SardarPatelUniversityBalaghat(M.P)

School of Engineering & Technology

Department of CSE

SubjectName:Energy&Environmental Engineering

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Unit1

IntroductiontoEnergy Science

Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment; Overview of energy systems, sources, transformations, efficiency, and storage; Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sustainability and environmental trade-offs of different energy systems; possibilities for energy storage or regeneration (Ex. Pumped storage hydro power projects, superconductor-basedenergy storages, high efficiency batteries)

Energy

Energy is the capacity to do work and is required for life processes. An energy resource is something that can produce heat, power life, move objects, or produce electricity. Matterthat stores energy is called a fuel.Human energy consumption has grown steadilythroughout human history. Early humans had modest energy requirements, mostly food and fuel for fires to cook and keep warm. In today's society, humans consume as much as 110 times as much energy per person as early humans.Most of the energy we use today comes from fossil fuels (stored solar energy).But fossils fuels have a disadvantage in that they are non-renewable on a human time scale, and because other potentially harmful effects on the environment.In any event, the exploitationof all energy sources (with the possibleexception of direct solar energy used for heating), ultimately rely on materials on planetEarth.

Sustainability& TheEnvironment

The definition of "sustainability"isthe studyof hownatural systemsfunction, remaindiverse and produce everything it needs for the ecology to remain in balance. It also acknowledges that human civilization takes resources to sustain our modern way of life. The Three Pillars of Sustainability.

EconomicDevelopment

Thisistheissuethatprovesthemostproblematicasmostpeopledisagreeonpoliticalideologywhatis andisnoteconomicallysound,andhowitwillaffectbusinessesandby extension,jobsandemployability.Itisalsoaboutprovidingincentivesforbusinessesand otherorganizationstoadheretosustainabilityguidelinesbeyondtheirnormallegislative requirements. Also, to encourage and foster incentives for the average person to do their bit where and when they can; one person can rarely achieve much, but taken as a group, effects insome areas are cumulative. The supply and demand market isconsumerist innature and modernliferequiresalotofresourceseverysingleday;for thesake oftheenvironment, gettingwhatweconsumeundercontrolistheparamountissue.Economicdevelopmentis about givingpeoplewhat theywantwithout compromisingqualityoflife, especially inthe developingworld, and reducing the financial burden and "red tape" of doing the right thing.

SocialDevelopment

There are many facets to this pillar. Most importantly is awareness of and legislation protection of the health of people from pollution and other harmful activities of business and other organizations. In North America, Europe and the rest of the developed world, there are strong checks and programmers of legislation in place to ensure that people's health and wellness is strongly protected. It is also about maintaining access to basic resources without

compromising the quality of life. The biggest hot topic for many people right now issustainable housing and how we can better build the homes we live in from sustainable material. The final element is education - encouraging people to participatein environmental sustainability and teaching them about the effects of environmental protection as well as warningof the dangers if we cannot achieve our goals.

EnvironmentalProtection

Weallknowwhatweneedtodotoprotecttheenvironment,whetherthatisrecycling, reducingourpowerconsumptionbyswitchingelectronicdevicesoffratherthanusing standby,bywalkingshortjourneysinsteadoftakingthebus.Businessesareregulatedto preventpollutionandtokeeptheirowncarbonemissionslow.Thereareincentivestoinstallingrene wable power sources in our homes and businesses.Environmentalprotection is the thirdpillarandto many,the primaryconcernofthe future ofhumanity.It defines how weshouldstudyandprotectecosystems,airquality,integrityandsustainabilityofourresourcesand focusingon the elements that place stress on the environment.

PrimaryGoalsofSustainability

- Theendofpovertyandhunger
- Betterstandardsofeducationandhealthcare-particularlyasitpertainstowater quality and better sanitation
- Toachievegenderequality
- Sustainableeconomicgrowthwhilepromotingjobsandstrongereconomies
- All of the above and more while tackling the effects of climate change, pollution and other environmental factors that can harm and do harm people's health, livelihoods and lives.
- Sustainabilitytoincludehealthoftheland, airandsea

EnergySources

Thereare5fundamentalsourcesofenergy:

1. NuclearfusionintheSun(solarenergy)
2. GravitygeneratedbytheEarth&Moon.
3. Nuclearfissionreactions.
4. EnergyintheinterioroftheEarth.
5. Energystoredinchemicalbonds.

Otherthanthisitcanbeclassifiedintwobroadterms:-

1. Renewableresources
    a. Solarenergy
    b. Windenergy
    c. Geothermalenergy
    d. Hydropowerenergy
    e. Biomass
    f. Hydrogenandfuel cells
2. NonrenewableResources
    a. Nuclearenergy
    b. Fuelenergy(Coal/Petroleum)

1. Renewable resources-: A renewable resource is a resource which can be used repeatedly and replacednaturally.Renewable energy is energy which comesfrom natural resourcessuch assunlight,wind,rain,tides,andgeothermalheat,whicharerenewable(naturally

replenished). In 2008, about 19% of global final energy consumption came from renewable,with 13% coming from traditional biomass, which is mainly used for heating, and 3.2% from hydroelectricity. New renewable (small hydro, modern biomass, wind, solar, geothermal,and bio-fuels) accounted for another 2.7% and are growing very rapidly. The share of renewablein electricity generation is around 18%, with 15% of global electricity coming from hydroelectricity and 3% from new renewable.

TypesofRenewableresources

1. **Solar. This form of energy relies on the nuclear fusion power from the core ofthe Sun.Thisenergycanbe collectedandconvertedinafewdifferent ways.Therangeisfromsolarwaterheatingwithsolarcollectorsorattic cooling with solar attic fans for domestic use to the complex technologiesofdirectconversionofsunlighttoelectricalenergyusingmirrorsand boilers or photovoltaic cells. Unfortunatelythese are currently insufficient to fully power our modern society.**

2. **Wind The movement of the atmosphere is driven by differences of temperature at the Earth's surface due to varying temperatures of the Earth's surface when lit by sunlight. Wind energy can be used to pump water or generate electricity, but requires extensive areal coverage to produce significant amounts of energy.**

3. **Hydroelectric energy this form uses the gravitational potential of elevated water that was lifted from the oceans by sunlight. It is not strictly speaking renewable since all reservoirs eventually fill up and require very expensive excavation to become useful again. At this time, most of the available locationsfor hydroelectric dams are already used in the developedworld.**

4. **Biomass is the term for energy from plants. Energy in this form is very commonly used throughout the world. Unfortunately the most popular is the burning of trees for cooking and warmth. This process releases copious amounts of carbon dioxide gases into the atmosphere and is a major contributor to unhealthy air in many areas. Some of the more modernformsof biomassenergy aremethanegeneration andproduction ofalcohol for automobilefuel and fueling electric power plants.**

5. **Hydrogen and fuel cells these are also not strictly renewable energy resources butareveryabundant inavailabilityand arevery low in pollution when utilized. Hydrogen can be burned as a fuel, typically in a vehicle, with only water as the combustion product. This clean burning fuel can mean a significant reduction of pollution in cities. Or the hydrogen can be used in fuel cells, which are similar to batteries, to power an electric motor. In either case significant production of hydrogen requires abundant power. Due to theneed for energy to produce theinitial hydrogen gas, theresult is the relocation of pollution from the cities to the power plants. There are several promising methods to produce hydrogen, such as solar power, that may alter this picture drastically.**

6. **GeothermalpowerEnergyleftoverfromtheoriginalaccretionoftheplanetanda ugmentedbyheatfromradioactivedecayseepsoutslowly everywhere,**

intemperaturewithdepth)ishighenough toexploittoelectricity. This possibility is limited to a few locations on Earth and manytechnicalproblemsexistthatlimititsutility.Anotherformofgeothermal energyis Earth energy, a resultof the heat storage in theEarth's surface.Soileverywheretendstostayatarelativelyconstanttemperature,the yearlyaverage,andcanbeusedwithheatpumpstoheatabuildingin winterandcool abuildingin summer.This formofenergycanlessen the needforother powerto maintaincomfortable temperatures inbuildings, but cannot be used to produceelectricity.

2. NonrenewableResources
    1. Nuclear Fission Reactions Radioactive Uranium is concentrated and made into fuel rods that generate largeamounts of heat asa result of radioactive decay. This heat is used to turn water into steam. Expansion of the steamcan then beused to drivea turbine and generateelectricity. Once proposed asacheap,clean,andsafewaytogenerateenergy,Nuclearpowerhas come under some disfavor. Costs of making sure nuclear power plants are clean and safe and the problem of disposing of radioactive wastes, whichareunsafe, aswellas questionsabout thesafetyof theplants under human care, has contributed to this disfavor.
    2. EnergyintheInterioroftheEarthDecayofradioactiveelementshasproducedhea tthroughoutEarthhistory.Itisthisheatthatcausesthe temperaturetoincreasewithdepthintheEarthandisresponsiblefor meltingofmantlerockstoformmagmas.Magmascancarrytheheatupwardintot hecrust.Groundwatercirculatinginthevicinityofigneous intrusions carries the heat back toward the surface. If this hot water can be tapped, it can be used directly to heat homes, or if trapped at great depth under pressure it can be turned into steam which will expand.
    3. FossilFuelsTheoriginoffossilfuelsandbiomassenergyingeneral,starts with photosynthesis. Photosynthesis is the most important chemical reaction to us as human beings, because without it, we could not exist. Photosynthesis is the reaction that combines water and carbon dioxidefrom the Earth and its atmosphere with solar energy to form organicmolecules that make up plants and oxygen essential for respiration. Because all life forms depend on plants for nourishment, either directly or indirectly, photosynthesis is the basis for life on Earth.Thus when oxygen is added to organic material, either through decay by reaction with oxygen in the atmosphere, or by adding oxygen directly by burning, energy is produced, and water and carbon dioxide return to the Earth or its atmosphere.
    4. Petroleum To produce a fossil fuel, the organic matter must be rapidly buried in the Earth so that it does not oxidize (react with oxygen in the atmosphere). Thena series of slow chemical reactions occur which turn the organic molecules into hydrocarbons- Oil and Natural Gas, together called Petroleum. Hydrocarbons are complex organic molecules that consist of chains of hydrogen and carbon.

Energytransformation

Energy transformation also termed as energy conversion, is the process of changing energy fromoneofitsformsintoanother. Inphysics,energyisaquantitythatprovidesthecapacity

toperformmanyactions—thinkofliftingorwarminganobject.Inaddition convertible, energy is transferable to a different location or object, but it cannot be createdordestroyed.Energyinmanyofitsformsmaybeusedinnaturalprocesses,ortoprovide someservicetosocietysuch asheating,refrigeration,lighteningorperformingmechanical work to operate machines. For example, in order to heat your home, your furnace can burnfuel,whose chemical potential energyis thus convertedinto thermal energy, which is thentransferredto your home's air in order to raise its temperature.

Conversionofthermalenergytoothertypes:-

Conversions to thermal energy (thus raising the temperature) from other forms of energy, may occur with essentially 100% efficiency[citation needed] (many types %, such as when potentialenergy isconverted tokineticenergyasan objectfallsin vacuum, orwhenanobject orbits nearer or farther from another object, in space.

Though, conversion of thermal energy to other forms, thus reducing the temperature of a system, has strict limitations, often keeping its efficiency much less than 100% (even when energy is not allowed to escape from the system). This is because thermal energy has already been partly spread out among many available states of a collection of microscopic particles constituting the system, which can have enormous numbers of possible combinations of momentum and position (these combinations are said to form a phase space). In such circumstances,a measure called entropy, or evening-outof energy distributions, dictates that future states of an isolated system must be of at least equal evenness in energy distribution. In other words, there is no way to concentrate energy without spreading out energy somewhereelse.

Transformationofkineticenergyofchargedparticlestoelectricenergy:-

In order to make the energy transformation more efficient, it is desirable to avoid thethermal conversion. For example, the efficiency of nuclear energy reactors, where kinetic energy of nuclei is first converted to thermal energy and then to electric energy, lies around 35%.By direct conversion of kinetic energy to electric, i.e. by eliminating the thermal energy transformation, the efficiency of energy transformation process can be dramaticallyimproved.

EnergyTransformationFromTheEarlyUniverse

Energy transformations in the universe over time are (generally) characterized by various kinds of energy which has been available since the Big Bang, later being "released" (that is, transformed to more active types of energy such as kinetic or radiant energy), when a triggeringmechanismis available to do it.

- **Releaseofenergyfromgravitationalpotential**
- **Releaseofenergyfromradioactivepotential**
- **Releaseofenergyfromhydrogenfusion potential**

Examplesofsetsofenergyconversionsinmachines

- **Forinstance,acoal-firedpowerplantinvolvestheseenergytransformations:**
- **Chemicalenergyinthecoalconvertedtothermalenergyintheexhaustgasesof combustion.**

- **Thermal energy of the exhaust gases converted into thermal energy of steam throughthe heat exchanger.**
- **Thermalenergyofsteamconvertedtomechanicalenergyintheturbine.**
- **Mechanical energy of the turbine converted to electrical energy by the generator, which is the ultimate output**
- **In such a system, thefirstand fourth steparehighly efficient, butthe secondand third steps are less efficient. The most efficient gas-fired electrical power stations can achieve 50% conversionefficiency. Oil- and coal-fired stations achieve less.**

Inaconventionalautomobile,theseenergytransformationsareinvolved:

- **Chemicalenergyinthefuelconvertedtokineticenergyofexpandinggasvia combustion**
- **Kineticenergyofexpandinggasconvertedtolinearpistonmovement**
- **Linearpistonmovementconvertedtorotarycrankshaftmovement**
- **Rotarycrankshaftmovementpassedintotransmissionassembly**
- **Rotarymovementpassedoutoftransmissionassembly**
- **Rotarymovementpassedthroughdifferential**
- **Rotarymovementpassedoutofdifferentialtodrivewheels**
- **Rotarymovementofdrivewheelsconvertedtolinearmotionofthevehicle.**

Energystorage

Energy storage is the capture of energy produced at one time for use at a later time. Adevice that stores energy is sometimes called an accumulator or battery. Energy comes in multiple forms including radiation, chemical, gravitational potential, electrical potential, electricity, elevated temperature, latent heat and kinetic. Energy storage involves converting energyfrom forms that are difficult to store to more conveniently or economically storable forms. Bulk energy storage is currently dominated by hydroelectric dams, both conventional as well as pumped.

Sometechnologiesprovideshort-termenergystorage,whileotherscanendureformuch longer.

A wind-up clock stores potential energy (in this case mechanical, in the spring tension), a rechargeable battery stores readily convertible chemical energy to operate a mobile phone, and a hydroelectric dam stores energy in a reservoir as gravitational potential energy. Fossil fuels such as coal and gasoline store ancient energy derived from sunlight by organisms that later died, became buried and over time were then converted into these fuels. Food (which is made by the same process as fossil fuels) is a formof energy stored in chemical form.

Ice storage tanks store ice frozen by cheaper energy at night to meet peak daytime demand for cooling. The energy isn't stored directly, but the work-product of consuming energy (pumpingaway heat) is stored, having the equivalenteffect on daytime consumption.

Fossilefuel:-

a fossil fuel is a fuel formed by natural processes, such as anaerobic decomposition of buried dead organisms, containing energy originating in ancient photosynthesis. The age of the organisms and their resulting fossil fuels is typically millions of years, and sometimes exceeds 650 millionyears.Fossil fuels contain highpercentagesof carbonandinclude petroleum,coal,

and natural gas. Othercommonly used derivatives include kerosene and propane. Fossil fuelsrange from volatile materials with low carbon to hydrogen ratios like methane, to liquids like petroleum, to non-volatile materials composed of almost pure carbon, like anthracite coal. Methane can be found in hydrocarbon fields either alone, associated with oil, or in the formof methane catharses.

AdvantagesofFossilFuels

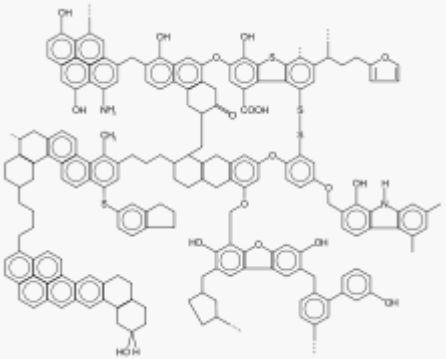
- **Amajoradvantageoffossilfuelsistheircapacitytogeneratehugeamountsof electricity in just a single location.**
- **Fossilfuelsareveryeasytofind.**
- **Whencoalisusedinpowerplants,theyareverycosteffective.Coalisalsoin abundantsupply.**
- **Transporting oil and gas to the power stations can be made through the use of pipes making it an easy task.**
- **Powerplantsthatutilizegasareveryefficient.**
- **Power stations that make use of fossil fuel can be constructed in almost any location. This is possible as long as large quantities of fuel can be easily brought to the power plants.**

DisadvantagesofFossilFuels

- **Pollution is a major disadvantage of fossil fuels. This is because they give off carbon dioxide when burned thereby causing a greenhouse effect. This is also the main contributoryfactor to the globalwarmingexperienced by the earth today.**
- **Coal also produces carbon dioxide when burned compared to burning oil or gas. Additionally,it gives off sulphurdioxide,a kind of gas that creates acid rain.**
- **Environmentally, the mining of coal results in the destruction of wide areas of land. Mining this fossil fuel is also difficult and may endanger the lives of miners. Coal miningis consideredone of the most dangerousjobs in the world.**
- **Power stations that utilize coal need large amounts of fuel. In other words, they not onlyneedtruckloadsbut trainloadsofcoalon aregularbasistocontinueoperating andgeneratingelectricity.Thisonly means that coal-firedpower plants shouldhave reserves of coal in a large area near the plants location.**
- **Useofnaturalgascancauseunpleasantodorsandsomeproblemsespeciallywith transportation.**
- **Use of crude oil causes pollution and poses environmental hazards such as oil spills when oil tankers, for instance, experience leaks or drown deep under the sea. Crudeoil containstoxic chemicals which cause air pollutantswhen combusted.**

Coal isa combustible blackorbrownish-black sedimentaryrock usuallyoccurringin rock strata in layers or veins called coal beds or coal seams. The harder forms, such as anthracite coal, can be regarded as metamorphic rock because of later exposure to elevatedtemperature and pressure. Coal is composed primarily of carbon, along with variable quantities of other elements, chiefly hydrogen, sulfur, oxygen, and nitrogen.[1] Coal is a fossil fuel that forms when dead plant matter is converted into peat, which in turn is convertedinto lignite, then sub-bituminous coal, after that bituminous coal, and lastly anthracite. This involves biologicaland geological processes.The geologicalprocesses take placeover millions of years.

