

**MICROSTRIP SQUARE PATCH ANTENNA DESIGN**

Design of microstrip patch antenna depends mainly upon three parameters, namely substrate and its dielectric constant, height of the substrate and resonant frequency. In this paper, selected three parameters are:ResonantFrequency($f_r$)=3.6GHz,Dielectricconstant ($\varepsilon_r$)=2.2,Heightofthedielectricsubstrate(h) =1.6mm.Fig.6representsthedesignedMicrostripPatchantennaanditspolarization.

.



Figure(6)Microstripsquarepatchantenna

**CALCULATIONS**

**Calculationofthewidth(W):**

ThewidthoftheMicrostrippatchantennaisgivenbyequation(1)[1, 2]:

$$W=\frac{c}{2f}\sqrt{\frac{2}{\varepsilon_r+1}} \quad \text{-----------------} \quad (1)$$



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The calculated width of proposed square patch antenna from equation (1) is W= 32.94 mm, where c is the speed of light.

**CalculationofEffectivedielectricconstant**($\varepsilon_{eff}$):

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 10\frac{h}{W}\right]^{1/2} \quad \text{-------} \qquad (2)$$

Thecalculatedeffectivedielectricconstantfromequation(2)[1],Ɛreff=2.329.

**CalculationoftheEffectivelength(Leff):**

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon_{eff}}} \quad \text{---------------------} \qquad (3)$$

Fromaboveequationtheeffectivelengthiscomesouttobe[1,3],Leff=27.30mm

**CalculationoftheLengthExtension(ΔL):**

$$\Delta L = 0.412h\frac{(\varepsilon_{eff} + 0.3).(W/h + 0.264)}{(\varepsilon_{eff} - 0.258).(W/h + 0.8)} \text{-----} \qquad (4)$$

Whichcomesouttobe[1,2]ΔL=0.8008mm.

**Calculationoftheresonantlengthofpatch(L):**

$L = L_{eff} - 2\Delta L$ ------------------- (5)

Thiscomesouttobe 25.698mm.

**CALCULATIONOFRADIATIONCONDUCTANCE(G):**

THERADIATIONCONDUCTANCEFORAPARALLEL-PLATERADIATORAS[1,2]

$$G = \frac{W\pi}{\eta\lambda_0}\left[1 - \frac{(kh)^2}{24}\right] = 3.2944\text{mS.}\text{----------------} \qquad (6)$$

**CALCULATIONOFINPUTRESISTANCEOFTHEPATCH(R):**

$$R = \frac{1}{2G} = 151.768\text{Ohms}\text{-----------------} \qquad (7)$$



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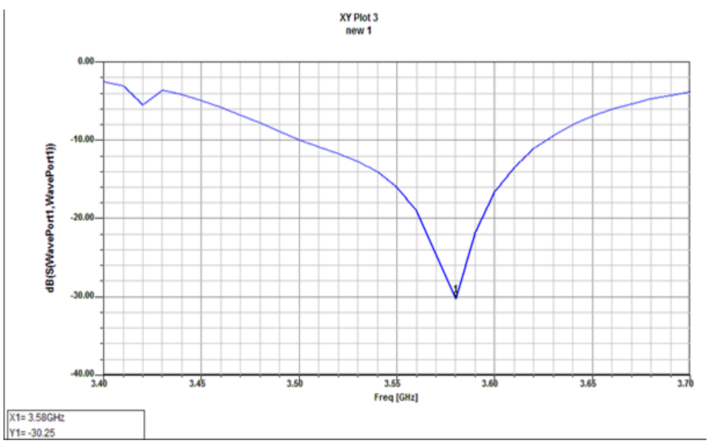
RESULTSANDDISCUSSIONS

Theproposedantennahasbeendesignedandsimulatedusing AnsoftHFSSsoftware.Figure(7)represents thevariationofReturnLoss withFrequency.Plot showsresonantfrequencyat3.58GHz withminimum-30.25dBreturnslossavailableatresonantfrequency.

Bandwidthoftheantennaisdefinedastherangeoffrequencies,overwhichtheperformanceoftheantenna with respect to some characteristic conforms to aspecific standard. Thebandwidth of theantennadepends on the patch shape, resonant frequency, dielectric constant and the thickness of the substrate [4, 7]. The bandwidth enhancement of a microstrip antenna has been directed towards improving the impedance bandwidth of the antenna element. Impedance bandwidth is usually specified in terms of a return loss.

Figure8representsthepolarizationofsimulatedMicrostripsquarepatchantenna.TheVSWRofmicrostrip square patch antenna is shown in figure 9.




**Figure(7)ReturnLossvs.Frequency**



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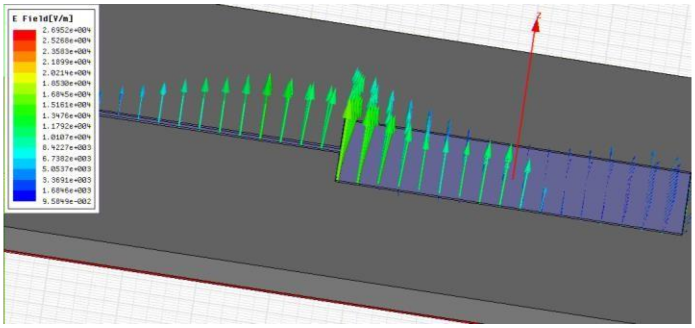
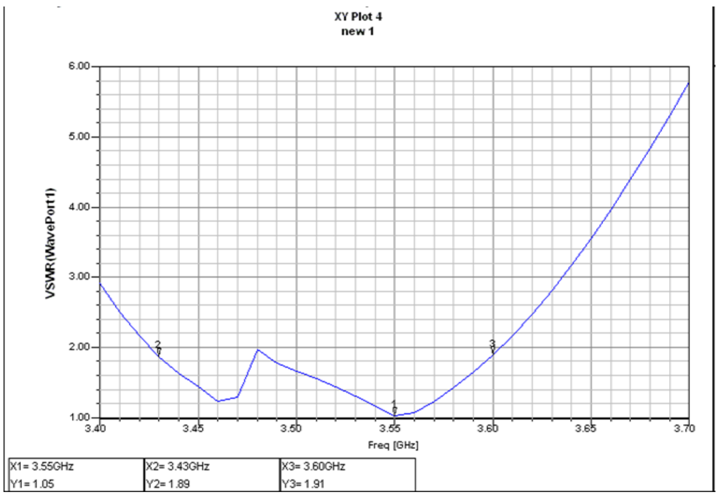
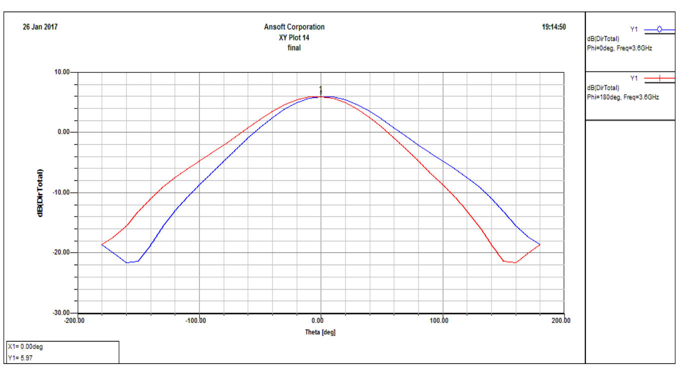


**Figure(8)PolarizationofSimulatedpatchAntenna**




**Figure(9)VSWRvs.frequency**

FROM FIGURE 9, THE BANDWIDTH OF PROPOSED MICROSTRIP SQUARE PATCH ANTENNA COMESOUTTOBE180MHZFORTHEVALUEOFVSWRBELOW2.THEDIRECTIVITYOFTHE MICROSTRIP SQUARE PATCH ANTENNA IS SHOWN IN FIGURE 10.




**FIGURE(10)DIRECTIVITYOFMICROSTRIPSQUAREPATCHANTENNA**

ANDTHERADIATIONPATTERNOFTHEMICROSTRIPSQUAREPATCHANTENNAISSHOWN IN FIGURE 11 AND 3-D POLAR PLOT IS SHOWN IN FIGURE 12.



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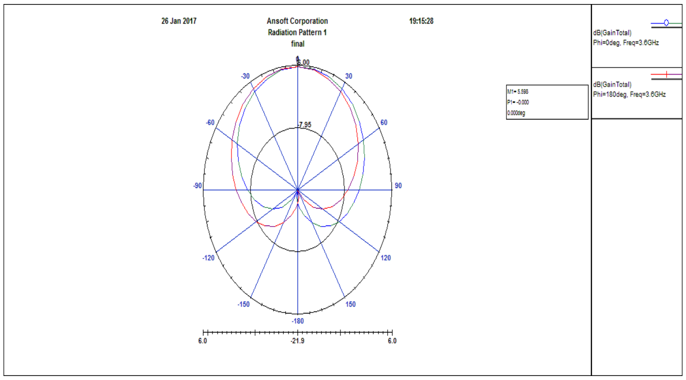


**FIGURE(11)RADIATIONPATTERNOFMICROSTRIPSQUAREPATCH ANTENNA**

**TheresultsforproposedmicrostripsquarepatchantennaareshownintheTable1.**

CONCLUSIONANDFUTURESCOPE

A square patch microstrip antenna design has been proposed and successfully implemented. The proposed structure has been simulated by using the Ansoft HFSS software. The square patch antenna enhances bandwidth, gain and good return loss ($S_{11}$ parameters) of -30.25dB is achieved along with broad side radiationpatternandlinearpolarization.Thelinearlypolarizedsquarepatchmicrostripantennacanbeused for wireless local area network (WLAN, IEEE 802.11) application. The use of thicker substrate increases the size of the patch antenna, which is the area that can be improved with the proposed design.

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ISBN:978-81-957858-1-0

# An Analytical Review of Corporate Governance Policies of Infosys Technologies Ltd.

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**Abstract**

Corporate governance is a multi-faceted subject. An important theme of corporate governance is the nature and extent of accountability of particular individuals in the organization, and mechanisms that try to reduce or eliminate the principal agent problem. All parties to corporate governance have an interest, whether direct or indirect, in the financial performance of the corporation. Directors, workers and management receive salaries, benefits and reputation, while investors expect to receive financial returns. For lenders, it is specified interest payments, while returns to equity investors arise from dividend distributions or capital gains on their stock. Customersareconcernedwiththecertaintyoftheprovisionofgoodsandservicesofanappropriate quality; suppliers are concerned with compensation for their goods or services, and possible continuedtradingrelationships.ThispaperexplorestheapplicationofvariousaspectofCorporate Governance, including Board Composition, Board Meetings, Board Committees, Code of Business Conduct and Ethics, Management Review and Responsibility andshareholders. Infosys TechnologiesLtd.hasbeenapioneerinbenchmarkingitscorporategovernancepracticeswiththe best in the world in the Infosys Ltd. Corporate governance is a reflection of Infosys's culture, policies, their relationship with stakeholders, and their commitment to values.

**Keywords:**CorporateGovernance,Accountability,InfosysTechnologiesLtd.CodeofBusiness Conduct and Ethics.

## Introduction

Corporate Governance is the set of processes, customs, policies, laws, and institutions affecting the way a corporation (or company) is directed, administered, or controlled and multi-faceted. Corporate governance also includes the relationships among the many stakeholders involved and thegoalsforwhichthecorporationisgoverned. Incontemporarybusinesscorporations,themain external stakeholder groups are shareholders,debenture holders, trade creditors, suppliers, customers,and communitiesaffected by the corporation'sactivities. Internal stakeholdersarethe boardofdirectors,executives,andotheremployees.Animportantthemeofcorporategovernance is the nature and extent of accountability of particular individuals in the organization, and mechanismsthattrytoreduceoreliminatetheprincipal-agentproblem.Corporategovernancecan bedescribedintermsofasystemofstructuring,operatingandcontrollingacompanywithaview toachievinglongtermstrategicgoalstosatisfyshareholders,creditors,employees,customersand suppliers,andcomplyingwiththelegalandregulatoryrequirements,apartfrommeeting



ISBN:978-81-957858-1-0

environmental and local community needs. However,thereis substantial interest in how external systems and institutions, including markets, influence corporate governance.

**2.CorporateGovernance Modelsaround the world:**

There are various different models of corporate governance around the world. These have the differenceaccordingtothevarietyofcapitalismoreconomicsysteminwhichtheyareembedded. The Anglo-American "model" tends to emphasize the interests of shareholders. The coordinated or multi-stakeholder model associated with Continental Europe and Japan also recognizes the interests of workers, managers, suppliers, customers, and the community.

**3.InfluentialPartiestoCorporateGovernance**:

The most influential parties involved in corporate governance include government agencies, authorities,stockexchanges,management(includingtheboardofdirectorsanditschair,theChiefExecutiveOfficerortheequivalent,otherexecutivesand,linemanagementshareholders andauditors). Other influential stakeholders may include lenders, suppliers, employees, creditors, customers and the community at large.

Aboard of directors is expected to play a key role in corporate governance. The board has the responsibilityofendorsingtheorganization'sstrategy,developingdirectionalpolicy,appointing, supervising and remunerating senior executives, and ensuring accountability of the organization to its investors and authorities. All parties to corporate governance have an interest, whether directly or indirectly, in thefinancial performanceof the corporation. Directors, workers and managementreceivesalaries,benefitsandreputation,whileinvestorsexpecttoreceive financial returns.Forlenders,itisspecifiedinterestpayments,whilereturnstoequityinvestorsarisefrom dividenddistributionsorcapitalgainsontheirstock.Customersareconcernedwiththecertainty of the provision of goods and services of an appropriate quality; suppliers are concerned with compensation for their goods or services, and possible continued trading relationships. These partiesprovidevaluetothecorporationintheformoffinancial,physical,humanandotherforms of capital. Many parties may also be concerned with corporate social performance.

**4.PopularlyespousedPrinciplesto CorporateGovernance:**

- **Rights and equitable treatment of Shareholders**: Organizations should respect the rights of shareholders and supports shareholders to exercise those rights. They can help shareholders exercise their rights by effectively communicating information that is understandable and accessible and encouraging shareholders to participate in general meetings.
- **Interests of other Stakeholders**: Organizations should recognize that they have legal and other obligations to all legitimate stakeholders.



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- **Role and responsibilities of the Board**: The board of Directors needs a range of skills and understanding to be able to deal with various business issues and have the ability to review and challengemanagementperformance.Itneedstobeofsufficientsizeandhaveanappropriatelevel ofcommitmenttofulfillitsresponsibilitiesandduties.Thereareissuesabouttheappropriatemix of executive and non-executive directors.

- **IntegrityandEthicalBehavior**:Ethicalandresponsibledecisionmakingisnotonly importantforpublicrelations,butitisalsoanecessaryelementin riskmanagement andavoiding lawsuits. Organizations should develop a code of conduct for their directors and executives that promotes ethical and responsible decision making.

- **DisclosureandTransparency**:Organizationsshouldclarifyandmakepubliclyknowntheroles and responsibilities of board and management to provide shareholders with a level of accountability.Theyshouldalsoimplementprocedurestoindependentlyverifyandsafeguardthe integrity of the company's financial reporting. Disclosure of material matters concerning the organizationshouldbetimelyandbalancedtoensurethatallinvestorshaveaccesstoclear,factual information.

**InfosysTechnologiesLtd:**

**Infosys Technologies Ltd :** Incorporated in 1981, The company, which is headquartered in Bangalore, takes pride in itstimely and accurate delivery using what they call “a low-risk Global Delivery Model (GDM)” and touched a turnover of US$ 2.15 billion in the year ended March 2006. It employs over 58,000 and has been lauded for creating jobs back in the US, where many ofitsclientsarebased.Ithasover40developmentcentersacrosstheglobe.Inasurveyconducted by BusinessWeek and Boston Consulting Group, of the World’s Most Innovative Companies, Infosys was ranked #10 in the Asia-Pacific region.

**“Our success is measured by the exceptional value we create for our clients. We constantly strive to create value in all our endeavors and prove it through tangible results.”**

**ision:**

ur vision is to be among **the top global technology service providers** offering a complete spectrumofe-business,InternetandCommunicationtechnologyservicesandcomponentsin an environment of empowerment, intellectual challenge and wealth sharing.



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**Mission:**

Emergeasa**leadingsolutionprovider**inthefieldof**softwaredevelopment&IT** enabledservicesbyperusinglatesttrendsintechnologyandqualitydrivenapproach.

Achievestrongexpertiseinchosendomainwithfocusedapproachanddelivery commitment.

Continuous investment in technology, skills and human resources.

Operatewithhighdegreeof Integrity,Securityandmaximumvalueformoney approach towards customers.

) **<u>CorporateGovernancePolicies</u>**:

orporate governance is a reflection of our culture, policies, our relationship with stakeholders,andourcommitmenttovalues.Infosyshasbeenapioneerinbenchmarkingits corporate governance practices with the best in the world.

) **<u>CorporateGovernanceReport</u>**:

s a part of our commitment to follow global best practices, we comply with the Euro shareholders Corporate Governance Guidelines 2000, and the recommendations of the Conference Board Commission on Public Trusts and Private Enterprises in the U.S.

)**<u>CorporateSocialResponsibility</u>**

nfosys Foundation, the philanthropic arm of Infosys Technologies Ltd. fulfils the social responsibilityofthecompany.TheFoundationhas undertakenvariousinitiativesinproviding medical facilities to remote rural areas, organizing novel pension schemes etc.

**<u>5. CorporateGovernanceof</u>**<u>InfosysTechnologiesLtd.</u>

The primary purpose of corporate leadership is to create wealth legally and ethically. This translates to bringing a high level of satisfaction to five constituencies - customers, employees, investors, vendors and the society-at-large.The raison d'être of every corporate body is to ensure predictability, sustainability and profitability of revenues year after year.



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**CorporateGovernance PoliciesofInfosys**

Infosyshasbeenapioneerinbenchmarkingitscorporategovernancepracticeswiththebestinthe world. The company's policies on corporate governance are listed below.

A. BoardComposition.

B. BoardMeetings.

C. BoardCommittees.

D. ManagementReview andResponsibility.

E. Shareholders.

Now,Letushave elaborationofthese issues:

**A. BoardComposition**

**a) SizeandCompositionoftheBoard**

Theirpolicy towardthecomposition oftheBoardis to haveanappropriate mix ofexecutiveand independentdirectorstomaintaintheindependenceoftheBoard,andtoseparateitsfunctionsof governanceand management. Currently, the Board consists of 14 members, five of whom are executiveorwhole-timedirectors,oneisnon-executiveandeightareindependentdirectors.Three oftheexecutivedirectorsaretheirfounders.TheBoardbelievesthatthecurrentsizeisappropriate, based on their present circumstances. The Board periodically evaluates the need for change in composition of its size.

**ResponsibilitiesoftheChairman,CEOandtheCOO**

TheirpolicyistohaveaNon-ExecutiveChairmanandChiefMentor–N.R.NarayanaMurthy;a Chief Executive Officer (CEO) and Managing Director – S. Gopalakrishnan; and a Chief Operating Officer (COO) and Director – S. D. Shibulal. The responsibilityand authority of these officials are as follows:

• The Chairman and Chief Mentor is responsible for mentoring their core management team intransforming them into a world-class, next-generation organization that provides state-of-the-



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art,



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technology-leveraged business solutions to corporations across the world. He also interacts with global thought leaders to enhance their leadership edge. In addition, he continues to interact with various institutionsto highlight the benefits of IT and help these benefits percolate to all sections ofsociety.AsChairmanoftheBoard,heisalsoresponsibleforallBoardandcorporategovernance matters.

• The CEO and Managing Director is responsible for corporate strategy, brand equity, planning, external contacts and other management matters. He is also responsible for achieving the annual business targets and acquisitions.

• TheCOOisresponsibleforallcustomerserviceoperations.Heisalsoresponsibleforinnovation and research in technology advancements, new initiatives and investments.

The CEO, COO and the other executive directors and the senior management personnel are responsible for achieving targets. They make periodic presentations to the Board on their responsibilities and performance.

**b) <u>BoardMembershipCriteria</u>**

The nominations committee works with the entire Board to determine the appropriate characteristics, skills and experience required for the Board as a whole as well as its individual members.Boardmembersareexpectedto possesstheexpertise,skillsandexperiencerequiredto manageandguideahigh-growth,high-techITservicescompany,derivingrevenueprimarilyfrom G-7countries.Expertiseinstrategy,technology,finance,qualityandhumanresourcesisessential. Generally, the members are between 40 and 60 years of age, and are not related to any executive directorsorindependentdirectors.Theyarenotexpectedtoserveinanyexecutiveorindependent position in any company that is in direct competition with them. Board members are expected to rigorously prepare for, attend and participate in all Board and applicable committee meetings.

**c) <u>Membership Term</u>**

The Board constantly evaluates the contribution of the members and periodically makes recommendationstotheshareholdersaboutre-appointmentsasperstatute.ThecurrentlawinIndia mandates the retirement of one-third of the Board members (who are liable to retire by rotation) every year, and qualifies the retiring members for re-appointment. Executive directors are appointedbytheshareholdersforamaximumperiodoffiveyearsatatime,butareeligibleforre-appointment upon completion of their term. Non-executive / independent directors do not have a specifiedterm,butretirebyrotationasperlaw.ThenominationscommitteeoftheBoard



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recommends such appointments and re-appointments. However, the membership term is limited by the retirement age for members.

**HRPolicyofDirectorsin CurrentScenario:**

**a) Retirementpolicy**

Underthispolicy,themaximumageofretirementforexecutivedirectorsis60years,whichisthe age of superannuation for their employees. Their continuation as members of the Board upon superannuation/retirementisdeterminedbythenominationscommittee.Theagelimitforserving on the Board is 65 years. The age limit for the independent chair is 70 years.

**b) BoardCompensationPolicy**

ThecompensationcommitteedeterminesandrecommendstotheBoardthecompensationpayable to the directors. All Board-level compensation is approved by the shareholders and separately disclosed in the financial statements. Remuneration of the executive directors consists of a fixed componentandaperformanceincentive.Thecompensationcommitteemakesaquarterlyappraisal oftheperformanceoftheexecutivedirectorsbasedonadetailedperformance-relatedmatrix.The annual compensation of the executive directors is approved by the compensation committee, within the parameters set by the shareholders at the shareholders' meetings. The compensation payable to the independent directors is limited to a fixed amount per year as determined and approved by the Board, the sum of which is within the limit of 1% of ournet profits for the year, calculated as per the provisions of the Companies Act, 1956. The performance of independent directors is reviewed by the entire Board on an annual basis.

**Memberships inotherboards**

Executivedirectorsmay,withthepriorconsentoftheChairpersonoftheBoardofDirectors,serve on the Board of two other business entities, provided that such business entities are not in direct competition with their business operations. Executive directors are also allowed to serve on the boardsofcorporateorgovernment bodieswhoseinterests aregermaneto thefutureofthe ITand software business, or the key economic institutions of the nation, or whose prime objective is benefiting society. Independent directors are not expected to serve on the Boards of competing companies.

**B. BoardMeetings**

**a) Schedulingandselectionofagendaitemsfor Boardmeetings**



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Dates for Board meetings in the ensuingyear aredecided in advance and published as part of the Annual Report. TheChairperson of the Board and the Company Secretary draft the agenda for each meeting, along with explanatory notes, in consultation with the CEO and the Lead Independent Director, and distribute these in advance to the directors. Every Board member can suggest additional itemsfor inclusion in the agenda. Independent directors areexpected to attend atleastfourBoardmeetingsinayear.Foreg.SixBoardmeetingswereheldduringtheyearended March31, 2010. The Board has unfettered and complete access to any information within the Company,andtoanyoftheiremployees.AtBoardmeetings,managerswhocanprovideadditional insights into the items being discussed are invited.

Regularupdates provided to theBoard include:

• Annualoperatingplansandbudgets,capitalbudgetsandupdates

• Quarterlyresultsofouroperatingdivisionsorbusinesssegments

• Minutesofmeetingsofaudit,compensation,nominations,riskmanagementandinvestor grievance committees as well as abstracts of circular resolutions passed

• TheBoard minutesofthesubsidiary companies

• Generalnoticesofinterestreceivedfromdirectors

• Dividenddata

• Informationonrecruitmentandremunerationofseniorofficersjustbelowthe Boardlevel, including appointment or removal of the CFO and Company Secretary

• Materiallyimportantlitigations,showcause,demand,prosecutionandpenaltynotices

• Fatalorseriousaccidents,dangerousoccurrences,andmaterialeffluentorpollutionproblems

• Anymateriallyrelevantdefaultsinfinancialobligationstoandbythem

• Anyissuethatinvolvespossible publicorproductliability claimsofasubstantial nature

•Detailsofjointventures,acquisitionsofcompaniesorcollaborationagreements

•Transactions that involve substantial payments toward goodwill, brand equity or intellectual property



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• Anysignificantdevelopmentonthehumanresources aspect

• Saleofmaterialnature,ofinvestments,subsidiariesandassets,whicharenotinthenormalcourse of business

• Details of foreign exchange exposure and the steps taken by the Management to limit risks of adverse exchange rate movement

• Non-complianceofanyregulatory,statutoryorlistingrequirements,aswellasshareholder services such as non-payment of dividend and delays in share transfer.

**C. BoardCommittees:**

Currently,theBoardhasfivecommittees:auditcommittee,compensationcommittee,nominations committee,investorgrievancecommitteeandriskmanagementcommittee.Allcommitteesconsist entirelyofindependentdirectors.TheBoard,inconsultationwiththenominationscommittee, isresponsible for constituting, assigning, co-opting and fixing terms of service for committee members.Itdelegatesthesepowerstothenominationscommittee.TheChairpersonoftheBoard, in consultation with the Company Secretary and the committee chairperson, determines the frequency and duration ofthecommitteemeetings. Normally, all thecommittees meet four times a year. Recommendations of the committees are submitted to the entire Board for approval. The quorum for meetings is either two members or one-third of the members of the committee, whichever is higher.

**D. ManagementReviewand Responsibility**

Formal evaluation of officers. The compensation committee of the Board approves the compensationandbenefitsforallExecutiveBoardMembersaswellasmembersoftheExecutive Council. Another committee, headed by the CEO, reviews, evaluates and decides the annual compensationofourofficersfromthelevelofVicePresident,excludingmembersoftheExecutive Council.

**a) Board interaction with clients, employees, institutional investors, the government and thePress**:

The Chairman, the CEO and the COO, in consultation with the CFO, handle all interactions with investors, the media and various governments. The CEO and the COO manage most of the interactions with clients and employees.



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**b) Risk management:**

They have an integrated approach to managing risks inherent in various aspects of our business. More details are provided in the Risk management report section of the Annual Report.

**c) Management'sDiscussionandAnalysis:**

A detailed report on the Management's discussion and analysis is provided in theManagement's discussion and analysissection of the Annual Report.

**E. Shareholders**

**a) Disclosuresregardingthe AppointmentorRe-appointmentof directors**

AccordingtotheArticlesofAssociation,one-thirdofthedirectorsretirebyrotationand,ifeligible, seek re-appointment at the Annual General Meeting of shareholders. As per Article 122 of the Articles of Association, N. R. Narayana Murthy, Prof. Marti G. Subrahmanyam, S. Gopalakrishnan,S.D.ShibulalandT.V.MohandasPaiwillretireintheensuingAnnualGeneral Meeting.TheBoardhasrecommendedthere-appointmentofalltheretiringdirectors.Thedetailed profiles of all these directors are provided in the Notice convening the Annual General Meeting.

**b) Communicationtothe shareholders**

Theysend quarterly reports to each shareholder via email. The report contains select financial data extracted from the audited financial statements under Indian GAAP and unaudited financial statements under IFRS. The quarterly report along with additional information is also posted on our website. Moreover, the quarterly / annual results and official news releases are generally published in The Economic Times, The Times of India, Business Standard, Business Line, Financial Express and Udayavani (a regional daily published from Bangalore). Quarterly and annual financial statements, along with segmental information, are posted on our website, www.infosys.com.Earningscallswithanalystsandinvestorsarebroadcastliveonthewebsiteand their transcripts are published on the website soon thereafter. Any specific presentations made to analystsandothersarealsopostedonourwebsite.TheproceedingsoftheAnnualGeneralMeeting are webcast live for shareholders across the world. The video archives are also available on our website for reference.

**c)InvestorGrievancesandShareTransfer**



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TheyhaveaBoard-level investor grievancecommitteeto examineand redress shareholders' and investors'complaints.Thestatusoncomplaintsandsharetransfersisreportedtotheentire Board.
Thedetails of shares transferred and the nature of complaints are provided in the Shareholder information section of the Annual Report. For shares transferred in physical form, the Company provides adequate notice to the seller before registering the transfer of shares. The share transfer committee of the Company will meet as often as required to approve share transfers. For matters regardingsharestransferredinphysicalform,sharecertificates,dividendsandchangeofaddress, shareholders should communicate with Karvy Computershare Private Limited, our registrar and share transfer agent. Their address is given in the Shareholder information section of the Annual Report.

**d) Generalbodymeetings**

Share transactions in electronic form can be effected in a much simpler and faster manner. After confirmation of sale / purchase transaction from the broker, shareholders should approach the depository participant with a request to debit or credit the account for the transaction. The depository participant will immediately arrange to complete the transaction by updating the account. There is no need for separate communication to the Company to register the share transfer.

**e) Code of Conduct**

In compliance with Clause 49 of the Listing Agreement, the Company has adopted a Code of Ethics for Principal Executives and Senior Financial Officers. This Code is applicable to all the membersoftheBoard,theExecutiveCouncilandseniorfinancialofficers.ThisCodeisinaddition to the Company's Code of Business Conduct, applicable to all the employees of the Company. A copy of the said Code of Ethics for Principal Executives and Senior Financial Officers and the CodeofBusinessConductisavailableontheirwebsite,www.infosys.com.Allthemembersofthe Board and the Executive Council and senior financial officers have affirmed compliance to the Code of Ethics for Principal Executives and Senior Financial Officers and the Code of Business Conduct, as at March 31, 2010. A declaration to this effect signed by the CEO and Managing DirectorandtheCFOisprovidedintheCEOandCFOcertificationsectionoftheAnnual Report.

**Conclusion**

Thus we can concludethat the corporategovernanceis very well defined, formulated and strictly appliedbyInfosys Technologies Ltd.



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The primary purpose of their corporate governance and corporate leadership is to create wealth legallyandethically.Thistranslatestobringingahighlevelofsatisfactiontofiveconstituencies - customers, employees, investors, vendors and the society-at-large. The raison d'être of every corporate body is to ensure predictability, sustainability and profitability of revenues year after year. Corporate governance is a reflection of Infosys Technologies Ltd.

InfosysTechnologiesLtd.hasbeenapioneerinbenchmarkingitscorporategovernancepractices with the best in the world.

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ISBN:978-81-957858-1-0

# AnInsightupontheroleofEthicsinHumanResourceManagement- sustainable approach for effective business development

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**Abstract**

The significance and role of ethics in business is nothing new. It has been a well-known and acceptedfactthattheenvironmentwhichsurroundsbusinessishighlyturbulent,demandshigher onpartofperformance,efficiencyandeffortsonpartofmanagementandemployees,maintaining and adopting ethics in organization culture, policies, people managementand in every decision making Though it demands toughness, adherence and regular monitoring on part of management and line managers but once instilled and reinforced will lead to transformation of culture accompaniedbyatransformationalleadershipleadingtoeffectiveresults.Inordertopracticethis roleofHRMbecomescrucialwhobywayofitpolices,exemplarybehaviorandpracticescanaid inenhancingtheincubationofsuchethicalpracticesinorganization.Realizingthisfactinregular practicethepresentpaperattemptstoprovideaninsightuponroleofHRMinthisregard.Itfocuses on role of ethics in business, different unethical practices in context to organization with special focus on HRM, examples of best ethical companies of 2010 and their practices and strategies to sustain ethics by HR intervention at large. The paper will help in understanding the role, significanceandfunctionsofHRMinmaintainingethicsatcorporatelevelandwillhelpmanagers to inculcatesimilarsuch practices in orderto makeorganization culturemuchmoreeffective and people-centric.

**Keywords**:BusinessEthics,HRMpractices,Ethisphere(Ethicspracticingorganization)

## Introduction

Afterbusinessdebaclessuchas Enron,Adelphia,andWorldComandmanyothersitmaybeeasy to concludethat business is acut-throat world whereethics go out thedoor.Business need not be that way and in fact business suffers when business people think and act is such a defeatist way. Tounderstandwhybusinessethics,domatterletusconsidertheissuethroughtheeyesofaGame Theorist, that most rational of economist who cares not for religious rights or wrongs but only to maximizeone'sownwellbeing.Businessethicsisthebranchofethicsthatexaminesethicalrules andprincipleswithinacommercialcontext;thevariousmoralorethicalproblemsthatcanarisein a business setting; and any special duties or obligations that apply to persons who are engaged in commerce.Businessethicsisaformofappliedethics,abranchofphilosophy.Generallyspeaking, business ethics is a normative discipline, whereby particular ethical standards are assumed and then applied. It makes specific judgments about what is right or wrong, which is to say, it makes claimsaboutwhat*ought*tobedoneorwhat*oughtnot*tobedone.Whilethereare someexceptions,



ISBN:978-81-957858-1-0

business ethicists are usually less concerned with the foundations of ethics (met ethics), or with justifying the most basic ethical principles, and are more concerned with practical problems and applications, and any specific duties that might apply to business relationships

## 1.2Needofethicsinbusiness

**a) IntroducingSocialisminBusiness:**Thismeansthegainsofbusinessmustbesharedbyall concerned and not just by owner of business. Profit is the result of group efforts and hence all concerned must share the same. In other words, the concept of socialism in business say that workers, shareholders, consumersallotherswhocontributetothesuccessofthebusinessmust share its gain.

**b) Interest of Industry:** Business ethics are required to protect the interest of small business firms. Big firms normally try to dominate and eradicate small firms. If industry follows code of conduct, small firms can fight for their existence and stay in the business for long.

**c) Buyers Market:** In recent times, structural changes have taken place in the concept of business.Incaseofmanyproducts,sellersmarkethasbeenconvertedintobuyersmarket.Under suchchangedbusinessconditionsbusinessethicsisneededtostresstheimportanceofconsuer satisfaction and service orientation in place of profit orientation.

**d) Better RelationswithSociety:** Code ofconduct results in betterrelations between business andsociety.Itwillreconcileconflictinginterestofvarioussectionsofthesocietysuchasworkers, shareholders, consumers, distributors, suppliers, competitors and government.

**e) Advantages to Business and Society:** Ethics point out what is good and bad, so also what is right or wrong. It brings to the notice of the business community the importance of honesty, sincerity, fairness which makes them alert and socially conscious.

## 2.RoleofEthicalpracticesin HRM

Researchsuggeststhatsuccessfulethicsmanagementdependslessonformalethicsprogramsand more on employees' fairness perceptions, ethical leadership at all levels, and the alignment of multiple formal and informal cultural systems to support ethical conduct. To the extent that HR systems invoke fairness evaluations, HR managers design leadership training, and HR systems helptocreateandmaintainorganizationalculture,HRprofessionalsmustplayakeyroleinethics management.

Research has found that employees' perceptions of fairness are equally or more important than otherfactorsintermsoftheirinfluenceonethics-relatedoutcomes.Fairtreatmentissoimportant because employees who perceive unfair treatment will rebalance the scales of justice by harming the organization. Employees who perceive fair treatment, on the other hand, will reciprocate by going above and beyond the call of duty to help management (by reporting ethical problems, for example).



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To ensure that employees feel they are treated fairly, it is important to design HR systems and interventionswithperceivedfairnessasakeygoal,withanemphasisonprocedural(fairdecision makingprocedures)andinteraction(fairinterpersonaltreatment)fairness.Employees'perceptions offairtreatmentshouldbemonitoredregularlyviaemployeesurveys,andchangesshouldbemade based upon the results.

It is also important for HR managers to work with the ethics/compliance office to follow up on employees' ethics concerns because a large percentage of reported concerns are fairness and therefore HR system-related. Most employees equate ethics and fairness; for them, there is no bright line between the ethics and HR offices.