Formation

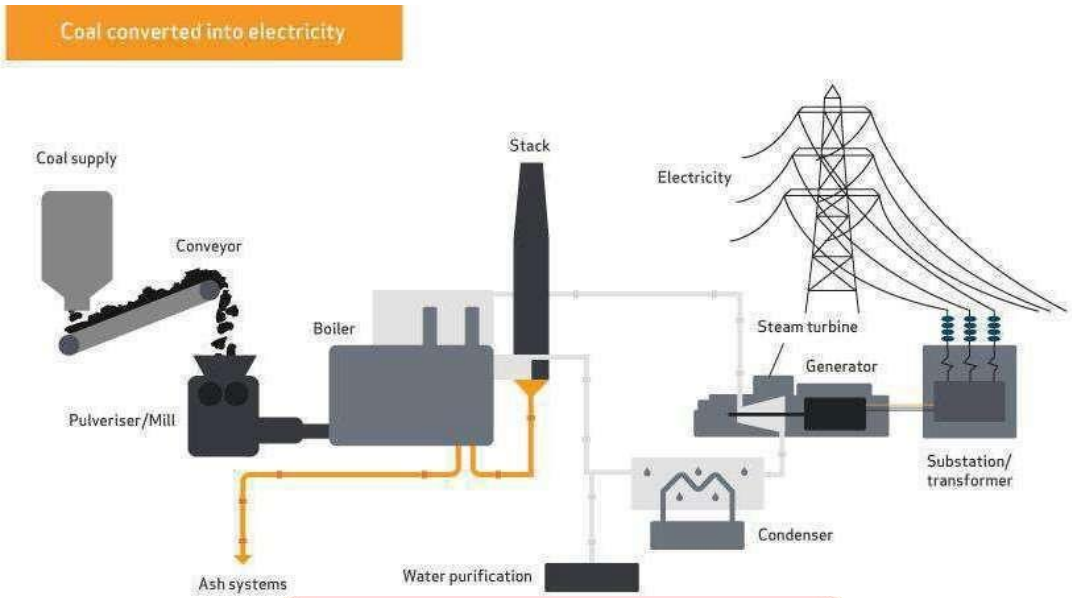


Examplechemicalstructureofcoal

At various times in the geologic past, the Earth had dense forests[8] in low-lying wetlandareas. Due to natural processes such as flooding, these forests were buried underneath soil. As more and more soil deposited over them, they were compressed. The temperature also rose as they sank deeper and deeper. As the process continued the plant matter was protected from biodegradation and oxidation, usually by mud or acidic water. This trapped the carbon in immense peat bogs that were eventually covered and deeply buried by sediments.Under high pressureandhigh temperature, deadvegetationwasslowlyconverted to coal. As coal contains mainly carbon, the conversion of dead vegetation into coal is called carbonization

<u>Productionofelectricityfrom coal</u>

Steamcoal,alsoknownasthermalcoal,isusedin powerstationstogenerateelectricity. Coal is first milled to a fine powder, which increases the surface area and allows it to burn more quickly. In these pulverised coal combustion (PCC) systems, the powdered coal is blown into the combustion chamber of a boiler where it isburnt at high temperature(seediagram).The hot gases and heat energy produced convertswater – in tubes liningthe boiler – into steam. Thehighpressuresteamispassedintoaturbinecontainingthousandsofpropeller-like blades. The steam pushes these blades causing the turbine shaft to rotate at high speed. Agenerator is mounted at one end of the turbine shaft and consists of carefully wound wirecoils. Electricity is generated when these are rapidly rotated in a strong magnetic field. After passing through the turbine, the steamis condensed and returned to the boiler to be heated once again.
The electricity generated is transformed into the higher voltages (up to 400,000 volts) used for economic, efficient transmission via power line grids. When it nears the point of consumption, such as our homes, the electricity is transformed down to the safer 100-250 voltage systems used in the domestic market.



Efficiencyimprovements

Improvements continue to be made in conventional PCC power station design and new combustion technologies are being developed. These allow more electricity to be produced from less coal - known as improving the thermal efficiency of the power station. Efficiency gains in electricity generation from coal-fired power stations will play a crucial part inreducing CO2 emissions at a global level. A one percentage point improvement in the efficiency of a conventional pulverised coal combustion plant results in a 2-3% reduction in CO2 emissions.

Shale oil

Shaleoilisunconventionaloilproducedfromoilshalerockfragmentsby pyrolysis, hydrogenation, or thermal dissolution. These processes convert the organic matter within the rock (kerogen) into synthetic oil and gas. The resulting oil can be used immediatelyasafuelor upgraded tomeet refinery feedstock specificationsby adding hydrogen and removing impurities such as sulfur and nitrogen. The refined products can be used for the same purposes as those derivedfrom crude oil.

The term "shale oil" is also used for crude oil produced from shale's of other very low permeability formations. However, to reduce the risk of confusion of shale oil produced from oil shalewith crudeoil in oil-bearing shale's, the term"tight oil" is preferred for thelatter.

Shaleoilextraction

Shale oil is extracted by pyrolysis, hydrogenation, or thermal dissolution of oil shale. The pyrolysis of the rock is performed in a retort, situated either above ground or within the rock formation itself. As of 2008, most oil shale industries perform the shale oil extraction process after the rock is mined, crushed and transported to a retorting facility, although several experimental technologies perform the process in place (in-situ). The temperature at which the kerogen decomposes into usable hydrocarbons varies with the time-scale of the process; in the above-ground retorting process decomposition begins at 300 °C (570 °F), but proceeds

morerapidlyandcompletely athigher temperatures.Decomposition takesplacemost quickly atatemperaturebetween480and520°C(900and970°F).

Hydrogenationandthermaldissolution(reactivefluidprocesses)extracttheoil using hydrogen donors, solvents, or a combination of these. Thermal dissolution involves the applicationofsolventsatelevatedtemperaturesandpressures,increasingoiloutput by cracking the dissolved organic matter. Different methods produce shale oil with different properties.

Propertiesof Shale

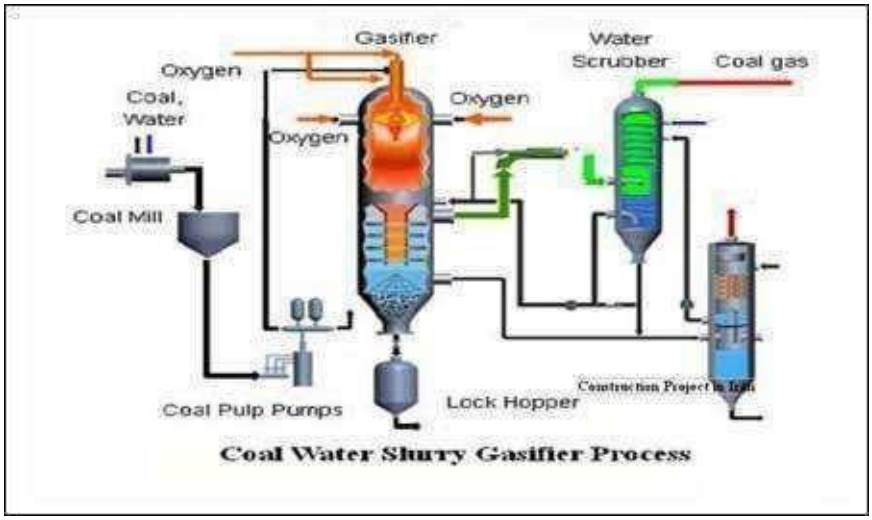
Properties of raw shale oil vary depending on the composition of the parent oil shale and the extraction technology used. Like conventional oil, shale oil is a complex mixture of hydrocarbons, and it is characterized using bulk properties of the oil. Shale oil usuallycontains large quantities of olefinic and aromatic hydrocarbons. Shale oil can also contain significantquantitiesofheteroatoms.Atypicalshaleoilcompositionincludes0.5–1% of oxygen, 1.5–2% of nitrogen and 0.15–1% of sulfur, and some deposits contain more heteroatoms. Mineral particles and metals are often present as well. Generally, the oil is less fluid than crude oil, becoming pourable attemperatures between 24and 27°C(75 and 81°F), whileconventional crude oil is pourable attemperatures between -60 to 30 °C(-76 to 86 °F); this property affects shale oil's abilityto be transportedin existingpipelines

Coal Gasification

Coal gasification is the process of producingsyngas–a mixture consisting primarily of carbon monoxide (CO), hydrogen (H_2), carbon dioxide(CO_2), methane(CH_4), and watervapour(H_2O)–fromcoalandwater,airand/oroxygen.

coal was gasified using early technology to produce coal gas (also known as "town gas"), which is a combustible gas traditionally used for municipal lighting and heating before the advent of industrial-scale production of natural gas.

In current practice, large-scale instances of coal gasification are primarily for electricity generation, such as in integrated gasification combined cycle power plants, for production of chemical feedstocks, or for production of synthetic natural gas. The hydrogen obtained from coalgasificationcanbeusedforvariouspurposessuchasmakingammonia,powering a hydrogen economy, or upgrading fossil fuels.



Coal Water Slurry Gasifier Process

Duringgasification,the coal is blown through with oxygen and steam (water vapor) whilealso being heated (and in some cases pressurized). If the coal is heated by external heat sources the process is called "allothermal", while "autothermal" process assumes heating of the coal via exothermal chemical reactions occurring inside the gasifier itself. It is essential that the oxidizer supplied is insufficient for complete oxidizing (combustion) of the fuel. During the reactions mentioned, oxygen and water molecules oxidize the coal and produce a gaseousmixtureofcarbondioxide(CO_2),carbonmonoxide (CO),watervapour(H_2O), and molecular hydrogen (H_2). (Some by-products like tar, phenols, etc. are also possible end products, depending on the specific gasification technology utilized.) This process has been conducted in-situ within natural coalseams (referred to as underground coalgasification)and in coal refineries. The desired end product is usually syngas (i.e., a combination of H_2 + CO), but the produced coal gas mayalso be further refined to produceadditionalquantitiesof H_2:

$$3C\ (i.e.,coal)+O_2+H_2O\rightarrow H_2+3CO$$

Iftherefinerwantstoproducealkanes(i.e.,hydrocarbonspresentinnaturalgas, gasoline, and diesel fuel), the coal gas is collected at this state and routed to aFischer-Tropsch reactor. If, however, hydrogen is the desired end-product, the coal gas (primarily the CO product) undergoes the water gas shift reaction where more hydrogenis produced by additionalreaction with water vapor:

$$CO+H_2O\rightarrow CO_2+H_2$$

Althoughothertechnologiesforcoalgasificationcurrentlyexist,allemploy,in general, the same chemical processes. For low-grade coals (i.e., "brown coals") which containsignificantamountsofwater,therearetechnologiesinwhichnosteamis required during the reaction, with coal (carbon) and oxygen being the only reactants. Aswell,somecoalgasificationtechnologiesdonotrequirehighpressures.Some utilize pulverized coal as fuel while others work with relatively large fractions of coal. Gasificationtechnologiesalso vary in the way the blowing is supplied.

"Direct blowing"assumesthe coal andthe oxidizerbeing supplied towardseach other from the opposite sides of the reactor channel. In this case the oxidizer passesthrough cokeand (morelikely)ashestothereaction zone whereitinteracts with coal. The hot gas produced then passes fresh fuel and heats it while absorbing some products of thermal destruction of the fuel, such as tars and phenols. Thus, the gas requires significant refining before being used in the Fischer-Tropsch reaction. Products of the refinement are highly toxic and require special facilities for their utilization. As a result, the plant utilizing the described technologies has to be very large to be economically efficient. One of such plants called SASOL is situated in the Republic of South Africa (RSA). It was built due to embargo applied to the country preventing it from importing oil and natural gas. RSA is rich in Bituminous coal and Anthracite and was able to arrange the use of the well known high pressure "Lurgi" gasification process developedin Germanyin the first half of 20th century.

"Reversed blowing" (as compared to the previous type described which was invented first) assumes the coal and the oxidizer being supplied from the same side of the reactor. In this case there is no chemical interaction between coal and oxidizer before the reaction zone. The gas produced in the reaction zone passes solid products of gasification (coke and ashes), and CO_2 and H_2O contained in the gas are additionally chemically restored toCOandH_2.Ascompared tothe"directblowing" technology,no toxic by-productsare present in the gas:those are disabledin the reaction zone.

Undergroundcoalgasification

Undergroundcoalgasification isan industrial gasification process, which is carried outin non-mined coal seams using injection of a gaseous oxidizing agent, usually oxygen or air, and bringing the resulting product gas to surface through production wells drilled from the surface. The product gas could to be used as a chemical feedstock or as fuel for power generation. The technique can be applied to resources that are otherwise not economical to extract and also offers an alternative to conventional coal mining methods for some resources. Compared to traditional coal mining and gasification, UCG has less environmental and social impact, though some concerns including potential for aquifer contamination are known

Carboncapturetechnology

Carboncapture,utilization,andsequestration(orstorage) isincreasinglybeingutilizedin moderncoalgasificationprojectstoaddressthegreenhousegasemissionsconcernassociatedwitht heuseofcoalandcarbonaceousfuels.Inthisrespect,gasificationhasa significantadvantageoverconventionalcoalcombustion,inwhichCO_2resultingfrom combustionisconsiderablydilutedbynitrogenandresidualoxygeninthenear-ambient pressure combustionexhaust, makingitrelativelydifficult, energy-intensive,and expensive to capturethe CO_2(this is known as "post-combustion"CO_2capture).

CO_2capturetechnologyoptions

All coal gasification-based conversion processes require removal of hydrogen sulfide (H_2S; an acid gas) from the syngas as part of the overall plant configuration. Typical acid gas removal (AGR)processesemployedforgasificationdesignareeitherachemicalsolventsystem (e.g., amine gas treating systems based on MDEA, for example) or a physical solvent system (e.g., Rectisol or Selexol). Process selection is mostly dependent on the syngas cleanup requirement and costs. Conventional chemical/physical AGR processes using MDEA, Rectisol or Selexol arecommercially proven technologiesand canbe designed for selective removal of CO_2 in addition to H_2S from a syngas stream. For significant capture of CO_2 fromagasification plant(e.g.,>80%)the COinthe syngasmust firstbe convertedtoCO_2 andhydrogen (H_2) via a water-gas-shift(WGS) step upstream of the AGR plant.

For gasification applications, or IGCC, the plant modifications required to add the ability to capture CO_2 are minimal. The syngas produced by the gasifiers needs to be treated through various processes for the removal of impurities already in the gas stream, so all that is required to remove CO_2 is to add the necessary equipment, an absorber and regenerator, to this process train. In combustion applications, smodifications must be done to the exhaust stack and because of the lower concentrations of CO_2 present in the exhaust, much larger volumes of total gas requireprocessing,necessitatinglarger and more expensiveequipment.

By-products

heby-productsofcoalgasmanufactureincluded coke, coaltar, sulfur and ammonia;all useful products. Dyes, medicines, including sulfa drugs, saccharin and many organic compoundsare therefore derived from coal gas.

Coke is used as a smokeless fueland for themanufacture of water gas and producer gas. Coal tar is subjectedto fractional distillation to recover various products,including

- **tar,forroads**
- **benzole,amotorfuel**
- **creosote,awoodpreservative**

- **phenol,usedinthemanufactureofplastics**
- **cresols,disinfectants**

Sulfurisusedinthemanufactureofsulfuricacidandammoniaisusedinthemanufacture of fertilisers.

IndianScenario

India is one of the countries where the present level of energy consumption, by world standards, isvery low.Theestimateof annual energy consumptionin India isabout 330 Million Tones Oil Equivalent (MTOE) for the year 2004. Accordingly, the per capita consumption of energy is about 305 Kilogram Oil Equivalent (KGOE). As compared to this, the energy consumption in some of the other countries is of the order of over 4050 for Japan, over 4275 for South Korea, about 1200 for China, about 7850 for USA, about 4670 for OECD countries and the world averageis about 1690.

In so faras electricity consumption isconcerned,India has reached alevel ofabout 600-kilowatt hour (kwh) per head per year. The comparable figures for Japan are about 7,800, for South Koreaabout7,000, for China about 1380, for USAabout 13,000, for OECD countries about 8050and world average areabout 2430. Thus, both in terms of percapita energyconsumptionand in terms of per capita electricity consumption, India is farbehind many countries, and as a matter of fact, behind even the world average. Therefore, to improve the standards of living of Indian people and to let them enjoy the benefit of economic development, it is imperative that both energy consumption and electricity consumption level is enhanced. India is targeting a growth rate of 9 – 10%, having already reached a level of almost8%. To sustain the double-digit growth ratefor next10-15years, it would be essential that the level of energy availability and consumption, and electricity consumption in particular, is enhanced substantially.In the profile of energy sources in India, coal has a dominant position. Coal constitutes about 51% of India's primary energy resources followed by Oil (36%), Natural Gas (9%), Nuclear (2%) and Hydro (2%). To address the issue concerning energy consumption, and more particularly, the need for enhancing the energy supply,India hasaccorded appropriate priority toboth - supply side management and demand side management.

Non-ConventionalEnergySources

	Potential (MW)	Existing capacity (MW)
Wind	45,000	4,400
Small Hydro (upto 25 MW)	15,000	1,700
Solar (PV)	20 MW/Sq.Km	Very little
Biogas plants	12 million	3.8 million
Urban/Industrial waste based plant	2,700	Very little

Indian Government has accorded very high priority to develop and expandinstalled capacity base through non-conventional sources of electricity generation. Thereis a separate Ministry in the Government of India to exclusively focus on this important area of power generation. National Electricity Policy notified in 2005 in pursuance of the Electricity Act, 2003, prescribes that State Electricity Regulatory Commissions should prescribe a proportion of power which should be produced and supplied to the grid through the non-conventional sources. Some of the Regulatory Commissions have come out with specific policy guidelines with a different approach on tariff for these plants in order to encourage these technologies and plants. National Electricity Tariff Policy mandates that State Commissions should fix such minimum percentage latest by April, 2006. India has very high potential for these capacities:

It may be seen from the above that India has achieved substantial success on wind turbinebased power generation. Ministry of Non-conventional Energy Sources (MNES) has set atarget ofachievingat least 10,000 MW capacitythroughvarious non-conventionalsources, by the year 2012.

ConventionalSourcesofElectricityGeneration

Fossil fuel based thermal power, hydro-electric, and nuclear constitute the conventional sources of power. Non-conventional sources are less than 5% of total installed capacity in India. The present installed capacity (as in March 2006) is about 1,25,000 MW, consisting of coal based plants (56%), gas based plants (10%), hydro-electric (26%), nuclear (3%) non-conventional (5%).

IndianPowerSectorwasopenedupforprivatepowergenerationin1991.In termsofownershipstructure,theprofileconsistsofCentralGovernmentowned companies(32%),StateGovernmentownedcompanies/ElectricityBoards(57%)andPrivateSector(11%).100%FDIispermittedinallsegmentsofelectricityindustry–viz. Generation, Transmission, Distribution, Trading.

In the last three years far-reaching structural changes have been introduced in the Indian Electricity Sector. Electricity Act 2003 is an historic legislative initiative with powerfulpotential to transformthe power sector industry and market structure.

Mostimportantfeaturesofthe ElectricityAct2003areasfollows:

1. TheActcreatesaliberalandtransparentframeworkforpowerdevelopment
2. Itfacilitatesinvestmentbycreatingcompetitiveenvironmentandreforming distributionsegmentofpowerindustry.
3. EntryBarriershavebeenremoved/reducedinfollowingareas:
   a) Delicensedgeneration.
   b) Freedomto captivegenerationincludinggroupcaptive
   c) Recognizingtradingasanindependentactivity
   d) Openaccessintransmissionfacilitatingmultibuyerandsellermodel.
   4. Open access to consumers above 1 MW within five years commencing from 27thJanuary, 2004 (date of enforcement of amendment to Electricity Act) Regulators have been mandated to ensure this.
   5. Multiple licenses in distribution in the same area of supply so that competition could yield better services to consumers.
   6. RegulatoryCommissions–todevelopmarketandtofixtariff.

BiomassEnergy

Renewableenergyfromplantsandanimals/biomassisarenewableenergysourcefrom living or recently living plant and animal materials which can be used as fuel. An example of biomassisplantmaterialthatproduceselectricitywithsteam.Anexampleofbiomassis animal fossil fuel.