Ethical leadership is vital to creating an ethical workforce. It is a myth that employees are fully formed moral agents who can 'lead themselves' when it comes to ethics. Research indicates that most employees look outside themselves to significant others for guidance in ethical dilemma situations. If this leadership and guidance is not provided by the leader of the organization, employees will seek it elsewhere, most likely from their peers.

Accordingtoresearchonethicalleadership,anethicalleaderisaleaderwhocares,listenstowhat employees have to say, and has the best interests of employees in mind. In addition, an ethical leadercommunicatesanethicsandvaluesmessage.Whenmakingdecisions,he/sheasks"whatis the right thing to do?" An ethical leader also role models ethical conduct and conducts his/her personallifeinanethicalmanner.Thisrolemodelistrustedbyemployeesandsetsanexampleof how to do things the right way in terms of ethics. An ethical leader holds everyone accountable, and defines success not just by results but also by the way they are obtained

It is important that HR managers design performance management, career development, andtrainingsystemsthat:1.Holdleadersaccountableforthe ethicaldimensionoftheirleadership; 2. Identifyethicalleadersandrelyonthemforrolemodelingandmentoringothers;3.Incorporate the ethical dimension of leadership into all leadership training and development programs

## 3. <u>Examplesand strategies ofmostethics practicingcompaniesof2010</u>

### i) Accenture

In Accenture’s ethics and compliance program, the company uses six “core values” of stewardship,bestpeople, clientvalue creation,oneglobalnetwork, respect fortheindividualand integrity. To better understand how the company’s ethics and compliance program is being receivedbyemployees,Accentureusesemployeesurveys,riskassessmentsandresultsof



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corporateinvestigations.Scrivnernotesthatinarecentsurvey,over90percentofemployeesfeel that Accenture is highly ethical and that the company's commitment to integrity has been communicated to the whole company.

**ii) Caterpillar**

Ed Scott, Chief Ethics and Compliance Officer at Caterpillar, says that the ethics at Caterpillar start at the top, beginning with CEO Jim Owens. "Our leaders work to ensure that Our Values in Action[Caterpillar's CodeofConduct]arepartofeverydaylifeatCaterpillar,"saysScott."They take various opportunities to incorporate Our Values in Action into their communications.

Scott says that he is most proud of the way that the company's ethics program reaches out to the thousandsofCaterpillaremployeesworkinginaround50countriesinallregionsoftheglobe.One item in particular is our Annual Assessment and Questionnaire. It is offered in 14 languages and all of our employees are required to complete this.

To help employees learn from prior real-world decisions—both good and bad—General Mills developedafeatureonitscompanyIntranetthatusesrealexamplesthatcamefromthecompany's EthicsLine."Wecontinuallylookforopportunitiestoincorporaterealstoriesfromourhistoryto bringtolifeourheritageofintegrityandtorespondtothatfeelingofprideweallhaveinworking for General Mills," Palmore says.

**iii) GeneralMills**

Asawellestablishedglobalbusiness,GeneralMillsknowsthatethicsprogramsmustbeadaptable to the different regions in which the company operates Palmore says that in order to remain relevant,GeneralMillsmakessurethatitsethicsandcomplianceprogramiscontinuallyevolving in a real-time way to meet the needs of a constantly changing demographic-base of employees.

**iv) PhilipsElectronicsNorth America**

Philips links its sustainability and ethics programs with the company's core strategy. And, even moreimportant,Philipsgradesitssuccessbymeasurableresults.By2012,Philipsaimstogenerate 30percentoftotalrevenueoffGreenProducts,furtherincreaseenergyefficiencyofthecompany by 25 percent and double the company's investment in Green Innovations to €1 billion.

**v) Unilever**



ISBN:978-81-957858-1-0

Unilever uses a number of approaches to engage its employees in the company ethics and compliance program. Employees annually acknowledge understanding and compliance with our Code of Business Principles. In addition to traditional training modules, we have utilized smaller ‘Ethical Moments’ – 3 to 5 minute clips – to raise awareness and strengthen the open ethics and compliance environment.”

Ethics and compliance program provides many benefits: solid leadership; encourages and facilitates open communication; clearly articulates the standards ofbusiness conduct; continually reinforces ethics awareness and actively demonstrates that the values are not just words on paper but are lived on a daily basis

**vi) T-MobileUSA**

RobertDotson,presidentandCEOofT-MobileUSAsaysthattherealtestofacompany’sethics programistheextenttowhichitis“inthefabric”ofallemployees.Hesaysthathappensthrough strongtoneofthetopOuremployeesstrivetogetresultstherightway;theyregularlyraiseissues or questions to management on our anonymous Integrity Line; and they take personal responsibility for how they live the values in their quarterly performance reviews. It’s a top to bottom program that is owned at all levels of the company

**4. UnethicalpracticesinHRpractices**

HRM-**Recruitment**– Recruitmentof kithand kinwithout assessingtheir abilities

- Recruitmentbasedonfinancialfavours
- Recruitmentofrelativesofotheremployees
- Recruitmentofunder-qualifiedpersons
- Recruitmentofover-qualifiedpersons
- Genderbased recruitments
- Employing child behavior
- Givinglessthanminimumwagesasfixedby government.

**Training**



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- Arrangingtrainingforonlypet employees
- Gettingoutsiderstotrainathighcostswheninsidersare available
- Planningtrainingprogramswithoutassessingtheirrealneed
- Organizingtrainingprogramsduringpeak seasons,upsettingthebusiness rhythm.
- Gettinghighprofiletrainerswithexpectationsofareciprocalfavor.
- Training programs without proper preparation just to show achievements in the annual report.
- Extendingtheduration oftraining programs
- Supplyingoutmodedtrainingmaterials
- Gettinguselesstrainers asanobligation

**Administration**

Tamperingwithleaverecordsof employees

- Playingwithemployeerecords –adverseremarksinafew cases
- Allowselectiveabsenteeismonpersonalconsiderations
- Givingpromotionletterssto favoritesearlierthanothers (makinghimmore senior)
- Favoritesupplierforoffice purchases
- Favoritesecurityagency
- Favoriteuniformsuppliers
- Uncleanpremises.

**IR**

- IRManagersnotaversetosidingwherevertherewere monetarybenefits.



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- Bargainingwith themanagementtill they wantto beseenas trueintheeyes of workers
- IR Managersfelt theywereasuperiorlot with great powers and used this to recruit their known ones
- Trytodelaythesolutionasfar aspossibleastheir workdependedonIR disputes
- Inciteworkerstogoon strike.
- InducingManagement/Workerstoindulgeinunhealthypractices.
- Pressurizeworkers andstatetheirgenuinedemandsasnotgenuine
- DivideandRule

**GeneralUnethicalHR practices**

Human Resource Management is a business function that is concerned with managing relations betweengroupsofpeopleintheircapacityasemployees,employersandmanagers.Inevitably,this processmayraisequestionsaboutwhattherespectiveresponsibilitiesandrightsofeachpartyare inthisrelationship,andaboutwhatconstitutesfairtreatment,buttheircanbecertainunfairpolicies like -

- Off-shoringandexploiting‘cheap’labormarkets
- Usingchild labor
- Renegingon companypension agreements
- Longerworkinghours
- Increasingwork stress
- Theuseof disputedanddubiouspracticesin hiringand firingof personnel.

**5. Reasonofchallengesin ethicsin businessenvironment**

Welivein acomplex society,whichis bothmorally andculturally diverse.



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Keydrivers andfeaturesofthiscomplexitycanbe identified:-

- Globalizationofmarketsandlaborforces (‘McDonalidisation’)
- Intensificationofbothcompetitionandmonopolies(‘Coca Colonization’)
- Paradigmaticchangesin technologyandtheapplicationofICT,creatingnew
- opportunities,butalsonewdilemmasovercommunication,surveillance and
- privacy
- Rapidlyincreasingratesofproductinnovation,obsolescenceanddemand
- Aggressivemarketingand theuseofcelebrities bythe media
- Anescalationofmaterialistvalues andthecommodificationofeverything, even
- education

**6. <u>InstancesofUnethicalPracticesin HRM</u>**

For HR practitioners reputation and credibility will always be important, whether as a full-time employee,anindependentcontractoronafixedtermcontract,atask-basedserviceprovider,oran adhocprovider.Forsome,maintainingtheirreputationsandcredibilitymaybeaboutprovidinga professional service to the employer and an ethical service to key operational service services to keep the job, hold onto the retainer, or just to get the invoice paid.

Practitionersknowthatthingscanchangefastinaunionisedworkenvironment,wherekeyservice receivers also include trade unions, practitioners in related disciplines, shop-stewards and industrial relations ("IR") or employee relations ("ER") managers. A complaint from any one of these or a grievance against the practitioner can lead to evidence in an internal disciplinary or grievance enquiry, an investigation or a starring role in the Commission for Conciliation, Mediation and Arbitration ("CCMA") or the Labour Court ("LC"). For example -

- A salary and benefit audit identifies a grading error which advantages a high performing employee, but the manager instructs that the error be concealed



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- A senior manager's serious disciplinary offence is hushed up, while for the same misconduct, ER practitioners have instructions to institute an immediate disciplinary enquiry in the case of junior managers and line supervisors

- Alinemanagerdismissesanemployeewithaknownterminalillness,oradisability,which causes the family to lose the death benefit, and leave with nothing, even though the employee could have been retained until demise;

- In a labour dispute in the High Court or CCMA, the ER Manager or legal representative deliberatelydoesnotcall theHRpractitionerasakeywitness,andcrucialevidenceisnot given and an unfair outcome happens

- In the recruitment process, a Safety Manager places pressure on an HR practitioner to discloseconfidential health status information, whichis thenused to justifynot hiring the person

- The HR executive places insurance business with a specific insurer or broker in order to receive a kickback or commission for doing so

- The employer's Employment Equity Plan as submitted to the Department of Labour is deliberately not being followed;

- Ancontracted-inmedicalpractitionerdecidestosidewiththeIRManagerinadisciplinary enquiry into an allegation of misconduct for intoxication at work, to maintain good relations and keep their contract with the employer.A Safety Manager ignores a medical practitioner'sHealthRiskReport,orfailstorespondwithinareasonabletime(ortorespond at all) to the key OHSA-related safety and health compliance recommendations by the doctor in it

- An HR Manager pressurizes the medical practitioner to declare an employee unsafe, to allow the employee to be removed from their post or to dismiss or retrench them.

- A line manager or senior practitioner appoints his or her relative or business associate in contravention of the established recruitment procedure.

- An employed practitionerdecides not to confront the Managerthey report to, becausethe annual performance review cycle is coming u.



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- Alinemanagerrefusestoestablishpostswhichcanbeusedforreturntoworkfrombenefits or sick leave, or to provide 'light duty'.

**Keychecklisttoensureethicalpracticein HRscenario**

Inrecruitmentandselection:ensurethatallassessmentmeasuresarefairandjust.

- Inrewardmanagement:ensurefairnessinallocationofpayandbenefits.
- Inpromotionanddevelopment:ensureequalopportunitiesandequal access.
- Ensureasafeworking environment in both forallemployees.
- Ensure that procedures are not unduly stressful, and that the needs of employees’ Work–life balance are not compromised.
- Whenredundanciesoccur, tobefairandjustin handlingjob losses.
- Dealeffectivelywithall formsofbullyingandharassment.
- Inoutsourcingandoffshoring:ensurethatcontractors,consultantsandfranchiseesarefair and honest in their dealings with employees, clients and customers.

**7.** **<u>StragglesforincubatingEthical environment</u>**

- SustainingSpiritualityintheWorkplaceWillGrow
- MaintainingsustainabilityinStatusQuo
- Maintainingtransparencyisimportant

Practicing four elementslike written standards, ethics training, ethics advice lines/offices, andsystems that can be used for anonymous reporting

**HRneedstohavefour responsibilitiestosustainethicalHR-**

1. HRprofessionalsmusthelpensurethatethicsisatoporganizationalpriority,HRleadersneeds totakeona"biggerroleinmonitoringthecultureoftheorganizationintermsofitsethicalstatus” Monitoringisagoodstartbutalonewillnotsuffice.HRexecutivesmusteithertakeonthemantle



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of ethics champion or ensure that some other capable person in the organization does so. Such a champion will need to be highly experienced and respected, having enough organizational clout to make a difference.

2. HR must ensure that the leadership selection and development processes include an ethics component.After all,leadersatalllevelsoftheorganizationneedtoboth modelethicalbehavior andcommunicateethicalstandardstoemployees.Selectionproceduresmustfilteroutpeoplewho, despite making their numbers, are known for cutting ethical corners. Leadership development should include not only ethics theory but also real-life examples, perhaps from mentors, on how managers have handled ethical dilemmas in the past.

Among the most difficult aspects of this may be convincing top management, perhaps including board members, that they too should receive ethics training. A Conference Board survey of over 80 ethics, HR, and legal officers found that only about a quarter had held training programs for their boards of directors

Promoting gender diversity among top leadership might also have a positive impact on ethics. A reportbyTheConferenceBoardofCanadashowed94percentofboardswiththreeormorewomen ensure their organizations adhere to conflict-of-interest guidelines, while only 68 percent of all- male boards do the same. The same survey suggested that boards with larger numbers of women also aremorelikely than areall-maleboardsto ensurethat codes of conduct arefollowed in their organizations (2002).

3. HR is responsible for ensuring that the right programs and policies are in place, "an organization's punishment is adjusted according to several factors, one of which is whether the organization has in place an effective program to prevent and detect violations of law in terms of ethical implications..

HRprofessionalsshould,ofcourse,beawareoftheseguidelinesandhowtheyareevolving.Even more challenging is the need to customize programs to the specific risks in a given corporate culture.

4. HRmuststayabreastofethicsissues.Thisdoesnotmeanjustfollowinglegislation,whichtends tobereactiveratherthanproactive.Itmeanslookingattheentiresocialandbusinessenvironment and spotting conflicts of interest and other ethics problems before they develop into full-blown scandals. A combination of tools can help with this. Obviously, employers need to pay close attentiontothequestionsandconcernsthatareflaggedviaemployeehotlineservices.Surveysor focusgroupsmayalsohelpfulinspotting potentialethicalconflictsintheworkplace.Togauge



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whatishappeningoutside the company,HRcanturn toenvironmentalscanningtechniques to imagine how new trends could result in large problems down the road.

## 8. Conclusion

Thus, it can beconcluded that though adopting and applying ethics is a difficult process but once madeapartofregularfunctioningandpracticesethicalculturewillhelpinmaintainingacongenial work environment and enhancing performance and a transparent organization culture.

Thus,byestablishingconsistencyandlogicintheenforcementofeverypolicy,HR contributesto anenvironmentofhigherlevelethicalthinkingacrosstheorganization.Asmoreandmorepeople see that all policies are routinely enforced, they're more inclined to report violations even when they are concerned or doubtful. They will begin to realize that they can trust HR and the organization's senior managers to act responsibly.

This transformation is by no means complete, and it will not be the last word on business ethics. The nature of business dictates that conflicts of interest will continue to exist, and these conflicts will exert an evolutionary pressure on matters related to corporate ethics. But it depends on top managementwillingnessandreadinesstoincorporatetheroleandapplicationandtherebyreaping the benefits of ethical organization.

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ISBN:978-81-957858-1-0

# BusinessEthicsandCorporateSocialResponsibilityasCompetitiveAdvantage for Companies

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**Abstract**

Businessethicsofafirmhasbeendefinedasoneoftheinvaluableintangibleassetsforcompeting intoday’sbusinessworldofglobalization.Businessethicsshouldbecomepartofcorporatecodes, and if implemented in the line of business as a corporate philosophy it should help achieving a competitive advantage for the firm. Thus, the importance of building a strong ethical culture is integraltothereputation,growth,andfinancesofanyorganization.Itbuildsabrandthatattracts the best talent and creates trust among the stakeholders. Most corporations recognize these responsibilitiesandmakeaseriouseffortofulfilthemwhiletryingtoutilizetheirbusinessethics as a source of competitive advantage. This research will explore the growing issue of business ethics and corporate social responsibility particularly as a competitive advantage.

**Keywords**: Intangible asset, Globalization, Competitive Advantage, Corporate Social Responsibility.

## 1. Introduction:

Companies are dedicated to being sustainable organizations through building long-term shareholdervaluewhilebeingaresponsiblecorporatecitizen.Itisgloballybelievedthattheonly way to achieve that is to incorporate economic, social and environmental codes of conduct into business strategy. Furthermore, global expansion has brought about greater involvement with different cultures and socioeconomic systems. Although companies are primarily business organizations run for the benefit of shareholders, they have a wide-ranging set of responsibilities to their own suppliers, customers and employees, to the communities in which they are located, and to society at large.Ethics is an attempt to work out the rights and obligations we have and sharewith others. While short-term competitive advantage is obtained by appealing to customers in targeted external markets (in the context of globalization), long-term sustainable competitive advantageistheresultofexploitinganenduringcoreofrelevantcapabilitydifferentialscultivated by responsible management of tangible and intangible internal skills and assets.In this context, Business Ethics becomes a prerequisite for conducting any type of business, particularly in the globalmarketplace.Traditionally,therehavebeentwoviewsontheroleofethicsinbusiness.The first perspective is that the corporate executives’ sole responsibility is to maximize the shareholder’svalue.The secondviewisthat“ethicspays,”whichimpliesthatactingin asocially responsible way towards shareholder will automatically enhance shareholder wealth.



ISBN:978-81-957858-1-0

## 2. BusinessEthicsasCorporateStrategy

It is increasingly important for companies to deal with ethics as a corporate strategy that, if uniquelyimplemented,couldachieve competitive advantageforthecompanyratherthanwaiting to react to possible ethical issues of importance to the targeted stakeholders.Competitive advantageallowsafirmtogainanedgeoverrivalswhencompeting.Competitiveadvantagecomes from a firm's unique ability to perform activities more distinctively and more effectively than rivals. A firm's distinctive competence or unique ability here implies, those special capabilities, skills, technologies or resources that enable a firm to distinguish itself from its rivals and create competitive advantage (such as superior quality, design skills, low-cost manufacturing, superior distributionetc.).Managersandtopmanagementhavearesponsibilitytoinstitutionalizeethicsby framing a code of ethics for the organization.

Businessethicsdeliveracompetitiveadvantageinmultipleways:

- Itbuildstrustandloyalty(andreferrals)fromcustomers.
- It motivates sales staffers because they really believe in the products and services they're selling.
- Itcreatesacultureofhonesty,especiallyimportantinabusinesswhereemployeesworkin customers' homes and can't be closely supervised all the time.
- Anditattractstopemployeeswhowanttoworkforacompanywhosestandardsthey respect and share.

**Businessand Society**

It is the perception about the nature of business and its relationship with society that defines the 'Social Responsibility of Business'. It determines what the responsibility of business towards society is and hence, the setting up standards of such responsibility is based on philosophy of business since it is concerned with 'the fundamental principles that underlie the formation and operation of a business enterprise'. The three inter-related aspects of the philosophy of business are:

natureof business;its rolein society;and itsmoral obligationstowards society.

*Nature of business*

Traditionally,businesshasbeenseenasapropertyinstitutionratherthanasocialinstitution.Inits conventionalform,theprimarymotiveofbusinesswastoearnprofits.Itwasbelievedthatbusiness should earn profits at any cost. This implies that the domain of business as an entity was distinct and independent from that of the rest of society.

*Roleofbusiness inrelation toother entities*



ISBN:978-81-957858-1-0

Societyexpectedbusinesstoproducegoodsandservicesaspertheneedofitsmembers.Business aswellassocietyexpectedtheStateorGovernmenttotakecareofothersocialandenvironmental concerns. Further, it was assumed that the managers would automatically meet the interest of shareholders.

*Moralobligation of business*

The conventional understanding is that a business is obliged to recompense factors of production which it does through the market mechanism. The factor incomes are commensurate to their contribution to social product. The price paid for other resources, including natural resources, is equal to the cost of those to in real terms. Hence, it is purported that a business automatically discharges its moral obligation towards society and does so in full measure.

## 3. CorporateResponsibility

Corporate Responsibility, it has been seen arises from Business Ethics and has three dimensions, that is: Good Governance, Corporate Social Responsibility and Environmental Accountability. Thisishowbusinessethicsbecomesanallpervadinginfluenceinthegovernanceofbusiness.The top management is not only responsibleto envision such achangebut to translatethis vision into practices and also to make sure that they adopt a balanced approach towards three dimensions. It should beevidenced from theconduct ofbusiness as it is not easy forthem to get away from this by indulging into only in lip service.

### CorporateSocialResponsibility (“CSR”)

The ethical dimension of CSR includes the social practices where the company is discharging its responsibility towards community at large i.e. stakeholders. Stakeholders are the ones who can influence or can be influenced by the actions, decisions, policies, practices and goals of the company. Apart from shareholder, it includes employees’ consumers, supplies, government competitors, and community at large. Traditionally, so far business was treated purely from the point of view of private personal pecuniary motive.

Now,acompanyhasacknowledgeditsresponsibilitiestosocietythatgoesbeyondtheproduction ofgoodsandservicesataprofit.Itinvolvestheideathatthecorporatehasabroaderconstituency toservethanthatofshareholderalone,inmorerecentyears,thetermstakeholderhasbeenwidely used to express this broader set of responsibilities. By now, it is accepted that corporations are more than economic institutions and they have a responsibility to help society to solve pressing socialproblems.CSRisabouthowcompaniesmanagethebusinessprocessestoproduceanoverall positive impact on society.

CSRisaboutbusinessgivingbacktosociety.Theconceptofsocialresponsibilityisfundamentally anethicalconceptasitinvolveschangingnotionsofhumanwelfare,andemphasizesaconcern



ISBN:978-81-957858-1-0

with the social dimension of business activity that have to do with improving quality of life. The concept provided a way for business to concern itself with these social dimensions and pay some attention to its social impacts. As a result, many of them put a step forward for discharging their responsibility by indulging into philanthropy or by bringing CSR into business strategy.

**4. TheRoleof Top Management**

For incorporating ethical considerations, that comes no doubt from top leadership who are aware of the fact that three dimensions of ethics percolates all through the organization. But such awareness about Corporate Responsibility must be backed by commitment and consciousness to enforce the top management to find out the ways to integrate ethics and values into their day-to-daydecision-making.Ofcourse,theroleoftopmanagementiscrucialinthesensethathehasthe responsibility to translate this vision into business strategy. He has to further harness the CR practicesbybringingouttheorganizationaltransformationwithwhichthisvisionwouldbecarried downfromtoptobottomlevelintheorganization.Itispossiblebydevelopingsystems,processes, policies, plans, practices, having programs so that it is deeply embedded into the organization. Ultimately, it pervades thewholeorganization which means not only fromtop to bottom but also in all functional areas, whether it be HR, marketing, account, finance etc. This whole process is known as institutionalization of CR practices into business system.

**5. BusinessEthicsasCompetitiveAdvantage**

sssBusiness ethics should become part of corporate codes, and if implemented in the line of businessas acorporatephilosophyitshould help achieving acompetitive advantageforthe firm. Whileshort-termcompetitiveadvantageisobtainedbyappealingtocustomersintargetedexternal markets(inthecontextofglobalization),long-termsustainablecompetitiveadvantageistheresult of exploiting an enduring core of relevant capability differentials cultivated by responsible management of tangible and intangible internal skills and assets.

Sustainable global competitive advantage occurs when a company implements a value-creating strategy which other companies are unable to imitate. For example, a company with superior business leadership skills in enhancing integrity capacity increases its reputation capital with multiplestakeholdersandpositionsitselfforcompetitiveadvantagerelativetocompanieswithout comparable leadership performance. Companies could perceives stakeholder interdependence, demonstrateethicalawareness,andrespondeffectivelytomoralissuemanagementputthemselves in a positionof a competitive advantage in comparison to other companies without those internal resources, by providing a more comprehensive list of ethics capacities.

International organizational leaders can and should be held accountable for enhancing the intangiblestrategicassetofintegritycapacityinordertoadvanceglobalorganizationalexcellence.



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The marketplace with globalization is becoming increasingly aware of, and increasingly discriminatingagainst,corporationsthatfailtomeetthecriteriaofethicalbusinessoperationsand ethical management principles

Furthermore, sustaining advantage requires change. It demands that a corporation exploit, rather than ignore industry trends (one of the major trends is the demand of business ethics). It also demands that a company invest to close off the avenues along which competitors could attack Business ethics as competitive advantage involves effective building of relationships with a company's stakeholders based on its integrity that maintains such relationships. Business relationships, like personal ones, are built on trust and mutual respect. Successful business must treat the parties affected by the corporation's actions as constituents to be consulted rather than spectators to be ignored. Doing so was just smart business. This was a novel step in that it was among thefirst attempts to characterizethe impact ofethical behaviour on acompany'sfinancial performance.

## 6. Conclusion

If the organization desires to have successful implementation of Business ethics and Corporate Responsibility practices, then these efforts are not only to be institutionalized but also to be perpetuated in organization. Besides this, top management should try its level best to build a system by which Business ethics and Corporate Responsibility would become sustainable, only then vision would become reality. The most important criterion is about what steps have been taken to have the sustainability and the perpetuation of Business ethics and Corporate Responsibilityeffortswithinorganizationtowardsgainingcompetitiveadvantage.Todayitismost urgentlyfeltthatdifferentdimensions,namely,socialresponsibility,environmentalaccountability andgovernancemustbebroughtunderoneumbrellaofbusinessethics.Thetopmanagementmust bring about organizational transformation so as to make such a trifocal approach sustainable.

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ISBN:978-81-957858-1-0

# CorporateSocialResponsibilityandEnvironmentalSustainability:ANew Paradigm in Building Competitive Advantage

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**Abstract**

The subject of Corporate Social Responsibility has evolved during last few decades from simple philanthropic activities to integrating the interest of the business with that of the communities in which it operates. By exhibiting socially, environmentally and ethically responsible behavior in governanceofitsoperations,thebusinesscangeneratevalueandlongtermsustainabilityforitself while making positive contribution in the betterment of the society. On the other hand, the quest for a comfortable life has led humankind to create a society based on convenience. However, environmentalproblemshavesurfaced,suchasclimatechange,resourcedepletion,andecosystem destruction. To realize a material cycle society in harmony with the earth, it has become of paramount importance for corporate their vision for environment sustainability and promote environmental conservation. Therefore, this paper of corporate social responsibility (CSR) and environmental sustainability (ES) is an attempt to get an insight into the practices adopted by the corporate for the same. The paper comprehends the concept of CSR and ES identify efforts and drivers of CSR and ES and suggest ways to enhance CSR and ES among Indian corporate in building competitive advantage.

**Keywords:** Corporate Social responsibility, Environmental Sustainability, Ethics, Society, Competitive Advantage.

## Introduction

Itisauniversaltruththatveryexistence,survivalandgrowthofeveryorganizationdependsonits social environment and its acceptance and approval by the society. In the last twenty years, there hasbeenaseachangeinthenatureofthetriangularrelationshipbetweencompanies,thestateand the society. No longer can firms continue to act as independent entities regardless of the interest of the general public. The evolution of the relationship between companies and society has been one of slow transformation from a philanthropic coexistence to one where the mutual interest of allthestakeholdersisgainingparamountimportance.Companiesarebeginningtorealizethefact that in order to gain strategic initiative and to ensure continued existence, business practices may have to be mounded from the normal practice of solely focusing on profits to factor in public goodwill and responsible business etiquettes (Reynard and Forstater, 2002). The subject of Corporate Social Responsibility has evolved during last few decades from simple philanthropic activitiestointegratetheinterestofthebusinesswiththatofthecommunitiesinwhichitoperates. Byexhibitingsocially,environmentallyandethicallyresponsiblebehavioringovernanceofits



ISBN:978-81-957858-1-0

operations, the business can generate value and long term sustainability for itself while making positive contribution in the betterment of the society.

The Indian corporate sector has seen the current decade as a period of high growth and the emergence of a strong India Inc. having a significant global footprint. The decade also saw the financial crisis that shook the global markets. While the corporate sector is recovering from the jolt of the global financial crisis, the future is looking bright. We have seen the business sector generatingwealthandvaluefortheshareholdersinthelastsixtyyears,butsimultaneouslywealso havetheproblemsofpoverty,unemployment,illiteracy,malnutritionetc.facingthenation.While the Government undertakes extensive developmental initiatives through a series of sectoral programmes, the business sector also needs to take the responsibility of exhibiting socially responsible business practices that ensures the distribution of wealth and well-being of the communities in which the business operates. On the other hand, the quest for a comfortable life has led humankind to create a society based on convenience. However, environmental problems have surfaced, such as climate change, resource depletion, and ecosystem destruction. To realize a material cycle society in harmony with the earth, it has become of paramount importance for corporate their vision for environment sustainability and promote environmental conservation. Therefore, this study of corporate social responsibility and environmental sustainability is an attempt to get an insight into the practices adopted by the corporate for the same.

## CORPORATESOCIALRESPONSIBILITY:APERSPECTIVE

**Corporate social responsibility** (**CSR**), also known as **corporate conscience**, **corporatecitizenship,responsiblebusiness,sustainableresponsiblebusiness(SRB),orcorporate social performance, is a form of corporateself-regulation integrated into a business model.** The entiretyofCSRcanbebestunderstoodbythree words:‘corporate,’‘social,’and‘responsibility.’ Inextensiveterms,CSRrelatestoresponsibilitiescorporationshavetowardssocietywithinwhich they are based and operate. Corporate Social Responsibility has become a worldwide concept whereby organizations consider the interests of society by taking responsibility for the impact of their activities on customers, employees, shareholders, communities and the environment in all aspects of their operations. It is one of the most important global issues with serious challenges and implications on almost all sectors. Corporate Social Responsibility (CSR) is generally understood to be the way a company balances the economic, environmental and social aspects of its operation, addressing the expectations of its stakeholders.

### *Definitionsof CSR*

Differentorganizationshaveframeddifferentdefinitions-althoughthereisconsiderablecommon ground betwen them.



ISBN:978-81-957858-1-0

The**World Business Council forSustainable Developmentinits publication "Making Good BusinessSense" byLordHolmeandRichardWatts**used thefollowingdefinition. "Corporate SocialResponsibilityisthecontinuingcommitmentbybusinesstobehaveethicallyandcontribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large"

**PhilipKotler**and**NancyLee(2005)** defineCSRas "acommitmenttoimprovecommunitywell being through discretionary business practices and contributions of corporate resources"

**Archie Carroll in 1991** describes CSR as a multi layered concept that can be differentiated into four interrelated aspects – economic, legal, ethical and philanthropic responsibilities.

While the definitions of CSR may differ, there is an emerging consensus on **some *common principles that underline CSR***:

1. *CSR is a business imperative:* Whether pursued as a voluntary corporate initiative or for legal compliancereasons,CSRwillachieveitsintendedobjectivesonlyifbusinessestrulybelievethat CSR is beneficial to them.

2. *CSR is a link to sustainable development:* businesses feel that there is a need to integrate social, economic and environmental impact in their operation; and

3. *CSRisawaytomanagebusiness:*CSRisnotanoptionaladdontobusiness,butitisabouttheway in which businesses are managed.

## HistoricalBackgroundofCSR

### *TraditionalConcepts*

Theterm"CSR"cameintocommonuseintheearly1970s,aftermanymultinationalcorporations formed, although it was seldom abbreviated. The term stakeholder, meaning those on whom an organization's activities have an impact, was used to describe corporate owners beyond shareholders as a result of an influential book by R Freeman in 1984. By late 1990s, the concept was fully recognized; people and institutions across all sections of society started supporting it. Thiscanbecorroboratedbythefactthatwhilein1977lessthanhalfoftheFortune500firmseven mentionedCSRintheirannualreports,bytheendof1990,approximately90percentFortune500 firms embraced CSR as an essential element in their organizational goals, and actively promoted theirCSRactivitiesinannualreports(BoliandHartsuiker,2001).PhilosopherslikeKautilyafrom India and pre-Christian era philosophers in the West preached and promoted ethical principles whiledoingbusiness.Theconceptofhelpingthepooranddisadvantagedwascitedinmuchofthe



ISBN:978-81-957858-1-0

ancient literature. In the global context, the recent history goes back to the seventeenth century when in 1790s, England witnessed the first large scale consumer boycott over the issue of slave harvested sugar which finally forced importer to have free-labor sourcing.

### *ModernConcepts*

ISO26000istherecognizedinternationalstandardforCSR(currentlyaDraftInternationalStandard). Publicsectororganizations(theUnitedNationsforexample)adheretothetriplebottomline(TBL).It iswidelyacceptedthatCSRadherestosimilarprinciplesbutwithnoformalactoflegislation.TheUN has developed the Principles for Responsible Investment as guidelines for investing entities.

**ISO 26000**: ISO, the International Organization for Standardization, has decided to launch the development of an International Standard providing guidelines for social responsibility (SR) named ISO 26000 or simply *ISO SR* and is expected to be released in 2010.

**Triplebottomline:**Thetriplebottomline(abbreviatedas"TBL"or"3BL",andalsoknownas"people, planet,profit"or"thethreepillars"capturesanexpandedspectrumofvaluesandcriteriaformeasuring organizational (and societal) success: economic, ecological and social. With the ratification of the United Nations and ICLEI TBL standard for urban and community accounting in early 2007, this became the dominant approach to public sectorfull cost accounting. Similar UN standards apply to natural capital and human capital measurement to assist in measurements required by TBL, e.g. the ecoBudgetstandardforreportingecologicalfootprint.Intheprivatesector,acommitmenttocorporatesocial responsibility implies a commitment to some form of TBL reporting. This is distinct from the more limited changes required to deal only with ecological issues.

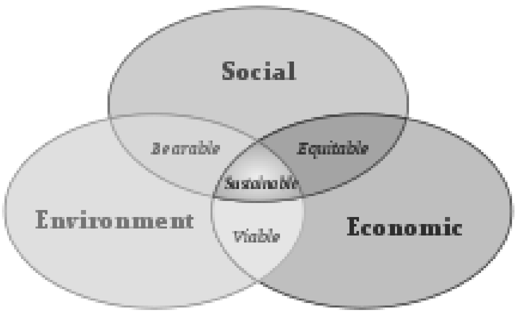
## ENVIRONMENTALSUSTAINABILITY:APERSPECTIVE

For the last decade, the risks and opportunities posed by climate change have been climbing the corporate and investor agendas. In the months before the UN Climate Change Conference in Copenhagen, interest in this issue has seemed to reach a new high – in particular, interest in the corporate response to the risks and opportunities of climate change. Maintaining the factors and practicesthatcontributetothequalityofenvironmentonalong-termbasis. The word sustainability is derived from the Latin *sustinere* (*tenere*, to hold; *sus*, up). Dictionaries providemorethantenmeaningsfor*sustain*,themainonesbeingto“maintain","support",or"endure”.

At the 2005 World Summit it was noted that this requires the reconciliation of environmental,social and economic demands - the "three pillars" of sustainability. This view has been expressed as an illustration using three overlapping ellipses indicating that the three pillars of sustainability are not mutually exclusive and can be mutually reinforcing.



ISBN:978-81-957858-1-0




*Source:http://en.wikipedia.org/wiki/FileSustainable_development.s*

Definitions of sustainability often refer to the "three pillars" of social, environmental and economic sustainability.

Healthy ecosystems provide vital goods and services to humans and other organisms. There are two majorwaysofreducingnegativehumanimpactandenhancingecosystemservicesandthefirstofthese isenvironmentalmanagement.Thisdirectapproachisbasedlargelyoninformationgainedfrom earthscience,environmentalscienceandconservationbiology.However,thisismanagementattheendofa longseriesofindirectcausalfactorsthatareinitiatedbyhuman consumption,soasecondapproach is through demand management of human resource use. At the global scale and in the broadest sense environmental management involves the oceans, freshwater systems, land and atmosphere, but followingthesustainabilityprincipleofscaleitcanbeequallyappliedtoanyecosystemfromatropical rainforest to a home garden.

***Environmental sustainability*** is "the ability to maintain things or qualities that are valued in the physical environment ". This is the simplest and most fundamental way to express the concept.

## CSRANDENVIRONMENTALSUSTAINABILITY

InthepastfiveyearsgreatstrideshavebeenmadetowardintegrateCSRintothecorecultureofmajor companies.