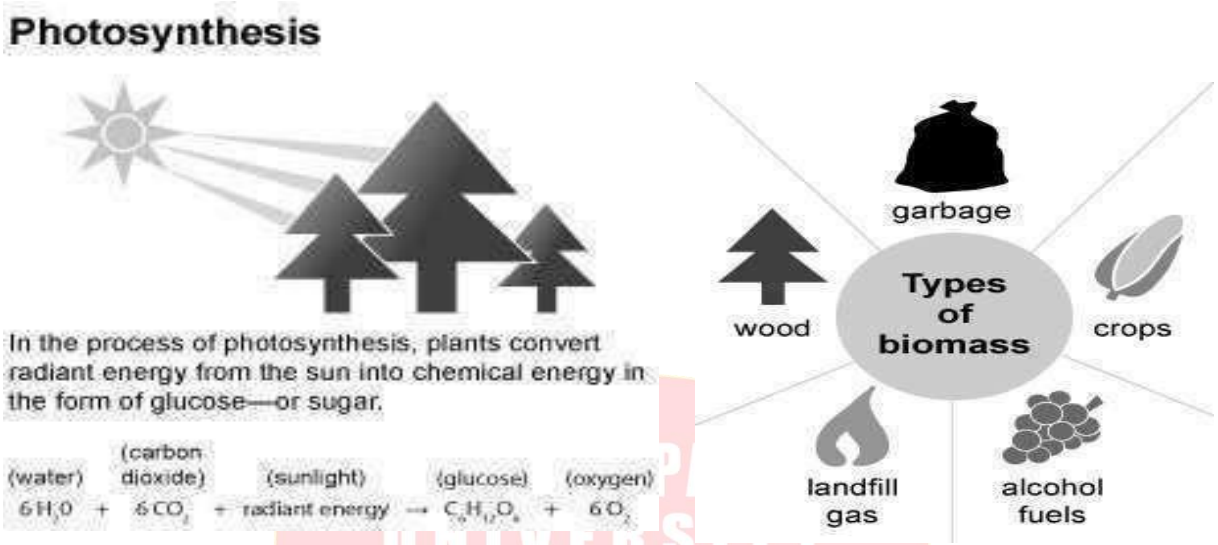
Biomass is organic material that comes from plants and animals, and it is a renewable source of energy.

Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process calledphotosynthesis.Whenbiomass isburned,the chemical energyinbiomassis releasedas heat. Biomass can be burned directly or converted to liquid biofuels or biogas that can be burned as fuels.

Or

Biomass energy is the energy which is contained inside plants and animals. This can include organic matter of all kinds: plants, animals, or waste products from organic sources. These sorts of energy sources are known as biofuels and typically include wood chips, rotted trees,

manure, sewage, mulch, and tree components. Chlorophyll present in plants absorbs carbondioxide from the atmosphere and water from the ground through the process of photosynthesis.The sameenergy is passed toanimals when they eatthem.Itis considered to be as renewable source of energy because carbon dioxide and water contained inside plants and animals are released back in to the atmosphere when they are burned and we can grow more plants and crops to create biomass energy.



TypesofBiomass

Weusefourtypesofbiomasstoday:1)woodandagriculturalproducts;2)solidwaste;3) landfillgas;and 4) alcoholfuels.

1. **Wood and Agricultural Biomass:- Most biomass used today is home grown energy. Wood-logs, chips, bark, and sawdust-accounts for about 79 percent of biomass energy. But any organic matter can produce biomass energy. Other biomass sources include agricultural waste products like fruit pits and corn cobs.**

2. **Solid Waste:- There is nothing new about people burning trash. What's new is burning trash to generate electricity. This turns waste into a usable form of energy. A ton (2,000 pounds) of garbage contains about as much heat energy, as pounds of coal. Power plants that burn garbage for energy are called waste-to-energy plants. These plants generate electricity much as coal-fired plants do except that garbage-notcoal-is thefuel used to fire an industrial boiler.Making electricity from garbage costs more than making it from coal and other energy sources. Themain advantage of burning solid waste is it reduces theamountof garbage dumped in landfills by 60 to 90 percent, and reduces the cost oflandfill disposal.**

3. **Landfill Gas:- Bacteria and fungi are not picky eaters. They eat dead plants and animals,causingthemtorotordecay.Eventhoughthisnaturalprocessis slowedintheartificialenvironmentof alandfill,asubstancecalledmethane gas is stillproduced as the waste decays. New regulations requirelandfills tocollectmethanegasforsafetyandenvironmentalreasons.Methanegasis colorlessandodorless,butitisnotharmless.Thegascancausefiresor explosions if it seeps into nearby homes and is ignited. Landfills can collect the methane gas, purify it, and then use it as an energy source. Methane, which is the same thingas natural gas, is a good energy source. Most gas furnaces and**

gas stoves use methane supplied by natural gas utility companies. The citylandfill in Florence, Alabama recovers 32 million cubic feet of methane gas a day. The city purifiesthe gas and then pumps it into naturalgas pipelines.

4. Alcohol Fuels:- Wheat, corn, and other crops can be converted into a variety of liquid fuels including ethanol and methanol. Using ethanol as a motor fuel is nothing new. Its use is almost as old as the automobile. Gasohol does have some advantages over gasoline. It has a higher octane rating than gasoline (provides your car with more power), and it is cleaner-burning than unleaded gasoline, with one-third less carbon monoxide emissions. Gasohol may also help reduce America's dependenceon foreign oil.

SourcesofBiomass

Here are various biomass sources, which are a great source of energy that can be used for variousapplications:

1) Wood and waste wood: Wood is the most commonly used type of biomass. Since the earliest days the fuel being used for cooking and heating is the wood. Even at present woodas the biomass material is majorsource of energy in a number of developingcountries.

Wood as a biomass can be used in various forms like large wooden blocks obtained from the trees, wooden chips, and saw dust. The wasted wood and wooden scrap are also the sourceof biomass.

2) Leaves of the plants: In the densely planted places lots of leaves fall from the trees. These can be dried, powdered and converted into small pieces, which can be used as the biomass fuel to generate heat used usually for cooking food.

3) Broken branches and twigs of the trees: No part of the plant goes wasted when it leaves the main body of the tree. Large and small branches and even all the small twigs are the source of biomass energy.

4) Agricultural waste: Lots of waste materials obtained from the farms are a great source of biomass materials.Livestockwaste can also be used to generate methane gas.

5) Waste paper: Tons of waste paper is produced every day. These can be burnt to produce lots of heat. The paper is manufactured from the plants, so it is considered to be biomass material.

6) Garbage: The garbage, also called as municipal solid waste is another source of biomass. Thegarbagecanbeintheform of food scrap, lawnclippings,wastepaper, fallen leavesetc all mixed together or collected individually.

7) Human waste: The human wastes are also considered to the source of biomass. These can used to generate methane gas which is the major componentof natural gas.

BiomassGasification

Biomass gasification, or producing gas from biomass, involves burning biomass under restrictedairsupplyforthegenerationofproducergas.Producergas isamixtureofgases:

18%–22%carbonmonoxide(CO),8%–12%hydrogen(H2),8%–12%carbondioxide(CO2),2%–4%methane(CH4)and45%–50% nitrogen(N2)makinguptherest.

Gasification reactions

Producinggasfrom biomassconsistsofthefollowingmainreactions,whichoccurinsidea biomassgasifier.

1. **Drying: Biomass fuels usually contain 10%–35% moisture. When biomass is heated to about 100 °C, the moisture is converted into steam.**
2. **Pyrolysis:Afterdrying,asheatingcontinues,thebiomassundergoespyrolysis. Pyrolysisinvolvesburningbiomasscompletelywithoutsupplyinganyoxygen.Asa result,thebiomassisdecomposedorseparatedintosolids,liquids,andgases. Charcoalisthesolidpart,taristheliquidpart,andfluegasesmakeupthegaseous part.**
3. **Oxidation: Air is introduced into the gasifier after the decomposition process. During oxidation, which takes place at about 700–1,400 °C, charcoal, or the solid carbonized fuel, reactswith the oxygenin the air to producecarbon dioxideand heat.**

C+O2&CO2+heat

4. **Reduction: At higher temperatures and under reducing conditions, that is when not enough oxygen isavailable, the following reactions take placeforming carbon dioxide, hydrogen, and methane.**

C +CO2&2CO
C + H2O &CO + H2
CO+H2O&CO2+H2 C +
2H2 &CH4

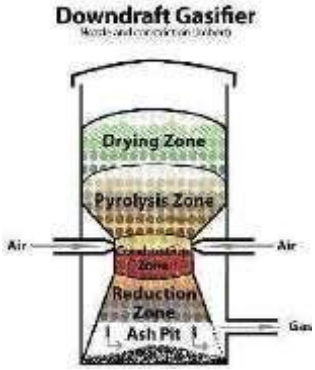
Typesofgasifiers

Gasifierscanbeclassifiedbasedonthedensityfactor,whichisaratiooofthesolid matter(the dense phase) a gasifier can burn to the total volume available.Gasifiers can be (a)densephasereactors,or(b)leanphasereactors.

Densephasereactors

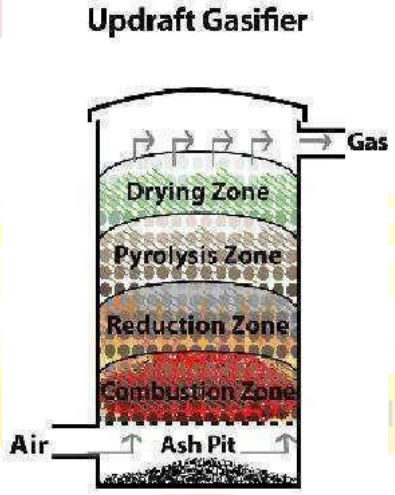
In dense phase reactors, the feedstock fills most of the space in the reactor. They are common, available in different designs depending upon the operating conditions, and are of three types: downdraft,updraft, and cross-draft.

1.Downdraftor co-currentgasifiers:- The downdraft (alsoknown as co-current) gasifieris the most common type of gasifier. In downdraft gasifiers, the pyrolysis zone isabove the combustion zone and the reduction zone is below the combustion zone.Fuel is fed from the top. The flow of air and gas is downwards (hence the name) through the combustion and reduction zones. The term co-current is used because air moves in the same direction as that of fuel, downwards. A downdraft gasifier is so designed that tar, which is produced in the pyrolysis zone, travels through the combustion zone, where it is broken down or burnt. As a result, the mixture of gasesin the exit stream is relatively clean. The position of the combustion zone is thus a critical element in the downdraft gasifier, its main advantage being that it producesgas with low tar content, which is suitablefor gas engines.



Updraftorcounter-currentgasifier

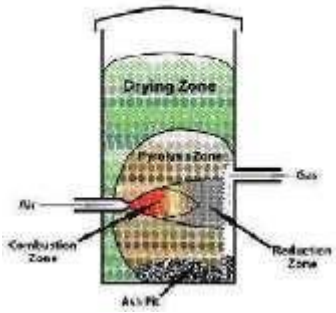
Inupdraftgasifiers(alsoknownascounter-current),airentersfrombelowthegrateand flows upwards, whereas the fuel flows downwards. An updraft gasifier has distinctlydefined zonesforpartialcombustion,reduction,pyrolysis,anddrying.Thegasproducedinthereductionzon eleavesthegasifierreactortogetherwiththeproductsofpyrolysisfromthe pyrolysis zoneand steam from the drying zone.The resulting combustible producer gas is rich inhydrocarbons(tars)and,therefore,hasahighercalorificvalue,whichmakesupdraft gasifiersmoresuitablewhereheatisneeded,forexampleinindustrialfurnaces.The producer gas needs to be thoroughlycleaned if it is to be used for generatingelectricity.



Cross-draftgasifier

In a cross-draft gasifier, air enters from one side of the gasifier reactor and leaves from the other. Cross-draft gasifiers have a few distinct advantages such as compact construction and low cleaning requirements. Also, cross-draft gasifiers do not need a grate; the ash falls to the bottom and does not come in the way of normal operation.

Crossdraft Gasifier

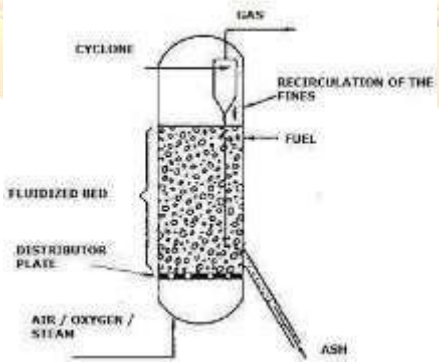


Leanphasereactors

Lean phase gasifiers lack separate zones for different reactions. All reactions – drying, combustion, pyrolysis, and reduction – occur in one large reactor chamber. Lean phase reactors are mostly of two types, fluidizedbed gasifiers and entrained-flowgasifiers.

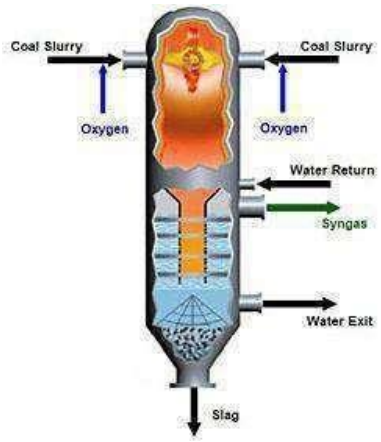
Fluidizedbedgasifiers

In fluidized bed gasifiers, the biomass is brought into an inert bed of fluidized material (e.g. sand, char, etc.). The fuel is fed into the fluidized system either above-bed or directly into the bed, depending upon the size and density of the fuel and how it is affected by the bed velocities. During normal operation, the bed media is maintained at a temperature between 550 °C and 1000 °C. When the fuel is introduced under such temperature conditions, itsdrying and pyrolyzing reactions proceed rapidly, driving off all gaseous portions of the fuel at relatively low temperatures. The remaining char is oxidized within the bed to provide theheat source for the drying and devolatilizing reactions to continue. Fluidized bed gasifiers are better than dense phase reactors in that they produce more heat in short time due to the abrasion phenomenon between inert bed material and biomass, giving a uniformly high (800–1000 ºC) bed temperature. A fluidized bed gasifier works as a hot bed of sand particles agitated constantlyby air. Air is distributedthroughnozzles located atthe bottom of the bed.



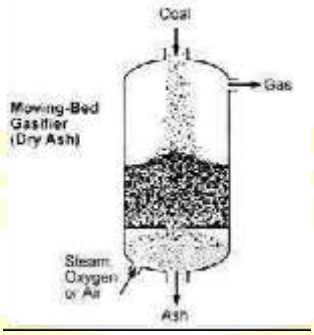
Entrained-flowgasifiers

In entrained-flow gasifiers, fuel and air are introduced from the top of the reactor, and fuel is carried by the air in the reactor. The operating temperatures are 1200–1600 °C and the pressure is 20–80 bar. Entrained-flow gasifiers can be used for any type of fuel so long as it is dry (low moisture) and has low ash content. Due to the short residence time (0.5–4.0 seconds), high temperatures are required for such gasifiers. The advantage of entrained-flow gasifiers is that the gas containsvery little tar.

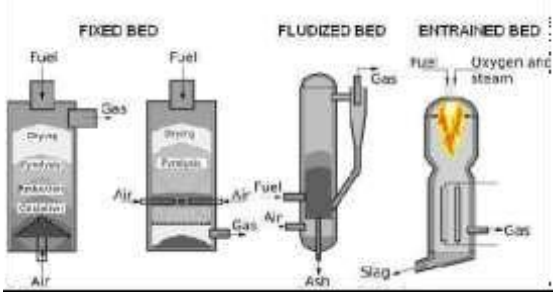


Thefixedbed

The fixed bed gasificationsystem consists of a reactor/gasifierwith a gascoolingand cleaning system.Thefixedbedgasifierhasabedofsolidfuelparticlesthroughwhichthegasifying media and gas move either up or down. It is the simplest type of gasifier consisting of usually acylindricalspace for fuel feedingunit,an ash removalunitand a gas exit. Inthefixedbed gasifier, the fuel bed moves slowly down the reactor as the gasification occurs. The fixed bed gasifiers are of simple construction and generally operate with high carbon conversion, long solidresidencetime,lowgasvelocityandlowashcarryover.Infixedbedgasifiers,tar removalusedtobeamajorproblem,howeverrecentprogressinthermalandcatalytic conversionof tar has given credible options.



Comperitivediagramofgasifiers



TypesOfConversionTechnologies

Therearefourtypesofconversiontechnologiescurrentlyavailable,eachappropriatefor specificbiomass?typesandresultinginspecificenergyproducts:

1. **Thermal conversion is the use of heat, with or without the presence of oxygen, to convert biomass materials or feedstocks into other forms of energy. Thermal conversiontechnolgies include direct combustion, pyrolysis, and torrefaction.**

As the term implies, thermal conversion involves the use of heat as the primary mechanismfor converting biomass into another form. Combustion, pyrolysis, torrefaction, and gasification are the basic thermal conversion technologies either in use today or being developed for the future.

1. Combustion

Direct combustion is the burning of biomass in the presence of oxygen. Furnaces and boilers are used typically to produce steam for use in district heating/cooling systems or todrive turbines to produceelectricity.In a furnace, biomass burns in a combustion chamber converting the biomass into heat. The heat is distributed in the form of hot air or water. In aboiler, the heat ofcombustion is converted into steam. Steam can be used to produce electricity, mechanical energy, or heating and cooling. A boiler'ssteam contains 60-85% of the energy in biomass fuel.

Co-firing–Thisisasub-setofcombustionbasedpowerproduction.Someof the modern coal fired power plants usebiomass for co-firingalong with coal. It isquiteefficient,cost-effective and requires moderate additionalinvestment. Ingeneral,combustionefficiency ofbiomasscanbe 10percentagepoints lower than for coal at the same installation, but co-firing efficiency in large-scale coal plants (35%-45%) is higher than the efficiency of biomass-dedicated plants. In the case of co-combustion of up to 5%-10% of biomass (in energy terms) onlyminorchangesinthehandlingequipmentareneededandtheboilerisnot noticeably de-rated.

2. Pyrolysis

Theseprocessesdonotnecessarilyproduceusefulenergydirectly,butunder controlledtemperatureand oxygen conditionsare used to convert biomassfeedstocks into gas, oil or forms of charcoal. These energy products are more energy dense than the original biomass, and therefore reduce transport costs, or have more predictable andconvenientcombustioncharacteristicsallowingthemtobeusedininternalcombustion engines and gas turbines. Pyrolysis is a processes of subjecting a biomass feedstock to high temperatures (greater than 430 °C) under pressurized environments andatlowoxygenlevels.Intheprocess,biomassundergoespartialcombustion. Processes of pyrolysis result in liquid fuels and a solid residue called char, or biochar. Biocharislikecharcoalandrichincarbon.Liquidphaseproductsresultfrom temperatures which are too low to destroy all of the carbon molecules in the biomass so the result is productionof tars, oils, methanol,acetone, etc.

- The two main methods of pyrolysis are "fast" pyrolysis and "slow" pyrolysis. Fast pyrolysis yields 60% bio-oil, 20% biochar, and 20% syngas, and can be done in seconds, whereas slow pyrolysis can be optimized to produce substantially more char (~50%) along withorganicgases,buttakesontheorder ofhourstocomplete.Ineither case, the gas or oil can be used as a fuel for firing the boiler for steam production and subsequent power production.
- Typically pyrolysis plants work well beyond 2 MW scale, while gasification plants work well until 2 MW scale, at the current technological progress. Thus, it canbe said that pyrolysis takes off where gasificationends.
- SlowPyrolysis
- In the caseof slow pyrolysis when you getan organic gas and charcoal. The gas can be cooled and fed to a gas engine for power production. Cooling this gas however results in a significant amount of hydrocarbons being removed. Thus most of the energy is wasted away. A more efficient idea that is being explored is to use this heterogeneous gas straight for combustion of boilers and running a steam cycle. Charcoalis avaluableproduct, which fetchesanywherebetween Rs10-Rs 25 per Kg. It

has a much better calorific value than coal and people in many places use charcoalbecause coal might not be available in those places.

- FastPyrolysis
- Fastpyrolysis isa process in which organic materials arerapidly heated to450 - 600°C in absence of air. Under these conditions, organic vapors, permanent gases and charcoalare produced. The vapors are condensed to pyrolysis oil. Typically, 50 - 75 wt % of the feedstock is converted into pyrolysis oil. The pyrolysis oil can be used as a replacement for furnace oil.

3. Torrefaction:- Like pyrolysis, is the conversion of biomass with the application of heat in the absence of oxygen, but at lower temperatures than those typicallyused in pyrolysis.In torrefaction temperaturestypically rangebetween200-320 °C. In the torrefaction process water is removed and cellulose?, hemicellulose and lignins are partially decomposed. The final product is an energy dense solid fuel frequently referred to as "bio-coal".

2. Thermochemical conversion is the application of heat and chemical processes in the production of energy products from biomass. A key thermochemical conversion process if gasification.

Gasification

Gasification is the use of high temperatures and a controlled environment that leadsto nearly all of the biomass being converted into gas. This takes place in two stages:partialcombustiontoformproducergasandcharcoal,followedbychemicalreduction.These stagesarespatially separated in the gasifier,with gasifier design very much dependant on the feedstock characteristics. Gasification requires temperatures of about 800°C. Gasification technology hasexisted since theturn ofthe centurywhen coalwas extensively gasified in theUKand elsewherefor usein power generation and inhousesforcookingandlighting.Amajorfutureroleisenvisagedforelectricity productionfrombiomassplantationsandagriculturalresiduesusinglargescale gasifiers with direct coupling to gas turbines.

3. Biochemicalconversioninvolvesuseofenzymes,bacteriaorothermicroorganismsto break down biomass into liquid fuels, and includesanaerobicdigestion, and fermentation.

Anaerobicdigestion

Anaerobicdigestionistheuseofmicroorganismsinoxygen-freeenvironmentsto break down organic material. Anaerobic digestion is widely used for the production of methane-and carbon-rich biogas from crop residues, food scraps,and manure(human andanimal).Anaerobicdigestionisfrequentlyusedinthetreatmentofwastewater andtoreduceemissionsfromlandfills.Anaerobicdigestioninvolvesamulti-stage process.First,bacteriaareusedinhydrolysistobreakdowncarbohydrates,forexample, into forms digestiblebyother bacteria. Thesecond set of bacteria convert theresultingsugarsandaminoacidsintocarbondioxide,hydrogen,ammoniaand organicacids.Finally,stillotherbacteriasconvertthesepproductsintomethaneand carbondioxide.Mixedbacterialculturesarecharacterizedbyoptimaltemperature ranges forgrowth. These mixed cultures allow digesters tobe operated over a widetemperature range, for example, above 0° C and up to 60° C. When functioning well,thebacteriaconvertabout90%ofthebiomassfeedstockintobiogas(containing about 55% methane), which is a readily useable energy source. Solid remnants of the originalbiomassinputareleftoverafterthedigestionprocess.Thisby-product,or digestate, has manypotential uses. Potential uses include fertilizer (althoughit should

bechemically assessedfor toxicityandgrowth-inhibitingfactorsfirst),animalbedding andlow-gradebuildingproductslikefiberboard.

Fermentation

Atits most basic,fermentationis the useofyeasts to convert carbohydratesinto alcohol – most notably ethanol, also called bioethanol. The total process involves several stages. In the firststagecrop materials arepulverized or ground and combined with water toform a slurry. Heat and enzymes are then applied to break down the ground materials into afiner slurry. Other enzymes are added to convert starches into glucose sugar. The sugary slurry is then pumped into a fermentation chamber to which yeasts are added. Afterabout 48-50 hours, the fermented liquid is distilled to divide the alcohol from the solid materials left over.

3. Chemicalconversioninvolvesuseofchemicalagentstoconvertbiomassinto liquid fuels.

ADVANTAGES

1) Biomass used as a fuel reduces need for fossil fuels for the production of heat, steam, and electricity for residential,industrial and agriculturaluse.
2) Biomassisalwaysavailableandcanbeproducedasarenewableresource.
3) Biomassfuelfromagriculturewastes maybe asecondary productthataddsvalue to agricultural crop.
4) GrowingBiomasscropsproduceoxygenanduseupcarbondioxide.
5) Theuseofwastematerialsreducelandfilldisposalandmakesmorespacefor everythingelse.
6) CarbonDioxidewhichisreleasedwhenBiomassfuelisburned,istakeninbyplants.
7) Lessmoneyspentonforeignoil.

DISADVANTAGES

1) Agriculturalwasteswill notbeavailableifthebasic cropisnolongergrown.
2) Additionalwork is needed in areas such as harvestingmethods.
3) Landusedforenergycropsmaybeindemandforotherpurposes,suchasfaming, conservation, housing, resort or agricultural use.
4) SomeBiomassconversionprojectsarefromanimalwastesandarerelativelysmalland thereforearelimited.
5) Researchisneededtoreducethecostsofproductionof Biomassbasedfuels.
6) Isinsomecasesis amajorcauseofpollution. Or

AdvantagesofBiomassEnergy

In many ways, biomass is a new source of power. While wood has always served as a fuel source for fires and ovens and conventional heating methods, biomass energy advancements are a few steps beyond that. Now these biomass fuel products are harvested and mass-produced and used in everythingfrom enginesto power plants.

1. No Harmful Emissions: Biomass energy, for the most part, creates no harmful carbon dioxide emissions. Many energy sources used today struggle to control their carbon dioxide emissions, as these can cause harm to the ozonelayer and increase the effects of greenhouse gases, potentially warming the planet. It is completely natural, has no such carbon dioxide side effects in its use.

2. Clean Energy:Becauseofitsrelatively cleanuse,biomassenergy,whenused incommercialbusinesses such as airlines, receives tax credit from the US government. This is good for the environment and good for business. It does release carbon dioxide but captures carbon dioxide for its own growth. Carbon dioxide released by fossil fuel are released into the atmosphere and are harmful to the environment.

3. Abundant and Renewable: Biomass products are abundant and renewable. Since theycome from living sources,and life is cyclical, these products potentially never run out, so long as there is something living on earth and there is someone there to turn that living things components and waste products into energy. In the United Kingdom, biomass fuels are made from recycled chicken droppings. In the United States and Russia, there are plentiful forests for lumber to be used in the productionof biomass energy.

4. Reduce Dependency on Fossil Fuels: It has developed as an alternate source of fuel for many homeownersand have helped them to reduce their dependencyon fossil fuels.

5. Reduce Landfills: Another benefit of this energy is that it can take waste that is harmful to theenvironment andturnitintosomethinguseful.Forinstance,garbageaslandfillcan,at least partially, be burned to create useable biomass energy.

6. Can be used to Create Different Products: Biomass energy is also versatile, as different forms of organic matter can be used to create different products. Ethanol and similar fuelscan be made from corn and other crops. With so many living things on the planet, there is no limit to how many ways it can be found and used.

Biomassenergypowerplant

Disadvantages of Biomass Energy

Besides above advantages, there are also some downsides to it. Let's see below some of itsdisadvantages.

1. Expensive:Firstly, its expensive. Livingthingsare expensive tocare for, feed,andhouse, and all of that has to be consideredwhen trying to use waste productsfromanimals for fuel.

2. Inefficient as Compared to Fossil Fuels: Secondly, and connected to the first, is the relative inefficiencyof biomass energy.Ethanol, asa biodieselis terriblyinefficientwhen comparedto gasoline, and it often has to be mixed with some gasoline to make it work properly anyway. On top of that, ethanol is harmful to combustionengines over long termuse.

3. HarmfultoEnvironment:Thirdly,usinganimalandhumanwastetopowerenginesmay save on carbon dioxide emissions, but it increases methane gases, which are also harmful to the Earth's— ozone layer.So really, we areno better off environmentallyfor using one or the other.Andspeakingofusingwasteproducts,thereisthesmelltoconsider.Whileitisnot physically harmful, it is definitely unpleasant, and itcan attract unwanted pests (rats, flies)and spread bacteria and infection.

4. Consume More Fuel: Finally, using trees and tree products to power machines is inefficient as well. Not only does it take a lot more fuel to do the same job as using conventional fuels, but it also creates environmental problems of its own. To amass enough lumber to power a nationfullofvehiclesorevenapowerplant,companieswouldhavetoclearconsiderable

forestarea.Thisresultsinmajortopologicalchangesanddestroysthehomesof animalsandplants.

5. Require More Land: Combustion of biomass products require some land where they can easily be burnt. Since, it produces gases like methane in atmosphere; therefore it can be produced in those areas which are quite far from residentialhomes.

Wind–Energy

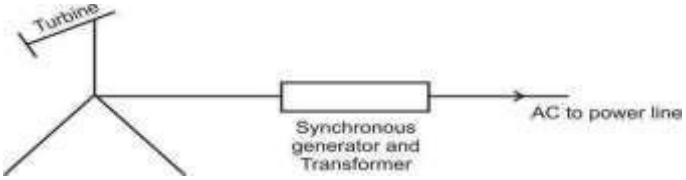


Fig.1.3 (A):WindPowerDirectFeedtoMainPowerline

Wind result from air in motion dueto pressuregradient. Wind is basically caused by thesolar energy irradiating the earth. This is why wind utilization is considered a part of solar technology.

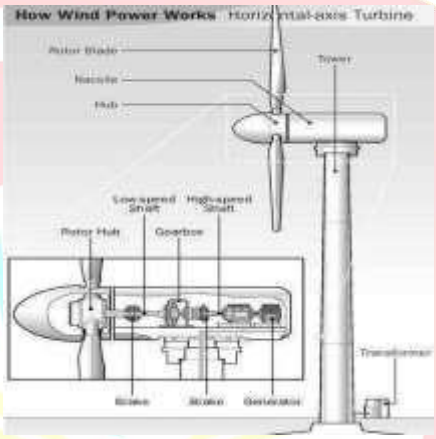


Fig.1.3(B):WindPowerDirectFeedtoMainPowerline

Energyofwind canbeeconomicallyusedforthegenerationofelectricalenergy. Winds are caused from two main factors:

1) Heatingandcoolingoftheatmospherewhichgeneratesconvectioncurrents. Heating is caused by the absorption of solar energy on the earth's surface and in the atmosphere.
2) The rotation of the earth with respect to atmosphere and its motion around the sun. Wind mill consists of wind turbine head, transmission and another supporting structure. Wind energy conversion devices like wind turbines are used for converting wind energy into mechanical energy.

   Windturbineconsists basically of a few sails, vans andblades radiating from a centralaxiswhenwindblowsagainstthebladesorvanstheyrotateaboutthe axis.Therotationalmotion isutilized toperformsomeusefulwork.By connecting thewindturbinetoanelectricgeneratorwindenergycanbeconvertedinto electricenergy.Winddensitiesupto10KW/m^3/dayareavailable.Morethan 20,000 MW electricity can be generated in Indiafrom wind.

Threefactorswhichdeterminetheoutputfromawindenergyconverter:

1. Thewindspeed.
2. TheCross-sectionofwindsweptbyrotor.
3. Conversionefficiencyoftherotortransmissionsystemandgeneratororpump.

A. Horizontal axis

B. Verticalaxis

Windpower istheuse of air flow through windturbines to mechanically power generators forelectricpower.Windpower,asanalternativetoburningfossilfuels,is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, consumes no water, and uses little land.[2] The net effects on the environment are far less problematicthan those of nonrenewablepower sources.

Wind farms consist of many individual wind turbines which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electric power, competitive with or in many places cheaper than coal or gas plants.[3][4][5]Offshore wind is steadier and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energyinto the grid or provide electric power to isolated off-grid locations.

Wind power gives variable power which is very consistent from year to year but which has significantvariationovershortertimescales.Itisthereforeusedinconjunctionwith other electric power sources to give a reliable supply. As the proportion of wind power in a region increases, a need to upgrade the grid, and a lowered ability to supplant conventional production can occur. Power management techniques such as having excess capacity, geographically distributed turbines, dispatchable backing sources, sufficient hydroelectric power, exporting and importing power to neighboring areas, or reducing demand when wind production is low, can in many cases overcome these problems. In addition, weather forecasting permits the electric power network to be readied for the predictable variations in production that occur.

Wind turbines mainly are of two types: vertical axis(VAWT) and horizontal axis(HAWT).HAWT are the most common type of wind turbines built across the world. VAWT is a type of wind turbine which have two or three blades and in which the main rotor shaft runsvertically. They are howeverused less frequently as they are not as effective as HAWT.
The Vertical Axis Wind Turbine (VAWT) is the most popular of the turbines that people are addingto make their home a source of renewable energy. While it is not as commonly usedas theHorizontal Axis Wind Turbine, they are great for placementat residential locations and more.Herewewill take a lookattheVAWT, andfill you in on theprosand theconsas wellas other important information that will alleviate stress and headache when you simply want to do your part to keep the environmentprotected.

Vertical turbines spin on the vertical axis and comes in various shapes sizes and colors. It's movement is similar to a coin spinning on the edge. The main difference between the VAWT and HAWT is the position of blades. In HAWT, blades are on the top, spinning in the air while in VAWT, generator is mounted at the base of the tower and blades are wrapped around the shaft. Vertical Axis Wind Turbines are designed to be economical and practical, as well as quiet and efficient. They are great for use in residential areas whereas the HAWT is best for use at a business location. There are two different styles of vertical wind turbines out there. One is the Savonius rotor, and the second is the Darrieus model. The first model looks like a55 gallon drum that is been cut in half with the halves placed onto a rotating shaft. Thesecond model is smaller and looks much like an egg beater. Most of the wind turbines being used today are the Savonius models. We will take a look more in- depth at both of thesetypes of turbines available.
A wind turbine secures air into a hub, which them turns into a generator. The air that passes through the blades of the wind turbine is spun into the generator through rotational momentum. The VAWT, as the turbines are oftener shortened, feature the followingqualities:

- **Two to three blades with a vertically operating main rotor shaft – the more bladesthat you have on the unit, the more wind energy it will receive and the more efficiency it will offer**
- **Usedlessfrequentlythanahorizontalwindturbine**
- **The position of the blades is different in the VAWT. On this model, the base of the tower holds the generator, and theblades then wrap themselvesaround theshaft. People use the VAWT because they can be placed closer to the ground, which makes them acceptable and effective for use at a residentiallocation.**
- **Withtheverticalaxiswindturbine,therotorshaftisarrangedinaverticalpattern**
- **TheVAWTareeasierandmoreaffordabletomaintainthanhorizontalunits**
- **One complain that some users have with the VAWT is that is creates less wind energy, which may cause a number of different noises to be heart. Turbulent air flow is also a possibilitythat can shorten the life of the system.**
- **InstallationoftheVAWTontotheroofwillcausethewindspeedtodoublefor maximumwindturbulenceandwindenergyusage.**

TypesofVerticalAxisWindTurbines

there are two different types of VAWTs that you can choose from. While we looked at these typesbrieflyabove,now wewill takealookatmoreinformationabouteachtypeanddiscuss the important factors that you should know. First, let's take a look at the Darrieus wind turbinemode.

DarrieusWindTurbine

Darrieus Wind Turbine is commonly known as an "Eggbeater" turbine. It was invented by Georges Darrieus in 1931. A Darrieus is a high speed, low torque machine suitable for generating alternating current (AC) electricity. Darrieus generally require manual push therefore some external power source to start turning as the starting torque is very low. Darrieushas two verticallyoriented blades revolvingaround a vertical shaft.

TheDarrieuswind turbineoffersthefollowingfeatures:

- **These eggbeater shaped turbines are great at efficiency, however, they are not as reliable.**
- **InordertousetheDarrieuswindturbineyoumusthaveanoutsidesourceof power in order to start them**
- **Itisinyourbestinteresttochooseawindturbinethathasatleastthreeblades.**
- **Tosupportsuchawindturbineitisnecessarythatyouhaveasuperstructure whichwillconnectitnearthetopbearing.**

Savonius Wind Turbine: A Savonius vertical-axis wind turbine is a slow rotating, high torque machine with two or more scoops and are used in high-reliability low-efficiency power turbines. Most wind turbines use lift generated by airfoil-shaped blades to drive a rotor, the Savonius usesdrag andthereforecannot rotatefaster thantheapproachingwind speed. Now let's take a look at the second type, which is also the most popular of the two. The Savonius wind turbine is the most popular of the two types. Let's go ahead and look at some of the features these VAWT offer to the homeowner.

- **Asadragtypeofturbine,theseunitsareless efficient.**
- **Whenyou live inan area that has strong and gustingwindsor whenyou needa unit that self-starts,this is the best type availableto you.**
- **ThisunitislargerthantheDarrieusmodel.**

Savonius verticalaxiswindturbineneedstobemanuallystarted.The slowspeedofSavonius increasescostandproduceslessefficiency.

AdvantagesofVerticalAxisWind Turbines

You might bewondering why you would consider usinga VAWT insteadof a HAWT.Thereare actually a number of reasons that this decision is made. Let's take a look at some of the advantagesthat you can enjoy with this type of wind turbinein use at your home.

- **You can build your wind turbine close to the ground so if you do not have asuitable rooftop for placement, or if you live where there are hills, ridges, etc. that prohibitthe flow of air, they work wonderfullyfor your needs.**
- **Since VAWT are mounted closer to the ground they make maintenance easier, reduce the construction costs, are more bird friendly and does not destroy the wildlife.**
- **Youdonotneedanymechanismsinordertooperatethewindturbine**
- **Lowerwind startupspeed**
- **The main advantage of VAWT is it does not need to be pointed towards the windto be effective. In other words, they can be used on the sites with high variable wind direction.**
- **Youcanusethewindturbinewheretallstructuresarenotallowed.**
- **VAWT's are quiet, efficient, economical and perfect for residential energy production, especially in urban environments.**
- **TheyarecosteffectivewhencomparetotheHAWTs.Itisstillbesttoshoparound andcheckpricesbeforemakingapurchase,however.**
- **Many of the turbines are resistant to many of the different weather elements that you may experience. It is imperative to choose a unit that offers this valuable protectionand extra durability when you need it the most.**

DisadvantagesofVerticalAxisWind Turbines

There are also disadvantages that come with the use of this type of wind turbine. While the many advantages are certainly great, it is imperative that you are aware of thedisadvantages. Before deciding which type of wind turbine is best for you it is good idea to take a look at both the pros and the cons. What is right for one person may not be right for you, althoughit is safe to say that a VAWT is great for almost any residentialsetting.

Let'stakealookatsomeofthedisadvantagesofusingaVAWT:

- **Decreased level of efficiency when compared to the HAWT. The reason for the reduced amount of efficiency is usually due to the drag that occurs within the blades as they rotate.**
- **Youareunabletotakeadvantageofthewindspeedsthatoccurathigherlevels.**
- **VAWT's are very difficult to erect on towers, which means they are installed on base, such as ground or building.**

Solarenergy

Solar panels converts the sun's light in to usable solar energy using N-type and P-type semiconductor material.When sunlight is absorbed by these materials, the solar energy knockselectrons loose fromtheir atoms,allowing the electrons to flow through thematerial toproduceelectricity.Thisprocessofconvertinglight(photons)toelectricity(voltage)is

called thephotovoltaic(PV) effect.Currentlysolarpanels convert mostof thevisiblelightspectrumandabout halfofthe ultravioletandinfrared light spectrumto usablesolar energy. Solar energytechnologiesusethesun's energyandlighttoprovideheat,light,hotwater, electricity, and even cooling,for homes, businesses,and industry.
Thereareavarietyoftechnologiesthathavebeendevelopedtotakeadvantageofsolar energy.

SolarEnergyTechnologies:

a) SolarWaterheating.
b) SolarHeatingof Building.
c) Solar– Distillation
d) SolarFurnaces
e) SolarCooking
f) SolarElectricPowerGeneration(PhotovoltaicSystem)
g) SolarThermalPowerProduction.
h) ProductionofPowerthroughSolarPonds.