Environmental sustainability and corporate social responsibility (CSR) among businesses are no longer“nicetohave”ideologies.Theyareimportantpartsofacompany’soverallgrowthstrategy. A recent PricewaterhouseCoopers study documented ways in which companies that report their sustainability efforts get better returns on their assets than companies that do not. Also according toaTIMEpollconductedin2009,40percentofconsumerssaidtheyboughtproductsorservices because they liked the social, political and environmental values of the company. Nearly half of Americans in the poll said protecting the environment should be given priority over economic growth.Environmentalsustainabilityisbecomingagreatchallengeasthedevelopedcountrystays ontherapiddevelopmentgrowthpath.Climatechange,mainlycausedbygreenhousegas



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emissions from energy intensive human economic activities based on fossil fuels, has become a grim reality. In India itself half of the 88 industrial clusters were identified as critically polluted by the Central PollutionControl Board. The Government is in the process of preparing an action plan for remediation of these critically polluted clusters.

*Corporate are seriously looking at sustainability as it helps them build trust with various stakeholders such as the government, shareholders, customers, employees, community at large and the regulators.*

Further, the pull by market is forcing these companies to adopt and practice various sustainable measures. As Indian companies become more global, overseas investors and customers are keen to know the sustainable or green practices followed by their vendors before they engage themselves with them.

Besidesadoptingsuchpractices,companiesarebeingforcedtodeclarewhattheyhavebeendoing throughthesustainabilityreports.Apartfromtheannualreports,largecompaniessuchasInfosys, Wipro and ITC among others have been bringing out their sustainability reports. Even some corporate that are interested in creating value for stakeholders are embarking on various sustainable innovative measures.

The sustainable initiatives are by and large confined to the large corporate. However, the small-andmedium-sizecompaniescouldalsobeforcedtoadoptsuchsustainablemeasurestobepartof the supply chain. As SMEs are part of supply chain, they would be forced to look at sustainable measures seriously going forward.

In market economies, the primary purpose of companies is to maximize shareholder value (e.g. economic profit, share price and dividends) bound by legal/regulatory obligations which address specificsocialandenvironmentalissues.Forthis,companiespursuecompetitivestrategieswhich rely upon and develop relationships between the corporation and its stakeholders.

Since the early 1990’s, corporate responsibility issues including the social obligations of corporationshaveattainedprominenceinpoliticalandbusinessdebate.Thisismainlyinresponse to corporate scandals but also due to the realisation that development centred only on economic growthparadigmsisunsustainableandthereforethereisaneedforamorepro-activerolebystates, companiesand communitiesinadevelopmentprocessaimed atbalancing economicgrowth with environmental sustainability and social cohesion.

## EFFORTSBYCORPORATESTOATTAINSUSTAINABILITY

- Reducespecificconsumptionofenergyandwater.
- Reducespecificgenerationofwasteandreducethequantumof wastegoing to landfills.
- Increaseuseofrenewable,includingrenewableenergy.



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- Reduce specific green house gas emissions and other process emissions by and explore opportunities through Clean Development Mechanism (CDM) & other Carbon Exchange Programs.
- Increase use of recyclables and enhance recyclability of resources embedded in the products.
- Increasethe shareof harvestedrain waterin theoverall annualuseof water.
  - Strivetoadoptgreenpurchasepolicyandincorporatelatestclean technologies.
  - Informingandinspiringconsumersabouttheenvironmentalchallenges.
  - Minimizingresourcedepletion.
  - Redesigningandrecyclingpackaging materials.

***ExamplesoffewCorporateInitiatives***:

- Infosys Technologies expects to consume 100 tonnes of paper less this year as it has made the printedcopyofits2009-10annualreportleanbyprovidingonlythestatutorydetailstoshareholdersin the hard copy, while putting out additional details on its Web site.
- Wipro aims to reduce the greenhouse gas emissions to 2.5 tonnes per employee by 2015 from a baseline measure of 4.45 tonnes per employee in 2007-08.
- Ballarpur Industries plans to join Business Call to Action with an intention to promote economic and environment sustainability of 5,000 low income pulpwood tree growers in Orissa and Andhra Pradesh.
- Dellhasreplacednon-biodegradablematerialwithbamboofor packingitsInspironnotebooks.
- Tata Auto Comp. Ltd aims to create a Carbon Neutral Footprint through enhancing green cover, becoming water positive and improving energy efficiency.

## DRIVERSOFCSRANDENVIRONMENTALSUSTAINABILITY

1. Company culture/values
2. Attractingandretainingemployees
3. Securinglongtermviabilityinthemarket place
4. Competitive advantage
5. Improvingenergy efficiency
6. Risk Management
7. Customer demand
8. Publicawarenessonclimatechange



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9. Product development/Innovation
10. Licensetooperate
11. Compliancewithlegislation/standards
12. IncreasedProductivity
13. Careerdevelopment
14. Reducingthecostof emitting
15. Morecost-effectivesupply chains
16. Shareholderdemand
17. Accessto Capital
18. PressurefromNGOs
19. Easieraccesstoforeignmarkets

## CONCLUSION

The corporate social responsibility and environmental sustainability aspect has become ethical perspectives for the corporate worldwide with no doubt. On one hand climate change has gained attention among managers and on the flip side customers do demand ethical practices from the sideofcompanies.Boththeseconceptshavebecomevisionfororganizationsnowdays.Therefore it is onus for companies to identify and develop new practices to satisfy their stakeholder and as wellasfocusonconservationofenvironment.Innowayanybusinessisallowedtoconductitself in a manner that may be detrimental to the interest of individuals and at large to the society. Hopefully these efforts will help to regain some of the footing that has been lost over the years. With a little effort and responsibility, perhaps theorganizations of today can leave the world in a better shape for our children and the generations to come. Hence it can be concluded that-

***"Corporate Social Responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the qualityoflifeoftheworkforceandtheirfamiliesaswellasofthelocalcommunity and society at large"***

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ISBN:978-81-957858-1-0

# EthicsinAdvertising:AnOxymoroninToday'sCompetitive Edge

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## ABSTRACT

Advertisingisoneofthemostpowerfulcommunicationaltoolsthatalmosteverycompanyuses inordertopromoteitsproductsorservices. Advertisingnowhasbecomeasocialbeing;ithas an influencethatcanbepersuasive,pervasiveandinfluentialthatitisimportantthattherightmessage is sent across.

Enormoushumanandmaterialresourcesaredevotedtoadvertising.Advertisingiseverywherein today's world, so it can be expressed as ***"No one now can escape from the influence of advertising."***There are several benefits attached to advertising as economical, political, cultural, moralandreligiousetc.Atthesametime,thesemayalsobeconsideredasharmsofadvertisingin ethical terms.

Within general framework, we can identify several moral principles that are particularly relevant to advertising as: truthfulness, the dignity of the human person, and social responsibility. In the final analysis, however, where freedom of speech and communication exists, it is largely up to advertisers themselves to ensure ethically responsible practices in their profession. Besides avoiding abuses, advertisers should also undertake to repair the harm sometimes done by advertising. In this way, they will make a special and significant contribution to human progress and to the common good.Reference: Advertising, Benefits, Harms, Ethical principles, Responsibility

## INTRODUCTIONTOADVERTISING

Advertising is one of the most powerful communicational tools that almost every company/organization uses in order to promote its products or services. Advertising now has become a social being; it has an influence that can be persuasive, pervasive and influential that it is important that the right message is sent across. Additionally messages sent should harbour people's thoughts, feelings and religion and avoid vulgarity, language and any offensive context becauseofthemulticulturalsocietythattheworldhas.Societyhasarighttoinformationbasedon truth, freedom, justice and solidarity.

The responsibility of media is to contribute to theauthentic, integral development of persons and tofosterthewellbeingofsociety.Theinformationprovidedbythemediaisattheserviceofthe



ISBN:978-81-957858-1-0

commongood.ThusthereareSomeregulationsthatcanbecontrolledbytheAdvertisingStandard Authority (ASA) which now controls advertising across all media channels used.

In today's society, advertising has a profound impact on how people understand life, the worldandthemselves,especiallyinregardtotheirvaluesandtheirwaysofchoosingandbehaving. Just as the media of social communication themselves have enormous influence everywhere, so advertising, using media as its vehicle, is a pervasive, powerful force shaping attitudes and behaviour in today's world.

The field of advertising is extremely broad and diverse. In general terms, of course, an advertisementissimplyapublicnoticemeanttoconveyinformationandinvitepatronageorsome otherresponse.Advertisingcanbeverysimple—alocal,even'neighbourhood,'phenomenon— or it can be very complex, involving sophisticated research and multimedia campaigns that span the globe. It differs according to its intended audience, so that, for example, advertising aimed at children raises some technical and moral issues significantly different from those raised by advertising aimed at competent youngsters. Advertising has two basic purposes: to inform and to persuade.

Advertising is not the same as marketing (the complex of commercial functions involved in transferring goods from producers and consumers) or public relations (the systematic effort to create a favourable public impression or image of some person, group, or entity).

Not only are many different media and techniques employed in advertising; advertising itself is of several **different kinds:**

- **Commercial advertising** for products and services; public service advertising on behalf ofvariousinstitutions,programs,andcauses;and—aphenomenonofgrowingimportance today
- **Politicaladvertising** intheinterestsofpartiesandcandidates.

Advertising also has an indirect but powerful impact on society through its influence on media.Manypublicationsandbroadcastingoperationsdependonadvertisingrevenueforsurvival. This often is true of religious media as well as commercial media. For their part, advertisers naturallyseektoreachaudiences;andthemedia,strivingtodeliveraudiencestoadvertisers,must shape their content so to attract audiences of the size and demographic composition sought. This economic dependency of media and the power it confers upon advertisers carries with it serious responsibilities for both.

## THEBENEFITSOF ADVERTISING

Enormous human and material resources are devoted to advertising. Advertising is everywhereintoday'sworld,soitcanbeexpressedas"Noonenowcanescapefromtheinfluence



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of advertising." Even people who are not themselves exposed to particular forms of advertising confront a society, a culture - other people - affected for good or ill by advertising messages and techniques of every sort.

***a) EconomicBenefitsof Advertising***

Advertisingcanplayanimportantroleintheprocessbywhichaneconomicsystemguided by moral norms and responsive to the common good contributes to human development. It is a necessary part of the functioning of modern market economies, which today either exist or are emerginginmanypartsoftheworldandwhich,currentlyseemtobe"themostefficientinstrument for utilizing resources and effectively responding to needs" of a socio-economic kind.

In such a system, advertising can be a useful tool for sustaining honest and ethically responsible competition that contributes to economic growth in the service of authentic human development.

Advertising does this, among other ways, by informing people about the availability of rationally desirable new products and services and improvements in existing ones, helping them to make informed, prudent consumer decisions, contributing to efficiency and the lowering of prices,andstimulatingeconomicprogressthroughtheexpansionofbusinessandtrade.Allofthis can contribute to the creation of new jobs, higher incomes and a more decent and human way of lifeforall.Italsohelpspayforpublications,programmingandproductionsthatbringinformation, entertainment and inspiration to people around the world.

***b) BenefitsofPoliticalAdvertising***

As India has a democratic system as it ensures the participation of citizens in making political choices, guarantees to the governed the possibility both of electing and holding accountable those who govern them, and of replacing them through peaceful means when appropriate.

Politicaladvertisingcanmakeacontributiontodemocracyanalogoustoitscontributionto economicwellbeinginamarketsystemguidedbymoralnorms.Asfreeandresponsiblemediain ademocraticsystemhelptocounteracttendenciestowardthemonopolizationofpowerontheparty ofoligarchiesandspecialinterests,sopoliticaladvertisingcanmakeitscontributionbyinforming people about the ideas and policy proposals of parties and candidates, including new candidates not previously known to the public.

***c) CulturalBenefitsofAdvertising***

Advertising has impact on media as it depends on it for revenue; advertisers have an opportunity to exert a positive influence on decisions about media content. They do this by supportingmaterialofexcellentintellectual,aestheticandmoralqualitypresentedwiththepublic



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interest in view,andparticularly byencouraging andmakingpossiblemediapresentations which are oriented to minorities.

Moreover, advertising can itself contribute to the betterment of society by uplifting and inspiringpeopleandmotivatingthemtoactinwaysthatbenefitthemselvesandothers.Advertising can brighten lives simply by being witty, tasteful and entertaining. Some advertisements are instances of popular art, with a vivacity all their own.

***d) MoralandReligiousBenefitsofAdvertising***

Many benevolent social and religious institutions use advertising to communicate their messages such as messages of faith, patriotism, tolerance, compassion and neighbourly service, charity toward the needy, messages concerning health and education, constructive and helpful messages that educate and motivate people in a variety of beneficial ways. Advertising, with involvement in media-related activities, is today a necessary part of a comprehensive pastoral strategy. This includes television and radio broadcasting, film and audiovisual production.

**HARMSDONEBYADVERTISING**

There is nothing intrinsically good or intrinsically evil about advertising. It is a tool, an instrument:itcanbeusedwell,anditcanbeusedbadly.Ifitcanhave,andsometimesdoeshave, beneficialresultssuchasthosejustdescribed,italsocan,andoftendoes,haveanegative,harmful impact on individuals and society.

If harmful or utterly useless goods are touted to the public, if false assertions are made about goods forsale,ifless thanadmirablehuman tendenciesareexploited, thoseresponsiblefor such advertising harm society and forfeit their good name and credibility. More than this, unremittingpressuretobuyarticlesofluxurycanarousefalsewantsthathurtbothindividualsand families by making them ignore what they really need.

***a) EconomicHarmsof Advertising***

Advertising can betray its role as a source of information by misrepresentation and by withholding relevant facts. Sometimes, the information function of media can be destabilized by advertisers' pressure upon publications or programs not to treat of questions that might prove embarrassingorinconvenient.Moreoften,though,advertisingisusednotsimplytoinformbutto persuadeandmotivate,toconvincepeopletoactincertainways:buycertainproductsorservices and patronize certain institutions.

The practice of brand related advertising can raise serious problems. Often there are only negligible differences among similar products of different brands and advertising may attempt to movepeopletoactonthebasisofirrationalmotives(brandloyalty,status,fashionetc.)insteadof presenting differences in product quality and price as bases for rational choice.



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Advertisingalsocanbeatoolofthephenomenonofconsumerism.Sometimesadvertisers speak of it as part of their task to create needs for products and services, to cause people to feel and act upon cravings for items and services they do not need.

This is a serious abuse, an affront to human dignity and the common good when it occurs in affluent societies. But the abuse is still more grave when consumerist attitudes and values are transmitted by communications media and advertising to developing countries, where they exacerbatesocio-economicproblemsandharmthepoor.Itistruethatajudicioususeofadvertising can stimulate developing countries to improve their standard of living. But serious harm can be done them if advertising and commercial pressure become so irresponsible that communities seekingtorisefrompovertytoareasonablestandardoflivingarepersuadedtoseekthisprogress by satisfying wants that have been artificially created. The result of this is that they waste their resources and neglect their real needs, and genuine development falls behind.

Similarly,thetaskofcountriesattemptingtodeveloptypesofmarketeconomiesthatserve humanneedsandinterestsafterdecadesundercentralized,state-controlled systemsismademore difficultbyadvertisingthatpromotesconsumeristattitudesandvaluesoffensivetohumandignity and the common good. The problem is particularly acute when, as often happens, the dignity and welfareofsociety'spoorerandweakermembersareatstake.Itisnecessaryalwaystobearinmind thattherearegoodswhichbytheirverynaturecannotandmustnotbeboughtorsoldandtoavoid an idolatry of the market that, aided and abetted by advertising, ignores this crucial fact.

***b) HarmsofPolitical Advertising***

Political advertising can support and assist the working of the democratic process, but it also can obstruct it. This happens when, for example, the costs of advertising limit political competition to wealthy candidates or groups, or require that office-seekers compromise their integrity and independence by over-dependence on special interests for funds.

Such obstruction of the democratic process also happens when, instead of being a vehicle for honest expositions of candidates' views and records, political advertising seeks to distort the viewsandrecordsofopponentsandunjustlyattackstheirreputations.Ithappenswhenadvertising appeals more to people's emotions and base instincts to selfishness, bias and hostility toward others,toracialandethnicprejudiceandthelikeratherthantoareasonedsenseofjusticeandthe good of all.

***c) CulturalHarmsofAdvertising***

Advertisingalsocanhaveacorruptinginfluenceuponcultureandculturalvalues.Wehave spoken of the economic harm that can be done to developing nations by advertising that fosters consumerism and destructive patterns of consumption. Consider also the cultural injury done to thesenationsandtheirpeoplesbyadvertisingwhosecontentandmethods,reflectingthose



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prevalentinthefirstworld,areatwarwithsoundtraditionalvaluesinindigenouscultures.Today this kind of domination and manipulation via media rightly is a concern of developing nations in relation to developed ones, as well as a concern of minorities within particular nations.

The indirect but powerful influence exerted by advertising upon the media of social communications that depend on revenues from this source points to another sort of cultural concern. In the competition to attract ever larger audiences and deliver them to advertisers, communicators can find themselves tempted in fact pressured, subtly or not so subtly toset aside high artistic and moral standards and lapse into superficiality, tawdriness and moral squalor.

Communicators also can find themselves tempted to ignore the educational and social needs of certain segments of the audience - the very young, the very old, the poor - who do not matchthedemographicpatterns(age,education,income,habitsofbuyingandconsuming,etc.)of thekindsofaudiencesadvertiserswanttoreach.Inthiswaythetoneandindeedthelevelofmoral responsibility of the communications media in general are lowered.

Alltoooften,advertisingcontributestotheinvidiousstereotypingofparticulargroupsthatplaces thematadisadvantageinrelationtoothers.Thisoftenistrueofthewayadvertisingtreatswomen; and the exploitation of women, both in and by advertising, is a frequent, deplorable abuse. How often aretheytreated not as persons with an inviolabledignity but as objects whosepurposeis to satisfyothers'appetiteforpleasureorforpower?Howoftentheroleofwomanaswifeandmother is undervalued or even ridiculed?Howoften is therole of women in business orprofessional life depicted as a masculine caricature, a denial of the specific gifts of feminine insight, compassion, and understanding, which so greatly contribute to the civilization of love.

***d) MoralandReligiousHarmsof Advertising***

Advertisingcanbetastefulandinconformitywithhighmoralstandards,andoccasionally evenmorallyuplifting,butitalsocanbevulgarandmorallydegrading. Frequently itdeliberately appealstosuchmotivesasenvyandstatusseeking.Today,too,someadvertisersconsciouslyseek to shock and titillate by exploiting content.

Therearecertainspecial problemsrelatingtoadvertisingthattreatsofreligionorpertains to specific issues with a moral dimension. In cases of the first sort, commercial advertisers sometimes include religious themes or use religious images or personages to sell products. It is possible to do this in tasteful, acceptable ways, but the practice is obnoxious and offensive when it involves exploiting religion or treating it flippantly. In cases of the second sort, advertising sometimesisusedtopromoteproductsandinculcateattitudesandformsofbehaviourcontraryto moral norms.



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## SOMEETHICALANDMORALPRINCIPLES

Within general framework, we can identify several moral principles that are particularly relevant to advertising. We shall speak briefly of three: truthfulness, the dignity of the human person, and social responsibility.

### *a) TruthfulnessinAdvertising*

Even today, some advertising is simply and deliberately untrue. Generally speaking, though,theproblemoftruthinadvertisingissomewhatmoresubtle:itisnotthatadvertisingsays what is overtly false, but that it can distort the truth by implying things that are not so or withholdingrelevantfacts.Boththeindividualandsociallevels,truthandfreedomareinseparable; withouttruthasthebasis,startingpointandcriterionofdiscernment,judgment,choiceandaction, there can be no authentic exercise of freedom. The content should, moreover, be communicated honestly and properly.

Advertising, like other forms of expression, has its own conventions and forms of stylization, and these must be taken into account when discussing truthfulness. People take for grantedsomerhetoricalandsymbolicexaggerationinadvertising;withinthelimitsofrecognized and accepted practice, this can be allowable.

But it is a fundamental principle that advertising may not deliberately seek to deceive, whether it does that by what it says, by what it implies, or by what it fails to say. The proper exerciseoftherighttoinformationdemandsthatthecontentofwhatiscommunicatedbetrueand, within the limits set by justice and charity, complete included here is the obligation to avoid any manipulation of truth for any reason.

### *b) TheDignityoftheHuman Person*

There is an imperative requirement that advertising respect the human person, his right dutytomakearesponsiblechoice,hisinteriorfreedom;allthesegoodswouldbeviolatedifman's lower inclinations were to be exploited, or his capacity to reflect and decide compromised.

These abuses are not merely hypothetical possibilities but realities in much advertising today. Advertising can violate the dignity of the human person both through its content, what is advertised, the manner in which it is advertised and through the impact it seeks to make upon its audience. It was already discussed of such things as appeals to vanity, envy and greed, and of techniques that manipulate and exploit human weakness. In such circumstances, advertisements readilybecomevehiclesofadeformedoutlookonlife,onthefamily,onreligionandonmorality, an outlook that does not respect the true dignity and destiny of the human person.

Thisproblemisespeciallyacutewhereparticularlyvulnerablegroupsorclassesofpersons areconcerned:childrenandyoungpeople,theelderly,thepoor,theculturallydisadvantaged.



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Muchadvertisingdirectedatchildrenapparentlytriestoexploittheircredulityandsuggestibility, in the hope that they will put pressure on their parents to buy products of no real benefit to them. Advertisinglikethisoffendsagainstthedignityandrightsofbothchildrenandparents;itintrudes upon the parent-child relationship and seeks to manipulate it to its own base ends. Also, some of thecomparativelylittleadvertisingdirectedspecificallytotheelderlyorculturallydisadvantaged seems designed to play upon their fears so as to persuade them to allocate some of their limited resources to goods or services of dubious value.

***c) AdvertisingandSocial Responsibility***

Socialresponsibilityissuchabroadconceptthatwecannotehereonlyafewofthemany issuesandconcernsrelevantunderthisheadingtothequestionofadvertising.Theecologicalissue is one. Advertising that fosters a lavish life style which wastes resources and despoils the environment offends against important ecological concerns. In his desire to have and to enjoy rather than to be and grow, man consumes the resources of the earth and his own life in an excessive and disordered way. Man thinks that he can make arbitrary use of the earth, subjecting it without restraint to his will, as though it did not have its own requisites and a prior God-given purpose, which man can indeed develop but must not betray.

As this suggests, something more fundamental is at issue here: authentic and integral human development. Advertising that reduces human progress to acquiring material goods and cultivating a lavish life style expresses a false, destructive vision of the human person harmful to individuals and society alike.

When people fail to practice a rigorous respect for the moral, cultural and spiritual requirements, based on the dignity of the person and on the proper identity of each community, beginning with the family and religious societies, then even material abundance and the conveniencesthattechnologymakesavailablewillproveunsatisfyingandintheendcontemptible. Advertisers, like people engaged in other forms of social communication, have a serious duty to expressandfosteranauthenticvisionofhumandevelopmentinitsmaterial,culturalandspiritual dimensions. Communication that meets this standard is, among other things, a true expression of solidarity. Indeed, the two things - communication and solidarity - are inseparable, because solidarity is a consequence of genuine and right communication and the free circulation of ideas that further knowledge and respect for others.

## CONCLUSION:SOMESTEPSTOTAKE

Theindispensableguarantorsofethicallycorrectbehaviourbytheadvertisingindustryare thewellformedandresponsibleconsciencesofadvertisingprofessionalsthemselves:consciences sensitivetotheirdutynot merelytoservetheinterestsofthosewhocommissionandfinancetheir



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workbutalsotorespectandupholdtherightsandinterestsoftheiraudiencesandtoserve the common good.

**Followingaresomeofthestepstobetakenforethicaladvertising:**

- ✓ **TakinghelpofAdvertisingProfessionals:**Manywomenandmenprofessionallyengaged in advertising do have sensitive consciences, high ethical standards and a strong sense of responsibility.Butevenforthemexternalpressuresfromtheclientswhocommissiontheir work as well as from the competitive internal dynamics of their profession can create powerful inducements to unethical behaviour. That underlines the need for external structuresandsystemstosupportandencourageresponsiblepracticeinadvertisingandto discourage the irresponsible.
- ✓ **Voluntary ethical codes**: These are one such source of support. These already exist in a numberofplaces.Welcomeastheyare,though,theyareonlyaseffectiveasthewillingness of advertisers to comply strictly with them. It is up to the directors and managers of the media which carry advertising to make known to the public, to subscribe to and to apply the codes of professional ethics which already have been opportunely established so as to havethecooperationofthepublicinmakingthesecodesstillbetterandinenforcingtheir observance.
- ✓ **Public Involvement:** We emphasize the importance of public involvement. Representativesofthepublicshouldparticipateintheformulation,applicationandperiodic updating of ethical codes. The public representatives should include ethicists and church people, as well as representatives of consumer groups. Individuals do well to organize themselves into such groups in order to protect their interests in relation to commercial interests.
- ✓ **Publicauthorities**:alsohavearoletoplay.Ontheonehand,governmentshouldnotseek to control and dictate policy to the advertising industry, any more than to other sectors of the communications media. On the other hand, the regulation of advertising content and practice, already existing in many places, can and should extend beyond banning false advertising, narrowly defined. By promulgating laws and overseeing their application, public authorities should ensure that public morality and social progress are not gravely endangered through misuse of the media. **For example, government regulations** should addresssuchquestionsasthequantityofadvertising,especiallyinbroadcastmedia,aswell asthecontentofadvertisingdirectedatgroupsparticularlyvulnerabletoexploitation,such as children and old people. Political advertising also seems an appropriate area for regulation: how much may be spent, how and from whom money for advertising may be raised, etc.



ISBN:978-81-957858-1-0

✓ **Keepthepublicinformed:**Themediaofnewsandinformationshouldmakeitapointto keep the publicinformed about the world ofadvertising. Considering advertising's social impact, it is appropriate that media regularly review and critique the performance of advertisers, just as they do other groups whose activities have a significant influence on society.

✓ It is also necessary to **integrate that message into the new culture** created by modern communications with itsnew ways of communicating new languages, new techniques and a new psychology.

✓ The **means of social communication** can give rise to certain passivity among users, making them less than vigilant consumers of what is said or shown. Users should practice moderation and discipline in their approach to the mass media.

✓ **Awarenessaboutcodeofpracticespeciallyforchilderen:**Anotherfactorthatadvertises should be aware of is advertising to children. Countries like the UK have a code of practice to control advertisements aimed at children. The code is designed to avoid the misleading presentationofproductsandmayrequireadvertiserstodiscloseproductinformation.Forexample when advertising toys, accurate information about their size, price and operation should be included.Alsoregulatedproductsasalcoholshouldnotbeadvertisearoundearlyhoursintheday normallyafter8-10pmwhenchildrenarenotwatchingTV.Inadditiontothisthesameregulation is taken place of the advertisements of confectionary between children programmes or even between or after the programmes.

Inthefinalanalysis,however,wherefreedomofspeechandcommunicationexists,itislargelyup to advertisers themselves to ensure ethically responsible practices in their profession. Besides avoiding abuses, advertisers should also undertake to repair the harm sometimes done by advertising,insofarasthatispossible:forexample,bypublishingcorrectivenotices,compensating injuredparties,increasingthequantityofpublicserviceadvertising,andthelike.Thisquestionof reparations is a matter of legitimate involvement not only by industry self-regulatory bodies and public interest groups, but also by public authorities.

Whereunethicalpracticeshavebecomewidespreadandentrenched,conscientiousadvertisersmay becalledupontomakesignificantpersonalsacrificestocorrectthem.Butpeoplewhowanttodo whatismorallyrightmustalwaysbereadytosufferlossandpersonalinjuryratherthantodowhat is wrong. We do not wish, and certainly we do not expect, to see advertising eliminated from the contemporary world. Advertising is an important element in today's society, especially in the functioning of a market economy, which is becoming more and more widespread.

Moreover, for the reasons and in the ways sketched here, we believe advertising can, and often does,playaconstructiveroleineconomicgrowth,intheexchangeofinformationandideas,and



ISBN:978-81-957858-1-0

in the fostering of solidarity among individuals and groups. Yet it also can do, and often does, grave harm to individuals and to the common good.

Inlightofthesereflections,therefore,wecalluponadvertisingprofessionalsanduponall those involved in the process of commissioning and disseminating advertising to eliminate its socially harmful aspects and observe high ethical standards in regard to truthfulness, human dignityandsocialresponsibility.Inthisway,theywillmakeaspecialandsignificantcontribution to human progress and to the common good.

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ISBN:978-81-957858-1-0

# GoldenRulesofIndianValues,PillarsofBusiness Ethics

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**Abstract**

Business is an i.e., activity carried on by the people entrepreneurs and managers, through the people i.e., employees and for the people i.e., consumers and the community. Consequently, Corporate Social responsibility is the obligation of business to pursue decisions and follow lines of action on environmental, social and economic issues, which are desirable in requisites of the objectives of the business and values of society. Ethics is a set of values and principles that we strongly believe and follow as well as personal trait which one adopts and follows as guiding principleorbasicDharmainone'slife.Inpresentscenario,withglobalizationandaftertheimpact ofeconomicrecessionthestipulationofthesocialresponsibilityarisesrelativelymorealongwith society values. Our Indian Values System provides ground set of laws, as in Shrimad Bhagawad Geeta many useful implications for corporate pupils on how to manage and achieve success are given like Jnanam (Vision), Dhriti (Patience), Theory of karma (Result of our Actions), self- control and meditation. The article objective is to come across how Indian approaches for Management,Spiritualbooks,KarmaYogaandotherIndianValuesystemsprovidesplatformfor buildingacharacterfoundationforCorporatetoo. ValuesystemofIndiaisalsoanenlightenpath for corporate governance basically in current state of affairs where power and accountability are considered, whoexercise power,on behalfofwhom and howtheexerciseofpoweris controlled. The future of business depends on its ability and willingness to respond to the changing expectations of society where basic principles and values of spirituality give us a thought avoids selfishness, do welfare of others. For that reason, Corporations must present themselves as being committed to social causes where global company has to develop global sensitivity.

**Keywords:**BusinessEthics,CorporateSocialResponsibility,ValueSystem

## Introduction:

Business is apartofthetotal environment in which welive, being influenced by it, whilebeinga force in influencing it. It an activity carried on by the people i.e., entrepreneurs and managers, through the people i.e., employees and for the people i.e., consumers and the community. Corporate Social responsibility is the obligation of business to pursue decisions and follow lines of action which are desirable in requisites of the objectives of the business and values of society. SocialResponsibilityencompassesgoodethics,bothwithinthewallsofthecompanyandoutside. Ethicsisafundamental,personaltraitwhichone adoptsandfollowsasguidingprincipleorbasic Dharma in one's life, Business ethics has come to be considered a management discipline, especiallysincethebirthofthesocialresponsibilitymovementinthe1960's.Anincreasing



ISBN:978-81-957858-1-0

numberofpeopleassertedthatbecausebusinessesweremakingaprofitfromusingourcountry's resources,thesebusinessesowedittoourcountrytoworktoimprovesociety.Manyresearchand business houses have recognized this broader constituency and in their planning and operations have replaced the word "stockholder" with "stakeholder", meaning to include employees, customers, suppliersand the wider community. Today 90% business houses adopt ethics.

Hence,Businessethicsarerulesofbusinessconduct,bywhichtheproprietyofbusinessactivities may be judged which are derived from ethical values , which are own as six pillars of character, viz. trustworthiness, respect, responsibility, fairness, caring and citizenship.

Valuesrepresentbasicconvictionsorenduringbeliefthataspecificmodeofconductorend–state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence.

Valuesdenoteasenseofrightorwrong,goodorbad,andanotherjudgmentalcriterionbasedon ourstrongsenseofwhattheidealoughttobe.Valuesshapeattitudes,perceptions,interestsand finally personality. Values that can be imparted to the members of organization collectively includes harmony, resourcefulness, discipline, dharma, equity, brotherhood, unity, peace, social conscience, cooperation, live and let live, concern, care, mutual trust, love, team spiritedness, efficiency, effectiveness, excellence, morale, commitment, productivity, responsibility, risk-bearing,accountability,sharing,sacrificeandsoon,whichinturnsachievecompany'svisionand mission.

**IndianEthosforManagement:**

Countries like India, which have huge population, high unemployment and generally people are poor is unable to fulfill the expected demand of the diverse fraternity within and outside the parametersofthecountry. Structuralreformandeconomicliberalizationwereintendedtopromote integration of the Indian economy with the global economy.

CSR hence involves a commitment to contribute to the economic, environmental and social sustainability of communities through the on-going engagement of stakeholders, the active participationofcommunitiesimpactedbycompanyactivitiesandthepublicreportingofcompany policies and performance in the economic, environmental and social arenas.

InourIndianValuesSystem,IndianApproachesforManagementprovidesgroundsetoflawsfor building a character foundation for Corporate and the Upanishads, Ramayana and Shrimad Bhagawad Geeta provides many useful implications for corporate pupils on how to manage and achieve success in their commitment, like

1) **HolisticApproachinManagement** basedon**spiritualprinciple** thatentire humanityis onethereisrespectforallhumanbeings.Spiritualandworldlylifeisequallyrecognizedandhas close relationship and this is called whole man approach. Thus, balance or equilibrium is the keynoteofIndianthought.Managerstofollowwholemanapproachofcombiningvaluesand



ISBN:978-81-957858-1-0

physicalaspectsoflife.Itwillbringoutdivineinmanwhichwillachieveperfection,andexcellence in our work.. It will achieve peace, harmony and prosperity within and without.

2) **EachPersonisapotentialDivineHuman,**meansperfectioninknowledge,wisdomand power. Therefore, a human being has immense potential power or energy for self development. **Janana Chakshu** , develop one's third eye ,the type of wisdom, vision, insight and foresight. Wisdom worker has an integrated personality. Inner resources (divine virtues) are much more powerful than outer resources,( capital, materials and plant, etc.)

3) **Karma Yoga, Work is work ship**, selfless work. Do your duty without ego and without calculationsoffruitsofaction..Pouryourheartandsoulintheperformanceofyourassignedduty. Work offers double benefit, personal benefit (self purification, salvation, personal growth) and social benefit (society). Work is a form of sacrifice (yogna), a spirit of renunciation, i.e. tyag and toserveotherswithoutselfinterest.Thedignityofworkisvaluablemeanspurifyingourmindand helps in gaining money, power , fame and name.

4) Indian Ethos give Greater **Emphasis on Values**, human and ethical, Knowledge is not power. Character is the real power and wealth.The Character is based on divine values. The Divine values are based on wisdom. Manager with enriched quality of mind and heart can have effective management.

5) **Cooperation**, a powerful instrument for team work. And success of any enterprise. The Gitasays,"Bycooperationandmutualhelpallsmallachievethehighesthumanwelfare."Healthy competition is a powerful motivator for excellence and success in business success.

6) **Yoga**, excellence at work throughself motivationand self development .Seek toperform yourassignedddutyorworkinanexcellentmanner.Perfectioninworkandqualityofoutputleads to total quality management.

7) **Humanism,** a way of life , concerned with dignity of man, i.e. right of the individual in relation torights of others**.,**creatingbest inter-personalrelations basedonequality, self-esteem, fraternal affection and promotion from within, effective communication and teamwork in an organization.

8) Inner management, mental and spiritual, Business is a **sadhana** and manager must cultivate noble values.

9) **Self-introspection**, self- analysis and self criticism help to locate areas of friction and disharmony.Weshouldpreparebalancesheetofownstrengthsandweakness.Constantpractice or sadhana helps us to discard unwanted traits and cultivate good valuesto purify our mind and heart.

10) **Brain–stilling**,(Decision-makinginmeditativesilence):Westernmanagementresortsto brain storming, while Indian insights advocates brain stilling, silence mind is more effective medium to get sound solutions to management problems.