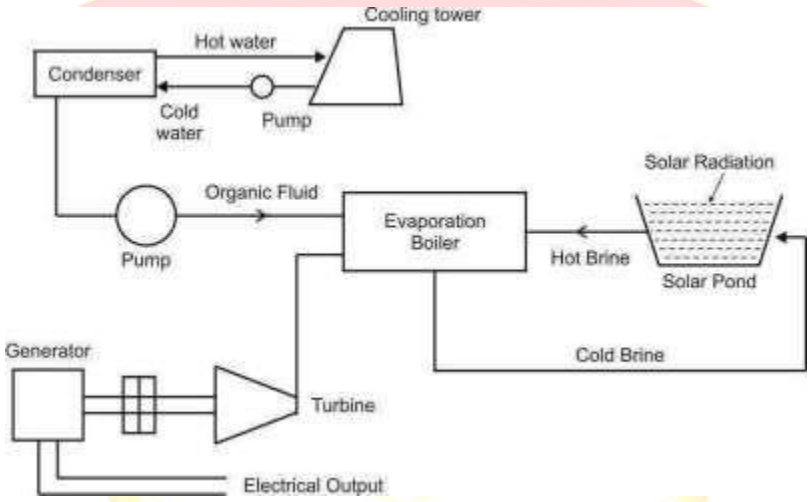


Fig.1.2 :SolarPondElectricPowerPlant

- India receives 5000 Trillion KW/hr of sun shine in an year. India receives abundant sunshine with about 1648-2108 KWhr/m^2/yr with nearly 250-300 days of useful sunshinein a year. The daily solar energy incidenceis between4 to 7 KWhr/m^2.
- Energyradiatedbythesunaselectromagneticwaves(Wavelength0.2 to0.4 um).
- Duetoabsorptionandscatteringintheatmospherethemaximumfluxdensityis1 KW/sq.m.45%energy intheform ofvisiblerays and44%asinfra-red radiation.The enormous solar energy resource may be converted into other forms of energy through thermal photovoltaic conversion routes. The solar thermal route uses radiation in the form of heat in turn may be converted to mechanical.

1.SolarWater heating

Solarwaterheating(SWH)isthe conversionof sunlightintoheatforwaterheatingusing a solar thermal collector. A variety of configurations are available at varying cost toprovide solutions in different climates and latitudes. SWHs are widely used for residential and some industrial applications.

A sun-facing collector heats a working fluid that passes into a storage system for later use. SWH are active (pumped) and passive (convection-driven). They use water only, or both water and a workingfluid. They are heated directly or via light-concentratingmirrors.They

operateindependentlyorashybridswithelectricorgasheaters.Inlarge-scale installations,mirrorsmayconcentratesunlightonto asmallercollector.

ActiveSolarWaterHeatingSystems

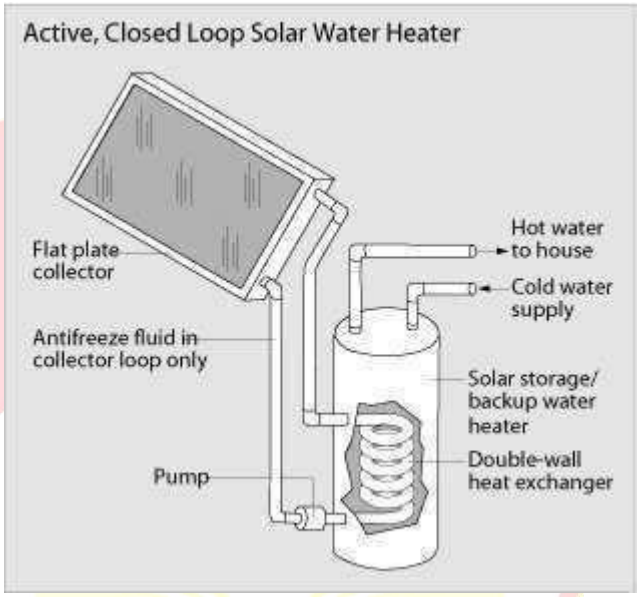
Therearetwotypesofactivesolarwaterheatingsystems:

Directcirculationsystems

Pumps circulate household water through the collectors and into the home. They work well in climates where it rarely freezes.

Indirect circulation systems

Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water that then flows into the home. They are popular inclimates prone to freezing temperatures.



ActiveSolarHeatingSystem

PassiveSolarWaterHeatingSystems

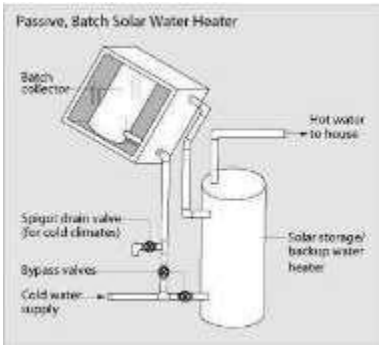
Passive solar water heating systems are typically less expensive than active systems, but they're usually not as efficient. However, passive systems can be more reliable and maylast longer.There are two basic types of passive systems:

Integral collector-storage passive systems

These work best in areas where temperatures rarely fall below freezing. They also work well in householdswith significant daytime and eveninghot-water needs.

Thermosyphon systems

Water flows through the system when warm water rises as cooler water sinks. The collector must be installed below the storage tank so that warm water will rise into the tank. These systems are reliable, but contractors must pay careful attention to the roof design because of the heavy storage tank. They are usually more expensive than integral collector-storage passive systems.



PassiveSolarWaterHeatingSystems

Solar space heating systems are an effective and excellent way to reduce costly energybills during your heating season.

Asolarspaceheaterworksalongsideyourcurrentheatingsystemtousethesun'senergy toreduceyourconsumptionofoil,propane,orotherfossilfuels.

Traditionally used with solar evacuated tube collectors, these systems work to providefree, solar heating for your home throughout your entire heating system. These solar heating systems can also be combined with our solar-ready ultra high efficiency DC- Inverter heat pump chiller.

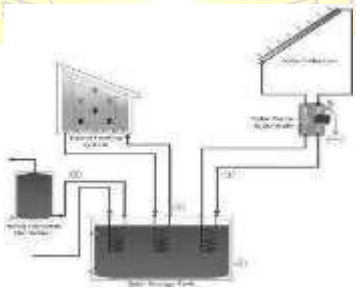
BenefitsofSolarSpaceHeating

The average American family spends over $2,000 a year in heating costs. Heating systems that rely on fossil fuels, such asoil, propane,and naturalgas will continueto rise in cost.

By using a solar space heating system, you can take advantage of the sun's free, abundant energy to heat your home for free. Heating your home with a solar heating system can significantly reduce your winter fuel bills. Another excellent benefit is that a solar space heating system also heats domestic hot water.

A solar space heating system will also reduce the amount of air pollution and greenhouse gases that result from your use of fossil fuels such as oil, propane, and other petroleum products.

SolarHeatingTank



Solarspaceheatingandcooling

Manylargebuildingsneedventilatedairtomaintainindoorairquality.Incoldclimates, heating this air can use large amounts of energy. A solar ventilation system can preheat theair, saving both energy and money. This type of system typically uses a transpired collector , whichconsistsofathin,blackmetalpanelmountedonasouth-facingwalltoabsorbthe sun'sheat.Airpassesthroughthemanysmallholesinthepanel.Aspacebehindthe perforated wall allows the air streams from the holes to mix together. The heated air is then sucked out from the top of the space into the ventilationsystem.

Solar process heating systems are designed to provide large quantities of hot water or spaceheating for nonresidentialbuildings.Atypicalsystem includes solar collectorsthatworkalong with a pump, a heat exchanger, and/or one or more large storage tanks. The two main types of solar collectors used - an evacuated-tube collector and a parabolic-trough collector - can operate at high temperatures with high efficiency. An evacuated-tube collector is a shallow boxfull of many glass, double-walled tubesand reflectors toheatthefluid insidethe tubes. A vacuum between the two walls insulates the inner tube, holding in the heat. Parabolictroughs are long, rectangular, curved (U-shaped) mirrors tilted to focus sunlight on a tube, whichruns down the center of the trough.Thisheats the fluid within the tube.

The heat from a solar collector can also be used to cool a building. It may seem impossible to use heat to cool a building,butit makes more sense if youjust think of the solar heat as anenergysource. Your familiar home air conditioneruses an energy source,electricity, to create cool air. Solar absorption coolers use a similar approach, combined with some very complex chemistrytricks,tocreatecoolairfromsolarenergy.Solarenergycanalsobeusedwith evaporative coolers (also called "swamp coolers") to extend their usefulness to more humid climates, using anotherchemistry trick called desiccantcooling.

WaveEnergy:

Wave Energy also known as Ocean Wave Energy, is another type of ocean based renewable energy source that uses the power of the waves to generate electricity. Unlike tidal energy which uses the ebb and flow of the tides, wave energy uses the vertical movement of the surfacewaterthatproducetidalwaves.Wavepowerconvertstheperiodicup-and- down movement of the oceans waves into electricity by placing equipment on the surface of the oceans that captures the energy produced by the wave movement and converts this mechanical energy into electrical power.

Amultipurposewaveregulator systemintheformofalongbarrierresultsin the formationof a calm pool between the barrier and shore and this can be used as harbor. Space of aquaculture space for coastal transport with light and faster crafts shore protection against the erosion by sea. It is pollution free.

Waves are generated by wind passing over the surface of the sea. As long as the waves propagateslower than the wind speed justabove the waves, thereis an energy transfer from the wind to the waves. Both air pressure differences between the upwind and the lee side ofa wavecrest,as well as friction on thewatersurface bythewind, making thewaterto go into the shear stress causes the growth of the waves.[5]

Wave height is determined by wind speed, the duration of time the wind has been blowing, fetch (the distance over which the wind excites the waves) and by the depth and topography of theseafloor (which can focus or disperse theenergy of thewaves).A given wind speed has a matching practical limit over which time or distance will not produce larger waves. When this limit has been reached the sea is said to be "fully developed".

Wave power devices are generally categorized by the method used to capture the energy of the waves, by location and by the power take-off system. Locations are shoreline, nearshore and offshore. Types of power take-off include: hydraulic ram, elastomeric hose pump, pump-to-shore, hydroelectric turbine, air turbine,[22] and linear electrical generator. Whenevaluating wave energy as a technology type, it is important to distinguish between the four most common approaches: point absorber buoys, surface attenuators, oscillating water columns, and overtopping devices.

inthetemperatureoftheairmassesaroundtheglobecausestheairtomovefromthe hotter regionstothecoolerregions,resultinginwinds.

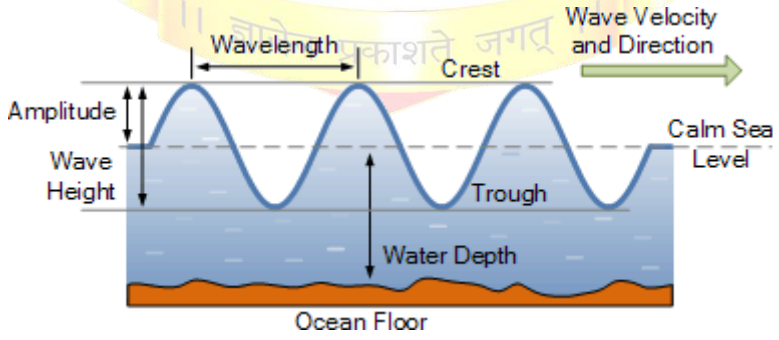
As the wind passes over the surface of the oceans, a portion of the winds kinetic energy is transferred to the water below, generating waves. In fact, the ocean could be viewed as avaststoragecollector of energy transferred by the sun to the oceans, with the waves carrying the transferred kinetic energy across the surface of the oceans. Then we can say that waves are actually a form of energy and itis this energy and not water thatmoves along the ocean's surface.

These waves can travel (or "propagate") long distances across the open oceans with verylittle loss in energy, but as they approach the shoreline and the depth of the water becomes shallower, their speed slows down but they increase in size. Finally, the wave crashes ontothe shoreline, releasing an enormous amount of kinetic energy which can be used for electricity production. A breaking waves energy potential varies from place to place depending upon its geographic location and time of year, but the two main factors which affectthe sizeof thewaveenergy arethe windsstrength and theuninterrupted distance over the sea that the wind can blow.

Then we can say that "Wave Energy" is an indirect form of wind energy that causesmovementof thewater on the surface of the oceans and by capturing this energy themotion of the waves is converted to mechanical energy and used to drive an electricity generator. In manyrespects,thetechnologyusedforcapturingthiswaveenergyissimilartotidal energy or hydroelectric power.

The kinetic energy of the wave turns a turbine attached to a generator, which produces electricity. However, the open oceans can be a stormy and violent environment, resulting in the wave energy machines being destroyed by the very energy they were designed tocapture.

In its simplest terms, an ocean wave is the up-and-down vertical movement of the sea water which variessinusoidally withtime.This sinusoidalwavehashigh pointscalled crestsandlow points called troughs. The difference in height of a wave between the crest and the trough is called the peak-to-peak amplitude, then the waves amplitude or height is the centre of these two points and corresponds to the actual sea level when there is no movement of the water, in other words, a calm sea.



The amplitude of an ocean wave depends on the weather conditions at that time, as the amplitude of a smooth wave, or swell, will be small in calm weather but much larger instormyweather with strong gales as the seawater moves up and down.

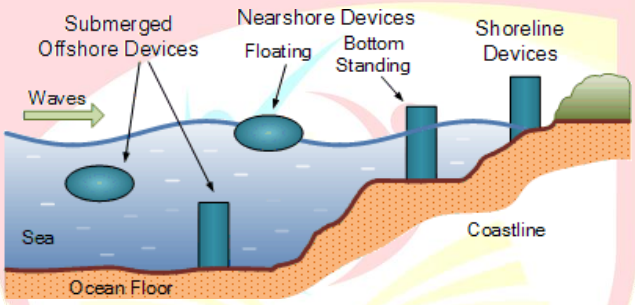
As well as the amplitude of the wave, another important characteristic is the distance betweeneach successivecrest, or trough, knownas thewaveperiod, (T).This waveperiod is the time in seconds between each crest of the wave. Then for a gentle swell this time period may be very long, but for a stormy sea this time period may be very short as each wave crashes onto the one in front.

The reciprocal of this time (1/T) gives us the fundamental frequency of the ocean wave relative to some static point. Smaller periodic waves generated or superimposed onto this fundamental wave such as reflected waves are called harmonic waves. Then the frequency and amplitude characteristics of a wind-generated wave depend on the distance the wind blows over the open water (called the fetch), the length of time thewind blows, the speed of the wind and the water depth.

Waves transport energy from where they were created by storms far out in the ocean to a shoreline. But a typical ocean wave does not resemble a perfect sinusoid, they are more irregular and complex than a simple sinusoidal wave. Only the steady up-and-down movement of a heavy swell resembles a sinusoidal wave much more than the chaotic nature of locally generated wind waves, as real sea waves contain a mixture of waves with different frequencies, wave heights and directions.

WavePowerDevices

Ocean wave energy has many advantages over ocean wind energy in that it is more predictable, less variable and offers higher available energy densities. Depending on the distance between the energy conversion device and the shoreline, wave energy systems can be classified asbeing either Shorelinedevices, near shore devices or offshoredevices.



Shoreline devices are wave energy devices which are fixed to or embedded in the shoreline, that is they are both in and out of the water. Nearshore devicesare characterised by being used to extract the wave power directly from the breaker zone and the waters immediately beyond the breaker zone, (i.e. at 20m water depth).

Offshore devices or deep water devices are the farthest out to sea and extend beyond the breaker lines utilising the high-energy densities and higher power wave profiles available in the deep water waves and surges.

Oneoftheadvantagesofoffshoredevicesisthatthereisnoneedforsignificantcoastal earthworks,asthereiswithonshoredevices.

As most of the energy within a wave is contained near the surface and falls off sharply with depth. There is a surprising range of designs available that maximise the energy available for capture. These wave energy devices are either fixed bottom standing designs used in shallow water and which pierce the waters surface, or fully floating devices that are used to capture the kinetic energy content of a waves movement and convert each movement into electricity using a generator.

Therearecurrentlyfourbasic"capture"methods:

- **Point Absorbers – These are small vertical devices either fixed directly to the oceanfloor or tethered via a chain that absorb the waves energy from all directions. These devices generate electricity from the bobbing or pitching action of a floating device.**

Typicalwaveenergydevicesinclude,floatingbuoys,floatingbags,ducks,and

articulatedrafts,etc.Thesedevicesconverttheup-and-downpitchingmotion waves into rotary movements, or oscillatory movements in a variety of devices to generate electricity. One of the advantages of floating devices over fixed devices it that they can be deployedin deeper water, where the wave energy is greater.

- **Wave Attenuators – also known as "linear absorbers", are long horizontal semi-submerged snake-like devices that are oriented parallel to the direction of the waves. A wave attenuator is composed of a series of cylindrical sections linked together by flexible hinged joints that allow these individual sections to rotate and yaw relative to each other. The wave-induced motion of the device is used to pressurise a hydraulic piston, called a ram, which forces high pressure oil through smoothing accumulators to turn a hydraulic turbine generator producing electricity. Then wave attenuators convert the oscillatingmovement of a wave into hydraulicpressure.**
- **Oscillating Water Column – is a partly submerged chamber fixed directly at the shoreline which converts wave energy into air pressure. The structure could be anatural cave with a blow hole or a man made chamber or duct with an wind turbine generator located at the top well above the waters surface. The structure is built perpendicular to the waves so that the ebbing and flowing motion of the waves force the trapped water insidethe chamber to oscillatein the vertical direction.**
  - **As the waves enter and exit the chamber, the water column moves up and down and acts like a piston on the air above the surface of the water, pushing it back and forth. This air is compressed and decompressed by this movement and ischannelled through a wind turbine generator to produce electricity. The speed ofair in the duct can be enhanced by making the cross-sectional area of the ductmuch less than that of the column.**
  - **Overtopping Devices – also known as "spill-over" devices, are either fixed orfloating structures that use ramps and tapered sides positioned perpendicular tothe waves. The sea waves are driven up the ramp and over the sides filling-up a small tidal reservoir which is located 2 to 3 metres above sea level. The potential energy of the water trapped inside the reservoir is then extracted by returning the water back to the sea through a low head Kaplan turbine generator to produce electricity.**

  Then overtopping devices convert the potential energy available in the head of water into mechanical energy. The disadvantage of onshore overtopping schemes is that they havea relatively low power output and are only suitable for sites where there is a deep water shorelineand a low tidal range of less than about a metre.

The idea of harnessing the tremendous power of the oceans waves is not new. Like other forms of hydro power, wave energy does not require the burning of fossil fuels, which can pollute the air, contributing to acid rain and global warming. The energy is entirely clean and endlessly renewable. Wave power has many advantages compared to other forms of renewable energy with its main advantagebeing that it is predictable.

However, like many other forms of renewable energy, ocean wave energy also has its disadvantagessuchasitsinflexiblegenerationtimesdependantuponthetides,thevisual impactof wavedevices on theseas surface, as wellas thethreatof collision toshipping and navigation.

<u>WaveEnergy Advantages</u>

- **Wave energy is an abundant and renewable energy resource as the waves are generated by the wind.**

- **Pollutionfreeaswaveenergygenerateslittleornopollutiontotheenvironment comparedtoothergreenenergies.**
- **Reducesdependencyonfossilfuelsaswaveenergyconsumesnofossilfuelsduringoperation.**
- **Wave energy is relatively consistent and predictable as waves can be accurately forecast several days in advance.**
- **Waveenergydevicesaremodularandeasilysitedwithadditionalwaveenergydevices addedasneeded.**
- **Dissipatesthewavesenergyprotectingtheshorelinefromcoastalerosion.**
- **Presentsnobarriersordifficultytomigratingfishandaquaticanimals.**

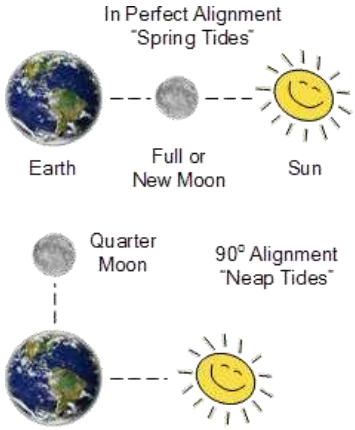
WaveEnergy Disadvantages

- **Visual impact of wave energy conversion devices on theshoreline and offshore floatingbuoys or platforms.**
- **Waveenergy conversion devices arelocation dependent requiring suitable sites were the waves are consistently strong.**
- **Intermittentpowergenerationasthewavescomeinintervalsanddoesnotgenerate powerduringcalmperiods.**
- **Offshorewaveenergydevicescanbeathreattonavigationthatcannotseeordetectthem by radar.**
- **High power distribution costs to send the generated power from offshore devices to the land using long underwater cables.**
- **Theymustbeabletowithstandforcesofnatureresultinginhighcapital,constructionand maintenancecosts.**

Tidalenergy

Tidal Energy or Tidal Power as it is also called, is another form of hydro power that utilises large amounts of energy within the oceans tides to generate electricity. Tidal Energy is an "alternative energy" that can also be classed as a "renewable energy source", as the Earth usesthegravitationalforcesofboththemoon and thesun everyday tomovevastquantities of water aroundthe oceans and seas producingtides.

As the Earth, its Moon and the Sun rotate around each other in space, the gravitational movement of the moon and the sun with respect to the earth, causes millions of gallons of water to flow around the Earth's oceans creating periodic shifts in these moving bodies of water. These vertical shifts of water are called "tides".



When the earth and themoons gravity lines up with each other, the influences of these two gravitational forces becomes very strong and causes millions of gallons of water to move or flow towards the shore creating a "high tide" condition. Likewise when the earth and the moons gravity are at 90o to each other, the influences of these two gravitational forces is weaker and the water flows away from the shore as the mass of water moves to another location on the earth, creating a "low tide" condition. This ebbing and flowing of the tides happens twice during each period of rotation of the earth with stronger weekly and annual lunar cycles superimposed onto these tides.

When the moon is in perfect alignment with the earth and the sun, the gravitational pull of the moon and sun together becomes much stronger than normal with the high tides becoming very high and the low tides becoming very low during each tidal cycle. Such tides are known as spring tides (maximum). These spring tides occur during the full or new moon phase.

The other tidal situation arises during neap tides (minimum) when the gravitational pull of the moon and thesunareagainsteach other, thus cancelling their effects.The netresultis a smaller pulling action on the sea water creating much smaller differences between the high and low tides thereby producing very weak tides. Neap tides occur during thequarter moon phase. Then spring tides and neap tides produce different amounts of potential energy inthe movement of the sea water as their effects differ from the regular high and low sea levels and we can use these tidal changes to produce renewable energy. So we can say that the tides are turning for alternative energy.

So we now know that the constant rotational movement of the earth and the moon with regards to each other causes huge amounts of water to move around the earth as the tides go in and out. These tides are predictable and regular resulting in two high tides and twolowtides each day with the levelof the oceansconstantly moving between a high tide anda low tide, and then back to a high tide again. The time taken for a tidal cycle to happen is about 12 hours and 24 minutes (called the "diurnal cycle") between two consecutive high tides allowing Oceanographers and Meteorologist to accurately predict the ebb and flow of the tides aroundthe oceans many years in advance.

The main big advantage of this is that the tides are therefore perfectly predictable and regular unlike wind energy or solar energy, allowing miles of coastline to be used for tidal energy exploitation and the larger the tidal influence, thegreater themovement of thetidal water and therefore the morepotential energy that can beharvested for power generation. ThereforeTidalEnergycanbeconsideredasarenewableenergysourceastheoceans

energyisreplenishedbythesunaswellasthroughtidalinfluencesofthemoonandsuns gravitationalforces.

TidalEnergyGeneration

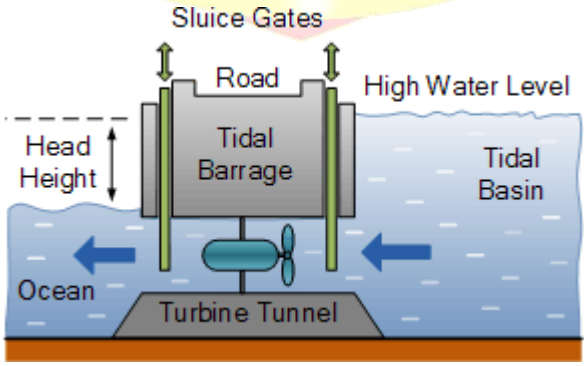
Since the position of the earth and the moon with respect to the sun changes throughoutthe year, we can utilise the potential energy of the water contained in the daily movement of the rising and falling sea levels to generate electricity. The generation of electricity from tides is similar in many ways to hydro-electric generation we looked at in the hydro energy tutorials. The difference this time is that the water flows in and out of the turbines in both directionsinstead of in just one forward direction.

Tidal energy, just like hydro energy transforms water in motion into a clean energy. The motion of the tidal water, driven by the pull of gravity, contains large amounts of kinetic energy in the form of strong tidal currents called tidal streams. The daily ebbing andflowing,back and forth of theoceans tidesalonga coastlineand into and out of small inlets, baysor coastal basins, is little different to the water flowingdown a river or stream.

The movement of the sea water is harnessed in a similar way using waterwheels and turbines to that used to generate hydro electricity. But because the sea water can flow in both directions in a tidal energy system, it can generate power when the water is flowing in and also when it is ebbing out. Therefore, tidal generators are designed to produce power when the rotor blades are turning in either direction. However, the cost of reversible electrical generatorsare more expensive than single direction generators.

DifferentTypesofTidalEnergySystems

1.TidalBarrage:-ATidalBarrageisatypeoftidalpowergenerationthat involves the construction of a fairly low dam wall, known as a "barrage" and henceitsname,acrosstheentranceof atidalinletorbasincreatingatidal reservoir.Thisdamhasanumberofunderwatertunnelscutintoitswidth allowing sea water to flow through them in a controllable way using "sluicegates". Fixed within the tunnels are huge water turbine generators that spin as the water rushes past them generatingtidal electricity.



Tidal barrages generate electricity using the difference in the vertical height between the incoming high tides and the outgoing low tides. As the tide ebbs and flows, sea water is allowed toflow in or outofthereservoir througha onewayunderwater tunnel system.This flow of tidal water back and forth causes the water turbine generators located within the tunnels to rotate producing tidal energy with special generators used to produce electricity on both the incoming and the outgoing tides.

The one disadvantage of Tidal Barrage Generation, is that it can only generate electricity

whenthetideisactuallyflowingeither“in”or“out”asduringhighandlowtidetimesthe

tidal water is stationary. However, because tides are totally predictable, other powerstations can compensate for this stationary period when there is no tidal energy being produced. Another disadvantage of a tidal barrage system, is the environmental and ecological effects that a long concretedam mayhave on the estuariesthey span.

Tidal Stream:- A Tidal Stream Generation system reduces some of the environmental effects of tidal barrages by using turbine generators beneath the surface of the water. Major tidal flows and ocean currents, like the Gulf Stream, can be exploited to extract its tidal energy using underwater rotors and turbines.

Tidal stream generation is very similar in principal to wind power generation, except this time water currents flow acrossa turbines rotorblades which rotates theturbine, much like how wind currents turn the blades for wind power turbines. In fact, tidal stream generation areason the sea bed can look just like underwaterwind farms.

Unlike off-shore wind power which can suffer from storms or heavy sea damage, tidal streamturbines operatejustbelowthe sea surfaceor arefixedto the sea bed.Tidalstreams are formed by the horizontal fast flowing volumes of water caused by the ebb and flow of the tide as the profile of the sea bed causes the water to speed up as it approaches the shoreline.

As water is much more denser than air and has a much slower flow rate, tidal stream turbines have much smaller diameters and higher tip speed rates compared to anequivalent wind turbine. Tidal stream turbines generate tidal power on both the ebb and flow of the tide. One of the disadvantages of Tidal Stream Generation is that as theturbines are submerged under the surface of the water they can create hazards to navigation and shipping.

Other forms of tidal energy include tidal fences which use individual vertical-axis turbines that aremounted within a fence structure, known as the caisson, which completely blocks a channel andforcewaterthroughthem. Anotheralternative way of harnessing tidal poweris by using an "oscillating tidal turbine". This is basically a fixed wing called a Hydroplane positioned on the sea bed. The hydroplane uses the energy of the tidal stream flowing pastit to oscillate its giant wing, similar to a whales flipper, up and down with the movement of the tidal currents. This motion is then used to generate electricity. The angle of the hydroplaneto the flow of the tide can be varied to increase efficiency.

Tidal energy is another form of low-head hydropower that is completely carbon neutral likewind and hydro energy. Tidal power has many advantages compared to other forms of renewable energy with its main advantage being that it is predictable. However, like many other forms of renewable energy, tidal energy also has its disadvantages such as itsinflexible generation times dependant upon the tides and the fact that it operates in the hostile conditions of the oceans and seas. So here are some of the advantages and disadvantages associated with "tidal energy".

AdvantagesofTidal Energy

1. **Tidalenergyisarenewableenergyresourcebecausetheenergyitproducesis free and clean as no fuel is needed and no waste bi-products areproduced.**
2. **Tidalenergyhasthepotentialtoproduceagreatdealoffreeandgreen energy.**
3. **Tidalenergyisnotexpensivetooperateandmaintaincomparedtoother forms of renewable energies.**
4. **Lowvisual impact as the tidalturbines are mainly if nottotallysubmerged beneath the water.**
5. **Lownoisepollutionasanysoundgeneratedistransmittedthroughthewater.**
6. **High predictability as high and low tides can be predicted years in advance,unlike wind.**
7. **Tidalbarragesprovideprotectionagainstfloodingandlanddamage.**
8. **Largetidalreservoirshavemultiple usesandcancreaterecreationallakesand areas where before there were none.**

DisadvantagesofTidalEnergy

1. **Tidal energy is not always a constant energy source as it depends on the strength and flow of the tides which themselves are effected by the gravitational effects of the moon and the sun.**
2. **TidalEnergyrequiresasuitablesite,wherethetidesandtidalstreams areconsistentlystrong.**
3. **Must be able to withstand forces of nature resulting in high capital, construction and maintenance costs.**
4. **High power distribution costs to send the generated power from the submergeddevices to the land using long underwatercables.**
5. **Intermittent power generation, only generates power ten hours a day during the ebb and flow of the tides Changes to estuary ecosystemand an increase in coastal erosion where the tides are concentrated.**
6. **Build up of silt, sediments and pollutants withinthe tidal barragefrom rivers and streams flowing into basin as it is unable to flow out intothe sea.**
7. **Danger to fish and other sea-life as they get stuck in the barrage or sucked through the tidal turbine blades.**

NuclearPowerSource

Nuclear energy is used to produce electricity. Heat generated from the splitting of uranium atomsinaprocessknownasfissionisusedtoproducesteam.Thissteaminturnpowers turbines, which areused to producethe electricitythat suppliesthe surroundingcommunity. Nuclear power stations are set up in a multiple-step process that has been designed to help containtheenergyandmanyofitsnegativebyproducts.Thisprocessaloneisthebaseof several advantagesand disadvantages for this energy source.

NuclearPowerPlant

AdvantagesofNuclearEnergy

Despitepotential drawbacksandthecontroversythatsurroundsit, nuclearenergydoeshave a few advantagesover some other methods of energy production.

Expense

Less uranium is needed to produce the same amount of energy as coal or oil, which lowers the cost of producing the same amount of energy. Uranium is also less expensive to procure and transport,which further lowers the cost.

Reliability

When a nuclear power plant is functioning properly, it can run uninterrupted for up to 540 days. This results in fewer brownouts or other power interruptions. The running of the plantis also not contingent of weather or foreign suppliers, which makes it more stable than other forms of energy.

NoGreenhouseGases

While nuclear energy does havesomeemissions, the plantitself does notgive off greenhouse gasses. Studies have shown that what life-cycle emissions that the plants do give off are onpar with renewable energy sources such aswind power. This lack of greenhouse gasescan be very attractive to some consumers.

DisadvantagesofNuclearEnergy

Oneofthereasonsthatnuclearenergyfallsunderfiresofrequentlyisduetothemany disadvantagesit brings.

Raw Material

Uranium is used in the process of fission because it's a naturally unstable element. Thismeans that special precautions must be taken during the mining, transporting and storing of the uranium, as well as the storing of any wasteproduct to prevent it from giving off harmful levels of radiation.

WaterPollutant

Nuclear fission chambers are cooled by water. This water is then turned into steam, which is used to power the turbines. When the water cools enough to change back into liquid form, it ispumpedoutsideintonearbywetlands.Whilemeasuresaretakentoensurethatno radiationis being pumped into the environment,other heavymetalsand pollutantscanmake their way outofthechamber.The immenseheatgiven off by this watercanalso bedamaging to eco systems located nearby the reactor.

Waste

When the uranium has finished splitting, the resulting radioactive byproducts need to be removed. While recycling efforts of this waste product have been undertaken in recentyears, the storage of the by-product could lead to contamination through leaks or containment

failures.

ShutdownReactors

There have been several nuclear reactors that have failed and been shutdown thatare still in existence. These abandoned reactors are taking up valuable land space, could be contaminatingthe areassurroundingthem, and yet are often too unstable to be removed.

A non-renewable resource isa resourceof economic value that cannot be readily replaced by natural means on a level equal to its consumption. Most fossil fuels, such as oil, natural gas and coal are considered nonrenewable resources in that their use is not sustainable because their formation takes billions of years.

Earthmineralsandmetaloresareexamplesofnon-renewableresources.Themetals themselves are present in vast amounts in Earth's crust, and their extraction by humans only occurs where they are concentrated by natural geological processes (such as heat, pressure, organic activity, weathering and other processes)enough to become economically viable to extract. These processes generally take from tens of thousands to millions of years, through plate tectonics, tectonic subsidenceand crustal recycling.

Natural resources such as coal, petroleum (crude oil) and natural gas take thousands of years to form naturally and cannot be replaced as fast as they are being consumed. Eventually it is considered that fossil-based resources will become too costly to harvest and humanity will need to shift its reliance to other sources of energy such as solar or wind power, see renewableenergy.

Energysourcesthatarealmostalwaysclassifiedasnon-renewable:

a. **Fossilfuels**
b. **Coal**
c. **Petroleum**
d. **Naturalgas**
e. **Fossil fuel**

Fossil fuels are fuels formed by natural resources such as anaerobic decomposition of buried dead organisms. The age of the organisms and their resulting fossil fuels is typically millionsof years and sometimes exceeds 650 million years. The fossil fuels, which contain high percentages of carbon, include coal, petroleum, and natural gas. Fossil fuels range from volatile materials with low carbon: hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like anthracite coal. Methane can be found in hydrocarbon fields, alone associated with oil, or in the form ofmethanecatharses. It is generally accepted that they formedfrom thefossilized remains of dead plants and animals by exposure to heat and pressure in the Earth's crust over millionsof years.

Coal: Coalis a combustible black or brownish-black sedimentary rock normally occurring in rock star forms, such as anthracite coal, can be regarded as metamorphic rock because oflaterexposuretoelevatedtemperatureandpressure.Coaliscomposedprimarilyof carbon along with variable quantities of other elements, chiefly sulfur, hydrogen, oxygen and nitrogen. Coal begins as layers of plant matter accumulate at the bottom of a body of water.Fortheprocesstocontinuetheplantmattermustbeprotectedfrom biodegradation and oxidization, usually by mud or acidic water. The wide shallow seas of theCarboniferousperiodprovidedsuchconditions.Thistrapped atmosphericcarbonin the ground in immense peatbogs thateventually werecovered over and deeply buried by sedimentsunderwhichtheymetamorphosedintocoal.Overtime,thechemicaland physicalproperties of theplant remains (believed to mainlyhave been fern-likespecies antedatingmoremodernplantandtreespecies)werechangedbygeologicalactionto create a solid material.

Petroleum:Petroleum{L.petroleum,fromGreek:petra(rock)+Latin:oleum(oil)}or

crudeoilisanaturallyoccurring,flammableliquidconsistingofacomplexmixtureof

hydrocarbons of various molecular weights and other liquid organic compounds, that arefound in geologic formations beneath the Earth's surface. Petroleum is recovered mostly through oil drilling. It is refined and separated, most easily by boiling point, into a large number of consumer products, from gasoline and kerosene to asphalt and chemical reagents usedto makeplastics and pharmaceuticals. The term petroleum wasfirstused in the treatise De Natura Fossilium, published in 1546 by the German mineralogist Georg Bauer, also known as Georgius Agricola. In the 19th Century, the term petroleum was frequently used to refer to mineral oils produced by distillation from mined organic solids such as cannel coal (and later oil shale) and refined oils produced from them; in theUnited Kingdom storage (and later transport) of these oils were regulated by a series of Petroleum Acts, from the Petroleum Act 1862 c. 66 onward.

Natural gas: Natural gas is a gas consisting primarily of methane, typically with 0-20% higher hydrocarbons (primarily ethane). It is found associated with other fossil fuels, incoalbeds,asmethaneclathrates,andisanimportantfuelsourceandamajor feedstockforfertilizers.Mostnaturalgasiscreatedbytwomechanisms:biogenicand thermogenic.Biogenicgasiscreatedbymethanogenorganismsinmarshes,bogs, landfills,andshallowsediments.Deeperintheearth,atgreatertemperatureand pressure, thermogenicgasiscreatedfrom buried organicmaterial. Beforenaturalgascan beused as a fuel, it must undergo processing to remove almost allmaterials other thanmethane.Theby-productsofthatprocessingincludeethane,propane,butanes, pentanes, andhigher molecular weighthydrocarbons,elemental sulfur, carbon dioxide, water vapour and sometimes helium and nitrogen.

IndianScenario

Indiais one ofthe countries wherethepresentlevel ofenergyconsumption, by world standards, isvery low.Theestimateof annual energy consumptionin India isabout 330MillionTonesOilEquivalent(MTOE)fortheyear2004.Accordingly,thepercapita consumptionof energy is about 305 Kilogram Oil Equivalent (KGOE). Ascompared to this, theenergyconsumptioninsomeofthe othercountriesisofthe orderofover4050for Japan, over 4275 for South Korea, about 1200 for China, about 7850 for USA, about 4670 for OECD countries and the world averageis about 1690.

In so faras electricity consumption isconcerned,India has reached alevel ofabout 600-kilowatt hour(kwh)per headper year. The comparable figures for Japan are about7,800, for South Koreaabout7,000, for China about 1380, for USAabout 13,000, for OECD countries about 8050and world average areabout 2430. Thus, both in terms of percapita energyconsumptionand in terms of per capita electricity consumption, India is farbehind manycountries,andasamatteroffact,behindeventheworldaverage.Therefore,to improvethestandardsoflivingofIndianpeopleandtoletthemenjoythebenefitof economicdevelopment,itisimperativethatbothenergyconsumptionandelectricity consumption level is enhanced. India is targeting a growth rate of 9 – 10%, having already reached a level of almost8%. To sustain the double-digit growth ratefor next10-15years, it would be essential that the level of energy availability and consumption,and electricity consumptioninparticular,isenhancedsubstantially.Intheprofileofenergysourcesin India, coal has a dominant position. Coal constitutes about 51% of India‘s primary energy resourcesfollowedbyOil(36%),NaturalGas(9%),Nuclear(2%)andHydro(2%).To addresstheissueconcerningenergyconsumption,andmoreparticularly,theneedfor enhancing the energy supply,India hasaccorded appropriate priority toboth - supply side management and demand side management.

Non-ConventionalEnergySources

	Potential (MW)	Existing capacity (MW)
Wind	45,000	4,400

Indian Government has accorded very high priority to develop and expandinstalled capacity base through non-conventional sources of electricity generation. Thereis a separate Ministry in the Government of India to exclusively focus on this important area of power generation. National Electricity Policy notified in 2005 in pursuance of the Electricity Act, 2003, prescribes that State Electricity Regulatory Commissions should prescribe a proportion of power which should be produced and supplied to the grid through the non-conventional sources. Some of the Regulatory Commissions have come out with specific policy guidelines with a different approach on tariff for these plants in order to encourage these technologies and plants. National Electricity Tariff Policy mandates that State Commissions should fix such minimum percentage latest by April, 2006. India has very high potential for these capacities:

It may be seen from the above that India has achieved substantial success on wind turbine based power generation. Ministry of Non-conventional Energy Sources (MNES) has set atarget ofachievingat least10,000 MW capacity throughvarious non-conventionalsources, by the year 2012.

ConventionalSourcesofElectricityGeneration

Fossil fuel based thermal power, hydro-electric, and nuclear constitute the conventional sources of power. Non-conventional sources are less than 5% of total installed capacity in India. The present installed capacity (as in March 2006) is about 1,25,000 MW, consisting of coal based plants (56%), gas based plants (10%), hydro-electric (26%), nuclear (3%) non-conventional (5%).