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- **Institutionindecisionmaking**istheactofdirectdecisionbyinnermindthroughinspiration, instant awareness, past experience. Fully developed institution is effective for taking prompt and sound decisions.
- **Good relationship** with people is more valuable than money because you cannot buy good relationship. Networking is a higher form of karma. Do good to people, Do it for the sake of giving, for the love of giving.
- In Indian Ethos, the inner mind and inner aspects of man are emphasized. Focus is on developing inner mind. Faith and sincerity are two requirements of management philosophy. Work must be done in the right spirit and with right attitude and in perfect way.
- IndianValuesinManagementasEthics:
- Be a seeker of spiritual enlightenment or a person facing a moral dilemma or a managing director of a multinational company working for success, from epics like Ramayana and Mahabharata, marvelous book of guidance Shrimad Bhagawad Geeta guide people effectively in achieving the objectives.
- **Jnanam** , a complete vision of the entire organization, its aim and objectives, its place in the country and also relation to other nations.Jananm emphasis on vision where head must see unity in all and relationship as a whole must be understood.
- **Buddhi**,anability,theheadshouldbecapableofimpartinghisvisiontoallhisworkersattheir ownlevelofunderstandingand field ofwork.While translatingthe visioninto reality buddhi-ability to understand the very cause of problems and to remove it effectively, is required.
- **Dhriti**, Patience and Fortitude. In an organization no goal is achieved easily and quickly the leader must have extreme patience to win them over and achieve the goal
- **Theory of Karma** (Result of our Actions), explains the entire phenomena of life. In the Bhagawad Geeta, Bhagwan Sri Krishan convinces Arjuna to shed weakness and act, take the responsibility and fight in the battlefield. The result of the action naturally will depend upon the quality of the action undertaken.. Hence excellence can be achieved through Karma Yoga only.
- **Meditation,**concentrationtheflowofthesamekindofthoughts,uninterruptedbycontraryor different thoughts and intellect is redeemed from its wasteful habits of wrong imaginations.
- **MaterialismandSpiritualitygotogether**
- Spirituality should have a touch of materialism and materialism should have a touch of spirituality. The last shloka of the Bhagavad Gita says where there is Arjuna, there is Krishna, Krishna represents spirituality and Arjuna materialism, and when both go together and there is success and prosperity. So we should not separate worldliness and spirituality.
- **Love and Inspiration,** the Ramayana brings that the element of love in leaders enables them to collect and harness fortitudes of ardent and dedicated effort, nothing significant can be achievedbymereofficialauthority,postorposition.ThesecretofLordRama’ssuccesswasHis pure love for all.



ISBN:978-81-957858-1-0

- **Right Person for Right Job,** the great Chanakya has said it well, a person should be engaged only in a job that he is capable of doing efficiently**.**
- ***Yoyasminkarmanikushalashsatasminevayoktavyah***
- Every person cannot do everything, but every person is capable of doing something. As such, the head will have to really find the capabilities of his workers and assign jobs to them accordingly.
- **Performyourworkinperfection,**theBhagawadGitasays,thatmanattainsperfectionby worshiping the lord by his own karmas,
- **SwakarmanaTam AbhyarchayaSidhimVindatiManavah.**
- Discoveredyourpotentialandaptitudesperformyourworkasyourworkshipofthelord.
- **Self Control** ischannel singour energies towardsapurposefulend.Withoutdiscipline the senses, no higher goals can be achieved in life.
- Values express wealth of character (divine nature) or Dharma (Indian ethos); and ideas (as in the west) which relate to internal domain of business, i.e. interactions with employees, customers, suppliers, creditors, public, etc.
- ValueDrivenManagement

Management with proper combination of values skills can be assures harmony and progress of an organization as well as society, being the corporate a good corporate citizen.

**Conclusion:**

SuccessofJapanisbasedonvalues,usingspiritualeducationandpractices,e.g.concentration, meditation, mind stilling institution, etc. to neutralize evil effects of industrialization and to synthesize the human values into management organization. Japan has combined spiritualism and materialism and adopted value driven holistic approach in management and organization. Thus, Modern managements must incorporate Indian Ethos to perfect the truncated model of man. Stressing only material progress at any cot and recognize man as a whole man to assure wholesome humanprogress, spiritual as well asmaterialprogress, to satisfythe hunger ofmind and soul as well a hunger of physical and vital human being.

Management with proper combination of values and skills can assure the harmony, progress of the organization and society. Value system of India is also an enlighten path for corporate governance basically in current state of affairs where power and accountability are considered, who exercise power, on behalf of whom and how the exercise of power is controlled. The future of business depends on its ability and willingness to respond to the changing expectations of society where basic principles and values of spirituality give us a thought avoids selfishness, do welfare ofothers.Forthatreason,Corporationsmustpresentthemselvesas beingcommittedto social causes where global company has to develop global sensitivity.

Hence,CorporateSocialResponsibilityisdefinedasoperatingabusinessthatmeetsorexceeds the ethical, legal, commercial and public expectations that society has of business. Example for Indian Oil CSR is a Cornerstone of our Enduring Success. And the Companies such as Tata, Hindustan Unilever,ITCLupin India Ltd, Cipla, Bharat Electronic Ltd andGAIL have provedthat



ISBN:978-81-957858-1-0

community involvement does not have to be relegated to a side project, but rather can be the primaryfocusforafirmandleadtonotonlyabettercommunity,butloyalcustomersandareliable welloffuturetalent.WiththeseindustrybodieslikeConfederationofIndianIndustriesandFICCI have introduced cross-sectoral programs, for the first time, in Business Ethics and CSR related areas.

Suggestions:

BusinessinIndiaispassingthroughturbulenttimesasthereislotofconcernforbusinesssurvival andgrowthduetovariousfactorssuchaseconomicrecession,globalanddomesticcompetition of MNC's, ecological and environmental degradation, need for balancing Corporate Social Responsibility( multiple stakeholders' expectations, etc.) In view of the circumstances, it is appropriate to mention the business ethics and values enunciated by a management thinker

i) **Righteousness (Dharma):** It is important for business to follow Dharma in the creation and sharing of wealth; maintaining the highest standards of ethics and integrity in every action we take.

ii) **Public Good (Loka Sangraha)** : Individuals and organizations should work not just for private gain, but also for well-being of community/public good including external and internal stakeholders.

iii) **Efficacy (Kauslam):** All the businesses persue efficiency, productivity resource optimizationandconserveresourcessoastointernalizethevalueof efficacyinthebest interest of preserving mother earth for future generations.

iv) **Learning (Jigasa)** : Business will be the key instrument to solve the problems of growth, employment,education,consumption,information,entertainmentandqualityoflife.Businesswill havetokeeplearningfromthefeedback. Loopfromsocietyandalsothroughinternalprocessof question,challenge,search,debates,sharing,training,monitoringetc.Theviabilityandhealthof nations and globalsociety will depend on the skills of learning and utilization of such learning by business.

v) Respectforindividualandhumandignity.Thesewillincreasecreativityandteamplay.

vi) **Dharmayudh:**Businessis aggressive,competitive withlotofinitative,creating wealthand therefore, our philosophy talks adout Dharmayudh. Yudh is necessary, but it has to be Dharmayudh.Translatedintobusinessthatwouldmethattothemarketingsales.Yourroleisnot losing yourmarketshare, but toincreasemarketshare.Andforthat whatever needsyoucan do youdo.Butwecanlearntobesureifthatisnotdoneethically,inthelongrun,itisgoingtoerode business.

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ISBN:978-81-957858-1-0

# LegalPerspectiveofCSRinIndia

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**Abstract**

Though not new to India, transformation from charity-oriented approach to the stakeholder-oriented approachtowardscorporatesocialresponsibilityismuchpost-liberalization phenomena.Afteralmost two decades of liberalization, Indian government had framed guidelines relating to corporate social responsibility,whichfurthermayleadtoincorporationandorfosterdevelopmentsoastoincludeitin the forthcoming revised company laws. The present paper with its three sections tries to recapitulate the theoretical development of the idea of CSR throughout the world which leads to the creation of framework in the way of guidelines for socially and environmentally responsible business. Also, the paperbrieflydiscussesandcomparestheguidelinesissuedbytheMCAforresponsiblecorporatewith its international guidelines issuing counterparts.

**Keywords:**Legal,Liberal,Charity,MCA,Stakeholder

## LegalPerspectiveofCSRinIndia

### Prelude

The bowelless competition in every sphere of business, inter or intra economy, is by-and-large considered to be the by-product of the global spread and put into practice the wider concept of globalization. It had pressurized the policy formulator of nations, whether developed, developing or under developed, not only to lay down road map for sustainable economic development but also to frame legal environment suited for the same.

In the broader context of sustainable economic development for given economy, Corporate Social Responsibility (CSR) has dual role to perform, viz., to raise labour standard and at the same time to encourage environmental protection. An economy to have development which is sustainable must ensure such socio-politico-economic framework which would provide ground for mushrooming entities not only local in nature but also global enterprises.

Corporate social responsibility is a form of corporate self-regulation integrated into a business model whereby business monitors and ensures its active compliance with the law, ethical standards, and international norms.The term "corporate social responsibility" came in to common use in the late 1960s and early 1970s, after many multinational corporations formed globally.

CSR has gained growing recognition as a new and emerging form of governance in business. It is alreadyestablishedinaglobalcontext,withinternationalreferencestandardssetbytheUnitedNations, OrganizationforEconomicCo-operationandDevelopment(OECD)guidelinesandInternational



ISBN:978-81-957858-1-0

Labour Organization (ILO) conventions. ISO 26000 is the recognized international standard for CSR (currentlyaDraftInternationalStandard).Publicsectororganizations,theUnitedNationsforexample, adheretothetriplebottomline(TBL). ItiswidelyacceptedthatCSRadherestosimilarprinciplesbut with no formal act of legislation worldwide.

ThepresentPaperwillexaminetheexistinglegalframeworkgoverningCSRinIndiancontextforboth localandglobalenterprisesandwillalsorefertovariousexistinginternationalguidelinesforthesame. Beforemovingtotheareaofconcern,thenextsectionisdevotedfullyonbriefdiscussiontohistorical perspective of CSR in academic literature. The paper is divided in to three sections as follows:

- SectionI:HistoricalChronologytoCSR
- SectionII:InternationalLegalaspectrelatingtoCSR
- SectionIII:ConceptualizationofLegalaspecttoCSRinIndia

## SectionI:HistoricalChronologytoCSR[1]

### Introduction

A rough sketch for the development of the idea of CSR and relevant social scientific debates is discussedbelowwhichinturnaidtodrawonCSRdefinitions,modelsoforganizationalbehaviourand governance approaches throughout the world. From the vast academic literature available on the subject,thefollowingparagraphswillprovidewithabriefdiscussionoverthedevelopmentofpresent- day concept of CSR.

### AcademicEvidencestotheGrowthofConceptofCSR

It is argued by academicians that the modern academic debate on Corporate Social Responsibility started in the 1950s. Under the title of ‘Social Responsibility’ it initially focussed on the societal expectations towards business and on the ethical obligations of companies towards society. Howard Bowen, the ‘founding father’ of CSR, defines CSR as comprising ‘the obligations of businessmen to pursuethosepolicies,tomakethosedecisions,ortofollowthoselinesofactionwhicharedesirablein termsoftheobjectivesandvaluesofoursociety’(Bowen1953).TheexplorationsofCSRinthe1960s and 1970s largely followed this basic question (Davis 1960, McGuire 1963, Fitch 1967, Jones 1980).

Incontrasttothis,inthe1970sthefocusshiftedtothecapacityofafirmtorespondtoitsenvironment. Under the title of ‘Corporate Social Responsiveness’ or ‘CSR2’, it was asked whether, how exactly and with what consequences companies should and could adapt to specific societal needs (Frederick 1978, Ackermann/Bauer 1976).

At the same time, the concept of ‘Corporate Social Performance’ (CSP) emerged (Sethi 1975, Wartick/Cochran1985,Carroll1979).Thenewtermsignalsaninterestintheoutcomesof CSR.

[1]Thissectionisdrawnmainlyfromdiscussionin **Chapter3(DrawingontheAcademicDiscourse)**ofthePaper***“RhetoricandRealities:Analysing Corporate Social Responsibility in Europe” (2005)***, et.al.



ISBN:978-81-957858-1-0

However,earlymodelsofCSPfocusedonanalyticallydistinguishingbetweendifferentdimensionsof the CSR concept, such as the proscriptive, prescriptive, and dimension content of CSP; the economic and legal vs. ethical vs. discretionary/philanthropic responsibilities; or the principles, processes and policies inherent in CSP. In the 1990s, Wood revised the CSP model and she looked more systematically into empirical performance and the measurable effects of corporate responsible behaviour (Wood 1991).

Building on the Woods model, other authors have included into the analysis economic and environmental outcomes/impacts beyond the social ones (e.g. Swanson 1995, Steg et al. 2003). The ‘environmentalisation’ and ‘sustainabilitisation’ of the CSR debate under the influence of the sustainability discourse have left their mark on latter recognition on CSR. The consideration of three dimensions of social, ecological and economical responsibility became common stimulated by concepts such as the triple bottom line approach (Elkington 1998) and corporate sustainability gained acceptance in the 1990s. Table 1 below depicts the chronological development of CSR concept in tabular form for ready references.

**le1:ChronologyofDevelopmentofCSR Concept**

| od | cept | f |
|---|---|---|
| | al Responsibility | alexpectationsfrombusiness |
| | | alobligationsofcompaniestowardssociety |
| -1070 | ard Brown Definition | gation of business in terms of objective and values ciety |
| -1975 | orateSocialResponsiveness SR 2 | acityoffirmsto respondtoitsenvironment |
| -1990 | orateSocialPerformance | omeof CSR |
| | | sedonanalyticaldistinctionbetweendimensionsof |
| | d'sRevision | ematic study of CSR incorporating empirical ormanceandmeasurableeffectstocorporate viour |
| –onward | leBottomLineApproach | siderationofsocial,ecologicalandenvironmental ensions of corporate responsibilities |

## Conclusion

The definition of CSR has been changing in meaning and practice since 1950 (Secchi 2007 and Lee 2008).TheclassicalviewofCSRwasnarrowlylimitedtophilanthropyandthenshiftedtotheemphasis



ISBN:978-81-957858-1-0

on business-society relations. It was argued that a corporation or firm must provide for solving social problems.Intheearlytwentiethcentury,socialperformancewastiedupwithmarketperformanceand theviewwaspioneeredbyOliverSheldon(1923,citedinBichta,2003).Managementwereencouraged to take the initiative in raising both ethical standards and justice in society through the ethic of economizing[2].

Further, theoretical perspectives on corporate social performance or stakeholder management were developed for over two decades (Carroll, 1979; Freeman, 1984; Donaldson and Preston, 1995; Clarkson, 1995; McWilliams and Siegel, 2001). However, sincelast decade businesseshavebegun to exhibit serious evidence of CSR in their strategic management and stakeholder social reporting.

Also, CSR as a rapidly developing business strategy was observed as a response to globalization and the extension of global multi-national enterprises (MNEs) across countries, with the implication that state control over such enterprises are rapidly fragmenting (Logsdon & Wood, 2002; Zumbansen, 2006).

Concluding the chronology gives the present-day concept of CSR whereby business organizations consider the interest of society by taking responsibility forthe impact of their activities on customers, suppliers,employees,shareholders,communities andother stakeholdersas wellastheirenvironment. This obligation shows that the organizations have to comply with legislation and voluntarily take initiatives to improve the well-being of their employees and their families as well as for the local community and society at large.

## SectionII:InternationalLegalaspectrelatingtoCSR

### Introduction

There is a dynamic relationship between CSR and good public governance. The corporate accountabilitythroughlawand'voluntary'CSRrelatedactionsbybusinesseslieswiththepublicgood governance agenda. Legislation is to deal with worst case instances of irresponsible behaviour and to set a minimum floor for business conduct.Despite of this fact, it is very much true that CSR is not binding under any legal regime but still is voluntary in nature, globally. Organisation of international repute who are concerned more on sustainable economic development throughout the length and breadth of the globe, have laid down much wider in nature a platform for better governance through voluntary approach, not binding legally on corporations, local or global, but morally binding to them only due to its very inherent importance. The present section discusses about the International Legal Regimes which govern CSR.

[2]Economizetheuseofresourcesunderthenameof efficient resourcemobilizationandusage



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**InternationalCSRStandardsandGuidelines:**

- *ILOTripartiteDeclarationofPrinciplesConcerningMultinationalEnterprisesandSocialPolicy*
- *OECDGuidelinesforMultinational Enterprises*
- *UN Global Compact*
- *TheUniversal Declarationof Human Rights*

***ILO[3]TripartiteDeclaration ofPrinciplesConcerningMultinationalEnterprisesandSocialPolicy***

The ILO "tripartite" declaration negotiated in 1977 was the earliest international instrument covering social dimensions of business and bring together representatives of governments, employees and workers to shape policies and programmes jointly. The Declaration sets out principles in the field of general policies, employment, and training, conditions ofwork and lifeand industrial relations which was not legally binding on enterprise but were recommended to be observed voluntarily.

**ThemainareascoveredbytheDeclaration are:**

- Generalpolicies–Toobeynationallawsandrespectinternationalstandards,
- Employment–Toguideforemploymentpromotion;equalityofopportunityandtreatmentandsecurity of employment
- Training-Policydevelopmentforvocationaltrainingandskills formation,
- ConditionsofWorkandLife–Toframepoliciesrelatingtowages,benefits,conditionsofwork, minimum age, safety and health
- IndustrialRelations–Toworktowardsfreedomofassociationandrighttoorganize,collective bargaining, consultation, grievances and settlement of disputes.

TheDeclarationwasrevisedin2000toincludetheFundamentalPrinciplesandRightsatWork.Itwas further revised in 2006 to update references to other ILO instruments. During this update, the list of ILO Conventions that member States are invited to ratify was extended to all the fundamental ILO Conventions. Moreover, a specific recommendation was added to encourage enterprises, both multinational and national, to take immediate and effective measures within their own competence to secure the prohibition and elimination of the worst forms of child labour, as a matter of urgency.

The ILO does not have a membership structure, so it does not require that user organizations report their use of the Declaration. The ILO established a subcommittee of the Committee on Legal Issues and International Labour Standards of the ILO Governing Body to oversee the Declaration, and to discuss ILO policy concerning CSR issues.

***OECDGuidelinesforMultinational Enterprises***

[3]InternationalLaborOrganizationanaffiliateofUnited Nations



ISBN:978-81-957858-1-0

TheOECD[4]MNEGuidelinesaresubscribedtobyallmembersoftheOrganizationforEconomicCo-operation and Development (OECD). A further ten non-member countries[5] have also adhered to the Guidelines. The Business and Industry Advisory Committee (BIAC) and the Trade Union Advisory Committee(TUAC)wereinvolvedintheirdevelopmentandendorsetheGuidelines.OECDWatch,a coalitionofmorethan65civilsocietyorganizations,alsosupportstheGuidelines.TheGuidelineshave been referenced by the UN Security Council and other interested non-OECD bodies.

The purpose of the OECD MNE Guidelines is to offer a balanced, multilaterally-endorsed, and comprehensive Code that expresses the shared values of adhering governments. They are "recommendations jointly addressed by governments to multinational enterprises" that provide "principles and standards of good practice consistent with applicable laws".

The guidelines are primarily meant for MNE's, but are relevant to both multinational and domestic. And within domestic also have similar treatment for SME's and large enterprises.

The Guidelines comprise a set of voluntary recommendations in all the major areas of corporate citizenship, including employment and industrial relations, human rights, environment, information disclosure,combatingbribery,consumerinterests,science andtechnology, competition,andtaxation. The Declaration on International Investment and Multinational Enterprises is designed to promote direct investment and international economic development and growth.

TheGuidelineswereexpresslydesignedtostrengthentheexistinginternationalnormativeframework. Among other norms, they reference the Universal Declaration of Human Rights, the ILO Declaration onFundamentalPrinciplesandRightsatWork,theRioDeclarationonEnvironmentandDevelopment andAgenda21,andtheCopenhagenDeclarationforSocialDevelopment.Explanatorymaterialshave been developed to outline their relationship with the UN Global Compact, the Principles for Responsible Investment, and with the GRI[6] Guidelines.

***UNGlobal Compact***

TheUNGlobalCompacthastwobroadgoals, viz.,

- tomainstreamtencoreprinciplesrelatingtohumanrights,labourstandards,theenvironment,andanti-corruption in business activities around the world, and
- tocatalyseactionsinsupportofbroaderUNgoals,suchastheMillenniumDevelopmentGoals (MDGs).

A voluntary initiative, it is not a code of conduct. It offers "a policy framework for organizing and developingcorporatesustainabilitystrategieswhileofferingaplatform(basedonuniversalprinciples) toencourageinnovativeinitiativesandpartnershipswithcivilsociety,governmentsandother

[4]Organisation forEconomicCo-operationand Development
[5]Argentina,Brazil,Chile,Egypt,Estonia,Israel, Latvia,Lithuania,Romania,andSlovenia
[6]GlobalReportingInitiative



ISBN:978-81-957858-1-0

stakeholders”.TheUNGlobalCompactinvitescompaniestoembrace,supportandenact,withintheir sphere of influence, the following ten principles:***Human Rights***

Principle1:Businessesshouldsupportandrespecttheprotectionofinternationallyproclaimedhuman rights; and

Principle2:makesurethatthey arenotcomplicitin human rights abuses.

***Labour Standards***

Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;

Principle4:Theeliminationofallformsofforcedandcompulsorylabour; Principle 5:

The effective abolition of child labour; and

Principle6: Theeliminationofdiscriminationinrespectof employmentand occupation.

***Environment***

Principle 7: Businesses should support a precautionary approach to environmental challenges;

Principle 8: To undertake initiatives to promote greater environmental responsibility;

andPrinciple9:Toencouragethedevelopmentanddiffusionofenvironmentallyfriendlytechnologies.

***Anti-Corruption***

Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

The UN Global Compact is directed primarily to the business sector, but is a multi-stakeholder initiative and engages all kinds of societal actors, including public agencies, labour and civil society organizations.

***TheUniversalDeclarationofHuman Rights***

TheUniversalDeclarationofHumanRightsstatesthat“everyindividualandorganofsociety”hasthe responsibility to strive “to promote respect for these rights and freedoms” and “by progressive measures, national and international, to secure their universal and effective recognition and observance”. The ILO Conventions establish norms covering all aspects of working conditions and industrialrelations.Someofthemostimportantcovercorelabourstandards(i.e.basichumanrightsin theworkplace).Theseincludetherighttofreedomofassociation,therighttoorganizeandtocollective bargaining, and freedom from forced labour. ILO conventions are binding on all countries that have ratified them. Two important conventions are discussed below:

*TheILOTripartiteDeclarationofPrinciplesConcerningMultinationalEnterprisesandSocialPolicy:*



ISBN:978-81-957858-1-0

It is a global instrument designed to provide guidance to government, employer and worker organizations in areas of employment, training, conditions of work and industrial relations. All core labour standards are covered. Although it is a non-binding instrument, its implementation is nevertheless the object of regular reviews.

*TheILO Declarationon FundamentalPrinciples andRights at Work:*

ItisbasedonthecorelabourstandardsoutlineintheILOConventions.TheDeclarationisnotbinding but applies to all ILO member states. As part of a strategy to help countries to have well-functioning labour markets, it provides for a mechanism for annual review of the efforts made by member states that have not yet ratified the core labour standards. The Declaration also reinforces the application of corelabourstandardsinprivatevoluntaryinstruments.The1992RioDeclarationsetsout27principles definingtherightsandresponsibilitiesofstatesinrelationtohumandevelopmentandwell-being.The Agenda 21 agreement provides guidance for governments, business and individuals on how to contributetoeffortstomakedevelopmentsocially,economicallyandenvironmentallysustainable.Its Chapter 30 recognizes the value of promoting “responsible entrepreneurship”.

**Conclusion**

Fromabovediscussionitisclearthatintoday'sbusinessscenario,thereisanincreasedfocusongiving backtosocietyandcreatingamodelwhichworkslongtermandissustainable.Itisimperativethatthe best practices forinclusivegrowth are shared with thestakeholders.Getting multinationals to comply with local laws is not an easy task. Corporations world over are subject to global expectations. A globally accepted and broad concept like sustainable development fits well with the economic, social andenvironmentalresponsibilitiesofglobalcorporations.Accordingly,thetriplebottomlineapproach toCSRsuggeststhatabusinessorganizationmuststrivetobalancethesethreeareasofresponsibility. But,toframealegalframeworkwhichwouldbeapplicabletoeverynationkeepinginviewthesethree areas of responsibility, who itself have diverse legal structure leads to only voluntarily guidelines by above mentioned international organisations and not a legally binding norms.

## SectionIII:ConceptualizationofLegalaspecttoCSRinIndia

### Introduction

Involvementofbusinessinsocialwelfareactivitieshasbeenatraditioninindia.Theconceptofparting away with surplus wealth for good of society is neither modern nor a Western import to India. Historically, from around 600 BC, the merchant were considered an asset to society and were treated with respect and civility as is recorded in the Mahabharata and the Arthashastra. Over the centuries, this strong tradition of charity in almost all the business communities of India has acquired a secular character. Also, many of India's leading businessmen were influenced by Mahatma Gandhi and his theoryoftrusteeshipof wealthcontributed liberallytohisprogrammes forremovalof untouchability, women's emancipation and rural reconstruction.



ISBN:978-81-957858-1-0

Leaving aside this fact, when come to the question of legislating corporate social responsibility and making it apartofCompaniesAct, not only in Indiabut world overit has along way to cover,dueto complexity into its acceptability. Coming to CSR activities in India, it is still taken as charitable initiativesbymostcompanies.ButthereareafewwhichhaveembeddedtheirCSRactivitieswiththeir existing business models.Among thesearethe ITC group, theTatas,Bharti Airtel and state-runfirms like the State Bank of India. When compared to private sector companies, public sector enterprises have contributed more towards social responsibilities. Currently, the government is in the process of issuingguidelinestostate-runfirmsonCSRspending,whichcouldbeintherange3-5%ofnetprofits of up to Rs 100 crore. Those earning net profit of more than Rs 100 crore may be asked to contribute up to 2 % of the amount[7].

**National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business**

Indian government in 2009, for the first time took a step forward towards mainstreaming the concept ofBusinessResponsibilitiesandhadreleasedVoluntaryGuidelinesonCSR,adraftguideline,withthe help of IICA[8]. The Corporate Affair Ministry after getting adequate responses from various stakeholders, in July 2011 revised the guidelines set in 2009 and brought a new set of comprehensive guidelinesunderthetitleof***NationalVoluntaryGuidelinesonSocial,EnvironmentalandEconomic Responsibilities of Business (2011)***.

TheGuidelinesusetheterms'ResponsibleBusiness'insteadofCorporateSocialResponsibility(CSR) andtakeintoaccountthelearning’sfromvariousinternationalandnational goodpractices,normsand frameworks[9], and provide a distinctively 'Indian' approach, which is expected to enable businesses to balance and work through the many unique requirements of India. The Guidelines emphasize that responsible businesses alone will be able to help India meet its ambitious goal of inclusive and sustainable all round development, while becoming a powerful global economy by 2020.

The Guidelines have been articulated in the form of nine (9) Principles with the Core Elements to actualizeeachoftheprinciplesandareapplicabletolargeandsmallbusinessesalike.Aspecialsection has been included on how MSMEs can be encouraged to adopt the Guidelines. Also, to assist implementation, a section has also been included on developing Management Systems and Processes for responsible business, and Indicators that businesses can adopt to self-steer and regulate so as to become sustainable and responsible businesses.

**PrinciplesRelatingtoResponsibleBusiness**

[7]http://www.igovernment.in/site/india-may-make-csr-law-37213
[8]IndianInstituteofCorporateAffairs
[9]such as ISO 26000, UNGC, GRI, OECD Guidelines in as much as theyhelp to address Indian particularities as well as national resources like the BIS standard 16000, PSU CSR Guidelines, and other sources



ISBN:978-81-957858-1-0

Thefollowing Principles arelaid down intherevised 2011 guidelines for Responsible business:

Principle1:BusinessesshouldconductandgovernthemselveswithEthics[10],Transparency[11]and Accountability[12]

Principle2:Businessesshouldprovidegoodsandservicesthataresafeandcontributetosustainability[13] throughout their life cycle[14]

Principle3:Businessesshould promotethe wellbeing[15] of allemployees[16]

Principle4:Businessesshouldrespecttheinterestsof,andberesponsivetowardsallstakeholders, especially those who are disadvantaged, vulnerable and marginalised[17].

Principle5: Businessesshouldrespectandpromotehuman rights

Principle6: Businessshouldrespect,protect,andmakeeffortstorestoretheenvironment

Principle 7: Businesses, when engaged in influencing public and regulatory policy, should do so in a responsible manner

Principle 8**: Businesses should support inclusive growth** and equitable developmentPrinciple 9: Businesses should engage with and provide value to their customers and consumers in a responsible manner

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[10]Ethical Behaviour: individual or collective behaviour that is in accordance with accepted written and /or unwritten codes of principles and values that govern decisions, actions and conduct within a business in the context of a particular situation and is consistent with accepted norms of behaviour
Adapted from Final Draft ISO 26000 and
http://business.lovetoknow.com/wiki/A_Definition_for_Business_Ethics

[11]Transparency: Itisdefinedas opennessaboutdecisionsand activities that affect society,the environment andtheeconomy and the willingness of businesses to communicate information in clear, accurate, honest timely and complete manner.

[12]Accountability:Principlethatorganizationsareresponsiblefortheiractionsandmayberequiredtoexplainthemtoothers. Adapted from IS 16001:2007

[13]Sustainability:Theoutcomeachievedbybalancingthesocial,environmentalandeconomicimpactsofbusiness.Itistheprocess that ensures that business goals are pursued without compromising any of the three elements.
http://www.pgaframework.org/pgaframework_pgadiagnostic.asp

[14]ProductLifeCycle:Thisreferstoallthestagesofaproductfromextractionoracquisitionofrawmaterialsthroughmanufacturing andprocessing,distributionandtransportation,useandreuse,recyclinganddisposal.Inthecaseofservices,itreferstoallactivities and processes from the design to delivery.
AdaptedfromWorldBusinessCouncilforSustainableDevelopment

[15]Well-being:Isastateofbeinghappy,healthyandprosperous.Itincludesindicatorsofwealthandemployment,builtenvironment, emotional, spiritual, social, physical and mental health, education,recreation and leisure time and social belonging. Well being is synonymously used with good quality of
life

[16]Employee:Apersonemployed,directlyorbyorthroughanyagency(includingacontractor),whether for remuneration or not, for carrying out activities of the organization or any part thereof, incidental toor connected with those activities, in pursuance of the organization's stated objectives."
AdaptedfromIS 16001:2007

[17]Vulnerable and Marginalised Groups: Group of individuals who are unable to realize their rights or enjoy opportunities due to adversephysical, mental, social,economic, cultural,political,geographic orhealthcircumstances. These groupsin India include:
- Womenandgirls
- Peoplewithdisabilities
- Children
- Tribal's
- Migrants,migrantworkers



ISBN:978-81-957858-1-0

**RelevantExistingLaws&Acts MappedAgainstPrinciples**

ThislistasgivenunderAnnexureCofthepresentguidelinesgivesanextensiveviewonthelegal framework which exists for Responsible Corporate and is elaborated below in the following table 2.

**Conclusion**

GuidelinesframedforResponsibleCorporate,theIndianversionofCorporateSocialResponsibilityas lay down by the apex legal formulating body, MCA, corresponds much with the guidelines issued by internationalorganisations.Theprincipleslaiddownby NationalVoluntaryGuidelinesdifferwithits UNGlobalCompactcounterpartinitsAnti-CorruptionPrincipleandreflectmoreorlesssameasthat envisaged in otherguidelines issued by international organisations. Further,from the abovetable2, it is clear that there exists an extensive legislative to cover the triple bottom line approach towards corporatesocialresponsibilityinIndia.Theproblemliesnotintheframeworkoflegislationbutinthe implementation of the existing laws. However, the current guidelines issued by the MCA are to defragmentthefragmentedexistinglawsrelatingtoenvironmentalissuesandlabour.Lawsrelatingto CSR is extensive and overlapping in nature and if implemented will be quite sufficient for ensuring overall inclusive development and sustainability.

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ISBN:978-81-957858-1-0

## Marketing-IssuesandImplications

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**Abstract**

This paper examines various ethical issues related to marketing exist in today's scenario. There arenumberofissuesaddinginthelistofmarkethicsduetorapidchangeintechnology,customers requirement(healthissues,environmentalissues,onlineprivacy).Someof issuesariseasaresult ofimproperregulationsorinadequatelegislation(clinicaltrials).Theseissuesmayaffectcorporate image adversely and cause destruction for society and its wellbeing. It also discusses about the forcesresponsibleforadheringethicalconductbycorporations.Theseforcesexertapressureover companies to follow ethics in day-to-day work culture. Caring about your customers not only results in profits, but create corporate image also. Deceiving customers may help a firm's profits in the short-run, but is not the way to build a successful business. The issues discussed in paper reveals how they affect organization, it's customers and society. There are various methods discussed which help marketers to inculcate ethics in working practices and avoid any unethical tactics.

**Keywords:** Ethical issues, Marketing, Technology, Customer requirements, Regulations, Corporate image, Ethical conduct

### Introduction

There is growing trend among academicians and professionals in India started realizing the significance of ethics and Corporate social responsibility CSR in marketing. The role of ethics in conductingbusinessistotakecareofsocietalinterestandatthesametimeoptimizeprofitsoftheir organization. In twenty first century companies not only want to win the race of competition but alsowanttoseethemselvesoutofthecrop.Thenewmantra"Markethics"isthesolutionforthis. In India some legendry corporate houses follow ethical conduct in day-to-day business practices and serve to society and its stakeholders via CSR and corporate governance.

Reliance industries chairman delivered a lecture in a function organized by an NGO (Madhya Pradesh) saying…." Indian corporate houses to adopt a new business model which should be measured on social returns together with financial returns, while imbibing countries ethos and value system. Though India stands nowhere in list of corporate ethics globally (The Ethisphere InstitutereleasedonMarch25,2010,itsfourthannuallistoftheWorld'sMostEthicalCompanies for 2010.**)** the Indian history of corporate houses reveals that organizations followed ethics even in early 1900's. Ethics is the philosophy of human conduct which determine the right or wrong aspectofbehaviour. Businessethics(also known ascorporateethics)isaformappliedethics that



ISBN:978-81-957858-1-0

examines ethical principles and moral or ethical problems that arisein abusiness environment. It applies to all aspects of business conduct and is relevant to the conduct of individuals and entire organizations. Business ethics has both normative and descriptive dimensions. Both descriptive andnormativeresearchersagreethatmarketersdodevelopguidelinesandrulesforethicalconduct based on accepted norms and moral philosophies. As a corporate practice and a career specialization,thefieldisprimarilynormative.Interestinbusinessethicsaccelerateddramatically during the 1980s and 1990s, both within major corporations and within academia. Governments use laws and regulations to point business behavior in what they perceive to be beneficial directions. Ethics implicitly regulates areas and details of behavior that lie beyond governmental control. The emergence of large corporations with limited relationships and sensitivity to the communities in which they operate accelerated the development of formal ethics regimes.

Marketing is a key functional area in the business organization that provides a connection with customers,media,investors,regulatoryagencies,channelmembersandtradeassociations.Soitis important to discuss marketing ethics from organizational and social perspective. According to Borgerson, and Schroeder (2008), marketing can influence individuals' perceptions of and interactions with other people, implying an ethical responsibility to avoid distorting those perceptions and interactions. Marketing Ethics came of age only as late as 1990s.Ethics in marketing deals with the principles, values and/or ideals by which marketers (and marketing institutions)oughttoact.Marketingethicswasapproachedfromethicalperspectivesduetovirtueethics, deontology, consequentialism, pragmatism and relativism. The organization and stakeholdersdefinemarketingethicalissuesthatmustbeidentifiedandresolvedtobuildtrustand effective relationships with stakeholders. Because marketing ethics sometimes deals with subjective moral choices, this requires decisions about the moral standards to apply and the definition of ethics issues (Murphy, Laczniak, Bowie and Klein, 2005 )

Marketing ethics is controversial, and there is no universally accepted approach for resolving questions.Oneperspective(Academician )thinkethicsisbeingmoralindividual.Thesepersonal valuesandmoralphilosophiesarekeytoethicaldecisions.Virtues(honesty,fairness,responsibility and citizenship)are assumed to be values that guide complex marketing decisions in context to organization.Fromorganizationalperspective,organizationalvalues,codesandtrainingnecessary toprovideconsistentandsharedapproachestomakeethicaldecisions(FerrellandFerrell ,2005).Marketing ethics not only requires an attempt to make ethical decisions but also avoid unintendedconsequencesofmarketingactivity.Thisrequireconsiderationofkeystakeholdersand their relevant interest (Fry and Polonsky 2004).