Indian Power Sector was opened up for private power generation in 1991. Interms of ownership structure, the profile consists of Central Government owned companies (32%), State Government owned companies/Electricity Boards (57%) and Private Sector (11%). 100% FDI is permitted in all segments of electricity industry – viz. Generation, Transmission, Distribution, Trading.

In the last threeyears far-reaching structural changes have been introduced in the Indian Electricity Sector. Electricity Act 2003 is an historic legislative initiative with powerfulpotential to transformthe power sector industry and market structure.

Mostimportantfeaturesofthe ElectricityAct2003areasfollows:

5. **TheActcreatesaliberalandtransparentframeworkforpower development**
6. **Itfacilitatesinvestmentbycreatingcompetitiveenvironmentandreforming distribution segment of power industry.**
7. **EntryBarriershavebeenremoved/reducedinfollowingareas:**
   e) **Delicensedgeneration.**
   f) **Freedomtocaptivegenerationincludinggroupcaptive**
   g) **Recognizingtradingasanindependentactivity**
   h) **Openaccessintransmissionfacilitatingmultibuyerandseller model.**
8. **Open access to consumers above 1 MW within five years commencing from 27thJanuary, 2004 (date of enforcement of amendment to Electricity Act) Regulators have been mandated to ensure this.**
9. **Multiple licenses in distribution in the same area of supply so that competition could yield better services to consumers.**
10. **RegulatoryCommissions–todevelopmarketandtofixtariff.**

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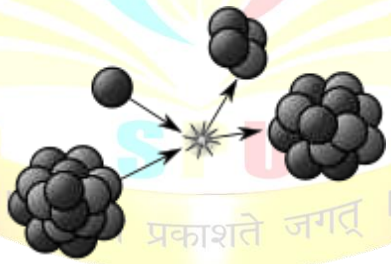
Nuclearenergy:Nuclearpoweristheuseofnuclearreactionsthatreleasenuclear energyto generate heat, which most frequently is then used in steam turbines to produce electricity ina nuclear power plant. The term includes nuclear fission, nuclear decay and nuclear fusion. Presently, the nuclear fission of elements in the actinide series of the periodic table produce the vast majority of nuclear energy in the direct service of humankind, with nuclear decay processes, primarily in the form of geothermal energy, and radioisotope thermoelectric generators, in niche uses making up the rest.

Nuclear Fusion is a reaction in which two or more atomic nuclei come close enough to form one or more different atomic nuclei and subatomic particles (neutrons or protons). The difference in mass between the products and reactants is manifested as the release of large amounts of energy. This difference in mass arises due to the difference in atomic "binding energy" between the atomic nuclei before and after the reaction. Fusion is the process that powers active or "main sequence" stars, or other high magnitudestars.

The fusion process that produces a nucleus lighter than iron-56 or nickel-62 will generallyyield a net energy release. These elements have the smallest mass per nucleon and thelargest binding energy per nucleon, respectively. Fusion of light elements toward these releases energy (an exothermic process), while a fusion producing nuclei heavier than these elements, will result inenergy retainedby the resultingnucleons,and the resulting reactionis endothermic. The opposite is true for the reverse process, nuclear fission. This means that the lighter elements, such as hydrogen and helium, are in general more fusible; while the heavierelements,suchas uranium and plutonium,aremorefissionable.The extreme astrophysical event of a supernova can produce enough energy to fuse nuclei into elements heavier than iron.

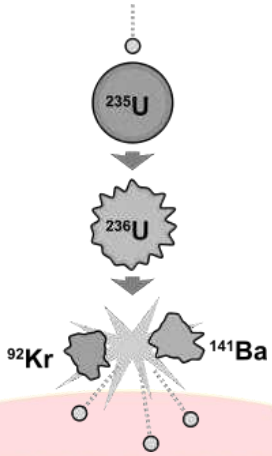


anuclearreactionorradioactivedecayprocessinwhich thenucleusof an atom splits into smaller parts (lighter nuclei). The fission process often producesfreeneutronsandgammaphotons,andreleasesaverylargeamount of energy even by the energetic standardsof radioactivedecay.

Nuclear fission of heavy elements was discovered on December 17, 1938 by German Otto Hahn and his assistant Fritz Stresemann, and explained theoretically in January 1939 by Lise MeitnerandhernephewOttoRobertFrisch.Frischnamedtheprocessbyanalogy with biological fission of living cells. It is an exothermic reaction which can release large amounts of energy both as electromagnetic radiation and as kinetic energy of the fragments (heating the bulk material where fission takes place). In order for fission to produce energy, the total binding energy of the resulting elements must be less negative (higher energy) than that of the starting element.

Fissionisaformofnucleartransmutationbecausetheresultingfragmentsarenotthesameelement as the original atom. The two nuclei produced are most often of comparable butslightlydifferentsizes,typicallywithamassratioofproductsofabout3to2,for

common fissile isotopes. Most fissions are binary fissions (producing two chargedfragments),but occasionally (2 to 4 times per 1000 events), three positively charged fragments are produced, in a ternary fission. The smallest of these fragments in ternary processes ranges in size from a proton to an argon nucleus.



ProcessofNuclearFusion

REACTORS

All nuclearreactorsaredevicesdesignedtomaintainachainreactionproducing asteady flow of neutrons generated by thefission of heavy nuclei. They are, however, differentiated either by their purpose or by their design features. In terms of purpose, they are either research reactors or power reactors.

TYPESOF REACTORS

Research reactors are operated at universities and research centres in many countries, including some where no nuclear power reactors are operated. These reactors generate neutrons for multiple purposes, including producing radiopharmaceuticals for medical diagnosisand therapy, testing materialsand conductingbasic research.

Power reactors are usually found in nuclear power plants. Dedicated to generating heat mainly for electricity production, they are operated in more than 30 countries (see Nuclear Power Reactors). Their lesser uses are drinking water or district water production. In the form of smaller units, they also power ships.

Differentiatingnuclearreactorsaccordingtotheirdesignfeaturesisespeciallypertinent whenreferringtonuclearpowerreactors(seeTypesofNuclearPowerReactors).

NuclearPowerReactors

There are many different types of power reactors. What is common to them all is that they produce thermal energy that can be used for its own sake or converted into mechanical energy and ultimately, in the vastmajority of cases, into electricalenergy.

In these reactors, thefission of heavy atomic nuclei, the most common of which is uranium-235, produces heat that is transferred to a fluid which acts as a coolant. During the fission process, bond energy is released and this first becomes noticeable as the kinetic energy of the fission productsgenerated andthat ofthe neutrons beingreleased.Since theseparticles undergo intense deceleration in the solid nuclear fuel, the kinetic energy turns into heat

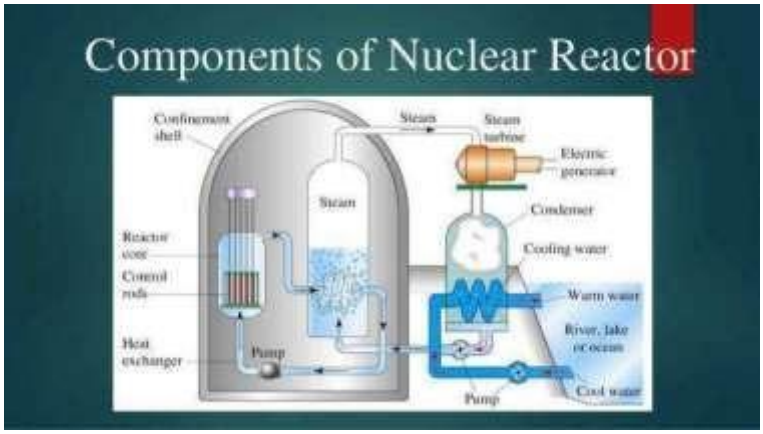
energy.

In thecaseof reactors designed to generate electricity, to which theexplanations belowwillnow be restricted, the heated fluid can be gas, water or a liquid metal. The heat stored by the fluid is then used either directly (in the case of gas) or indirectly (in the case of waterand liquid metals) to generate steam. The heated gas or thesteam is then fed into a turbine driving an alternator.

Componentsofanuclearreactor

Thereareseveralcomponentscommontomosttypesofreactors:

1. **Fuel. Uranium is the basic fuel. Usually pellets of uranium oxide (UO_2) are arranged in tubes to form fuel rods. The rods are arranged into fuel assemblies in the reactor core.* In a 1000 MWe class PWR there might be 51,000 fuel rods with over 18 million pellets.**
2. **Moderator. Material in the core which slows down the neutrons releasedfromfissionso thatthey causemorefission. Itis usually water, but may be heavy water or graphite.**
3. **Control rods. These are made with neutron-absorbing material such as cadmium, hafnium or boron, and are inserted or withdrawn from the core to control the rate of reaction, or to halt it. In some PWR reactors, special control rods are used to enablethecoretosustainalowlevelofpowerefficiently. (Secondary control systems involve other neutron absorbers, usually boron in the coolant – its concentration canbe adjusted over time as the fuel burns up.) PWR control rodsare inserted from the top, BWR cruciform blades from the bottom of the core.**
4. **Coolant. A fluid circulating through the core soas to transfer the heat from it. In light water reactors the water moderator functions also as primary coolant. Except in BWRs, there is secondary coolant circuit where the water becomes steam.**
5. **Pressure vessel or pressure tubes. Usually a robust steel vessel containing the reactor core and moderator/coolant, but it may be a series of tubes holding the fuel and conveying the coolant through the surrounding moderator.**
6. **Steam generator. Part of the cooling system of pressurisedwater reactors (PWR & PHWR) where the high-pressure primary coolant bringing heatfrom thereactor is used to makesteam for the turbine, in a secondary circuit. Essentially a heat exchanger like a motor car radiator.* Reactors have up to six 'loops', each with a steam generator.**
7. **Containment. The structure around the reactor and associated steam generators which is designed to protect it from outside intrusion and to protect those outside from the effects of radiation in case of any serious malfunction inside. It is typicallya metre-thick concrete and steel structure.**



TypesofNuclear PowerReactors

Nuclear power reactors can be classified according to the type of fuel they use to generate heat.

Uranium–fuelledReactors

The only natural element currently used for nuclear fission in reactors is uranium. Natural uranium is a highly energetic substance: one kilogram of it can generate as much energy as 10 tonnesof oil. Naturally occurring uranium comprises,almostentirely,twoisotopes: U238 (99.283%) and U235 (0.711%). Theformer is notfissionable while the latter can befissioned by thermal (i.e. slow) neutrons. As the neutrons emitted in a fission reaction are fast, reactors using U235 as fuel must havea means of slowing down these neutrons before they escapefrom the fuel. Thisfunction isperformedby whatiscalled amoderator,which,in the case of certain reactors simultaneously acts as a coolant. It is common practice to classify power reactors according to the nature of the coolant and the moderator plus, as the need may arise, other design characteristics.

ReactorType	Coolant	Moderator	Fuel	Comment
Pressurised water reactors (PWR, VVER)	Lightwater	Lightwater	Enriched uranium	Steamgenerated insecondaryloop
Boiling water reactors(BWR)	Lightwater	Lightwater	Enriched uranium	Steam from boilingwaterfed to turbine
Pressurised heavy water reactor (PHWR)	Heavy water	Heavy water	Natural uranium	
Gas-cooledreactors(Magnox, AGR, UNGG)	CO2	Graphite	Natural or enriched uranium	
Light water graphite reactors (RBMK)	Press-urised boiling water	Graphite	Enriched uranium	Sovietdesign

PWRs and BWRs are the most commonly operated reactors in Organization for EconomicCooperation and Development (OECD) countries. VVERs, designed in the former Soviet Union, are based on the same principles as PWRs. They use "light water", i.e. regular water (H2O) as opposed to "heavy water" (deuterium oxide D2O). Moderation provided by light water is not sufficiently effective to permit the use of natural uranium. The fuel must be slightly enriched in U235 to make up for the losses of neutrons occurring during the chain reaction. On the other hand, heavy water is such an effective moderator that the chain reaction can besustainedwithouthaving to enrich theuranium.This combination ofnatural uranium and heavy water is used in PHWRs, which are found in a number of countries, including Canada, Korea, Romania and India.

Graphite-moderated,gas-cooledreactors,formerlyoperatedinFranceandstilloperatedin GreatBritain,arenotbuiltanymoreinspiteofsomeadvantages.

RBMK-reactors (pressure-tube boiling-water reactors), which are cooled with light waterand moderated with graphite, are now less commonly operated in some former SovietUnion bloc countries. Following the Chernobyl accident (26 April 1986) the construction of this reactor type ceased. The operating period of those units still in operation will be shortened.

Plutonium-fuelledReactors

Plutonium (Pu) is an artificial element produced in uranium-fuelled reactors as a by-product of the chain reaction. It is one hundred times more energetic than natural uranium; one gram of Pu can generate as much energy as one tonne of oil. As it needs fast neutrons in order to fission, moderating materials must be avoided to sustain the chain reaction in the best conditions. The current Plutonium-fuelled reactors, also called "fast" reactors, useliquid sodium which displays excellent thermal properties without adversely affecting the chain reaction. These types of reactors are in operation in France, Japan and the Commonwealth of Independent States (CIS).

LightWaterReactors

The Light Water Reactors category comprises pressurised water reactors (PWR, VVER) and boiling water reactors (BWR). Both of these use light water and hence enriched uranium.The light water they use combinesthe functions of moderatorand coolant. This water flows through the reactor core, a zone containing a large array of fuel rods where it picks up the heat generated by the fission of the U235 present in the fuel rods. After the coolant has transferred the heat it has collected to a steam turbine, it is sent back to the reactor core, thus flowing in a loop, also called a primary circuit.

In order to transfer high-quality thermal energy to the turbine, it is necessary to reach temperatures of about 300 °C. It is the pressure at which the coolant flows through the reactorcorethatmakesthedistinctionbetweenPWRsandBWRs.

In PWRs, the pressure imparted to the coolant is sufficiently high to prevent it from boiling. The heat drawn from thefuel is transferred tothe water of a secondary circuit through heat exchangers.Thewater of thesecondarycircuitistransformed into steam, which is fed into a turbine.

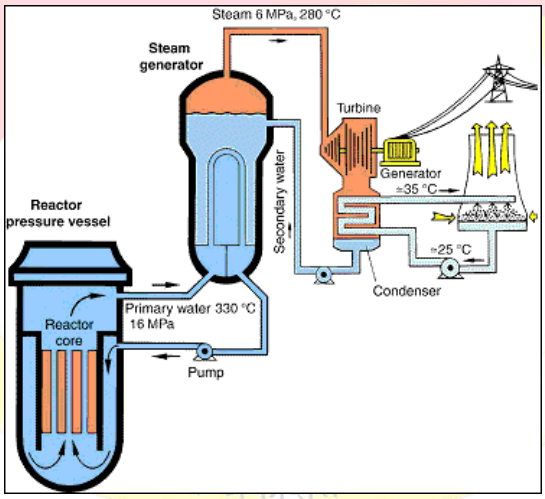
InBWRs,thepressureimpartedto thecoolantissufficientlylowerthaninaPWRtoallowit

This basic difference between pressurised and boiling water dictates many of the design characteristicsof the two types of light water reactors, as will be explainedbelow.

Despite their differing designs, it must be noted that the two reactor types provide an equivalent level of safety.

PressurisedWaterReactors

The fission zone(fuel elements) iscontained in a reactor pressurevessel under a pressureof 150 to 160 bar (15 to 16 MPa). The primary circuit connects the reactor pressure vessel to heat exchangers. The secondary side of these heat exchangers is at a pressure of about 60 bar (6 MPa) - low enough to allow the secondary water to boil. The heat exchangers are, therefore, actually steam generators. Via the secondary circuit, the steam is routed to a turbine driving an alternator. The steam coming out of the turbine is converted back into water by a condenser after having delivered a large amount of its energy to the turbine. It then returns to the steam generator. As the water driving the turbine (secondary circuit) is physically separated from the water used as reactor coolant (primary circuit), the turbine-alternator set can be housed in a turbinehall outsidethe reactor building.



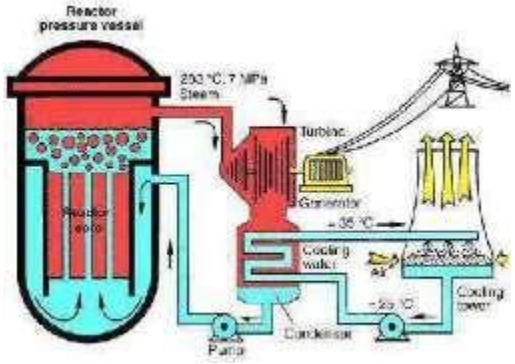
Nuclearpowerplantwithpressurizedwaterreactor

BoilingWaterReactors

The fission zone is contained in a reactor pressure vessel, at a pressure of about 70 bar (7 MPa). At the temperature reached (290 °C approximately), the water starts boiling and the resulting steam is produced directly in the reactor pressure vessel. After the separation of steam and water in the upper part of the reactor pressure vessel, the steam is routed directly to a turbine driving an alternator.

The steam coming out of the turbine is converted back into water by a condenser after having delivered a large amount of its energy to the turbine. It is then fed back into the primary cooling circuitwhere it absorbsnew heat in the fission zone.

Sincethesteamproducedinthefissionzoneisslightly radioactive,mainlyduetoshort-lived activationproducts,theturbineishousedinthesamereinforcedbuildingasthereactor.



Principleofanuclearpowerplantwith boilingwaterreactor

Advantagesofnuclearpower

Thegeneration ofelectricitythrough nuclear energy reduces theamount of energy generated from fossil fuels (coal and oil).Less use offossil fuelsmeanslowering greenhousegasemissions(CO^2andothers).

Currently,fossilfuelsareconsumedfasterthantheyareproduced,sointhenext futuretheseresourcesmaybereducedorthepricemayincreasebecoming inaccessibleformostofthepopulation.

Anotheradvantageis the requiredamountof fuel:lessfuel offersmore energy.It representsa significantsaveon raw materialsbut also in transport,handlingand extractionofnuclearfuel.Thecostofnuclearfuel(overalluranium)is20%ofthe costofenergygenerated.

Theproductionofelectricenergyiscontinuous.Anuclearpowerplantis generatingelectricityforalmost90%ofannualtime.Itreducestheprice volatilityofotherfuelssuchaspetrol.

Thiscontinuitybenefitstheelectricalplanning.Nuclearpowerdoesnotdepends onnatural aspects.It's asolutions forthemaindisadvantage ofrenewable energy,likesolarenergyoreolicenergy,becausethehoursofsunorwinddoes notalwayscoincidewiththehourswithmoreenergydemand.

It'sanalternativetofossilfuels,sotheconsumptionoffuelssuchascoaloroilis reduced.Thisreductionofcoalandoilconsumptionbenefitsthesituationof globalwarmingandglobalclimatechange.Byreducingtheconsumptionoffossil fuelswealsoimprovethequalityoftheairaffectingthediseaseandqualityof life.

Disadvantagesofnuclearpower

We'vepreviouslydiscussedtheadvantageofusingnuclearenergytoreducefossil fuelconsumption.Organizations oftenusethisargumentinfavorofnuclearenergy but it's a partial truth. Much of the consumption offossil fuelsisduetoroadtransport, usedinheatengines(cars,trucks, etc.).Savings infossilfuelforpowergenerationisfairlylow.

Despitethehighlevelofsophisticationofthesafetysystemsofnuclearpower plantsthehumanaspecthasalwaysanimpact.Facinganunexpectedevent ormanaginganuclearaccidentwedon'thaveanyguaranteethatdecisionswe tookarealwaysthebest.TwogoodexamplesareChernobylandFukushima.

TheChernobyl nuclear accidentis,byfar, theworstnuclear accident inthe history.Differentwrongdecisionsduringthemanagementofthenuclearplant causedabignuclearexplosion.