In 2004 ,American Marketing association develop new definition, which includes concern for stakeholders beyond the organization and customers. The definition "*marketing in an organizationalfunctionandsetofprocessforcreating,communicatinganddeliveringvalueto*



ISBN:978-81-957858-1-0

*customers,formanagingcustomerrelationshipsinwaysthatbenefittheorganizationanditsstake holder*. This definitionemphasis upon responsibility of marketers and importance of delivering value.

The latest description of the Hunt and Vitell (2005), theory of marketing) provides an excellent frameworkforunderstandingthe"why"questionsaboutmarketingethics.Themodelshowswhy peoples' ethical judgments differ in an organizational context. Many researchers and managers believethatpersonalethicsdeterminesorganizationalethics,whilethisframeworksandempirical research question this assumption. The role of corporate culture along with internal control of opportunity to engage in misconduct remains a key determinant of marketing ethics.

The development of stakeholder theory and the importance of stakeholder orientation provide a newdirectionforintegratingethicsintomarketingdecisions(Maignan,FerrellandFerrell,2004). This perspective focuses on understanding and responding to important stakeholder groups that hold marketing accountable for its actions. This approach assumes that stakeholders are knowledgeable on key ethics issues and that the organization can respond in a manner that maintains marketing relationships.

**Literaturereview**Thehistoricalbackgroundformarketingethicsisderivedfromearlyconcerns during the turn of the 20th century concerning antitrust and consumer protection, misleading advertising.InacademichistoryFrankChapmanSharpstartedteachingacourseinbusinessethics attheUniversityofWisconsinin1913andSharpandFox(1937)publishedatextbookonbusiness ethics. Till 1950,many academic articles and studies published and all focused upon fair trade, antitrust, advertising and pricing. In 1960's the concern was rise of consumerism ,growth of ecological problems(pollution and disposal of nuclear waste. After it in 1967 the first comprehensive model for marketing ethics contributed by Robert Bartel. which provided a framework for social and personal ethics in marketing and acted as foundation for empirical research that followed in 1970's.

Theworkduring1970'sto1980'sfocusuponbeliefofmarketingmanagerandmanagerialissues (e.g purchasing and the four p's). Ferrell and Gresham (1985) proposed "*A Contingency FrameworkforUnderstandingEthicalDecisionMakinginMarketing"*emphasizedtheinteraction oftheindividualandorganization,includingorganizationculture,co-workers,andopportunityto explainhow ethical decisionsaremade. Hunt and Vitell(1986) "A General Theory of Marketing Ethics" is widely accepted and also provides an empirically grounded model to illustrate how ethicaldecisionmakingoccursinanorganizationkeepingconsumerconcerninmind.Hunt,Wood and Chonko (1989) conducted research demonstrating a strong link between corporate ethical valuesandorganizationalcommitmentinmarketingTheircorporateethicalvaluesscaleiswidely usedinorganizationalethicsresearch.GundlachandMurphy(1993)buildanormativeframework forrelationalmarketingexchangesbasedontheethicalexchangedimensionsoftrust,equality,



ISBN:978-81-957858-1-0

responsibility,andcommitment.Theydevelopfoundationalunderstandingoftheinterrelationship of ethics and law in marketing exchange. This was a significant contribution that the legal and ethical dimensions of exchange are independent.

Dunfee, Smith and Ross (1999)also suggested a normative framework for marketing ethics. This normativeframeworkissignificanttomarketingbecauseitemphasizedtheexchangerelationship between the firm and its stakeholders. The Integrative Social Contract Theory (ISCT) links the decision-makingprocess,multiplecommunities,hypernorms,andethicaljudgmentsbasedonthe dominant legitimate norms. More recently, marketing ethics has built on both of the streams, applying normative guidance from moral and political philosophy (such as deontology, social contracts theory, and virtue theory) to the more complex understanding of the marketing ethics decision-making process provided by descriptive research (Dunfee et al. 1999;Murphy 1999; SmithandCooper-Martin1997;TakalaandUusitalo1996).In2002Sarbanes-OxleyAct,passed, which is the most far-reaching change in organization control, corporate governance.

Ethical issues address a problem, situation, or opportunity that requires an individual, group, or organization to choose among several actions that must be evaluated as right or wrong (Ferrell, Fraedrich, and Ferrell, 2005).The social and environmental issues appeared to be gaining serious attention recently with Michael Porter and others focusing on a more strategic use of corporate responsibility and sustainable marketing (Murphy et al. 2005; Porter and Kramer 2006). The service-dominant(S-D)logic,asproposedbyVargoandLusch(2004a,b,2006),providesamore integrated approach to marketing theory that reduces these tensions, enabling amore ethical foundation for marketing.

**Forcestomarketingethicsin environment**

Thebottomlineisthatgoodethicsisgoodbusiness.Thereisadirectcorrelationbetweenbehaving ethicallyandcreatinglong-term shareholdervalue. Furthermore,high integrityin external business dealings goes hand in hand with creating greater transparency and increased integrity in internal relationships. This necessitates choosing leaders who are not only ethical themselves but also committed to ensuring their organizations operate ethically at all times. companies encourage ethics in marketing to protect their publicity. Lack of good marketing practices affects publicity (Schlegelmilch, 1998). This makes difficult for the customers to buy products and services from the company. Also, it leads to lack of trust as customersand no longer trust the company. Most businesses have lost customer trust because of poor marketing practices. For instance, the companies have lost customer trust because ofdeveloping adverts that are not ethical. Also, the companieshavelostcustomertrustbydevelopingproductsthataffectcustomersnegatively.There are many other factors too that inhibits conducting of unethical practices in marketing.

**(1) Risingcustomerexpectation,andaction**Manycompaniesfindingthatconsumersarewilling topaymoreforgreenproductandwhattheyfeelarelesstoxic,containrecycledmaterials.For



ISBN:978-81-957858-1-0

exampleToyotaisverysuccessfulwithitshybridcars.Sometimestheyconsiderbusinessestobe unethical in some ways (e.g. animal furs) or acting irresponsibly or use business practices which they find unacceptable, cause to failure of business .

**(2) Govt legislation and pressure** In India various laws and regulation exist that don't derail corporate from the track. The Ministry of Corporate Affairs (MCA) timely amend these laws or bring new laws if require. Environmental laws, labor laws, child labor law. consumer protection act are few of these. Recently the issue of ban over fast food shop in school premises caught the fire. The centre has asked state govt. to ban sale of junk food and carbonated drinks on school premises and withdraw such item that lead to unhealthy eating from canteen.

**(3)The inclusion of social criteria by investors**Investors are more likely to invest in the companies which follow ethics and CSR norms **.**Companies mission statement clearly outline companies planned standard of excellence for operating in business environment .The mission statement can focus more on a social aspect of operation rather then profit. In such type of companies shareholder invest more because they believe in company and desire to see company will succeed in its mission.

**(4)To maintain image industry and in society** Each corporation has a particular public image, which represents the way in which the public views the corporation .The public images are the result of a number of different things, but they are primarily the result of the way in which a corporationactswithrespecttothedifferentthingsaroundit..publicimageisimportanttosuccess in most cases, which is one of the reasons as to why ethics are important to a company's overall success.

**(5)Pressuregroups**Pressuregroupsareexternalstakeholders.VariousNGOandActivistgroups put pressure on corporate to follow ethical practices. They focus upon activities of companies which can damage the target customers and society.

**Ethical issues inmarketing**

Ethics in marketing has become a major issue in the society. This is because of the ethical issues associated with marketing. Companies are required to apply ethics in different areas. There are many issues that can be discussed with respect to marketing ethics. For example, the companies aresupposedtoapplyethicsinpromotion,advertisinganddistributionofproducts(Schlegelmilch, 1998). They are also supposed to apply ethics in pricing of product. The different areas of marketing ethics are related to media ethics. This is because companies use different media to markettheirproductsandservicesandalsopromotethem.Companiesaresupposedtoensurethe advertisingandpromotionofproductsandservicesisethical.Someofethicalissuesinmarketing discussed below



ISBN:978-81-957858-1-0

**(1) Marketing redundant or dangerous products/services** An organistion is responsible for delivering goods and services that don't harm the society. Some products and services are inherently dangerous (weapons, chemicals ,alcohols and tobacco). It is the duty of manufactures to warn customers about risk of consuming or use oftheir product. For example Tobacco and Cigarette manufacturer print pictorial warning on their products. Another concern issues now a days is explosion in mobile batteries in mobiles. But manufacturers don't shoulder the responsibility of such issues by saying ,the battery used in exploded mobiles were counterfeit. Though they know such cases may happen rarely .

**(2) Manufacturingoffakeproducts**Thefactthatduplicateproducts,look-alikesandspell-alikes exist cheek by jowl with genuine products on the same shelf, are less costly and earn the retailer higher profits always known .These products easily available in the traditional village haats, the main selling locales of rural India. The research group AC Nielsen also indicated that FMCG segment in the country alone incurs a loss of about Rs 1,800 crore due to counterfeit products in (2001) .With the result of this research outcome50 manufacturers, legal experts and research companyACNielsencametogethertosetupaBrandProtectionCommitteeundertheaegisofthe Federation of Indian Chambers of Commerce and Industry (FICCI). The idea was to curtail fake products in the country.

**(3) Transparency about environmental risks, Possible health risks, security risks, etc** Organizations should beware customer regarding possible hazards and risk associated with a product and it use society (e.g., illegal drugs, tobacco, alcohol, etc.). In this direction social marketingisasteptoinfluenceatargetaudiencetovoluntarilyaccept,reject,modify,orabandon abehaviorforthebenefitofindividuals,groupsorsocietyasawhole.alsoTheyshould market safe products.

**(4) Transparencyabout<u>productingredients</u>**Mostcompaniesmarketpoorqualityproducts.The product does not contain the content that is being marketed. This affects the customer safety. Companies that market unsafe products are more likely to face legal suits and loose customers. The company should ensure the product beingmarketed is safe and of good quality (Horowitz, 2006).Such practices affect the public image of the company and lead to low profits. The constituents ofproduct ensurequality of aproduct. This issueis very crucial with respect to food products. Genetic For example now days Genetic modified vegetables and fruits are greatly used infoodproducts.Geneticmodificationdifferedfromconventionalcrossbreedingbyalteringplants at the molecular level, sometimes by combining the DNA of different species. Genetic modificationisusedinfarmingandfoodpracticestocreate"superproducts"thatgrowfasterand cheaperthantraditionalmethodsbut,butwithrepeatconsumptiontheireffectscanbecancerous.

**(5) Respectforconsumerprivacyandautonomy-**Themarketingrepresentativesandsalespeople canforce vendors to usetheir products insteadofcompetitor's products. .Use of psychological



ISBN:978-81-957858-1-0

tricks or fear or pressure to close asale. By this they intrude in customer autonomy .They may evenforcetake-homesamplesonbuyer.Sellingbuyeraproductwithattributesthebuyerdoesnot need. Many distributers keep customer database and sell it to others for benefits.

**(6) Onlineprivacy**Consumeronlineprivacybecometalkofthetown,whenissuethat“govt will have eye upon tweets and facebook post” raised concern for it .Public use social site for several reason (eg. promote the product via social networking ) .It is invasion in their privacy.

Oneofthebiggestimpedimentsingrowthofonlinemarketingistheprospectthatconsumersand businesses may not trust it. Misusing confidential information.is another concern in online marketing.

**(7) Advertising truthfulness** Anadvertisement should be evaluated to ensurethe content aired is not offensive. This will ensure the companies do not face ethical issues (Brenkert, 2008) Exaggerated product claims (puffery) are considered deceptive, unethical as they affect the customersandthecompany.Itcanleadtolooseofcustomersifthecustomersknowthetruthabout the product and services (Horowitz, 2006).Next to it the way the women are portrayed affectsthemarketingoftheproducts.Harmfulstereotypingincludesportrayingwomenasobsessedwith theirappearanceandconformingtotheirsizeandbeauty.Thisaffectstheorganizationnegatively when people consider such images as harmful.

**(8) Fairness in pricing & distribution.** Ethics are applicable in pricing too. Pricing is one of the components of marketing mix. There are various pricing practices that are considered unethical. Examples includeprice discrimination and price skimming. Other practices include variable pricing, competitive pricing and predatory pricing (Horowitz, 2006). Price discrimination occurs when the identical goods or services provided by one provider are sold at diffident prices.

Price differentiation occurs mostly in companies that have high market share. It also occurs in monopolistic markets. The seller tries to sell the goods at different prices. In addition, price discrimination occurswhenasellersaletheproductatsamepricestocustomers ,havingdifferent supply costs. Price discrimination has adverse effects on consumers. For example, it leads to low pricesforsomecustomersandhighpricesforothers.Thecompanyshouldensurepricessetbythe companyarefair.Thecompanyshouldnotencouragepricedifferentiationasitwillaffectsalesin thecompany(Horowitz,2006).Pricefixingisconsideredtobeanagreementbetweentwoormore participants in a market. The parties agree to buy and sell products at a fixed price. Also, the partiesdecide to maintain market conditions so as to ensure the price is maintained at a certain level. This enables them to control supply and demand. Price fixing affects customer as most customers are not satisfied with the price (Horowitz, 2006).

**(9) Marketingtominorities.** Marketsinthecountryaredividedintodifferentsegmentsinwhich the residents share similar characteristics (Brenkert, 2008). In this case, ethical issues arise when



ISBN:978-81-957858-1-0

marketing strategies are designed to exploit a market segment occupied by minorities. Most companies may find it difficult to develop marketing strategies that do not encourage discrimination.Thisleadstooffensivepracticeslikestereotypicalrepresentationofthepopulation. The minority groups get poor or dissatisfying services compared to other groups in the country. Also,ethicalissuesarisewhenstoressellpoorproductsandofferpolyproservicestotheminority groups. For example, alcohol and cigar fake advertisements target young children. Another example a mobile phone is used to impress a teen girl by a song ringing on mobile. The adverts affectthechildrennegatively.Also,theadvertstargetminoritygroupsandwomen.Thecompany shoulddevelopmarketingstrategiesthatarenotoffensiveandstereotyping.Mostcompanieshave established rules to govern marketing in the organizations. The rules help prevent the company from facing law suits. This is because the company makes ethical decisions. Also, the rules help ensure customer satisfaction and attract customers.

**(10) Ethicsindistributionchannels**Marketingrepresentativesandsalespersonalsareevaluated according to the amount of sales. This leads to ethical dilemmas as the marketing representatives and sales people go against the marketing rules. For instance, they may pressure the vendors to buy more than they need. This affects the customers negatively and affects sales. Also, the marketing representatives and sales people can force vendors to use their products instead of competitor's products. This is leads to ethical issues in the company. Various products related issue has raised questions about ethics in marketing. The questions are related to quality of products and services being advertised.

**Violation of Ethics**

Despite extensive and thoughtful efforts devoted to marketing ethics in past several decades ,the incidenceforethicalviolationinmarketingpracticesremainhigh(Abela,Murphy,2008).Number of frauds/defaults/scandals get noticed in past decades, which includes political, financial and corporate frauds. For example the group ITC ,Which is better known for its ethics and corporate social responsibility, was charged for FERA violation ,excise duty evasion and share price manipulationin1990's.Anewbuzznowadaysinmarketingethicsisonlineprivacy,andofflabel use of pharmaceuticals.

The incidence of clinical trials without approval in India is the great concern point in same sequence.The unethical trials result death of many of innocent patients and some are fighting for lives. Such incident mostly prevail in countries where the legislation either inadequateor not implemented.TocopeupsuchsituationinU.StheUSfoodandDrugAdministration(FDA) ,ethics section of World Medical Association and European Agency for Evaluation of medicinal products(EMEA) ,decided to set a ethics committee which will provide approval for sales and distribution of drug at global level. Most but notall developing countries have review committee informofresearchinstituteorotherscientificpanel.Theconsequencesofsuchincidencesshould



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be taken as a lesson by the corporate ,so they don't indulge in unethical defaults here are many other violations that exist in day to day life in marketing like

**Stealth Marketing**, also known as undercover marketing, is an aspect of marketing in which consumers do not realize they are being marketed to. For example, a marketing company might payanactororsociallyadeptpersontouseacertainproductvisiblyandconvincinglyinlocations wheretargetconsumerscongregate.Whilethere,theactorwillalsotalkuptheirproducttopeople they befriend in that location, even handing out samples if it is economically feasible.

**Bait and Switch**is a form of fraud, most commonly used in retail sales but also applicable in other contexts too. First, customers are "baited" by advertising for a product or service at a low price, later the customers discover that the advertised good is not available and are "switched" to a costlier product.

Shilling: Paying people to talk about (or promote) a product without disclosing that they are working for the company;impersonating a customer.

Defacement:Vandalizingordamagingpropertytopromoteaproduct. Spam: Sending bulk or unsolicited email or other messages without clear, voluntary permission.

Infiltration: Using fakeidentities in an onlinediscussion to promote aproduct; taking over a web site,conversation,orliveeventagainstthewishesorrulessetbytheproprietor. Comment Spam: Using automated software ('bots') to post unrelated or inappropriate comments to blogs or other online communities

**Do'sandDon'tsfor marketers**

Marketing practitioners must recognize that they not only serve their enterprises but also act as stewards of society in creating, facilitating and executing the efficient and effective transactions that are part of the greater economy. Marketers should embrace the highest ethical norms of practicingprofessionalsandtheethicalvaluesimpliedbytheirresponsibilitytowardstakeholders (e.g., customers, employees, investors, channel members, regulators and the host community).Along with this

1. Marketersmustacceptresponsibilityfortheconsequencesoftheiractivitiesandmakeeveryeffort toensurethattheirdecisions,recommendations,andactionsfunctiontoidentify,serve,andsatisfy all relevant publics: customers, organizations and society

2. Honesty,IntegrityandQualityarefarmoreimportantthanquickprofits(ShelHorowitz)

3. Marketersshouldensurethatproductsandservicesaresafeandfitforintendedusesand communications about offered products and services are not deceptive.



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4. Marketers should not demand, encourage, or apply coercion to encourage unethical behavior in their relationships with others.

5. They should conduct your business so as to build long term loyalty. When you get a customer, youwanttokeepthatcustomerandbuildasalesrelationshipthatcannotonlylastyears,but also create a stream of referral business (Shel Horowitz).

6. Marketers must do no harm. This means doing work for which they are appropriately trained or experiencedsothattheycanactivelyaddvaluetotheirorganizationsandcustomers.Italsomeans adheringtoallapplicablelawsandregulationsandembodyinghighethicalstandardsinthechoices they make.

7Marketers must embrace, communicate and practice the fundamental ethical values that will improve consumer confidence in the integrity of the marketing exchange system. These basic values areintentionally aspiration and includehonesty, responsibility, fairness, respect, openness and citizenship.

Usingthesedo'sanddon't,amarketingorganizationormarketercangethugeprofitsalongwith long term success.

**Conclusion**

There are high awareness level among customers, industries and other stakeholders about ethics inmarketing,theonlyneedtoadherethecodeofethicsbycorporate.Societymustusethelawto define, as clearly as possible, those practices that are illegal, anti-social, or anticompetitive. Companies must adopt and disseminate a written code of ethics, build a company tradition of ethical behavior, and hold its people fully responsible for observing ethical and legal guidelines.

Therearevariousunethicalmarketingpracticesthatexistinmarket.Theseissuesareincreasingin numbersdaybyday.Suchissuescan'tbecurbedtillmarketersshouldertheresponsiblytovanish outthemfromsociety.Inadditionindividualmarketermustpracticea"socialconscience"intheir specific dealings with customers and various stakeholders.

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ISBN:978-81-957858-1-0

# MarketingEthicsintheEraofCut-ThroatCompetition

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**Abstract**

Ethical issues are mostly discussed as a part of social issues, we cannot separate business from society and marketing is an integral part of business. Business ethics is the art and discipline of applying ethical principles to examine and solve complex moral dilemmas. Business ethics is basedontheprincipleofintegrityandfairnessandconcentratesonthebenefitstothestakeholders, both internal and external. Marketing ethics is viewed as important because of marketing's interface with many diverse stakeholders. Marketing usually occurs in the context of an organization, and unethical activities usually develop from pressure to meet performance objectives.Someobviousethicalissuesinmarketinginvolveclear-cutattemptstodeceiveortake advantage of situation. Ethical marketing practices and principles are core building blocks in establishing trust, which help build long-term marketing relationships.This paper is an effort to view that ethics in marketing is not just concerned about bringing out safe product but also concerned about the process of delivering the product- namely how firm advertise, promote, distribute and price the products and examine the areas within marketing of good and bad ethical practices.

**Keywords:** Marketing ethics, take holders, culture, product development, pricing, distribution, advertising.

## Introduction

Thestudyofethicshasbecomeanimportantingredientofthesyllabusofmanagementschoolsin recent years.This is because of ethical issues that have come to the forefront as a result ofmany well-known failures of corporate. ***Ethics reflects a society's notations about the rightness or wrongness of an act***. It is generally described as a set of principles or moral conduct.

The word "ethics" is derived from the Greek word "*ethikos"* meaning custom or character. The *ConciseOxfordDictionary* defines ethicsasthetreatingofmoralquestions.Butthisdefinitionis imprecise&leavesanumberoflooseends.Whosemorals?Whichmoralquestion?Businessethics covers diverse areas ranging from labour practices, free & fair trade, health concerns, euthanasia to animal welfare, environmental concerns, to genetic modifications, to human cloning etc.

Ethics is a branch of philosophy and is considered a normative science because it is concerned withthenormsofhumanconduct,asdistinguishedfromformalsciencessuchasmathematicsand logic,physicalsciencessuchaschemistryandphysics,andempiricalsciencessuchaseconomics and psychology.



ISBN:978-81-957858-1-0

## WHATISBUSINESS ETHICS?

Ethics is a conception of right and wrong behaviour, defining for us when our actions are moral andwhentheyareimmoral.Businessethics,ontheotherhand,istheapplicationofgeneralethical ideas to business behavior.Ethical business behaviouris expected by the public; it facilitates and promotes goods to the society, improves profitability, fosters business relations and employee productivity, reduces criminal penalties from public authorities and regulators, protects business against unscrupulous employees and competitors, protects employees from harmful actions by their employers, and allows people in business to act consistently with their personal ethical beliefs.

Businessethicsisbasedontheprincipleofintegrityandfairnessandconcentratesonthebenefits to the stakeholders, both internal and external. Stakeholders include those individuals and group without which the organization does not have an existence. It includes shareholders, creditors, employees, customers, dealers, vendors, government and the society.

## WHATIS NOT BUSINESS ETHICS?

### Ethicsisdifferentfromreligion

Thoughallreligionspreachhighethical/moralstandardsgenerallytheydonotaddressallthetypes ofproblemspeopleconfronttoday.Forinstance,cybercrimeandenvironmentalrelatedissuesare totally new in the context of most religions. Moreover, many persons today do not subscribe to religious beliefs and have turned agnostics. But ethics applies to all people, irrespective of their religious affiliation.

### Ethicsis not synonymswith law

Generally, a good legal system may incorporate many ethical/moral standards. However, legal system may vary from society to society depending upon itssocial, religious and cultural beliefs. For instance, the United States law forbids companies from paying bribes either domestically or overseas; however in other part of world, bribery is accepted way of doing business. Sometimes law could be unreasonable or even stupid, as for instance, it is illegal in Israel for a hen to lay an egg on a Friday or Saturday! (The Trend Team, Times of India, Chennai, July 7$^{th}$, 2008.)

### Ethicalstandardsaredifferentfrom culture

TheEnglishadage’WheninRome,doastheRomansdo’leadstoanunethicalculturalbehaviour. Some cultures may be ethical, but many of them are not. For instance Indian system of castes reflectsanunethicalstreakinasmuchasittendstotakeforgrantedthatsomepeoplearesuperior to others in God’s creation.

### Ethicsisdifferentfromfeelings



ISBN:978-81-957858-1-0

Our ethical choices are based on our feelings. Most of us feel bad when we indulge in something wrong. But many, especially hardened criminals, may feel good even when they do something good.Mostpeoplewhentheydosomethingwrongforthefirsttime,mayfeelbad,butiftheyfind ittobebeneficialorifitbringsthempleasure,theymaymakeitahabitwithoutfeelinganyregret.

**Ethicsisnotjustacollectionof values**

Valuesarealmostalwaysoversimplifications.Whichrarelycanbeapplieduniformly.Valuestend to be under defined, situational by nature and subject to flawed human reasoning such that by themselvestheycannotassuretrueethicalconduct.Considerthesought-aftervaluesofemployee loyalty.Shouldemployeesbeloyaltoco-workers,supervisors,customers,orinvestors?Sinceitis impossibletobeabsolutelyloyaltoallthefoursimultaneously,inwhatordershouldtheseloyalties occur? Employers who demand employee loyalty rarely can answer this question completely or satisfactorily.

**HONESTY,INTEGRITYANDTRANSPARENCYARETHETOUCHSTONESOF BUSINESS ETHICS**

Ethicalcorporatebehaviourisnothingbutretentionoftheancientwisdomthat‘honestyisthebest policy’.Thedramaticcollapseofsomeofthefortune500companiessuchasEnronandWorldCom orthewellknownauditingfirmAndersonshowedthatevensuccessfulcompaniescouldultimately come to grief, if they do not land on the basic principle of integrity. For every profession “we would think of a code of conduct or a set of values, which has a moral content and that would be the essence of ethics for that profession”. There should be transparency in operations leading to accountability, which should ensure safety and protect the interest of all stakeholders.

**ROOTSOFUNETHICALBEHAVIOUR**

There are certain factors that make the employees think and act in unethical behaviour. Some of the influencing factors are “pressure to balance work and family, poor communications, poor leadership,longworkhours,heavyworkload,lackofmanagementsupport,pressuretomeetsales or profit goals, little or no recognition of achievements, company politics, personal financial worries, and insufficient resources.”

ThestatisticaldataisgivenbyEthicsOfficersAssociationsin2005showhowcertainpracticesor factors contribute to unethical behaviour.

**MARKETINGETHICS –INTRODUCTION**

Marketing ethics is viewed as important because of marketing’s interface with many diverse stakeholders.Marketingisakeyfunctionalareainthebusinessorganizationthatprovidesavisible interface with not only customers, but other stakeholders such as the media, investors, regulatory agencies,channelmembers,tradeassociations,aswellasothers.Formarketers,ethicsinthe



ISBN:978-81-957858-1-0

workplacereferstorules(standards,principles)governingtheconductoforganizationalmembers andtheconsequencesofmarketingdecisions(Ferrell,2005).Therefore, ethicalmarketingfroma normative perspective approach is defined as "practices that emphasize transparent, trustworthy, and responsible personal and organizational marketing policies and actions that exhibit integrity as well as fairness to consumers and other stakeholders (Murphy, Laczniak, Bowie and Klein, 2005). Marketing ethics focuses on principles and standards that define acceptable marketing conduct, as determined by various stakeholders and the organization responsible for marketing activities.Whilemanyofthebasicprincipleshavebeencodifiedaslawsandregulationstorequire marketerstoconformtosociety'sexpectationsofconduct,marketingethicsgoesbeyondlegaland regulatory issues. In addition, the boundary-spanning nature of marketing (i.e. sales, advertising, and distribution) presents many of the ethical issues faced in business today.

Both marketing practitioners and marketing professors approach ethics from different perspectives.Forexample,oneperspectiveisthatethicsisaboutbeingamoralindividualandthat personalvaluesandmoralphilosophiesarethekeytoethicaldecisionsinmarketing.Virtuessuch as honesty, fairness, responsibility, and citizenship are assumed to be values that can guide complex marketing decisions in the context of an organization. On the other hand, approaching ethics from an organizational perspective assumes that establishing organizational values, codes, andtrainingisnecessary toprovideconsistentandsharedapproachestomakingethicaldecisions (Ferrell and Ferrell, 2005).

## EVOLUTIONOFMARKETING ETHICSOVERTHEYEARS

The historical background for marketing ethics is derived from early concerns during the turn of the 20th century concerning antitrust and consumer protection, especially adulterated food products. From the beginning of advertising, there have always been concerns about misrepresentationsandpurposefuldeceptionofconsumers.FrankChapmanSharpstartedteaching a course in business ethics at the University of Wisconsin in 1913 and Sharp and Fox (1937) publishedatextbookonbusinessethics.Thebookwasbasedontheconceptof"fairservice"and the authors stated "it will be possible to reduce our study of fair service to the principles of fair salesmanship" (Sharp and Fox, 1937). The book could have been titled 'Marketing Ethics' and had chapters on commercial coercion, let the buyer beware, the limits of persuasion, fair pricing, andtheethicsofbargaining.Withintheacademichistoryofmarketing,oneofthefirstarticlesthat appearedinthe*JournalofMarketing*wasanarticlebyCharlesF.Phillips(1939)entitled,"Some Theoretical Considerations Regarding Fair Trade Laws." In this article, ethics was not directly addressed,buttheimpactofresalepricemaintenanceoncompetition,especiallychannelmembers and customers, was addressed. The concern was that customers were not receiving information aboutpricesandmightassumethatthequalityofcoffeeofferedbyallstoreswasidentical.Most



ISBN:978-81-957858-1-0

academic publishing in the 1950s focused on issues such as fair trade, antitrust, advertising and pricing.

During the 1960s American society turned to causes. An anti-business attitude developed as many critics attacked the vested interests that controlled the economic and political sides of society—the so-called military-industrial complex. The 1960s saw the decay of inner cities and thegrowthofecologicalproblems,suchaspollutionandthedisposaloftoxicandnuclearwastes. This period also witnessed the rise of consumerism—activities undertaken by independent individuals,groups,andorganizationstoprotecttheirrightsasconsumers.In1962President John F. Kennedy delivered a “Special Message on Protecting the Consumer Interest,” in which he outlinedfourbasicconsumerrights:therighttosafety,therighttobeinformed,therighttochoose, and the right to be heard. These came to be known as the Consumers’ Bill of Rights (Ferrell, Fraedrich, and Ferrell, 2005).

During this period of time, Robert Bartels (1967) contributed the first comprehensive modelforethicsinmarketing.Thisfirstacademicconceptualizationofthevariablesthatinfluence marketing ethics decision making tried to determine the logical basis for marketers to determine what is right or wrong. It presented a schematic plan for analyzing the variables inherent in the ethics of decision making; and provided a framework for social and personal ethics in marketing decisions.Themodeldidagoodjobindelineatingvariablesthatinfluenceethicaldecisionmaking, including participants, cultural influencers, role expectations, and the complexity of ethical decision making. During this same period of time, Richard Farmer (1967) published an article, “Would You Want Your Daughter to Marry a Marketing Man?” that maintained that much of marketing is unethical and irrelevant. This article was received so well that in 1977, Farmer published an article entitled, “Would You Want Your Son to Marry a Marketing Lady?” and in 1987 published another article entitled, “Would You Want Your Granddaughter to Marry a TaiwaneseMarketingMan?”Thetitlesofthesearticlesindicatethatpossiblymarketingethicswas not considered a serious academic research area. The 1967 Bartels article provided a foundation for empirical research that followed in the 1970s.

In the 1970s significant research was conducted to describe the beliefs of managers about marketingethics.Carroll(1975)foundthatyoungmanagerswouldgoalongwiththeirsupervisors to show loyalty in dealing with matters related to judgments on morality. A follow-up study by Bowman (1976) supported these findings. Ferrell and Weaver (1978) provided insights into organizational relationships that influence marketing mangers’ ethical beliefs and behavior. The findings indicated that respondents perceived that the ethical standards of their peers and top management were lower than their own standards. Empirical research in the 1970s set the stage for frameworks that describe ethical decision making within the context of a marketing organization.



ISBN:978-81-957858-1-0

The Ferrell and Gresham (1985) “A Contingency Framework for Understanding Ethical Decision Making in Marketing” emphasized the interaction of the individual and organization, including organization culture, co-workers, and opportunity to explain how ethical decisions are made.Mostofthepropositionsinthismodelhavebeentestedtoprovideagroundedunderstanding of ethical decision making. Hunt and Vitell (1986) “A General Theory of Marketing Ethics” is widelyacceptedandalsoprovidesanempiricallygroundedmodeltoillustratehowethicaldecision makingoccursinanorganization.Researchfollowedinbothmarketingandmanagementliterature that helped test the Ferrell and Gresham and Hunt and Vitell models (Hunt and Vitell, 2005).

In the 1980s, business academics and practitioners acknowledged business ethics as an important field of study. Industry developments, such as the Defense Industry Initiative on Business Ethics and Conduct, established a method for discussing best practices and working tactics to link organizational practice and policy to successful ethical compliance. In the 1990s, the government also provided support and rewards for ethics programs through the Federal Sentencing Guidelines for Organizations, approved by Congress in 1991. The Guidelines broke new ground by codifying into law incentives to reward organizations for taking action to prevent misconduct.A special task force provided a report for updating and refining the guidelines in 2003(UnitedStatesSentencingCommission,2003).In2005,afederalamendmenttotheFederal Sentencing Guidelines added oversight of ethics and compliance programs to the responsibilities of board of director positions. The amendment places more responsibility on board members to monitor and audit ethics programs, including marketing ethics.

While the regulatory system was developing incentives for ethical conduct in organizations, Hunt, Wood and Chonko (1989) conducted research demonstrating a strong link between corporate ethical values and organizational commitment in marketing. Their corporate ethicalvaluesscaleiswidelyusedinorganizationalethicsresearch.GundlachandMurphy(1993) build a normative framework for relational marketing exchanges based on the ethical exchange dimensions of trust, equality, responsibility, and commitment. They develop foundational understandingoftheinterrelationshipofethicsandlawinmarketingexchange.Thisisasignificant contribution becausesomeobserverstaketheperspectivethat the legal and ethical dimensions of exchange are independent. They conclude that ethical marketing exchanges require a managerial emphasis on ethical corporate culture, ethics training programs, and on ethical audits.

Dunfee,SmithandRoss(1999)suggesttheneedforanormativeframeworkformarketing ethics. Integrative Social Contract Theory (ISCT) links the decision-making process, multiple communities, hypernorms, and ethical judgments based on the dominant legitimate norms. This frameworkcan be used forresolving ethical issues that arise among different communitiesand is significant because marketers frequently engage in boundary-spanning relationships and cross-culturalactivities.Thisnormativeframeworkissignificanttomarketingbecauseitemphasizesthe



ISBN:978-81-957858-1-0

exchangerelationshipbetweenthe firm anditsstakeholders,including the righttoexist and even prosper in society. This theory can be used to bridge normative and descriptive research in marketing ethics (Dunfee, Smith and Ross, 1999).

As the 21st century arrived, ethics in the world of business became a major issue with scandalsassociatedwithEnron,WorldCom,Tyco,Qwest,Sunbeam,andArthurAndersen.While most of these scandals were associated with accounting fraud, in many cases companies such as Sunbeam, using inventory sales shifting strategies (buy and hold), relied on salespersons to help implement the fraud. These activities resulted in the passage of the Sarbanes-Oxley Act in 2002, which is the most far-reaching change in organization control, corporate governance, and governmentoversightsincetheSecuritiesandExchangeActof1934.Duringthistimeperiod2000 to2006the*JournalofMarketing*publishednoarticleswiththewordethicsinthetitle,butarticles did appear dealing with ethical issues (Klein, Smith and John, 2004). There is still a need to continue both theory development and empirical testing of theories of ethical decision making in marketing.

**ETHICSINCONTEXTOF4PS**

**I) Ethicsin productdevelopment**

Theproductsandserviceshavetobesafe.Thentheymustbefitfortheirindeeduse.Themarketer must disclose all substantial risks associated with product and service usage.

Marketercanbe‘suggested’toturntomakecurrentproductsafer.Such‘suggestions’canbefrom consumer opinion, public outcry, government sanctions, or even competitors moves, etc. for instance:

- Saferproductfromconsumeropinion,bywayofchangespreferences.Thesecouldbeinterms of lighter Diet Coke etc.
- Governmentimposeshighertaxesfornon-filteredcigarette.Thisforcesfirmstofocusmoreon filtered cigarettes.
- Public outcry and court intervention forced Delhi Transport Corporation to introduce safer buses. Itnow increasinglypliesbusesthat runon alternative fuelslike compressednaturalgas (CNG) instead of diesel.

Therearemanycasesofmarketersofmakingproductsaferormarketingsaferalternativesontheir own volition. For instance:

- Childlocksin doorsofcars;airbags incars etc.
- Child-proofbottle lids forproductsthosearedangerous to children.



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- De-materialization of physical shares into electronic form to prevent theft and secure other benefits.
- Manyproductshavemovedfromplastic bottlestotetra-packs thatareenvironmentally safer.

Safety is a concept that requires constant renewal of its meaning to understand the full impact in the sense of marketing ethics. For instance, in India, these marketing actions go on whether it is unethical or illegal or both:

- 'Appy Fizz' apple juice is packed in a bottle that resembles a champagne bottle. Children can get carried away by such packaging that paves way of easier adoption of alcoholic drink later, another such example is candy designed like a cigarette.
- Mostpublicandprivatetransportvehiclescarrymorepassengersthantheirstipulatedcapacity.
- Mono-sodium-glutamate, MSG, is a flavour enhancer in many products. It is known to have many adverse reactions, including stomach upset to allergy. In India, this product is known as '*aginomoto*' most commonly used in chowmin, but is in fact a brand of MSG.
- Some motorbikes brands tout its racing capacity as its unique selling proportion (USP). It is knownthatmostmetropolitantrafficcannotbearsuchhighspeed-eitheritisimpossibledueto heavy traffic or it is likely to be unsafe for user.
- Several agricultural products use harmful chemicals. Sometimes they are also genetically temperedfortaste,varietyandabundanceinproductionandmarketedwithoutcarefulstudyof its side effects on consumption.

**II) Ethics inPricing**

Cost is a fact, price is a fiction. Price is the money a consumer is to pay for the value of goods and services. Not engaging in price fixing, or practicing predatory pricing, and disclosing the fullpriceassociatedwithanypurchasecanbeconsideredethicalmarketing.Thefollowingare often considered unethical:

- Increaseprices andthen discount-engageinbogus'sale'.
- Introductiondiscountfor newcustomers. *Reader'sDigest* oftenresortstosuchpricing.
- Highpricesforcaptive customersoronrenewalforexisting customers.
- Lowproduct pricebut veryhigh servicecosts. For instance; washing machines that cost about Rs.10,000 but whose annual maintenance contract (AMC) cost about Rs.2,000. If there is no AMC,thenitmaycostaboutRS.750foramerevisittodiagnosetheproblem;additionallyone would have to pay for the spares purchased.



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- High prices during shortages. For instance: many vegetable vendors would chargehigh prices on old produce during transport strike.
- Predatory pricing- Too heavily discount the offering, and drive competitors out of business- then hike prices.
- ManyretailerspassoffproductsaboveMRP.
- Mostautorickshawsdemandhighfares,regardlessoflegalfaresthattheyareallowedtocharge.

**III) Ethicsin Distribution(Place)**

Distributionismanagingtheforwardflowofgoodsandservicestotheconsumerandreverseflow ofmoneyfromtheconsumer.Distributionismanagedbyanorganizednetworkofagenciesand institutions. Not manipulating the availability of a product or service for the purpose of exploitation and not using coercion or undue influence in the marketing channel are certain normsofethicalmarketingaction.Thereversecanalsobeconsidered;alargechannelorretailer can coerce a manufacture to consider unethical terms because of its large consumer base.

- Majorfirmscoercivelypushaslowmovingproductalongwithafastmovingonetotheretailer.
- Firmsoftenhavedirectsalesdepartmentsthatbypassestablished retailers.
- Manyretailerssell productsthathavecrossedexpiry date.
- Mostdrugstoreswouldgiveinnumerabledrugswithoutprescriptionfroma qualifieddoctor.
- Productaremovedinunsafevehicles-forexample,cookinggascylindersaremovedinvehicles that are not designed to carry them and often they lack fire safety equipment in case of emergency.

**IV) Ethics inPromotions**

H. G. Wells once commented *“Advertising is legalized lying”.* Advertising uses media like the print, TV, radio, billboards, etc. Ethical marketing action is avoiding false and misleading advertising. Concerns are about puffery, exaggerations, concealment of information, and psychological manipulation.

- Surrogateadvertising
  - Mostliquorfirmscarryadsofproductslikegolfingequipment,applejuice,orsodawaterwith prominentdisplayofthenameoftheliquorbrandwithoutanyreferencetoliquor.ITCwithdrew fromsponsoringtheIndiacricketteamthroughitsWillsbrand;reasonsapparentlyareofethics.
  - PanParag,Chutki,andRajnigandhaarebrandsofpanmasala(non-tobaccobased)andgutkha (tobaccobased).Thesebrandsarefreelyairedonallmediawithoutadequatelydifferentiating



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between tobacco or non-tobacco versions. Health minister does not opine such ads as surrogate advertising.

- Using irrelevant attributes in ads: Nirma used to promote its washing cake with the tagline ‘Zyada jhaag, zyada safedi’- more froth, more whitening capabilities. When it was pointed out that frothing in no manner enhances product performance. Use of irrelevant attributes in ads abound. The italicized attributes here below are irrelevant
  - Polo, a mint with a *hole*
  - Pears*transparent*soap.
  - Fair&LovelyFairnessSoapwith *fairnessbeads*.
- False claims:ManyB-schoolsclaims100 percentseventhoughin truth many seatsmight have been filled through not so ethical means.
- Use of deception: Some opine that IIPM, a B-school with branches in several cities in India, usesinitsadsgoodrankingofanyoneofitsbranchesasifitwererankingforallitsbranches.
- Advertisingtochildren:Issueshereareverycomplicatedandimmenselyserious.
  - Averagechildrenundertheageof 5 cannotdistinguishbetweencommercialsand programs.
  - Advertisements directed to children under eight are inherently unfair, as children are unable to evaluate product claims and they trust the source of claim.
  - Children can be mislead or deceived by technique (size, shape, speed, performance) used to display product to best advantage.
- Affecting values of a society: Consider the ad for Hyundai Santro’s Zip Drive that featured popularcineactorShahRukhKhan,zippingzig-zagtobeaheadofaheavytraffic.Obviously, the brands fail to convey the importance of orderly and lane driving.
- Use of sexual themes: Consider the brand ‘FCUK’, originally ‘French connection United Kingdom’ vendor of youth fashion, shoes and fragrance. It is known for controversial ads in publicplaces.Forinstance,afullpageadblared—“World’sBiggestFCUK”,announcingthe opening of its biggest store to date.
- Useoffearappeals:
  - Life insurance firms often use fear appeals targeted at women suggesting dire consequences upon the husband’s death lest one is not insured.
  - A popular fairness cream brand promotes itself by using the fear of rejection at an interviewmerely because one is dark skinned.



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- Doctors prescribe high priced medicine promoted by salesmen backed by gifts and commissions.

**BEYONDTHE FOURPS**

Marketingethicsgoesbeyondthefour Ps-productdevelopments,pricing,placing,andpromotion. Afew moreaspectsarediscussed here under.

- Keepingtheinformationaboutthestakeholderconfidential.
  - Cases where banks sells its customers list containing phone numbers and addresses to a communications firm that makes a contact by phone or mail to market its product.
  - Somelargefirmsoftenpasstheirclientlisttootherdivisionsforcross-sellingorup-selling.For instance,abank'sinsurancedivisionmaydipintothecreditcard'scustomerlistforprospecting. Oneor two such stray calls may not be uncomfortable to a customer; but consider a bank with ten different divisions and each dipping into the same list of prospecting. ICICI bank recently announcedthatifitscustomerswantprivacy,theymaylogintotheirWebsiteorwritetothem for exclusion from such prospecting.
- Inmarketingresearch/intelligence,itwouldbeethicalto
  - Not subject respondents to undue mental stress in the name of research; it should not have permanent damage to any faculty of the respondent;
  - Maintainintegritybynotmisrepresentingoromittingpertinentresearchdata;
  - Not hires competitor's employees or induce competitor information by corrupting the competitor's employees. The latter is unethical gathering.

**CONCLUSION**

Marketing ethics denotes expressed and unexpressed standards of fair and ethical dealing in marketing which conscience of the community may progressively develop over time. Marketing ethicswouldincludeknowledgeofmarketingethics,theabilitytoidentifythesituationsofethics infractions in practice, and motivation of disseminate such knowledge. Unfortunately in India, widespread corruption, low social moral standards, archaic laws, inept government, slow judicial process, lack of competition, lackadaisical consumers and the way B-schools train students with marketers' prospective leaves little room for ethical capacity in the marketing to foster. Ethics in marketing would include making safer products, not using deceptive or misleading advertising, notindulginginhardsell,notusingcoerciononchannelpartnerstopushproduct,andnotengaging inpricefixing—inshort,fairandhonestdealingthathavethecustomers'andotherstakeholders' interests in mind.



ISBN:978-81-957858-1-0

Toexistandbesuccessfulincompetitiveworld,businesshastobeethical.Moralorethical behaviour should come from within and should be driven by examples of top management. Managers have to reconcile divergent values and modify them if necessary. Organization should workonsynergyanddelegationwhichwillbringallroundprogress.Nowadays,companiesadopt innovative tools to communicate their ethical culture as a response to the changing business environment.

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ISBN:978-81-957858-1-0

# MarketingEthicsintheWakeofConsumerism:Issuesto Ponder

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**Abstract**

Gonearethedays when MNCs weremerely interestedin profiteering(exploiting theconsumers) with their poor products and services. Now, there is a growing trend among marketers and professionals(IndianMarketersandMNCsoperatinginIndia)ofrealizingtheimportanceofethics inmarketingand theirroleinconductingthebusinesswhichtakes careofthesociety'sinterest at thesametimeoptimizingtheprofitoftheirorganizations.ThisPaperexplainstheconceptofEthics in Marketing and Identifies and Analyses the importance of ethical issues in marketing of the products & services at various stages of the production and marketing.

**Keywords:** Conflict, Stakeholders, Consumerism, Profiteering, Delivery Channels, Ethical Values.

## Introduction

Business ethics is a form of applied ethics that examines ethical rules and principles within the commercial context. Ethics refers to value oriented decisions and behavior. Ethics comes from a Greekrootanditmeanscharacter,beliefs,standardsordealswhichpervadeacommunity,agroup or people. Today ethics is the study of moral behavior. Terms such as Business ethics, corporate ethics and legal ethics indicate its application in different areas.

Ethicsreferstowhatisrightandwhatiswrong.Itisnormativeandprescriptivebutitisnotnatural. It answers the questions what ought to be. Today business firms are paying more and more attention to ethical concerns because of the following reasons:

1. **Moral Consciousness**: in the present scenario, firms feel more socially responsible and morally concerned about the wellbeing of the society.
2. **LongtermsurvivalandGrowthofbusiness:**Businessfirmshavingethicalconcernstendto have the long term survival and growth of business.
3. **Social pressure:** social pressure exerted upon the firms by the community, competitors, peer groups, govt. and other related agencies etc force them to behave more ethically.
4. **LegalPerspective:**LegalaspectsincluderegulationsbytheGovt.,CentralandStateagencies, financial institutions etc. which force the firms to adopt ethical behavior in their conduct of business.

The practice of following ethics has been increased in the last decade because the consumer as well as seller has been aware about his rights. **Consumerism** is concerned with broadening therightsofconsumers.Theconceptsofsocialresponsibilityandconsumerismgohand-in-



ISBN:978-81-957858-1-0

hand. If every organization practiced a high level of social responsibility the consumer movementmightneverhavebegun.Consumerismisastruggleforpowerbetweenbuyersand sellers;specifically,itisasocialmovementseekingtoincreasetherightsandpowersofbuyers in relation to sellers.

Seller'srightsandpowersarepresentedinthefollowinglist:

- Tointroduceanyproductinanysizeandstyletheywishintothemarketplace,solongasitis nothazardoustopersonalhealthorsafetyorifitishazardous,tointroduce itwiththeproper warnings and controls
- Topricetheproductatanyleveltheywish,providedthereisnodiscriminationamongsimilar classes of buyers
- Tospendanyamountofmoneytheywishtopromotetheproduct,solongasthepromotionis not defined as unfair competition
- To formulate any message they wish about the product provided that it is misleading or dishonest in content or execution
- Tointroduceanybuying–incentiveschemestheywish In

contrast, here are buyers' rights and power:

- Torefusetobuyaproductthat isofferedto them
- Toexcepttheproducttobesafe
- Toexpecttheproduct toessentiallymatchhowthesellerrepresented it
- Toreceiveadequateinformationabouttheproduct

Itisinthebestinterestof marketersto understandthelevelofconsumerstandardsandthenature of consumer perceptions, as well as what is required to foster realism and accuracy among consumers. The unethical behavior may lead to the following-

**MarketingEthics**

Marketing serves customers' expressed and talent needs with appropriate products/services at affordable price, accessible selling point with the right combination of features and benefits.

Marketingethicsinthewakeofconsumerismisviewedimportantbecauseofmarketing'sinterface with many diverse stakeholders. Marketing is a key functional area in the business organization thatprovidesavisibleinterfacewithnotonlycustomers,butotherstakeholderssuchasthemedia, investors, regulatory agencies, channel members, trade associations, as well as others.

The Gamut of operations covered by the marketing are wide and include pricing, distribution, advertising,salespromotionandcustomerrelations.Eachoftheseprovidesamplescopeto



ISBN:978-81-957858-1-0

meet thecustomers'expectations with therightvalueproposition. However unethical marketing practices are not uncommon.

## DamagingEffectsofUnethicalMarketing

- **Damagingpersonalautonomy**.Thevictimofmarketinginthiscaseistheintendedbuyerwhose right to self-determination is infringed.
- **Causing harm to competitors**. Excessively fierce competition and unethical marketing tactics are especially associated with saturated markets.
- **Manipulatingsocialvalues**.Thevictiminthiscaseissocietyasawhole,ortheenvironmentas well.
- **Marketing has a major impact on our self-images**, our ability to relate to one another, and it ruins any knowledge and action that might help to change that climate.
- **Marketing/AdvertisingCreatesArtificialityAndInfluencesSexual Attitudes**

## LiteratureReview

- **Dr. Surendra Sisodia (2010**) pointed out that properly practiced creativity can make one Advertisement do the work often. When this happens, Clients become more profitable and in return they give back to the society.
- **Professor Nawab Ali Khan and Dr. Mohammed Asif Khan (2009)** are of the opinion that wholehumansocietyhas progressedby followingcertain ethicalvalues andprinciples. Indian Culture and heritage is unparallel in this respect. There are no universal ethical standards as such.Butallreligionshavesomuchonethicsandvaluesthatiftheirfollowersactupononlya handful of principles, this world would become a paradise**.**
- **Ashish Mathur & Dr. Meeta Nihalani (2011)** stresses that the industry can take advantage by offering high values of Respect and trust so as to enhance the relationhip with the customers.
- **P.S.S.Kumar&Dr.B.Kuberudu(2011)**areoftheopinionthatCorporateSocialResponsibility isnotlimitedonlytothemajorcorporate.Foreverysmallorbiglevel,NationalorInternational – from a Pan Broker to Conglomerate- Social Responsibility is a must. Organizations should restructurethesystemstoevolveintoavaluebasedorganizationratherthanwealthmaximizing money machine.

## EthicalConflictFacedbytheMarketers:

Marketersmustbeawareofethicalstandardsandacceptablebehavior.Thisawarenessmeansthat marketers must recognize the viewpoints of three key players: the company, the industry, and society.Sincethesethreegroupsalmostalwayshavedifferentneedsandwants,ethicalconflicts



ISBN:978-81-957858-1-0

are likely to arise. Ethical conflicts in marketing arise in two contexts: First, when there is a difference between the needs of the three aforementioned groups (the company, the industry, and society) a conflict may arise. Second and ethical conflict may arise when one's personal valuesconflictwiththeorganization.Ineithercase,a**conflictofinterest**isapossibleoutcome.

Anexampleofthefirsttypeofconflictisthetobaccoindustry.Cigaretteshaveformanydecades beenalucrativebusiness.So,cigaretteandtobaccomarketinghavebeenforcompaniesandgood forthetobaccoindustry.Manythousandsofpeoplearoundtheworldareemployedinthetobacco industry. So, the world economy has been somewhat dependent on cigarettes and tobacco. However, cigarettes are harmful to society. There is documented proof that cigarette smoking is harmful to health. This is an ethical conflict for cigarette marketers.

An example of the second type of conflict, when one's personal values conflict with the organizations occurs when a leader in the company seeks personal gain (usually financial profit) from **false advertising. "**Cures" for fatal diseases are one type of product that falls into this category of ethical conflict: In their greed to make a profit, a marketer convinces those who may bedyingfromanincurablediseasetobuyaproductthatmaynotbeacure,butwhichadesperately illperson(ormembersofhisorherfamily)maychoosetopurchaseinanefforttosavethedying family member suffering. Promoting and marketing such products violates rules of marketing ethics.

## EthicalIssuesinMarketing

### EthicsinProducts/Services

1. **Offering the products/ services against broader interest of the society**: Not every product is useful to all. Some products cause harm to others like cigarettes. Passive smoking is proven health hazard for the non-smokers. Firms attempt to expand the market by launching a wide range of products. For example tobacco based products are not only restricted to cigarettes only but they cover zarda, bidis, pan masala, cigars etc.
2. **Targeting inappropriate audiences:** The consumption of some products is meant for a particularaudience.Marketersofsomeproductcategoriessuchascigarettes,alcoholicbeverages and condoms etc. need to exercise restraint in their marketing communication and distribution.

### Ethics inPricing

1. **Bidrigging**isaformoffraudinwhichacommercialcontractispromisedtoonepartyeven though for the sake of appearance several other parties also present a bid. This form of collusion is illegal in most countries and is followed in Govt. Contracts to a greater extent in India.



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2. **Dumping**isdefinedastheactofamanufacturerinonecountryexportingaproducttoanother country at a price which is either below the price it charges in its homemarket or if it can be proven that there has been a substantial increase of a specific good;
3. **Pricediscrimination**or**pricedifferentiation**existswhensalesofidenticalgoodsorservices are transacted at different prices from the same provider.
4. **Price war** is a term used in economicsectorto indicate astate of intense competitiverivalry accompaniedbyamulti-lateralseriesofpricereduction.OneCompetitorwilllowerits price, and then others will lower their prices to match. If one of them reduces their price again, a new round of reductions starts.
5. **Supra competitive pricing** It may be indicative of a business that has a unique legal, technology advantage or competitive advantage, or possibly anti competitive behavior that has driven competition from the market.
6. **Pricefixing** is an agreement between participants on the samesidein amarket to buy orsell aproduct,service,orcommodityonlyatafixedprice,ormaintainthemarketconditionssuch that the price is maintained at a given level by controlling supply and demand. The group of market makers involved in price fixing is sometimes referred to as a CARTEL.

**Ethicsinadvertisingandpromotion**

- **DeceptiveSalesPromotion:**Oneoftheunethicalmarketingpracticesistoconcealtheterms andconditionsusedbythefirmsintheirsalespromotioncampaign.Termsandconditionsare printed in a very small font, containing the eligibility details. Another malpractice is to promise benefits but the winner has to shell out some money to avail those benefits.
- **MakingfalseclaimsintheAdvertising:**Asurfeitofbrandsinthemarketplaceputspressure andlimitedwaysofdifferentiatingfromcompetingbrandspromptsadvertiserstoinflatetheir product benefits. Exaggerated claims have become so common that mature audience feels being cheated and takes it with a pinch of salt.
- **Rampant degrading of Competitors'products:** it is another unethical practice in the area of advertising and mostly followed by hard core competitors.
- **Issues over truth and honesty:** In the 1940s and 1950s, tobacco used to be advertised as *promoting* health. Today an advertiser who fails to tell the truth not only offends against morality but also against the law. It is mandatory to mention on all tobacco products that , " Smoking or Chewing tobacco is injurious to health."
- **Issues with violence, sex and profanity:**Advertisements related with these issues may affected people greatly especially teenagers and youngsters.
- **Issues including dangerous actions:** This may be imitated by the young children and adolescents.Itismandatoryonalltheadvertisementsinvolvinganykindofrisktomentionthat these acts are performed under specialists'supervision and should not be imitated.



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- **Negative advertising techniques:** Such as attack ads. In negative advertising, the advertiser highlights the disadvantages of competitor products rather than the advantages of their own.

**Ethics in Delivery Channels**

1. Direct Marketing is the most controversial of advertising channels, particularly when approachesareunsolicited.TVcommercialsanddirectmailarecommonexamples.Mobileads and telemarketing affects the ethics and legality more strongly.AMWAYis an example of a company which marketed itself and its entire product range solely on an ethical message.
2. Fake reviews may be published by the companies and misuse of delivery channels is not very uncommonintheorganizations.ForexampleShillsareprimarilyformessage-delivery,butthey can also be used to drive up prices in auctions, such as Ebay auctions.

**ControversialMarketingStrategiesAssociated withtheInternet:**

**Search engine optimization**: **SEO** is the process of improving the visibility of a website or a web page in search engines via the "natural" or un-paid ("organic " or "algorithmic") Search results. Other forms of search engine Marketing (SEM) target paid listings. more frequently a site appears in the search results list, the more visitors it will receive from the search engine's users.

- **Spyware/Adware**:**Spyware**isatypeofmalwarethatcanbeinstalledontheComputers,and which collects small pieces of information about users without their knowledge.The presence ofspywareistypicallyhiddenfromtheuser,andcanbedifficulttodetect.Typically,spyware is secretly installed on the user's Personal computers. **Ad ware**, or **advertising-supported software**, is any Software package which automatically plays, displays, or downloads advertisements to a computer. The object of theAd ware is to generate revenue for its author

**RoleofMarketingEthics**

Marketingmanagerscannotmotivateemployeesorcoordinateimplementmarketingstrategies without effectivecommunication about values, standards and expectations. Communication is important in marketing for ethical standards and activities across the functional areas of business.

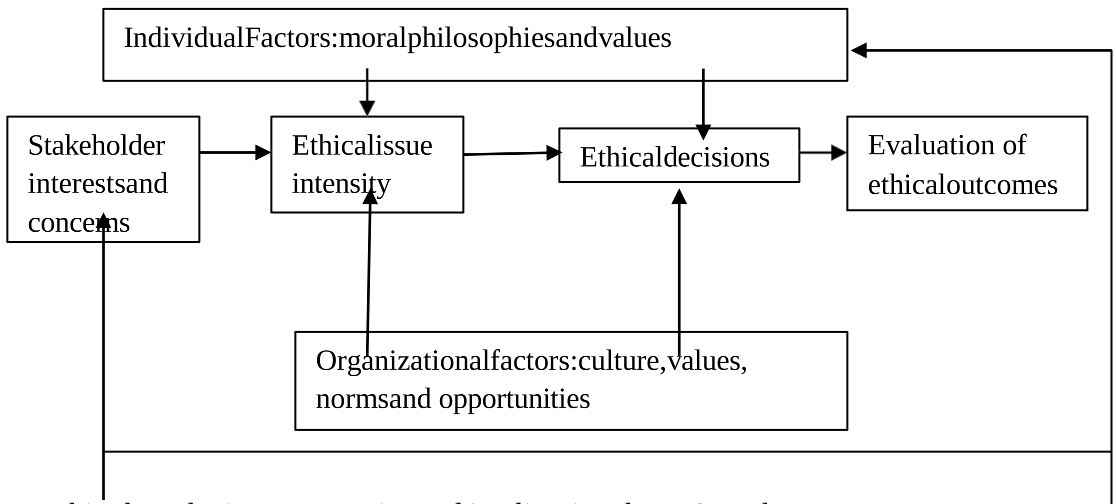
No marketing strategy can be implemented without complete understanding of its objectives and employee cooperation to make it work.

Employees need guidance on where to go for assistance from managers or other designated personnel in resolving ethical problems. To communicate ethical values and implement an effective ethics program, there must be interaction including monitoring, reporting and answering concerns and questions about issues and events.



ISBN:978-81-957858-1-0

**FrameworkforUnderstandingOrganizationalEthicaldecision-making**




*Source:EthicalMarketingPerspectiveandApplicationsby K.Suresh*

**Goodwill:AMarketing Asset**

Goodwillisoneoftheorganization’sgreatestintangibleassets.Thevalueofapositivereputation isdifficulttoquantifybutitisanimportantintangibleassetthatallmarketersunderstand.Asingle negative incident can influence perceptions of a corporation’s image and reputation instantly and for years afterwards, affecting sales and customer relationships.

When worms were found in the Cadbury’s chocolates, company’s reputation was tarnished.This blunder created a major harassment for a renowned company and it took several months for the company to rebuild its corporate image again.

Similarly when United Parcel Service lost a cardboard box containing computer tapes with personal information about 3.9 million city group customers, both companies’reputation were at aslack.Theincident involves the names, social security numbers, account numbers and payment history of all of City group’s US Customers.

“Marketers have to take the responsibility in protecting customers as well as employees, private information or they risk reputation crisis.”

Reputation or Goodwill is tied to perceptions of the corporate image, brand and (mental) associations in the minds of key stakeholders. Other factors which influence the corporate reputationincludesindividual’sexperienceswiththecompany,subjectivejudgmentsofcorporate actions(orinactions),assessmentofresponsibilityandculpabilityfornegativelyperceivedevents.



ISBN:978-81-957858-1-0

Positive reputations develop slowly and incrementally. On the other hand, damage to a positive reputation can occur very quickly. We have seen this happening with the Satyam, Enron, City Group and Walmart.

When NIKE claimed no responsibility for the subcontractor's poor working conditions and extremely low wages, some consumers demanded greater accountability and responsibility by engaging in boycotts, letter writing campaigns and public service announcements etc. NIKE ultimately responded to the growing negative publicity by changing its practices.

## Conclusion

Over the past few years, the overall perception about business has changed. High profile frauds haveshakentheconfidenceofpublicinbigcorporateentitieslikeSatyamscam,CommonWealth Scam etc. Unethical practices are abounding across all disciplines and industries, be it manufacturing, accounting or marketing.

BecauseMarketersengageinbehaviorsimpactingmanyvariedstakeholders,theirpotentialtodo harm and opportunity to have a very positive impact is great. In identifying needs in the market place,marketingmanagershavethe opportunitytoaddresswaystoimproveourlives.Inventions in new drugs, cars with improved safety and fuel efficiency, smaller and more efficient technologies etc. all have the potential to improve the quality of life.
Thecausesforunethicalmarketingpracticesrangesfrominadequateregulations,loopholesinthe implementation of mechanisms, lack of Govt. initiatives, lack of industry level initiatives and absence of internal policies to promote ethics.

Most corporations have developed comprehensive codes of conduct that address specific ethical risk areas in marketing practice. Recent regulatory changes that require boards of directors to be responsible for oversight on all ethics issues within an organization elevate the importance of marketing ethics. It is clear that marketing ethics is part of organizational responsibility and individualscannotmakeindependentdecisionsaboutappropriateconductatleastinthiserawhere consumer knows his rights and options very well.

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ISBN:978-81-957858-1-0

# NeedtoExpandtheEthicalStandardsofHumanResourceManagement

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**Abstract**

Theverynotionofhumanresourcemanagement–thathumansshouldbemanagedasresources– is ethically wrong. The management of humans as a form of 'resource' risks the humanness, dignity,rightsandlibertyofthosewhoaremanagedand alsoputatrisk thevirtue,autonomyand moral well-being of those who manage them. Such issues and matters remain hidden in the research literature despite the growth of human resource management as a management practice and a scholarly field. In fact there is a dire need of considering ethics in the work place which is essential for sound decision making.Every organization has its own values, ethics and moral principles. In the course of executing and communicating HR decisions, organizations have the potentialtochange,shape,andredirectorfundamentallyalterthecourseoftheiremployees'lives. Thehighsoundingethicalprinciplesmaybementionedinwordbutarehardlyputintoaction.This researchexplorestheethicalpracticeswhicharetobefollowedinorganizationsonthepartofthe employer on the one hand and on the part of the employee on the other. The objective is to bring into light the important factors that determine the ethics in the organizations.

## Introduction

**"**Human resource management encompasses those activities designed to provide, motivate and coordinate the human resources of an organization". (1)" Human Resource Management is concernedwiththewayinwhichorganizationsmanagetheirpeople."(2)Itcoversawiderangeof ideas, approaches, and techniques for managing and improving relationships and performance in organizations. Incessant competition has caused innumerable problems to the human resource departmentsofalmostalltheorganizations.Asthenamesounds,thehumanrecoursedepartments areexpectedtoorganizethehumanresourcesinanefficientwaytoenhancetheirproductivityand aretobringqualitativeimprovementinthembutinsteadofittodaythesedepartmentslargelyaims athumanexploitationtosuchanextentthatemployeesdarenoteventochangetheirorganization asthesameexploitationisbeingpracticedinmostoftheorganizationsirrespectiveoftheirregion or place and the nature of work they offer. In taking out the best among employees they forget to treat them as humans and as living and breathing individuals with brimming up emotions. This research presents a study of ethical and moral behavior that organizations should follow. Instead of setting the things right they should do right things.

## Discussion



ISBN:978-81-957858-1-0

Managing ethics in the work place is essentially important. Ethics refers to a system of moral principles- a sense of right and wrong, good and evil, and just and unjust actions. In the words of Garrat–"Ethicsisthescienceofjudginghumanendsandtherelationshipofmeansofthoseends. Insomewayitisalsotheartofcontrollingmeanssothattheywillservespecificallyhumanends." "Managersineverysocietyareinfluencedbythreerepositoriesofethicalvalues:religion,culture and law. These repositories contain unique systems of value that exert varying degree of control over managers."(3) Ethical values are a mechanism that controls human behavior; give them wisdom to take genuine and sincere decisions in business and as well as in other walks of life. Ethicalrestraintsaremoreeffectivethanotherphysicalorlegal controlsastheytestthedecisions on the touchstone of moral values. Ethical values channel individual energy into pursuits that are benign to others and beneficial to the society. Ethics corresponds to basic human needs and managing ethics is an on going process which should be integrated with other management programmers and practices**.** Explicit elements of a corporate ethics program include the things whichanorganizationsaysitbelievesin,andtheeffortsaremadetocommunicatethoseprinciples directly. Most of the text in these codes is concerned with the duty and the responsibility of the employee to the company. "The code of ethics must become a written statement in a firm, which getssuperimposedasthefirm'svision,missionandgoals"(4).Itseemsthatthemainobjectiveof a corporate code is to protect the organization from the unethical behavior of the employees and to promote humanity and harmony among individuals' in spite of the difference in race, background, and beliefs. Honesty, fairness, respect and mutual understanding can all be included and developed within that code of conduct which states the very methodology of working of an organization. The purpose of this Code of Conduct is to:

a) Motivate the employees of the company to follow the high standards of honesty, integrity and the ethical code of conduct.

b) Entrust in them enthusiasmto protect and guardthe interests of employees, customers,suppliers, and creditors.

c) Guideemployeesinfollowingthepracticesconsiderednecessarytomaintainconfidencein the Company's integrity.

d) Achieveresponsibleuseofandcontroloveralltheassetsandresourcesemployedor entrusted.

e) Setoutresponsibilityofemployeesto reportandinvestigateany reportedviolationsofthis code or unethical or unlawful behavior.

This Code of Conduct helps in creating confidence among the Company's customers, shareholders, suppliers and the society at large with respect to the dependability and sincerity of theCompany.Atthesametimeitisequallyimportantforaccompanyoranorganizationto



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incorporatethesame codeofethics at theemployeelevel so that theirgrowth and welfare should also be promoted.

Corporate Social responsibility is a concept that facilitates the employees for their multi dimensional development by endeavoring to make a positive contribution to the underprivileged communities by supporting a wide range of socio-economic, educational and health initiatives. It is an integrated approach towards the upliftment of the whole of society by adhering to the rules and regulations which benefit these employees in particular and society at large. The World BusinessCouncilforSustainableDevelopmentin itspublication"MakingGoodBusinessSense" byLordHolmeandRichardWattsusedthefollowingdefinition.“CorporateSocialResponsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of thelocalcommunityandsocietyatlarge.”CorporateSocialResponsibility*(CSR)is*aboutbusiness which indirectly contributes towards the greater good of the society. An essential component of our corporate social responsibility is the care for the community. It respects cultural differences and finds the business opportunities in building the skills of employees, the community and the governing society. Initiatives are supposed to be taken for achieving an ethically and socially responsible organizations which includes

(a) Leadingby example,

(b) Establishingwrittencodesof conduct

(c) Developingformalmechanismfordealingwithethicalproblems,and

(d) Providingtraininginethics.

Sociallyresponsibleactscanbe

(a) Creating apleasant workplace,

(b) Reducing and bridging disparities in income among the same level of employees within the organization,

(c) Safeguardingthe environmentand

(d) Engaginginphilanthropy.

Followingethicsin anorganizationensuresthateveryone

(1) Shouldrecognizesituationsthatmightrequireethicaldecisionmaking;

(2) Shouldunderstandthevaluesandcultureoftheorganization; and



ISBN:978-81-957858-1-0

(3) Shouldevaluatetheimpactofethicaldecisionsonthecompany'soverallgrowthanditsfuture prospects.

The fundamental basis of corporate governance and its responsibility in the wake of the ethical standards includes -

1. Itshumanresourceprinciples—respectanddignityforall.

2. Itsdedicationtoaccurateandtransparentaccountingandfinancialstandards.

3. Itsconcern fortheenvironment,and sustainabledevelopment forthefurther growth.

4. Itsoverridingpassiontoservecustomersandto guaranteeitsproductsandservices.

5. Itsinsistenceonfairtreatmentofsuppliersandcompetitors

6. Itsuncompromisingcommitmenttocomplywithgovernmentlawsandregulationsinall countries where it operates; and

7. Its desire to work with others to lead the society to a better economic standard and quality of life.

**Conclusion**

Thus in the era of cut throat competition each and every organization aims at its own profit ignoringtheneedsand requirementsofitsemployeesandworkforcesimilarlyemployeesdisplay the same behavior by grabbing better opportunities at any cost even by leaking the important information of their organization. Growing materialism in the society has its expression in the origination. So it a time when employee and employer both are expected to follow the ethical conduct in the workplace. Ethical behavior and human resource development are closely associated.Thecodeofconductistobefollowed onthepartoftheemployeesintheorganization which is merely the miniature of society and an employer should understand the corporate social responsibilitiesandshoulddischargeitsdutiesinaccordancewithit.ThetwodimensionsofCSR are sustainability and benefits. As the whole of the world is the work place, it is the social and ethical responsibility ofeach and every individual to performhis or her duty leaving no placefor oppression,andexploitationthatisneitherbyemployernorbyemployeeandthusbyunitedefforts make earth a better place to live in.

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ISBN:978-81-957858-1-0

## RoleofEthicsinBusiness

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**Abstract**

Business ethics reflects the philosophy of business, one of whose aims is to determine the fundamental purposes of a company. If a company's purpose is to maximize shareholder returns, then sacrificing profits to other concerns is a violation of its fiduciary responsibility. Corporate entities arelegally considered as personsin USA and in most nations. The'corporatepersons' are legally entitled to the rights and liabilities due to citizens as persons. Ethical issues include the rights and duties between a company and its employees, suppliers, customers and neighbors, its fiduciary responsibility to its shareholders. Issues concerning relations between different companiesincludehostiletake-overandindustrial espionage.Relatedissuesincludegovernance; corporate; political contributions; legal issues such as the ethical debate over introducing a crime of corporate manslaughter; and the marketing of corporations' ethics policies.

**Keywords:** Meaning of Business Ethics, Functional business areas, Implementation, Academic discipline and conclusion.

### Introduction

**ETHICS:**Dictionary meaning – “system of moral principles, rules and conduct.” The origin of this word is from ETHOS which means Character. Ethics is defined as the ability to distinguish between right and wrong and to act accordingly.

**Businessethics**(alsoknownascorporateethics)isaformofappliedethicsorprofessionalethics thatexaminesethicalprinciplesandmoralorethicalproblemsthatariseinabusinessenvironment. Itappliestoallaspectsofbusinessconductandisrelevanttotheconductofindividualsandentire organizations. Business ethics has both normative and descriptive dimensions. As a corporate practice and a career specialization, the field is primarily normative. Academics attempting to understand business behavior employ descriptive methods. The range and quantity of business ethicalissuesreflectstheinteractionofprofit-maximizingbehaviorwithnon-economicconcerns. Interestinbusinessethicsaccelerateddramaticallyduringthe1980sand1990s,bothwithinmajor corporations and within academia. For example, today most major corporations promote their commitmenttonon-economicvaluesunderheadingssuchasethicscodesandsocialresponsibility charters. Adam Smith said, "People of the same trade seldom meet together, even for merriment anddiversion,buttheconversationendsinaconspiracyagainstthepublic,orinsomecontrivance to raise prices. Governments use laws and regulations to point business behavior in what they perceivetobebeneficialdirections.Ethicsimplicitlyregulatesareasanddetailsofbehaviorthat



ISBN:978-81-957858-1-0

lie beyond governmental control. The emergence of large corporations with limited relationships and sensitivity to the communities in which they operate accelerated the development of formal ethics regimes.

**History**

Business ethical norms reflect the norms of each historical period. As time passed, those norms evolved, and many behaviors that were once generally accepted became objectionable. Business ethics and the resulting behavior evolved as well. Business was involved in slavery, colonialism, and the cold war.

The term 'business ethics' came into common use in the United States in the early 1970s. By the mid-1980s at least 500 courses in business ethics reached 40,000 students, using some twenty textbooksandatleasttencasebooksalongsupportedbyprofessionalsocieties,centersandjournals ofbusinessethics.TheSocietyforBusinessEthicswasstartedin1980.Europeanbusinessschools adopted business ethics after 1987 commencing with the European Business Ethics Network (EBEN). In 1982 the first single-authored books in the field appeared.

Firmsstartedhighlightingtheirethicalstatureinthelate1980sandearly1990s,possiblytryingto distancethemselvesfromthebusinessscandalsoftheday,suchasthesavingsandloancrisis.The idea of business ethics caught the attention of academics, media and business firms by the end of the Cold War. However, legitimatecriticism ofbusiness practices was attacked forinfringing the "freedom" of entrepreneurs and critics were accused of support from communists. This scuttled the discourse of business ethics both in media and academia.

**British Airways VsVirginAirlines:**

British Airways Vs Virgin Airlines BA’s framed a baseless story that In Night Club of Richard Branson there were HIV infected needles were found. They also hacked the Virgin Reservation Software, called the customers and told them flights have been cancelled and switched them to British Airways.

**Other cases:**

Other cases Mumbai based Tata VSNL employee was caught while leaking information to competitor Gillette engineer who led the Razor blade was also supplying the important details to its competitors Real Life Case of Reliance Life Insurance and SAMSUNG Satyam Case

**CocaColaand Pepsi:**

CocaColaandPepsi

**ExpertOpinion-ProfVarunArya (AmemberofIIM-Ahd Governing Society):**



ISBN:978-81-957858-1-0

ExpertOpinion-ProfVarunArya(AmemberofIIM-AhdGoverningSociety)Hesaid“InIndia, you can not just grow unless you compromise:” There is rampant corruption here and all the shortcutsandunfairmeansarecorrect.Mostofthetopcorporateshavesetofdesignedvaluesbut hardly any of them walk their talk. Its not only in India but in world also.

## FUNCTIONALBUSINESSAREAS

### Finance

Fundamentally,financeisasocialsciencediscipline.Thedisciplinebordersbehavioraleconomics, sociology, economics, accounting and management. It concerns technical issues such as the mix of debt and equity,dividend policy, the evaluation of alternative investment projects, options, futures,swaps,andotherderivatives,portfoliodiversificationandmanyothers.Itisoftenmistaken to be a discipline free from ethical burdens. The 2008 financial crisis caused critics to challenge the ethics of the executives in charge of U.S. and European financial institutions and financial regulatory bodies. Finance ethics is overlooked for another reason—issues in finance are often addressed as matters of law rather than ethics.

### Finance paradigm

Aristotle said, "the end and purpose of the polis is the good life". Adam Smith characterized the good lifein terms ofmaterial goods and intellectual and moral excellences of character. Smith in his*TheWealthofNations*commented,"Allforourselves,andnothingforotherpeople,seems,in every age of the world, to have been the vile maxim of the masters of mankind.

However, a section of economists influenced by the ideology of neoliberalism, interpreted the objectiveofeconomicstobemaximizationofeconomicgrowththroughacceleratedconsumption and production of goods and services. Neoliberal ideology promoted finance from its position as a component of economics to its core. Proponents of the ideology hold that unrestricted financial flows,ifredeemedfromtheshacklesof"financialrepressions",besthelpimpoverishednationsto grow. The theory holds that open financial systems accelerate economic growth by encouraging foreign capital inflows, thereby enabling higher levels of savings, investment, employment, productivity and "welfare", along with containing corruption. Neoliberals recommended that governmentsopentheirfinancialsystemstotheglobalmarketwithminimalregulationovercapital flows. The recommendations however, met with criticisms from various schools of ethical philosophy. Some pragmatic ethicists, found these claims to unfalsifiable and a priori, although neitherofthesemakestherecommendationsfalseorunethicalperse.Raisingeconomicgrowthto the highest value necessarily means that welfare is subordinate, although advocates dispute this sayingthateconomicgrowthprovidesmorewelfarethanknownalternatives.Sincehistoryshows that neither regulated nor unregulated firms always behave ethically, neither regime offers an ethical panacea.



ISBN:978-81-957858-1-0

### Other issues

Fairnessintradingpractices,tradingconditions,financialcontracting,salespractices,consultancy services, tax payments, internal audit, external audit and executive compensation also fall under theumbrellaoffinanceandaccounting.Particularcorporateethical/legalabuses include:creativeaccounting,earnings management, misleading financial analysis insider trading, securities fraud, bribery/kickbacks and facilitation payments. Outside of corporations, bucket shops and forexscamsarecriminalmanipulationsoffinancialmarkets.Casesincludeaccountingscandals,Enron, WorldCom and Satyam.

### HUMANRESOURCEMANAGEMENT

Humanresourcemanagementoccupiesthesphereofactivityofrecruitmentselection,orientation, performanceappraisal,traininganddevelopment,industrialrelationsandhealthandsafetyissues. Business Ethicists differ in their orientation towards labour ethics. Some assess human resource policies according to whether they support an egalitarian workplace and the dignity of labor.

Issues including employment itself, privacy, compensation in accord with comparable worth, collective bargaining (and/or its opposite) can be seen either as inalienable rights[78][79] or as negotiable. Discrimination by age (preferring the young or the old), gender/sexual harassment, race,religion, disability, weight and attractiveness. A common approach to remedying discrimination is affirmative action.

Potential Employees have ethical obligations to employers, involving intellectual property protection and whistle-blowing.

Employers must consider workplace safety, which may involve modifying the workplace, or providing appropriate training or hazard disclosure.

Largereconomicissuessuchasimmigration,tradepolicy,globalizationandtradeunionismaffect workplaces and have an ethical dimension, but are often beyond the purview of individual companies.

### Trade unions

Unions for example, may push employers to establish dueprocess forworkers,but may also cost jobs by demanding unsustainable compensation and work rules.

Unionizedworkplacesmayconfrontunionbustingandstrikebreakingandfacetheethical implications of work rules that advantage some workers over others.

### Management strategy

Amongthemanypeoplemanagementstrategiesthatcompaniesemployarea"soft"approachthat regardsemployeesasasourceofcreativeenergyandparticipantsinworkplacedecisionmaking,



ISBN:978-81-957858-1-0

a "hard" version explicitly focused on control and Theory Z that emphasizes philosophy, culture andconsensus.Noneensureethicalbehavior.Somestudiesclaimthatsustainablesuccessrequires a humanely treated and satisfied workforce.

**Sales andmarketing**

MarketingEthicscameofageonlyaslateas1990s.Marketingethicswasapproachedfromethical perspectives of virtue or virtue ethics,deontology, consequentialism, pragmatism and relativism.

Ethics in marketing deals with the principles, values and/or ideals by which marketers (and marketing institutions) ought to act. Marketing ethics is also contested terrain, beyond the previously described issueofpotential conflicts between profitability and otherconcerns. Ethical marketingissuesincludemarketingredundantordangerousproducts/servicestransparency about environmental risks, transparency about product ingredients such as genetically modifiedorganisms possible health risks, financial risks, security risks, etc., respect for consumer privacy and autonomy, advertising truthfulness and fairness in pricing& distribution.

According to Borgerson, and Schroeder (2008), marketing can influence individuals' perceptions of and interactions with other people, implying an ethical responsibility to avoid distorting those perceptions and interactions.

Marketingethicsinvolvespricingpractices,includingillegalactionssuchaspricefixingandlegal actions including price discrimination and price skimming. Certain promotional activities have drawnfire,including greenwashing,baitandswitch,shilling,viralmarketing,spam(electronic),pyramid schemes and multi-level marketing. Advertising has raised objections about attack ads, subliminal messages, sex in advertising and marketing in schools.

**Production**

Thisareaofbusinessethicsusuallydealswiththedutiesofacompanytoensurethatproductsand productionprocessesdonotneedlesslycauseharm.Sincefewgoodsandservicescanbeproduced and consumed with zero risk, determining the ethical course can be problematic. In some case consumers demand products that harm them, such as tobacco products. Production may have environmentalimpacts,includingpollution,habitatdestructionandurbansprawl.Thedownstream effects of technologies nuclear power,genetically modified food and mobile phones may not be well understood. While the precautionary principle may prohibit introducing new technology whose consequences are not fully understood, that principle would have prohibited most new technologyintroducedsincetheindustrialrevolution.Producttestingprotocolshavebeenattacked for violating the rights of both humans and animals.

**Property**



ISBN:978-81-957858-1-0

The etymological root of property is the Latin'proprius' which refers to 'nature', 'quality', 'one's own', 'special characteristic', 'proper', 'intrinsic', 'inherent', 'regular', 'normal', 'genuine', 'thorough, complete,perfect'etc.Thewordpropertyisvalueloadedandassociatedwiththepersonalqualities of propriety and respectability, also implies questions relating to ownership. A 'proper' person owns and is true to herself or himself, and is thus genuine, perfect and pure.

**Modernhistoryofpropertyrights**

Moderndiscourseonpropertyemergedbytheturnof17thcenturywithintheologicaldiscussions of that time. For instance, John Locke justified property rights saying that God had made "the earth, and all inferior creatures, [in] common to all men".

In1802UtilitarianJeremyBenthamstated,"propertyandlawareborntogetheranddietogether".

One argument for property ownership is that it enhances individual liberty by extending the line of non-interference by the state or others around the person. Seen from this perspective, property right is absolute and property has a special and distinctive character that precedes its legal protection.Blackstoneconceptualizedpropertyasthe"soleanddespoticdominionwhichoneman claims and exercises over the external things of the world, in total exclusion of the right of any other individual in the universe".

**Intellectualproperty**

Intellectual property (IP) encompasses expressions of ideas, thoughts, codes and information. "Intellectual property rights" (IPR) treat IP as a kind of real property, subject to analogous protections, rather than as a reproducible good or service. Boldrin and Levine argue that "governmentdoesnotordinarilyenforcemonopoliesforproducersofothergoods.Thisisbecause it is widely recognized that monopoly creates many social costs. Intellectual monopoly is no different in this respect. The question we address is whether it also creates social benefits commensurate with these social costs."

InternationalstandardsrelatingtoIntellectualPropertyRightsareenforcedthroughAgreementonTrade RelatedAspectsofIntellectualPropertyRights(TRIPS).IntheUS,IPotherthancopyrights is regulated by the United States Patent and Trademark Office.

TheUS Constitution included the powerto protect intellectual property, empowering the Federal government "*to promote the progress of science and useful arts, by securing for limited times to authorsandinventorstheexclusiverighttotheirrespectivewritingsanddiscoveries*".Boldrinand Levineseenovaluein suchstate-enforcedmonopoliesstating,"weordinarilythinkofinnovative monopoly as an oxymoron. Further they comment, 'intellectual property'"is not like ordinary property at all, but constitutes a government grant of a costly and dangerous private monopoly overideas.Weshowthroughtheoryandexamplethatintellectualmonopolyisnotnecessaryfor



ISBN:978-81-957858-1-0

innovation and as a practical matter is damaging to growth, prosperity, and liberty" .Steel man defends patent monopolies, writing, "Consider prescription drugs, for instance. Such drugs have benefited millions of people, improving or extending their lives. Patent protection enables drug companies to recoup their development costs because for a specific period of time they have the sole right to manufacture and distribute the products they have invented." The court cases by 39 pharmaceuticalcompaniesagainstSouthAfrica's1997MedicinesandRelatedSubstancesControl AmendmentAct,whichintendedtoprovideaffordableHIVmedicineshasbeencitedasaharmful effect of patents.

OneattackonIPRismoralratherthanutilitarian,claimingthatinventionsaremostlyacollective, cumulative,pathdependent,socialcreationandtherefore,noonepersonorfirmshouldbeableto monopolize them even for a limited period. The opposing argument is that the benefits of innovation arrive sooner when patents encourage innovators and their investors to increase their commitments. Roderick Long, a libertarian philosopher, observes, "Ethically, property rights of any kind have to be justified as extensions of the right of individuals to control their own lives. Thus any alleged property rights that conflict with this moral basis—like the "right" to own slaves—areinvalidated. In my judgment, intellectual property rights also fail to pass this test. To enforce copyright laws and the like is to prevent people from making peaceful use of the information they possess. If you have acquired the information legitimately (say, by buying a book),thenonwhatgroundscanyoubepreventedfromusingit,reproducingit,tradingit?Isthis not a violation of the freedom of speech and press? It may be objected that the person who originated the information deserves ownership rights over it. But information is not a concrete thinganindividualcancontrol;itisauniversal,existinginotherpeople'smindsandotherpeople's property,andoverthesetheoriginatorhasnolegitimatesovereignty.Youcannotowninformation without owning other people" Machlup concluded that patents do not have the intended effect of enhancing innovation. Self-declared anarchistProudhon, in his 1847 seminal work noted, "Monopolyisthenaturaloppositeofcompetition,"andcontinued,"Competitionisthevitalforce whichanimatesthecollectivebeing:todestroyit,ifsuchasuppositionwerepossible,wouldbeto kill society"

MindeliandPipiyaholdthattheknowledgeeconomyisaneconomyofabundancebecauseitrelies on the "infinite potential" of knowledge and ideas rather than on the limited resources of natural resources,laborandcapital.Allisonenvisionedanegalitariandistributionofknowledge.Kinsella claimsthatIPRcreateartificialscarcityandreduceequality.Bouckaertwrote,"Naturalscarcityis that which follows from the relationship between man and nature. Scarcity is natural when it is possible to conceive of it before any human, institutional, contractual arrangement. Artificial scarcity, on the other hand, is the outcome of such arrangements. Artificial scarcity can hardly serve as ajustification forthelegal framework that causes that scarcity. Such an argument would becompletelycircular.Onthecontrary,artificialscarcityitselfneedsajustification"Corporations



ISBN:978-81-957858-1-0

fund much IP creation and can acquire IP they do not create, to which Menon and others object. Andersen claims that IPR has increasingly become an instrument in eroding public domain.

Ethical and legal issues include: Patent infringement, copyright infringement, trademarkinfringement,patentandcopyrightmisuse,submarinepatents,genepatents,patent,copyright and trademark trolling, Employee raiding and monopolizing talent, Bioprospecting,biopiracy and industrial espionage,digital rights management.

**Industry-specificconcerns**

Health care is one ofmany industriesthat havespecific ethical concerns.High costs limit access, andunproventherapeuticregimesoffercomplextrade-offsbetweenaccessandsafety.Patentlaw is intended to encourage innovation but may further limit access to needed therapies.

**Internationalissues**

Whilebusinessethicsemergedasafieldinthe1970s,internationalbusinessethicsdidnotemerge untilthelate1990s,lookingbackontheinternationaldevelopmentsofthatdecade.[204]Manynew practical issues arose out of the international context of business. Theoretical issues such as cultural relativity of ethical values receive more emphasis in thisfield. Other, older issues can be grouped here as well. Issues and subfields include:

- Thesearchforuniversalvaluesasabasisforinternationalcommercial behavior.
- Comparison of business ethical traditions in different countries. Also on the basis of their respective GDP and [Corruption rankings].
- Comparisonofbusinessethicaltraditionsfromvariousreligiousperspectives.
- Ethical issues arising out of international business transactions; e.g., bioprospecting and biopiracy in the pharmaceutical industry; the fair trade movement; transfer pricing.
- Issuessuchasglobalization andculturalimperialism.
- Varyingglobalstandards—e.g., theuseofchild labor.
- Thewayinwhichmultinationalstakeadvantageofinternationaldifferences,suchas outsourcingproduction(e.g.clothes)andservices(e.g.callcentres)tolow-wagecountries.
- Thepermissibilityofinternationalcommercewithpariahstates.

Thesuccessofanybusinessdependsonitsfinancialperformance.Financialaccounting helpsthe management to report and also control the business performance.

The information regarding the financial performance of the company plays an important role in enablingpeopletotakerightdecisionaboutthecompany.Therefore,itbecomesnecessaryto



ISBN:978-81-957858-1-0

understand how to record based on accounting conventions and concepts ensure unambling and accurate records.

Foreigncountriesoftenusedumpingasacompetitivethreat,sellingproductsatpriceslowerthan their normal value. This can lead to problems in domestic markets. It becomes difficult for these markets to compete with the pricing set by foreign markets. In 2009, the International Trade Commission has been researching anti-dumping laws. Dumping is often seen as an ethical issue, as larger companies are taking advantage of other less economically advanced companies.

**Economic systems**

Political economy and political philosophy have ethical implications, particularly regarding the distribution of economic benefits. John Rawls and Robert Nozick are both notable contributors.

**Law andregulation**

Veryoftenitisheldthatbusinessisnotboundbyanyethicsotherthanabidingbythelaw.Milton Friedmanisthepioneeroftheview.Heheldthatcorporationshavetheobligationtomakeaprofit within the framework of the legal system, nothing more.[206] Friedman made it explicit that the dutyofthebusinessleadersis,"tomakeasmuchmoneyaspossiblewhileconformingtothebasic rulesofthesociety,boththoseembodiedinthelawandthoseembodiedinethicalcustom".Ethics for Friedman is nothing more than abiding by 'customs' and 'laws'. The reductions of ethics to abidance to laws and customs however have drawn serious criticisms.

**IMPLEMENTATION**

**Corporatepolicies**

As part of more comprehensive compliance and ethics programs, many companies have formulatedinternalpoliciespertainingtotheethicalconduct ofemployees. Thesepoliciescanbe simple exhortations in broad, highly generalized language (typically called a corporate ethics statement), or they can be more detailed policies, containing specific behavioral requirements (typically called corporate ethics codes). They are generally meant to identify the company's expectations of workers and to offer guidance on handling some of the more common ethical problemsthatmightariseinthecourseofdoingbusiness.Itishopedthathavingsuchapolicywill leadtogreaterethicalawareness,consistencyinapplication,andtheavoidanceofethicaldisasters.

Anincreasingnumberofcompaniesalsorequireemployeestoattendseminarsregardingbusiness conduct,whichoftenincludediscussionofthecompany'spolicies,specificcasestudies,andlegal requirements. Some companies even require their employees to sign agreements stating that they will abide by the company's rules of conduct.



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Many companies are assessing the environmental factors that can lead employees to engage in unethical conduct. A competitive business environment may call for unethical behaviour. Lying has become expected in fields such as trading. An example of this are the issues surrounding the unethical actions of the Saloman Brothers.

Not everyone supports corporate policies that govern ethical conduct. Some claim that ethical problems are better dealt with by depending upon employees to use their own judgment.

Others believe that corporate ethics policies are primarily rooted in utilitarian concerns, and that they are mainly to limit the company's legal liability, or to curry public favour by giving the appearance of being a good corporate citizen. Ideally, the company will avoid a lawsuit because itsemployeeswillfollowtherules.Shouldalawsuitoccur,thecompanycanclaimthattheproblem would not have arisen if the employee had only followed the code properly.

Sometimesthereisdisconnectionbetweenthecompany'scodeofethicsandthecompany'sactual practices. Thus, whether or not such conduct is explicitly sanctioned by management, at worst, this makes the policy duplicitous, and, at best, it is merely a marketing tool.

JonesandParkerwrite,"Mostofwhatwereadunderthenamebusinessethicsiseithersentimental commonsense,orasetofexcusesforbeingunpleasant."Manymanualsareproceduralformfilling exercisesunconcernedaboutthere alethicaldilemmas.Forinstance,USDepartmentofCommerce ethics program treats business ethics as a set of instructions and procedures to be followed by 'ethics officers'., some others claim being ethical is just for the sake of being ethical. Business ethicists may trivialize the subject, offering standard answers that do not reflect the situation's complexity.

**Ethics officers**

Ethics officers (sometimes called "compliance" or "business conduct officers") have been appointed formally by organizations since the mid-1980s. One of the catalysts for the creation of this new role was a series of fraud, corruption, and abuse scandals that afflicted the U.S. defense industryatthattime.ThisledtothecreationoftheDefenseIndustryInitiative(DII),apan-industry initiative to promote and ensure ethical business practices. The DII set an early benchmark for ethics management in corporations. In 1991, the Ethics & Compliance Officer Association (ECOA)—originally the Ethics Officer Association (EOA)—was founded at the Center forBusiness Ethics (at Bentley College, Waltham, MA) as a professional association for those responsibleformanagingorganizations'effortstoachieveethicalbestpractices.Themembership grewrapidly(theECOAnowhasover1,200members)andwassoonestablishedasanindependent organization.



ISBN:978-81-957858-1-0

Anothercriticalfactorinthedecisionsofcompaniestoappointethics/complianceofficerswasthe passing of the Federal Sentencing Guidelines for Organizations in 1991, which set standards that organizations(largeorsmall,commercialandnon-commercial)hadtofollowtoobtainareduction in sentence if they should be convicted of a federal offense. Although intended to assist judges with sentencing, the influence in helping to establish best practices has been far-reaching.

In the wake of numerous corporate scandals between 2001–04 (affecting large corporations like Enron,WorldCom and Tyco), even small and medium-sized companies have begun to appoint ethics officers.They often reportto theChief ExecutiveOfficer and areresponsibleforassessing the ethical implications of the company's activities, making recommendations regarding the company's ethical policies, and disseminating information to employees. They are particularly interestedinuncoveringorpreventingunethicalandillegalactions.Thistrendispartlyduetothe Sarbanes-Oxley Act in the United States, which was enacted in reaction to the above scandals. A related trend is the introduction of risk assessment officers that monitor how shareholders' investments might be affected by the company's decisions.

Theeffectivenessofethicsofficersisnotclear.Iftheappointmentismadeprimarilyasareaction tolegislativerequirements,onemightexpectlittleimpact,atleastovertheshortterm.Inpart,this is becauseethical business practices result from a corporate culturethat consistently places value onethicalbehaviour,acultureandclimatethatusuallyemanatesfromthetopoftheorganization. Themereestablishmentofapositiontooverseeethicswillmostlikelybeinsufficienttoinculcate ethicalbehaviour:amoresystemicprogrammewithconsistentsupportfromgeneralmanagement will be necessary.

The foundation for ethical behaviour goes well beyond corporate culture and the policies of any given company, for it also depends greatly upon an individual's early moral training, the other institutionsthataffectanindividual,thecompetitivebusinessenvironmentthecompanyisinand, indeed, society as a whole.

**Academic discipline**

As an academic discipline, business ethics emerged in the 1970s. Since no academic business ethicsjournalsorconferencesexisted,researcherspublishedingeneralmanagementjournals,and attended general conferences. Over time, specialized peer-reviewed journals appeared, and more researchers entered the field. Corporate scandals in the earlier 2000s increased the field's popularity.Asof2009,sixteenacademicjournalsdevotedtovariousbusinessethicsissuesexisted, with Journal of Business Ethics and Business Ethics Quarterly considered the leaders.

The International Business Development Instituteis a global non-profit organization that represents217nationsandall50UnitedStates.ItoffersaCharterinBusinessDevelopment(CBD) thatfocusesonethicalbusinesspracticesandstandards.TheCharterisdirectedbyHarvard,MIT,



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and Fulbright Scholars, and it includes graduate-level coursework in economics, politics, marketing, management, technology, and legal aspects of business development as it pertains to businessethics.IBDIalsooverseesthe InternationalBusinessDevelopmentInstitute ofAsiawhich provides individuals living in 20 Asian nations the opportunity to earn the Charter.

**Religiousviews**

The historical and global importance of religious views on business ethics is sometimes underestimatedinstandardintroductionstobusinessethicsaccordingtoDr.ToddAlbertsonauthor of *The Gods of Business*. Particularly in Asia and the Middle East, religious and cultural perspectiveshaveastronginfluenceontheconductofbusinessandthecreationofbusinessvalues.

In Sharia law, followed by many Muslims, banking specifically prohibits charging interest on loans. Traditional Confucian thought discourages profit-seeking Christianity offers the GoldenRulecommand,"Thereforeallthingswhatsoeveryewouldthatmenshoulddotoyou,doyeeven so to them: for this is the law and the prophets."

**Relateddisciplines**

Business ethics is partofthe philosophy ofbusiness, thebranch of philosophy that deals with the philosophical, political, and ethical underpinnings of business and economics. Business ethics operatesonthepremise,forexample,thattheethicaloperationofaprivatebusinessispossible—thosewhodisputethatpremise,suchas libertarian socialists,(whocontend that"businessethics" is an oxymoron) do so by definition outside of the domain of business ethics proper.[

The philosophy of business also deals with questions such as what, if any, are the socialresponsibilities of a business; business managementtheory; theories of individualism vs. collectivism; free will among participants in the marketplace; the role of self interest; invisiblehand theories; the requirements of social justice; and natural rights, especially property rights, in relation to the business enterprise

Businessethicsisalsorelatedto**politicaleconomy,**whichiseconomicanalysisfrompoliticaland historical perspectives. Political economy deals with the distributive consequences of economic actions. It asks who gains and who loses from economic activity, and is the resultant distribution fair or just, which are central ethical issues.

**Conclusion:**

ConclusionInordertoWinthegame,youneedtoplan.Toplan,informationisimperative.Getit throughlegalandethicalmeans.It'sfactthattowinconsistently,youneedtoplaybyrules.Inlife, playhardandplayfair.InlifeandBusiness,EthicalStandardMustbeSet,EthicalStandardMust be Met. Ethics plays very important role in business. Modern ethics code will consider the main ethicaldilemmasofacompany'semployees,anddeterminethemostvulnerableethicalareasfor



ISBN:978-81-957858-1-0

the company. The execution of a company's ethics program depends on identifying these vulnerabilities. All future messages, from the code, to materials, to training, will focus on these major ethical dilemmas.

Companies are also interested in determining whether ethical behavior can be measured, just as efficiencyandproductivityare.KPMG'sBusinessEthicsInstituteistakingtheleadonresearchin this area. Often companies must innovate ways to measure ethical behavior, which in turn motivates ethical behavior.

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ISBN:978-81-957858-1-0

# RoleofEthicsintheContemporaryBusinessWorld

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**Abstract**

The overall purpose of this paper is to reflect on the importance and impact of linkages amongst businessethicsasagrowingacademicdiscipline,theprincipleofsocialengagement,andtherole and impact of academic research as carried out in higher education institutions. Taken together, thesearegaininggreaterimportanceintheglobalizedsocietyof21st century.Incorporatingvalues and ethics into business decisions have become increasingly important to business people, universities, government, and the public in general. Business ethics can be thought of in many different lights, and part ofthereason that business ethics has becomesuch acontemporaryissue is because it cannot be defined precisely. Although most people have different standards of what is morally justifiable, society generally feels that there are certain values that should be set as the minimum ethical behavior. Most people believe that in order to meet the minimum ethical standards,abusinessmustbehonest,obeythelaw,andnotdirectlyinfringeontherightsthatour society holds as inalienable human rights. Some other ethical issues involve compensation of employees,jobsecurityforemployees,hiringpractices,wastemanagementissues,pollution,and conflicts of interest.

**Keywords:**Business,Ethics,Money,Academics,Management

## Introduction

When business people speak about "business ethics" they usually mean one of three things: (1) avoid breaking the criminal law in one's work-related activity; (2) avoid action that may result in civil law suits against the company; and (3) avoid actions that are bad for the company image. Businesses are especially concerned with thesethreethings since theyinvolveloss ofmoney and company reputation.

Running a legitimate business is not as easy as counting 1 2 3, there are a lot of critical things to be considered when running a business. There a lot of issues which need to be addressed outside the scope of just making money? Among them the most important one is ethics.

As our business grows we start to create an impact in the lives of people involved. We cannot imagineallofthem.Agrowingbusinesscreatesjobs,createswealthandinspiresotherbusinesses to grow as well.

The failure to understand business ethics can lead to a business closing down. It can lead your business to a bad reputation and can destroy your business.



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Ethics usually involves the importance of treating your customers adequately with integrity and respect. Maintaining integrity is crucial to developing long lasting relationships with customers.

Corporatevaluesdefinethestandardsthatguidetheexternaladaptationandinternalintegrationof organizations (Schein, 1985). Corporate ethical values help establish and maintain the standards thatdelineatethe"right"thingstodoandthethings"worthdoing"(JansenandVonGlinow,1985). Such ethical values require the organization or individual to behave in accordance with carefully thought-outrulesofmoralphilosophy.Theseincludehonestyandfulldisclosure,andengagingin practices that do not break orbend therules forthesakeofprofit maximization. Thesevaluesare considered to be a composite of individual ethical values of managers and both the formal and informal policies on ethics of the organization (Hunt et al., 1989). In turn, such ethical standards caninfluenceindividuals'choicesandleadtoactionsthatbenefit theirorganizations(Connerand Becker, 1975).

**BUSINESS**

Business is an economic activity, which is related with continuous and regular production and distribution of goods and services for satisfying human wants.

A business plan represents all aspects ofbusinessplanning process; declaring vision and strategy alongside sub-plans to cover marketing, finance, operations, human resources as well as a legal plan, when required.

**II.AReflectiononBusinessEthics**

Business ethics are ethics that refer to the moral rules and regulations governing the business world.Inotherwords,theyarethemoralvaluesthatguidethewaycorporationsorotherbusiness make decisions.

Businessethicsisthebehaviorthatabusinessadherestoinitsdailydealingswiththeworld.The ethics of a particular business can be diverse. They apply not only to how the business interacts with the world at large, but also to their one-on-one dealings with a single customer.

Areflectiononbusinessethicsrequiresapriorconsiderationofthedomainofethics.This,unlike mathematics, is not an exact science.

Inthebusinessworld,ethicsoftenaredisplacedbygreedwhenthereisaperiodicfrenzyofrising stockmarketprices.Inevitably,asteepdownturntheninflictslossesoninvestorsandonbusinesses with a concomitant reduction in the work force. An excessive competitive spirit tends to induce unethical business practices so the business world becomes a battlefield where the normal rules are flouted, skirted or simply disregarded. The ensuing instability is bad for the economy and for the government.



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Who is better placed than one to take care of one's own needs and desire? Nevertheless, if self-seeking wreaks great harm to the general good in the process of bringing advantage to the individual,theimbalancemustberedressed.Itisnotonlypainfulbutinefficienttoliveinasociety where there are no ethics, law and order. Worse, if individuals or businesses become steeped in unethicalpractices,thistrendgenerallyengulfsthepoliticalworldaswell.Atthispoint,thequality of democracy languishes and the citizens losefaith in their institutions and their elected officials.

Understandingofproblemsofbusinessethicscanbeaddressedthroughaseriesofquestionswhich offer different perspectives on the subject.

The **first** question relates to the origins of ethics - whether they come from religion, philosophy, and the laws of nature, scientific study, and study of political theory relating to ethical norms created in society or other fields of knowledge.

The **second** question goes to the issue of whether ethics vary at different times and in different cultures.

The**third** question asked is whether ethics varydepending upon whowearedealing with --with a friend or foe.

The**fourth**questionaskswhetherdifferentethicalconductdependonthesubjectmatterinvolved.

The**fifth**questionrelatestohowethicalrulesshouldbetransmittedandformalizedandhowthey have been formalized to date.

The **sixth** question is whether or not certain activities or businesses are unethical by nature in wholeorinpart.Italsoconsiderswhetherthecorporateinstitutioncanfunctionasanethicalentity since it was designed to generate profit.

The**seventh**questioniswhetherornotethicalconductpaysinabusinesscontext.Formostpeople, ethics are related to justice.

The**eighth** question deals with this subject.

The**last**questionrelatestohowethicscanbeenforced.

This brings us to a fundamental question; what is an enterprise’s purpose of being? Of course earnings are the catalyst that brings about an enterprise into existence and goes on to sustain it. Thatverymotiveofprofiteeringshouldnotbeanendallandbeall.Theultimateaimistosucceed intheeyesofyourstakeholdersandthatcanbeachievedbyaccomplishingsomethingthatoneis proud of. There is perfect symmetry in the logic that if we satisfy our stakeholders, we will be profitablenotjustinthefinancialsensebutintheethicalandmoralsense.Thegoalthenistoattain ethical profits and superiority over competition; not just financial.



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All businesseshavethesameessential issues of ethical business conduct namely product quality, transparency of financial statements, workplace quality and safety standards, keeping pace with global environmental issues and compliance with country laws and industry standards.

Essentially, it is an issue of how profits are made and distributed and by doing so whether the business can be sustained going forward.

Enterprise ethics are the crucial to earnings. If clientele and customers don't trust you and your companyethics theywill not do enterprisewith you. Would you buy from abusiness you did not have confidence in? Of training course not.

Company ethics have turn out to be a scorching-button matter. There are frequently ethical conflicts between making money and doing what is correct. There can be dilemmas about doing whatisfinestforyouremployerwhatisgreatestforyourpersonaloccupationandwhat'sgreatest for the consumer. Enterprise ethics is about negotiating these mine-fields. Right here are my Leading ten Principles for Positive Company Ethics:

1. Company Ethics are developed on Personal Ethics. There is no actual separation in between undertakingwhatisrightinbusinessandplayingfairtellingthetruthandbecomingethicalinyour private life.

2. EnterpriseEthics are basedmostlyon Fairness.Woulda dis-interested observer agree thatthe two sides are becoming treated pretty? Are the two sides negotiating in great faith? Does each transactionjusttakespotona"degreeplayingsubject"?Ifsothebasicrulesofethicsarebecoming satisfied.

3 Enterprise Ethics require Integrity. Integrity refers to complete reliability and consistency. Ethicalbusinessestreatpeoplewithrespecthonestyandintegrity.Theyagainuptheirclaimsand they preserve their commitments.

4 Business Ethics call for Reality-telling. The days when an enterprise could sell a defective product and conceal behind the "purchaser bewares" protection are extended gone. You can sell items or services that have limitations defects or are out-dated but not as initial-class new merchandise. Reality in marketing is not only the law enterprise ethics call for it.

5. Business Ethics need Dependability. If your organization is new unstable about to be sold or going out of business ethics needs that you permit customers and customers know this. Ethical companies can be relied upon to be obtainable to solve problems answer inquiries and offer support.

6. Company Ethics call for a Business Strategy. A company's ethics are built on its picture of by itselfanditsvisionof thepotentialanditspart in thelocalcommunity. Enterpriseethicsdonot



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happeninavacuum.Theclearerthecompany'sprogramforprogressstabilityprofitsandservice the stronger its commitment to ethical business practices.

7. Enterprise Ethics apply internally and externally. Ethical businesses deal with both clients and workers with respect and fairness. Ethics is about respect in the convention area negotiating in good faith retaining promises and meeting obligations to workers employer's distributors and customers. The scope is universal.

8. Company Ethics need Revenue. Ethical organizations are properly-run well-managed have efficient inner controls and obvious expectations of growth. Ethics is about how we reside in the current to get ready for the long term and a enterprise without having earnings (or a strategy to create them) is not meeting its ethical obligations to put together for the potential properly-being of the company its employees and clients.

9. Enterprise Ethicsarevalues-based mostly.The legislationandprofessionalorganizationsmust create written specifications that are inflexible and universal. While they might discuss about "ethics"thesepaperwork aretypicallyprescriptive andrefertominimalspecifications.Ethicsare aboutvaluesidealsandaspirations.Ethicalorganizationsmaypossiblynotalwaysliveuptotheir ideals but they are distinct about their intent.

10. EnterpriseEthicscomefromtheBoss.Leadershipsetsthetoneineachlocationofacompany. Ethics are both central to the way a organization capabilities or they are not. The executives and professionals either lead the way or they communicate that reducing corners deception and dis-respectareappropriate. Lineemployeeswilloftenriseorsinktothelevelofoverallperformance they see modeled above them. Business ethics begins at the leading.

Ethics is about the quality of our lives the top quality of our services and eventually about the bottom line. An unhappybuyer complains to a typical of 16 people. Treating employee's client's distributorsandthepublicinanethicalreasonableandopenwayisnotonlytheproperissueinthe long run it is the only way to keep in an enterprise.

Sometimescompaniesfacesituationswhereethicalchoicesareinoppositiontotheirinterests.An example of this could be a logging company doing business in forests around the world. One ethical consideration must be protecting the rain forest from destruction. Environmentalists may propose that the company stop logging completely; however, this may bring up another ethical issue such as the preservation of jobs for loggers.

**FactorsAffectingEthicalDecision-making**

In general, there are three types of influences on ethical decision- making in business: (1) individualdifferencefactors,(2)situational(organizational)factors,and(3) issue-relatedfactors.

**IndividualDifferenceFactors**



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The Individual Difference Factor that has received the most research support is “cognitive moral development.” This framework, developed by Lawrence Kohlberg in the 1960s & extended by him and other researchers in the subsequent years, helps to explain why different people make different evaluations when confronted with the same ethical issue.

According to the theory, individuals’ level of moral development passes through stages as they mature. Theoretically, there are three major levels of development. The lowest level of moral development is termed as the “pre-conventional” level. The pre-conventional level of moral development is usually associated with small children or adolescents.

Themiddlelevelofdevelopmentiscalledthe“conventional”level.Atthestagesofconventional level, the individual assess ethical issues on the basis of the fairness to others and a desire to conform to societal rules and expectations. According to Kohlberg, most adults operate at the conventional level of moral reasoning.

The highest stage of moral development is the “principled” level. According to Kohlberg, a principled person looks inside him or herself and is less likely to be influenced by situational (organizational) expectations.

The cognitive moral development framework is relevant to business ethics because it offers a powerfulexplanationofindividualdifferencesinethicalreasoning.Individualsatdifferentlevels of moral development are likely to think differently about ethical issues and resolve them differently.

**Situational(organizational)factors**

Individuals’ ethical issue recognition, judgment, and behavior are affected by contextual factors. Inthebusinessethicscontext,theorganizationalfactorsthataffectethicaldecision-makinginclude the work group, the supervisor, organizational policies and procedures, organizational codes of conduct, and the overall organizational culture.

**Issuerelatedfactors**

Conceptualresearchby ThomasJonesinthe1990sandsubsequentempiricalstudiessuggestthat ethical issues in business must have a certain level of “moral intensity” before they will trigger ethical decision making processes. In summary, business ethics is an exceedingly complicated area, one that has contemporary significance for all business practitioners.

**Overview of issues in business ethics**

**General business ethics**

This part of business ethics overlaps with thephilosophy ofbusiness, one ofthe aims ofwhich is todeterminethefundamentalpurposesofacompany.Ifacompany'smainpurposeistomaximize



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the returns to its shareholders, then it could be seen as unethical fora company to consider theinterests and rights of anyone else.

CorporatesocialresponsibilityorCSR:anumbrellatermunderwhichtheethicalrightsandduties existing between companies and society is debated.

Issues regarding the moral rights and duties between a company and its shareholders: fiduciaryresponsibility, stakeholder concept v. shareholder concept.

Ethicalissuesconcerningrelationsbetweendifferentcompanies:e.g.hostiletake-over’s,industrial espionage.

**Professionalethics**

Professionalethicscoversthemyriadofpracticalethicalproblemsandphenomenawhichariseout ofspecificfunctionalareasofcompaniesorinrelationtorecognizedbusinessprofessions.

**Ethicsoffinanceand accounting**

Creativeaccounting,earningsmanagement,misleadingfinancialanalysis.

Insidertrading,securitiesfraud,bucketshop,forexscams:concerns(criminal)manipulationofthe financial markets.

Executivecompensation:concernsexcessivepaymentsmadetocorporateCEO's.Bribery, kickbacks, and facilitation payments: while these may be in the (short-term) interests of the company and its shareholders, these practices may be anti-competitive or offend against the values of society.

**Ethicsofhumanresource management**

The ethics of human resource management (HRM) covers those ethical issues arising around the employer-employee relationship, such as the rights and duties owed between employer and employee.

Discriminationissuesincludediscriminationonthebasesofage,gender,race,religionand disabilities. Issues surrounding the representation of employees and the democratization of the workplace:union busting, strike breaking.

Issues affecting the privacy of the employee: workplace surveillance, drug testing. Issues affecting the privacy of the employer: whistle-blowing.

Occupationalsafetyandhealth.

**Ethicsofsales and marketing**



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Marketing which goes beyond the mere provision of information about (and access to) a product mayseektomanipulateourvaluesandbehavior.Tosomeextentsocietyregardsthisasacceptable, but where is the ethical line to be drawn?

Pricing:pricefixing,pricediscrimination,priceskimming.

Anti-competitive practices:these include butgobeyondpricingtacticstocover issuessuchas manipulation of loyalty and supply chains.

Childrenandmarketing:marketinginschools.

Black markets, grey markets.

**Ethicsofproduction**

This area of business ethics deals with the duties of a company to ensure that products and production processes do not cause harm. Some of the more acute dilemmas in this area arise out of the fact that there is usually a degree of danger in any product or production process and it is difficult to define a degree of permissibility, or the degree of permissibility may depend on the changing state of preventative technologies or changing social perceptions of acceptable risk. Defective, addictive and inherently dangerous products and services.

Ethical relations between the company and the environment: pollution, environmental ethics, carbon emissions trading.

Ethical problems arising out of new technologies: genetically modified food, mobile phone radiation and health.

**Internationalbusiness ethics**

Whilebusinessethicsemergedasafieldinthe1970's,internationalbusinessethicsdidnotemerge untilthelate1990's,reflectingtheinternationaldevelopmentsofthatdecade.Manynewpractical issuesaroseouttheinternationalcontextofbusiness.Theoreticalissuessuchasculturalrelativity of ethical values receive more emphasis in this field. Other, older issues can be grouped here as well. Issues and subfields include:

Thesearchforuniversalvaluesasabasisforinternationalcommercialbehavior. Comparison of business ethical traditions in different countries.

Comparisonofbusinessethicaltraditionsfromvariousreligiousperspectives.

Ethicalissuesarisingoutofinternationalbusinesstransactions;e.g.bioprospectingandbiopiracy in the pharmaceutical industry; the fair trade movement; transfer pricing.

Issuessuchasglobalizationandculturalimperialism.

Varyingglobalstandards-e.g. theuseofchild labor.



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Theway inwhichmultinationalstake advantageofinternationaldifferences,suchasoutsourcing production (e.g. clothes) and services (e.g. call centers) to low-wage countries.

**Ethicalissuesand approaches**

Philosophers and others disagree about the purpose of a business in society. For example, some suggestthattheprincipalpurposeofabusinessistomaximizereturnstoitsowners,orinthecase of a publicly-traded concern, its shareholders. Thus, under this view, only those activities that increase profitability and shareholder value should be encouraged. Some believe that the only companies that are likely to survive in a competitive marketplace are those that place profit maximizationaboveeverythingelse.However,somepointoutthatselfinterestwouldstillrequire abusinesstoobeythelawandadheretobasicmoralrules,becausetheconsequencesoffailingto dosocouldbeverycostlyinfines,lossoflicensure,orcompanyreputation.TheeconomistMilton Friedman is a leading proponent of this view.

Other theorists contend that a business has moral duties that extend well beyond serving the interests of its owners or stockholders, and that these duties consist of more than simply obeying the law. They believe a business has moral responsibilities to so-called stakeholders, people who have an interest in the conduct of the business, which might include employees, customers, vendors,thelocalcommunity,orevensocietyasawhole.Theywouldsaythatstakeholdershave certain rights with regard to how the business operates, and some would even suggest that this even includes rights of governance.

Ethical issues can arise when companies must comply with multiple and sometimes conflicting legalorculturalstandards,asinthecaseofmultinationalcompaniesthatoperateincountrieswith varyingpractices.Thequestionarises,forexample,oughtacompanytoobeythelawsofitshome country, or should it follow the less stringent laws of the developing country in which it does business? To illustrate, United States law forbids companies from paying bribes either domestically or overseas; however, in other parts of the world, bribery is a customary, accepted way of doing business. Similar problems can occur with regard to child labor, employee safety, work hours, wages, discrimination, and environmental protection laws.

**Benefitsofgoodbusinessethics-**

Good business ethics brings much goodwill to a company that will in the long run translate into tangible benefits. Goodwill is that intangible asset that a company has earned over her period of operation as a result of being perceived by business associates and other third parties as being transparent, reliable, trustworthy etc.

Notetheuseofword‘earned’,thismeansthattruegoodwillisearnednotpurchased.Someofthe tangible benefits that accrue a company for operating on an ethically sound business values are-



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**PROFITABILITY**

Thefirstdirectdividendofethicalbusinessoperationisprofitability.Acompanythatisbasedon soundbusinessvalueismorelikelytobeprofitablethanacompanyoperatingoncorruptpractices.

**SUSTAINABILITY**

Without sustainability, investments in business will simply not yield fruit. And without running your business on sound ethical values, sustainability will not be achieved in businesses and investments.

**COMPETITIVEEDGE**

Good business ethics will definitely reflect on the quality of the products, because you have the satisfactionofyourcustomersathandwhileyouwereproducingyourproducts.Thiswillgiveyou and your business easy access to your heart of the general public if you build your business on ethical

**WhyShould OneBe Ethical?**

Thereisalreadysomething oddaboutthisquestion.Itislikeasking,“Whyare bachelors unmarried?”Theyareunmarriedbydefinition.Iftheyweremarried,theywouldnot be bachelors.Itisthesamewithethics.Perhapswhenbusinesspeopleaskwhytheyshouldbeethical, theyhave adifferent question in mind: what is the *motivation* forbeing good? Is theresomething in it for them?

It is perfectly all right to ask if there is a reward for being good, but this has nothing to do with *whether*oneshouldbegood. Itmakes nosenseto tryconvincing peoplethattheyshouldbe good bypointingtotherewardsthatmayfollow.Oneshouldbegoodbecause“good”is,by definition, that which one should be.

As for motivation, good behavior often brings a reward, but not every time. Think about it. If it were always in one’s interest to be good, there would be no need for ethics. We could simply act selfishly and forget about obligation. People invented ethics precisely because it does not always coincide with self interest.

**DoingWell by Doing Good**

Thereisnodenyingthatonecanoftendowellbydoinggood.Anethicalcompanyis morelikely tobuildagoodreputation,whichismorelikelytobringfinancialrewardsoverthelongterm.But goodbehaviorcannotbegroundedintangiblerewardalone.Peoplewhoareinterestedonlyin



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reward will behave ethically when it suits their purpose, but they will go astray whenever the incentives change.

It is important to know that one can normally do well by doing well. Otherwise ethical people could go into business only with a high risk of failure. Business ethics, however, addresses the opposite question: *how can one do well by doing well?* It begins with the premise that managers want to do something good with their lives and investigates how to accomplish this through business. In other words, it treats profit and business success as means to a greater end:

Makingtheworld alittlebetter.

**Conclusion**

An organization that fosters a spirit of abiding by the expectations of its stakeholders including customers, employees, suppliers, investors, owners, managers and the environment in particular willenjoyimprovedperformanceandrecognition.Successforanybusinessisultimatelymeasured in profits and losses, and the socially conscious business will surely generate the capital and revenuesrequiredtooperateandstayinexistenceovertheextendedhaul.

Ethics areimportant not only in business butin all aspects oflife becauseit is an essential partof the foundation on which of a civilized society is built. A business or society that lacks ethical principles is bound to fail sooner or later.

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ISBN:978-81-957858-1-0

# TQM:ThewaytoensureethicsinQualityControl

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**Abstract**

Customer is becoming more and more concerned about Quality, very easy to make buying decision of Chinese or Japanese products; Globalization has provided unprecedented opportunity for manufacturing industries to grow but has resulted in fierce competitiveness among them for survival. Industries are becoming more and more competitive to increase theirbaseandcapturethelargerpartofmarketandproducingformidablechallengesforothers to enter the market and claim their product best in quality and make plenty of commitments withcustomers,butthebillion-dollarquestioniswhethertheyarerightortheyarejustminting money by saying all this. Quality improvement is a highly desired objective in the fiercely competitive world, what a customer wants: a quality product in all respects (no harm to use, humans,climate,andmust fulfillitscreationmeanssatisfactionofcustomer)atareasonable cost,andwhatcompanieswants: maximumprofittoallshareholdersandstakeholdersbut to maximizeprofitandtosurvive,manycompaniesadoptmanytimessomeunethicalways,like usage of substandard material, usage of loose controls, making false statements about productsorchargingmorecostthenitdeserves,inmostofthecasesithappensduetolackof strong quality control systems at place. Ethics in quality can be defined by making standard products, providing the right information of all kinds about the product, making all the right commitmentstocustomers,whichisonlypossiblebyhavingbestqualitycontrolsystemsand procedures at workplace like TQM, the present paper explores of opportunities to make and provide the ethical quality products by having TQM practices at place.

**Keywords:** Buying decision, Globalization, Competitiveness, Ethical practices, Quality control, Total Quality Management (TQM)

## Introduction

Intheacademicworldresearchinthefieldsofqualitymanagementandbusinessethics are often separated. One reason for this is that the origins are very different; business ethics stemming from philosophy while quality management has developed from management studies. With the present developments in both fields there are strong reasons to link the disciplines.Ethicsinqualitycontrolisviewedasmostimportantbecausequalityofproducts differentiate the growth of any organization, quality is a key area in all organization that providethestrongbasetosurvive,itisimportantwhenaddressingtheethicsinqualitycontrol to recognize that it should be examined from all perspective like individual, policies and procedures,stakeholders'value,culture,managementcommitmentandsocietal.Examining



ISBN:978-81-957858-1-0

quality control ethics from a narrow issue perspective does not provide foundational background that provides a complete understanding of the domain of quality control ethics. Quality is something, without which nobody wants to buy any product, and quality products are only possible when an industry has effective system and procedures of quality control.

Quality ethics in aproduct can bedefined as “No harmto usersand climate, conformanceto standardsanduse,reasonablecostandreasonableprofittocompanyandallstakeholders”and inaprocessas“isanapproachthatseekstoimprovequalityandperformancewhichwillmeet or exceed customer expectations. This can be achieved by integrating all quality-related functions and processes throughout the company” and most ofthe times many organizations bypass this concept because of making profits. But without compromising on quality ethics organizations can generate profits by applying Total Quality Management practices.

Alltheindustriesmustfocusontheprocessnottheresultbecauseifyouhavestrongprocess bounded by effective quality control system your end result means product would be excellent,alsoinGITAitissaidbyLordKrishna:“Donotdesirefortheresult;justfocuson Karmas” and to get the good result you need to do the right Karmas, here right karmas are like the process in industries guided and monitored by quality control systems; stronger the quality control system, better the quality products. But there is one more important factor in this process and that is human factor or management approach in companies, management must ensure the best quality control existence and implementation on shop floor. This paper is an attempt to show that quality control ethics can be achieved by implementing Total QualityManagementPracticeswhichincludessystems,procedures,employees’involvement and top management commitment.

Ethicsinqualitycontrolismostimportanttounderstandandexplainbutbeforemovingahead let us understand a little bit about the word ethics, quality and quality control:

**Ethics:**ThewordETHICShascomefromtheword*ethos*whichmeanscharacterormanner. In Latin it is called *ethicus* and in Greek it is called *ethikos*. ETHICS may be defined as character, norms, morals and ideals prevailing in an individual or a group or the society at large. Ethics is a mass of moral principles or set of values about what conduct ought to be. Ethicsmaybedefinedassomestandardizedformofconductwhichmaybeusedtodetermine what is right or what is wrong, what is true or what is false, what is just or what is unjust, what is proper or what is improper and what is fair or what is unfair. The current competing views include “Maximize Profit”. Maximizing profits illustrate the greatest commitment to stakeholders.Inthisparticulartheory,themanagerialstaffisonlycommittedtomaximizethe bottom-lineintermsofprofit:ameantoanendinordertoachievethehighestpossibleprofits, the deviations in the quality approach most of the times happen because of loose controls existence of quality in the process.



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**Quality:** various definitions of quality given by various people/societies/standards time totime some of them are given below:

1. ISO9000:"Degreetowhichasetofinherentcharacteristicsfulfillsrequirements."
2. PhilipB.Crosby:"Conformancetorequirements."
3. JosephM.Juran:"Fitnessforuse." Fitnessisdefined bythecustomer.
4. PeterDrucker:"Quality in aproduct or serviceis not what thesupplierputs in. Itis what the customer gets out and is willing to pay for."
5. W.EdwardsDeming:concentratingon"theefficientproductionofthequalitythatthemarket expects,"andhelinkedqualityandmanagement:"Costsgodownandproductivitygoesupas improvementofqualityisaccomplishedbybettermanagementofdesign,engineering,testing and by improvement of processes."

**Qualitycontrol**:or**QC**forshortisaprocessbywhichentitiesreviewthequalityofallfactors involved in production. This approach places an emphasis on three aspects:

1. Elements such as controls, job management, defined and well managed processes, performance and integrity criteria, and identification of records
2. Competence-such asknowledge,skills,experience,andqualifications

- Quality control emphasizes testing of products to uncover defects and reporting to management who make the decision to allow or deny product release.

**REVIEW OF LITERATURE**

TQM is popular today and has its roots in eliminating waste, reducing variations and continually improving. TQM practices performance relationships have been studied by researchers from various fields such as quality management, operation management, and strategicmanagement.HoweveraconsistentpatternshowaTQMeffectqualityperformance hasyettoemerge.Improvedqualityiscommonlythoughttoreducecostaswasteiseliminated bydoingthingscorrectlythefirsttime(Crosby,1979,1984;Deming,1986)with thehelpof quality tools.

Powell(1995),Adam(1997)andSamson(1999)hadsuggestedthateffectiveuseofsoftTQM practices (executive commitment, employee empowerment, customer focus) can bring performance improvement. On the contrary Motwani (1994) Forza and Fillippini (1998) advocated that quality success could be achieved by increasing use of hard TQM (process control and supplier quality management, design process, SPC, QFD)



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The literature has also focused on factors which contribute to success of TQM. Lu & Sohal (1993) identified implement opportunities in the approaches adopted by Australian organization. Factors likely to contribute to success are: -

- Identificationofthestrategicdirectionofthebusiness(Mission,Vision& Policies)
- Determinationofcustomerexpectation&measurementofperception
- Definitionofstrategyforimplementationof theprogram
- Formalstructureofcontrol,monitor,&maintainimprovement initiatives
- Qualityassurancesystem(ISO9000)
- Useofexternalcontestants

**SYNTHESISOFTOTALQUALITYMANAGEMENTANDBUSINESSETHICS**

The discussion on developments of both total quality management and business ethics has shown that there are several linkages:

**1.** Anobviousconnection is thatbothqualitymanagementandbusinessethicsfocus on the responsibilities of an organization towards different stakeholders. However, on a closer look, the responsibility discussed in total quality management refers to organizational responsibility of employees, while business ethics is more concerned with professional, relational and social responsibility.

**2.** In order to achieve the organizational responsibility that is desired in quality programmes it is necessary to have some leeway in relational responsibility. This is illustratedbytheapparentparadoxofcontrolthatshowsthatexcellent performance can only be achieved by making a delicate balance between controlsofbehaviorontheonehandand release to act on the other.

**3.** A third link between total quality management and business ethics refers to the necessity to link a meaningful answer to the good intentions stressed in ethics programmes. The ability to work in corespondance with personal motives on an individual level, and a code of conduct on a collective level, should be organized and managed. Quality management tools, including the control of internalprocesses,createanessentialpartofthis ability.

Theforegoinganalysisshowsthattherearenotonlycongruencesbetweenqualitymanagement andbusinessethicsbuttheyarealsoprerequisitesforeachother.Inordertogiveameaningful answer,whileavoidingtheparadoxofcontrol,carefulbalancingbetweenthedifferenttypesof responsibilityisnecessary.Ononehand,weneedcontrolwherequalitymanagementtoolscan be very useful. On the other hand, we need trust from, and moral concern for, the people involved. This balance can be organized by:



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- Respectforindividualsastheultimatesensemaking‘entities’.
- Theinalienableimperativeofindividualsto reflect upontheirownmoralpositions.
- Identificationofcollectiveentities(teams,groups,organizations)withmoralimpactsontheir environment.
- Organizingforresponsibilityonacollectivelevel.

Buttheconceptofempoweredemployeesgoesfarbeyondself-control.Employeesalsoknow howtochangetheprocessandtoimproveperformance,improvingboththeeffectivenessand the efficiency of the process. They also understandhowto plan forquality. They know very wellwhotheircustomersare;whattheircustomerswantandexpect;howtodesignnewgoods andservicetomeettheirexpectations;howto develop the necessary work processes; how to developandusethenecessaryqualitymeasurements;andhowtocontinuouslyimprovethese processes,theapproachwhichincludesthehumanfactorwithsystemsandproceduresiscalled Total Quality Management.

In above analysis it is made clear that quality management and business ethics have more linking them together than simply similarities. The connection is much stronger; quality management and business ethics require each other! Still, in practice, many organizations in organizing their relational, social and professional responsibility do so with distinct ethical programmes. In my opinion, the linkages between quality management and business ethics are a strong argument for integrating the associated managementsystems,whichcanbefulfilledbyTotalQualityManagementapproach.

## TOTALQUALITY MANAGEMENT

Total quality management is an approach that seeks to improve quality and performance which will meet or exceed customer expectations. This can be achieved by integrating all quality-related functions and processes throughout the company. TQM looks at the overall quality measures used by a company including managing quality design and development, qualitycontrolandmaintenance,qualityimprovement,andqualityassurance.TQMtakesinto account all quality measures taken at all levels and involving all company employees.

### HistoricaldevelopmentofQualityManagement:from QCto TQM

Total quality management has evolved from the quality assurance methods that were first developed around the time of the First World War. The war effort led to large scale manufacturingeffortsthatoftenproducedpoorquality.Tomakeitcorrect,qualityinspectors were introduced on the production line to ensure that the level of failures due to quality was minimized.

After the First World War, quality inspection became more commonplace in manufacturing environmentsandthisledtotheintroductionofStatisticalQualityControl(SQC),atheory



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developedby Dr.W. EdwardsDeming. This quality method provided astatistical method of qualitybasedonsamplingwhereitwasnotpossibletoinspecteveryitem;asamplewastested for quality. The theory of SQC was based on the notion that a variation in the production processleadstovariationintheendproduct.Ifthevariationintheprocesscouldberemoved this would lead to a higher level of quality in the end product.

AfterWorldWarTwo,theindustrialmanufacturersinJapanproducedpoorqualityitems.In aresponsetothis,theJapaneseUnionofScientistsandEngineersinvitedDr.Demingtotrain engineersinqualityprocesses.Bythe1950'squalitycontrolwasanintegralpartofJapanese manufacturing and was adopted by all levels of workers within an organization.

Bythe1970'sthenotionoftotalqualitywasbeingdiscussed.Thiswasseenascompany-wide quality control that involves all employees from top management to the workers, in quality control. In the next decade more non-Japanese companies were introducing quality management procedures that based on the results seen in Japan. The new wave of quality control became known as Total Quality Management, which was used to describe the many quality-focused strategies and techniques that became the center of focus for the quality movement.

**PrinciplesofTQM**

TQM can be defined as the management of initiatives and procedures that are aimed at achieving the delivery of quality products and services. A number of key principles can be identified in defining TQM, including:

- Management–TopmanagementshouldactasthemaindriverforTQMandcreatean environment that ensures its success.
- Training–Employeesshouldreceiveregulartrainingonthemethodsandconceptsofquality.
- CustomerFocus–Improvementsinqualityshouldimprovecustomersatisfaction.
- DecisionMaking–Quality decisionsshouldbemadebasedon measurements.
- MethodologyandTools–Useofappropriatemethodologyandtoolsensuresthatnon-conformances are identified, measured and responded to consistently.
- ContinuousImprovement–Companiesshouldcontinuouslyworktowardsimproving manufacturing and quality procedures.
- Company Culture –The cultureof the company should aim at developing employees ability to work together to improve quality.
- EmployeeInvolvement–Employeesshouldbeencouragedtobepro-activeinidentifyingand addressing quality related problems.



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**TheCostof TQM**

Many companies believe that the costs of the introduction of TQM are far greater than the benefits it will produce. However research across a number of industries has costs involved indoingnothing,i.e.thedirectandindirectcostsofqualityproblems, arefargreaterthanthe costs of implementing TQM.

The American quality expert, Phil Crosby, wrote that many companies chose to pay for the poorqualityinwhathereferredtoasthe“PriceofNonconformance”.Thecostsareidentified in the Prevention, Appraisal, and Failure (PAF) Model.

Preventioncostsareassociatedwiththedesign,implementationandmaintenanceoftheTQM system. They are planned and incurred before actual operation, and can include:

- ProductRequirements–Thesettingspecificationsforincomingmaterials,processes,finished products/services.
- QualityPlanning–Creationofplansforquality,reliability,operational,productionand inspections.
- QualityAssurance–The creation andmaintenance ofthequality system.
- Training–Thedevelopment,preparationandmaintenanceofprocesses.
- Appraisalcostsareassociatedwiththevendorsandcustomersevaluationofpurchased materials and services to ensure they are within specification. They can include:
- Verification–Inspectionofincomingmaterialagainstagreeduponspecifications.
- QualityAudits–Checkthatthequalitysystemisfunctioningcorrectly.
- VendorEvaluation–Assessmentandapprovalofvendors.
- Failurecostscanbesplitintothoseresultingfrominternalandexternalfailure.Internalfailure costs occur when results fail to reach quality standards and are detected before they are shipped to the customer. These can include:
- Waste – Unnecessary work or holding stocks as a result of errors, poor organization or communication.
- Scrap–Defectiveproductormaterialthatcannotberepaired,usedor sold.
- Rework–Correctionof defectivematerialor errors.
- FailureAnalysis–Thisisrequiredtoestablishthe causesofinternalproduct failure.
- Externalfailurecostsoccurwhenthe productsorservices failtoreachqualitystandards,but are not detected until after the customer receives the item. These can include:
- Repairs–Servicingofreturnedproductsoratthe customersite.
- WarrantyClaims–Itemsarereplacedorservicesre-performedunderwarranty.
- Complaints–Allworkandcostsassociatedwith dealingwithcustomer’s complaints.
- Returns–Transportation,investigationandhandlingofreturned items



ISBN:978-81-957858-1-0

**The Building blocks of TQM: Process, People, Management systems and performance measurement**

Processconsistsofbunchofactivities,whichisthetransformationofasetofinputs,whichcan include action, methods and operations, into the desired outputs, which satisfy the customer's needs and expectations. In each area or function within an organization there will be many processes taking place, and each can be analyzed by an examination of the inputs and outputs to determine the action necessary to improve quality.

Ineveryorganizationtherearesomeverylargeprocesses,whicharegroupsofsmallerprocess, called key of core business processes. These must be carried out well if an organization is to achieve its mission and objectives. The section on processes discusses processes and how to improve them, and implementation covers how to priorities and select the right process for improvement

Theonlypointatwhichtrueresponsibilityforperformanceandqualitycanlieiswiththepeople whoactuallydothejoborcarryouttheprocess,eachofwhichhasoneorseveralsuppliersand customers.

An efficient and effective way to tackle process or quality improvement isthrough teamwork. However, people will not engage in improvement activities without commitment and recognition from the organization's leaders, a climate for improvement and a strategy that is implemented thoughtfully and effectively. The section on people expands on these issues, covering roles within teams, team selection and development and models for successful teamwork.

An appropriate documented quality management system will help an organization not only achieve the objectives set out in its policy and strategies, but also, and equally importantly, sustainandbuilduponthem.Itisimperativethattheleaderstakeresponsibilityfortheadoption and documentation of an appropriate management system in their organization if they are serious about the quality journey. The system section discusses the benefits of having such a system, how to set one up and successfully implement it.

Once the strategic direction for the organization's quality journey has been set, it needs performance measures to monitor and control the journey, and to ensure the desired level of performanceisbeingachievedandsustained.Theycan,andshouldbe,establishedatalllevels in the organization, ideally being cascaded down and most effectively undertaken as team activities.

**TheResultsofTotalQuality Management**



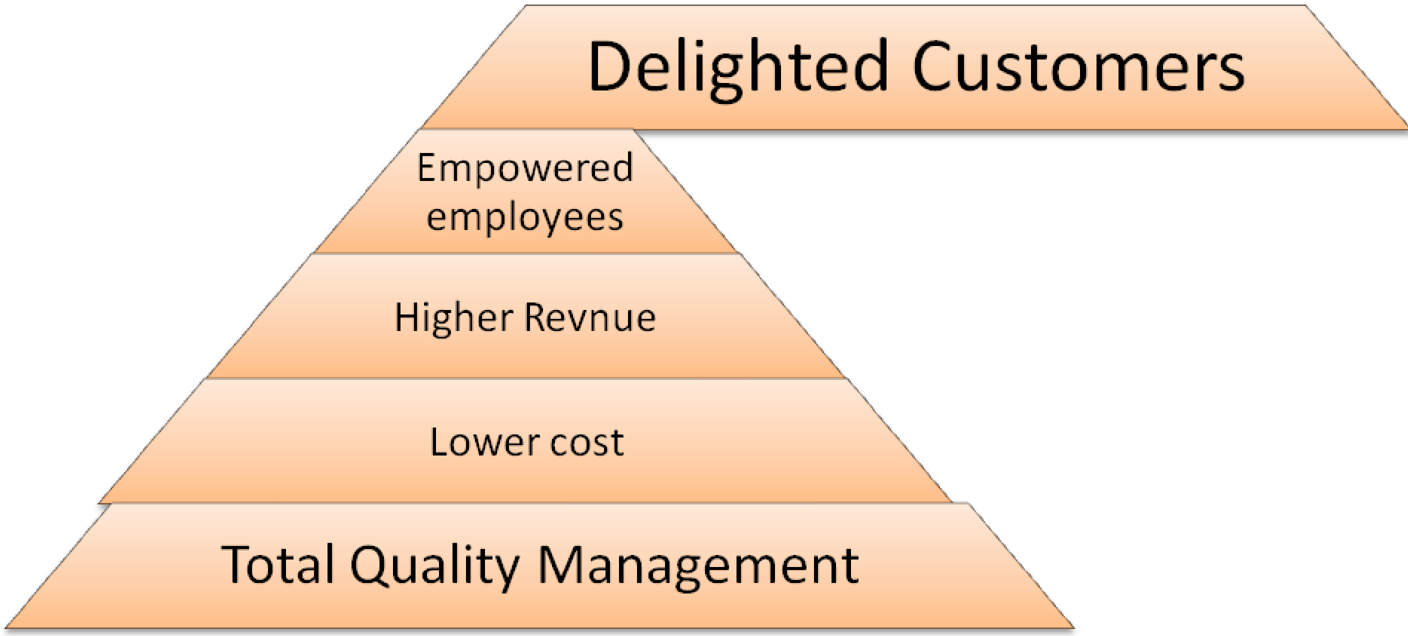
ISBN:978-81-957858-1-0

The almost universally accepted goals of total quality are lower costs, higher revenues, delighted customers, and empowered employees. These goals need little explanation. In the past few years we have moved quickly from the old concept that was managing quality just meansconformancetospecificationsandrequirements.Buttoday-Qualitymeansmeetingand even exceeding the needs and expectations of customers. Quality includes having the right features,correctdocumentation,anderror-freeinvoices.Italsoincludestheproperfunctioning ofcriticalbusinessprocesses—on-timedelivery,friendlyandaccuratetechnicalsupport,and no failures. Quality involves reducing all thecosts ofpoorquality.

- **LowerCosts**.Higherquality can mean lowering costs by reducing errors, reducing rework, and reducingnon-value-addedwork.Inthepast15or20yearscompaniesaroundtheworldhave repeatedlydemonstratedthathigherqualityfrequentlymeanslowercosts.Thecostsassociated with preventing errors during design are often far less than correcting the errors during production, the costs of preventing errors during production are far less than correcting the errors afterfinal inspection, andthecostsoffinding and correcting errors duringfinal inspection arefarlessthan fixingthe errors after the customer has received the goods or services.
- **Higher Revenues.**Higher quality can mean better satisfied customers, increased market share, improved customer retention, more loyal customers, and even premium prices. Customersareincreasinglybeginningtoexpectanddemandhigh-qualitygoodsandservices. By exceeding the levels of quality offered by competitors in the marketplace, organizations can add new customers, retain old customers, and move into new markets. Often, informed customersarewillingtopayapricepremiumforhigherlevelsofqualitythatprovidenewand useful features or that reduce total life-cycle costs.
- **Delighted Customers.** "Delighted" customers are customers who buy over and over again, customerswhoadvertiseyourgoodsandservicesforyou,customerswhocheckyoufirstwhen they are going to buy anything else to see if you also offer those goods or services. Loyal customers will frequently increase their purchases to the point of selecting sole suppliers for certain goods and services.
- **Empowered Employees.**Formanyyearsorganizationsviewedempoweredemployees asa meansforachievinglowercosts,higherrevenues,anddelightedcustomers.Nowmostleading organizations realize that to create such employees is also a major goal of total quality management.These organizations not only aim to solvetheproblems of today, but they also wanttocreateanorganizationthatcansolve,orevenavoid,theproblemsoftomorrow.



ISBN:978-81-957858-1-0




Theconceptofempoweredemployeesembracesmanynewideas.Empoweredemployeesare in self-control. They have the means to measure the quality of their own work processes, to interpretthemeasurements,andcomparethesemeasurementstogoalsandtakeaction when the process is not on target.

Buttheconceptofempoweredemployeesgoesfarbeyondself-control.Employeesalsoknow howtochangetheprocessandtoimproveperformance,improvingboththeeffectivenessand the efficiency of the process. They alsounderstandhowto plan forquality. They understand whotheircustomersare;whatthecustomersneed,want,andexpect;howtodesignnewgoods andservicestomeettheseneeds;howtodevelopthenecessaryworkprocesses;howtodevelop andusethenecessaryqualitymeasurements;andhowtocontinuouslyimprovetheseprocesses.

**DISCUSSIONANDCONCLUSION**

As we start with most of the times many organizations overlooked ethical part of the quality because of making profits in this competitive era, they do it in the absence of strong quality controls,lackofcommitmentsbyemployeesandtopmanagement,andwesuggestedtheway to adopt Total Quality Management by which they can generate sufficient profits by cutting wastefulactivities,byreducingscarps,byreducingcostofrework,repair,customercomplaints and warranty claims, by reducing design costs, by reducing in process cost without compromising ethical part of quality; which will yield substantial increment in customer's numbersandfinallybettermarketshareinthiscompetitiveera.ToolsandtechniquesofTotal Quality Management is very simple to understand and implement, the only need is the commitmentofeveryoneinorganization,thesuccessfulimplementationofTQMreducesthe



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operatingcost,improvestherevenuesanddelightedthecustomersandemployees,soTQMis highlyrecommendedtomakeanddelivertheethicalqualityproductsinthiseraofcutthroat competition.


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ISBN:978-81-957858-1-0