ReferringtotheFukushimanuclearaccident,theoperationsdonebythestaffwerehighlyquestionable.Fukushimanuclearaccidentisthesecondworst accidentinthehistory.
Oneofthemaindisadvantagesisthedifficultyinthemanagementofnuclear waste.Ittakesmanyyearstoeliminateitsradioactivityandrisks.
Theconstructednuclearreactorshavean expirationdate.Then, they'vetobe dismantled,sothatmaincountriesproducingnuclearenergycouldmaintaina regularnumberofoperatingreactors.They'vetobuiltabout80newnuclear reactorsduringthenexttenyears.
Nuclearplantshavealimitedlife.Theinvestmentfortheconstructionofa nuclearplantisveryhighandmustberecoveredassoonaspossible,soitraises thecostofelectricitygenerated.Inotherwords,theenergygeneratedischeap comparedtothecostoffuel,buttherecoveryofitsconstructionismuchmore expensive.
Nuclearpowerplantsareobjectivesofterroristorganizations.
Nuclearpowerplantsgenerateexternaldependence.Notmanycountries haveuraniumminesandnotallthecountrieshavenucleartechnology,sothey havetohireboththingsoverseas.
Currentnuclearreactorsworkbyfissionnuclearreactions.Thesechainreactionsisgeneratedincase controlsystemsfail,generatingcontinuous reactionscausingaradioactiveexplosionthatwouldbevirtuallyimpossibleto contain.

Hydrogenenergy

Hydrogen can be produced using a number of different processes. Thermochemical processes use heat and chemical reactions to release hydrogen from organic materials such as fossil fuels and biomass. Water (H_2O) can be split into hydrogen (H_2) and oxygen (O_2) using electrolysisor solar energy.Microorganisms suchas bacteriaand algae can producehydrogen through biological processes.

THERMOCHEMICALPROCESSES

Some thermal processes use the energy in various resources, such as natural gas, coal, or biomass, to release hydrogen from their molecular structure. In other processes, heat, in combination with closed-chemical cycles, produces hydrogen from feedstocks such as water. Learn more about the following thermochemical processes:

- Naturalgasreforming(alsocalledsteammethanereformingorSMR)
- Coalgasification
- Biomassgasification
- Biomass-derivedliquidreforming
- Solarthermochemicalhydrogen(STCH).

ELECTROLYTICPROCESSES

Electrolyzers use electricity to split water into hydrogen and oxygen. This technology is well developed and available commercially, and systems that can efficiently use intermittent renewable power are being developed.Learn more about electrolysis.

DIRECTSOLARWATERSPLITTINGPROCESSES

Direct solar water splitting, or photolytic, processes use light energy to split water into hydrogen and oxygen. These processes are currently in the very early stages of research but offer long-term potential for sustainable hydrogen production with low environmental impact. Learn more about the following solar water splittingprocesses:

- **Photoelectrochemical(PEC)**

  In photoelectrochemical (PEC) water splitting, hydrogen is produced from water usingsunlight and specialized semiconductors called photoelectrochemical materials, which use light energy to directly dissociate water molecules into hydrogen and oxygen. This is a long- term technologypathway,with the potential for low or no greenhousegas emissions.

  Prodcution

  The PEC water splitting process usessemiconductor materials to convert solar energy directly to chemical energy in the form of hydrogen. The semiconductor materials used in the PEC process are similar to those used in photovoltaic solar electricity generation, but for PEC applications the semiconductor is immersed in a water-based electrolyte, where sunlight energizes the water-splitting process.

- **Photobiological**

  The photobiological hydrogen production process uses microorganisms and sunlight to turn water, and sometimes organic matter, into hydrogen. This is a longer-term technology pathway in the early stages of research that has a long-term potential for sustainable hydrogen production with low environmental impact.

  Prodcution

  In photolytic biological systems, microorganisms—such as green microalgae or cyanobacteria—usesunlight to split water into oxygen and hydrogen ions. The hydrogen ions can be combined through direct or indirect routes and released as hydrogen gas. Challenges for this pathway include low rates of hydrogen production and the fact that splitting water also produces oxygen, which quickly inhibits the hydrogen production reaction and can be a safety issuewhen mixed with hydrogen in certain concentrations.Researchers areworking to develop methods to allow the microbes to produce hydrogen for longer periods of time andto increase the rate of hydrogen production.

  Some photosynthetic microbes use sunlight as the driver to break down organic matter, releasing hydrogen. This is known as photofermentative hydrogen production. Some of the major challenges of this pathway include a very low hydrogen production rate and low solar-to-hydrogen efficiency, making it a commercially unviable pathway for hydrogen production at this time.

  Researchers are looking at ways to make the microbes better at collecting and using energyto make more available for hydrogen production, and to change their normal biological pathways to increase the rate of hydrogen production.

BIOLOGICALPROCESSES

Microbes such as bacteria and microalgaecan produce hydrogen through biologicalreactions, using sunlight or organic matter. These technology pathways are at an early stage ofresearch, but in the long term have the potential for sustainable, low-carbon hydrogen production.Learn more about the following biological processes:

- **Microbialbiomassconversion**

Microbial biomass conversion processes take advantage of the ability of microorganisms to consume and digest biomass and release hydrogen. Depending on the pathway, this research could result in commercial-scale systems in the mid- to long-term timeframe that could be suitable for distributed, semi-central, or central hydrogen production scales, depending onthe feedstock used.

Prodcution

In fermentation-basedsystems,microorganisms, such asbacteria,breakdown organicmatter to produce hydrogen. The organic matter can be refined sugars, raw biomass sources such as corn stover, and even wastewater. Because no light is required, these methods aresometimes called "dark fermentation" methods.

In direct hydrogen fermentation, the microbes produce the hydrogen themselves. These microbes can break down complex molecules through many different pathways, and the byproducts of some of the pathways can be combined by enzymes to produce hydrogen. Researchers are studying how to make fermentation systems produce hydrogen faster (improving the rate) and produce more hydrogen from the same amount of organic matter (increasing the yield).

Microbial electrolysis cells (MECs) are devices that harness the energy and protons produced by microbes breaking down organic matter, combined with an additional small electric current, to produce hydrogen. This technology is very new, and researchers are working on improving many aspects of the system, from finding lower-cost materials to identifying the most effective type of microbes to use.

- **Photobiological.**

The photobiological hydrogen production process uses microorganisms and sunlight to turn water, and sometimes organic matter, into hydrogen. This is a longer-term technology pathway in the early stages of research that has a long-term potential for sustainable hydrogen production with low environmental impact.

<u>Hydrogenenergy</u>

AdvantagesofHydrogenEnergy

1. **It'sarenewableenergysourceandbountifulinsupply**

Hydrogen is a rich source of energy for many reasons; the main being that it's bountiful in supply. While it may takea lot of resources to harness it, no other energy source is infinite as hydrogen. That, essentially, means there is no possibility of it running out like other sourcesof energy.

When hydrogen is burnt to produce fuel, the byproducts are totally safe, which means, theyhave no known side effects. Aeronautical companies actually use hydrogen as a source of drinking water. After hydrogen is utilized, it is normally converted to drinking water for astronauts on ship or space stations.

2. Hydrogenenergyis non-toxic

This means that it does not cause any harm or destruction to human health. This aspectmakes it preferred compared to other sources of fuel like nuclear energy, natural gas, which are extremely hazardous or daunting to harness safely. It also allows hydrogen to be used in places where other forms of fuel may not be allowed.

3. It'sfarmoreefficientthanothersourcesofenergy

Hydrogen is solidly efficient energy type since it has the abilityto convey a lot of energy foreverypoundoffuel.Thiscategoricallymeansthatanautomobilethatutilizeshydrogen energywill travelmore miles than one with anequal amount of gasoline.

4. Usedforpoweringspaceships

Hydrogen energy's efficiency and power makes it an ideal fuel source for spaceships.Its power is so high that it's able to quickly rocket spaceships to exploration missions. It's alsothe safest form of energy to perform such an energy-intensive task. Hydrogen energy is infact 3 times more potent than gasoline and other fossil-based sources of fuel. This ideally means that you need less hydrogento completean enormoustask.

It also offers motive power for airplanes, boats, cars, and both portable and stationary fuel cell applications. The downside to using hydrogen in cars is that it's practically difficult to store in cryogenic or high-pressure tanks.

DisadvantagesofHydrogenEnergy

While hydrogen energy has a lot of admirable benefits, it's not really the outright preferable, clean and cheapenergysourcefor most governments and companies.In gaseousstate,it's quitevolatile.Whileitsvolatilitygivesitanedgeoverenergysourcesintermsof accomplishingnumeroustasks, it equallyrenders itriskyto use and work around.Some of the disadvantages of hydrogen energy include:

1. Hydrogenenergyis expensive

Electrolysis and steam reforming, the two main processes of hydrogen extraction are extremely expensive. This is the real reason it's not heavily used across the world. Today, hydrogen energy is chiefly used to power most hybrid vehicles. A lot of research and innovation is required to discovercheap and sustainable ways to harness this form of energy. Until then, hydrogenenergy would remain exclusivelyfor the rich.

2. Storagecomplications

Oneofhydrogenpropertiesisthat ithas a lowerdensity.Infact,itisalotlessdenserthan gasoline. This means that it has to be compressed to liquid state and stored the same way at lowertemperaturestoguaranteeitseffectivenessandefficiencyasanenergysource.This reason alsoexplainswhyhydrogenmust atall timesbestored andtransportedunderhigh pressure, which is why transportationand common use is far from feasible.

3. It'snotthesafestsourceof energy

The power ofhydrogenshould not beunderestimatedatall. Althoughgasolineis alittle more dangerous than hydrogen, hydrogen is hugely flammable and frequently makes headlines for its potential dangers.Compared togas,hydrogen lackssmell, which makesanyleakdetection almost impossible.To detect leaks, one must install sensors.

4. Trickytomovearound

It's a daunting task to transport hydrogen brilliantly due to its lightness. Oil can be transported safely because it's mostly pushed through pipes. Coal can conveniently be transportedin dump trucks.Hydrogenalso presents challenges when considering moving it in

large quantities, which is why it's mostly only transported in small batches.

5. **Hydrogenenergycannotsustainthepopulation**

Despite the fact that hydrogen isbountiful in supply, the cost of harnessing it limits extensive utilization. As you realize, it's quite challenging to disrupt the status quo. Energy from fossil fuels still rule the world. There is also no framework put in place to ensure cheap and sustainablehydrogenenergyforthenormal carowner in thefuture. Evenifhydrogenwereto becomecheapright now, itwould take years tobecome the most usedsource ofenergy since vehicles themselves and service stations would need to be customized to conform to hydrogenrequirements.This would require massive capital outlay.

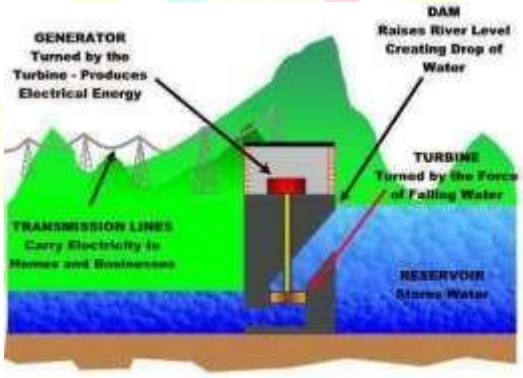
It's a factthathydrogen energy is a renewable resource because it's abundantly available and itsimpactshugely neglected.However,hydrogencompanies will,inrealsense,need other forms of non-renewable energy such as fossil (coal,naturalgas, and oil) toseparate it fromoxygen.Wemaybeabletominimizeover-relianceonfossilsfuelswhenweembracehydrogenenergy, but it will be dauntingto get rid of it from the system.

Hydro

Power

HYDROPOWER

Hydropower transforms the potential energy of a mass of water flowing in a river or stream with a certain vertical fall (termed the "head") Hydroelectric power is the cheapest source of energy, renewable and environmentally benign during running. The potential annual power generation of a hydropowerprojectis proportionalto the head and flow of water.



Elementsofhydropowerplant

1) Dam

The dam is the most important component of hydroelectric power plant. The dam is built ona large river that has abundant quantity of water throughout the year. It should be built at a location where the height of the river is sufficient to get the maximum possible potential energy from water.

2) WaterReservoir

The water reservoir is the place behind the dam where water is stored. The water in the reservoir is located higher than the rest of the dam structure. The height of water in the

reservoir decides how much potential energy the water possesses. The higher the height of water, the more its potential energy. The high position of water in the reservoir also enablesit to move downwards effortlessly. The height of water in the reservoir is higher than the naturalheight of waterflowingin the river, so it is considered to havean altered equilibrium. Thisalsohelpstoincreasetheoverallpotentialenergyofwater,whichhelpsultimately producemoreelectricityinthepowergenerationunit.

3) IntakeorControlGates

These are the gates built on the inside of the dam. The water from reservoir is released and controlled through these gates. These are called inlet gates because water enters the power generation unit through these gates. When the control gates are opened the water flows due to gravity through the penstock and towards the turbines. The water flowing through the gates possesses potentialas well as kinetic energy.

4) The Penstock

The penstock is the long pipe or the shaft that carries the water flowing from the reservoir towards the power generation unit, comprised of the turbines and generator. The water inthe penstock possesses kinetic energy due to its motion and potential energy due to itsheight. The total amount of power generated in the hydroelectric power plant depends onthe height of the water reservoir and theamount of water flowing through the penstock. The amount of water flowing throughthe penstockis controlled by the control gates.

5) WaterTurbines

Water flowing from the penstock is allowed to enter the power generation unit, whichhouses the turbine and the generator. When water falls on the blades of the turbine the kinetic and potential energy of water is converted into the rotational motion of the blades of the turbine. The rotating blades causes the shaft of the turbine to also rotate. The turbine shaft is enclosed inside the generator. In most hydroelectric power plants there is more than one power generation unit. There is large difference in height between the level of turbine and level of water in thereservoir.This difference in height, also known as the head of water, decides the total amount of power that can be generated in the hydroelectric power plant. There are various types of water turbines such as Kaplan turbine, Francis turbine, Pelton wheels etc. The type of turbine used in the hydroelectric power plant depends on the height of the reservoir,quantity of water and the total power generationcapacity.

6) Drafttube:

Thedraft tubeisapartof thereactionturbine. Thedraft tubeisa diverging dischargepassage connecting the running with tailrace. It is shaped to decelerate the flow with a minimum loss so that the remaining kinetic energy of the water coming out of the runner is efficiently regainedby converting into suction head., thereby increasingthe total pressure difference on the runner. This regain of kinetic energy of thewater coming out from the reaction turbine is the primary function of the draft tube. The regain of static suction head in case where the runner is located abovethe tail water level is the secondary purposeof the draft tube.

7) Generators

It is in the generator where the electricity is produced. The shaft of the water turbine rotates in the generator, which produces alternating current in the coils of the generator. It is the

rotation of the shaft inside the generator that produces magnetic field which is convertedinto electricity by electromagnetic field induction. Hence the rotation of the shaft of the turbineiscrucialfortheproductionofelectricityandthisisachievedbythekineticand

potentialenergyofwater.Thusinhydroelectricitypowerplantspotentialenergyofwateris convertedinto electricity.

Seaftyservices

9. **Spillway:**

The function of spillway is to provide safety of the dam. Spillway should have the capacity to discharge major floods without damage to the dam and at the same time keeps the reservoir levels below some predetermined maximum level.TrashRack:

The water intake from the dam or from the forebay are provided with trash rack. The main function of trash rack is to prevent the entry of any debris which may damage the wicket gates and turbine runners or choke-up the nozzles of impulse turbine. During winter season when water forms ice, to prevent the ice from clinging to the trash racks, they are often heated electrically. Sometimes air bubbling system is provided in the vicinity of the trashrackswhich bringswarmer water to the surface of the trash racks.

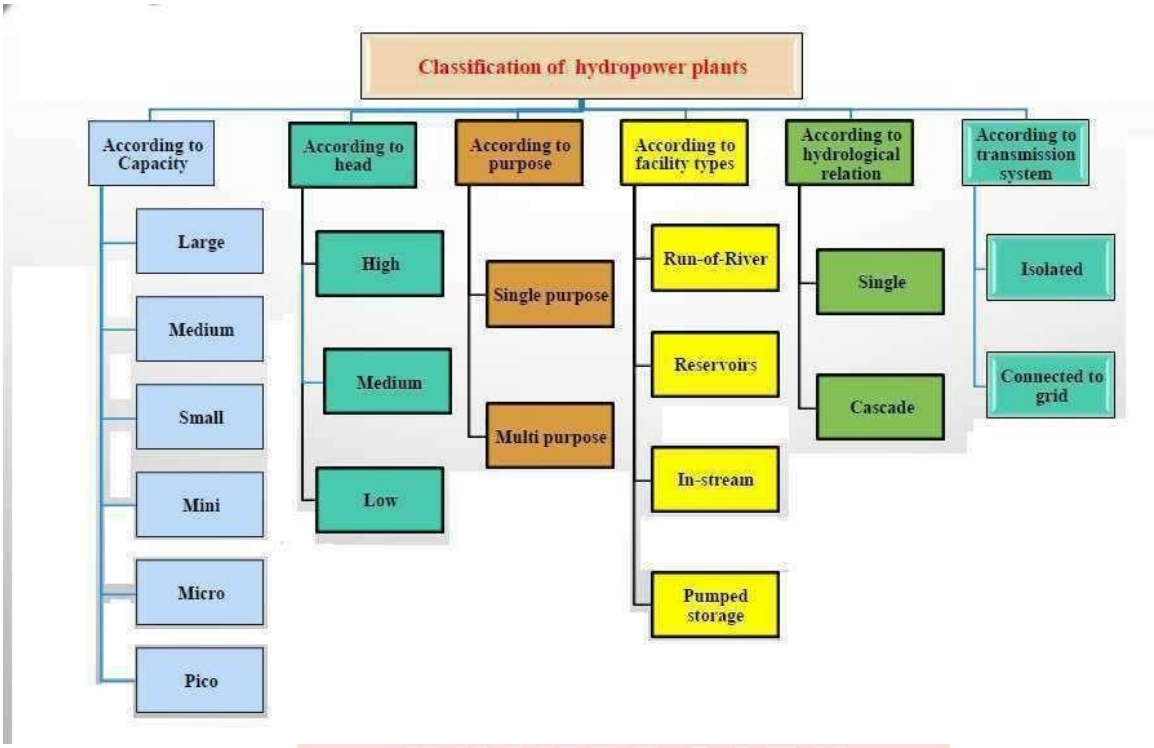
2. **Forebay:**

The function of forebay is to act as regulating reservoir temporarily storing water when the load on the plant is reduced and to provide water for initial increment of an increasing load while water in thecanalis being accelerated.In manycases, the canalitself is large enough to absorb the flow variations. In short, forebay is naturally provided for storage of water to absorb any flow variations if exist. This can be considered as naturally provided surge tank as it does the function of the surge tank. The forebay is always provided with some type ofoutlet structureto direct water to penstock dependingupon the local conditions.

3. **SurgeTank:**

The main function of surge tank is to reduce the water hammering effect. When there is a sudden increase of pressure in the penstock which can be due sudden decrease in the load demand on the generator. When there is sudden decrease in the load, the turbine gates admitting water to the turbine closes suddenly owing to the action of the governor. This sudden rise in the pressure in the penstock will cause the positive water hammering effect. This may lead to burst of the penstock because of high pressures. When there is sudden increase in the load, governor valves opens and accepts more water to the turbine. This results in creation of vacuum in the penstock resulting into the negative water hammering effect. Therefore the penstock should have to withstand both positive water hammering effect created due to close of governor valve and negative water hammering effect due to opening of governor valve.In order to protect the penstock from these water hammering effects, surge tank is used in hydroelectric power station. A surge tank is introduced in the system between dam and the power house nearest. Surge tank is a tank provided to absorb any water surges caused in the penstok due to sudden loading and unloading of thegenerator. When thevelocity of thewater in thepenstock decreases duetoclosing of turbine valves,the water level in the surge tank increases and fluctuating up and down till its motion is damped out by the friction. Similarly when the water accelerates in the penstock, water is provided by the surge tank for acceleration. Surge tank water level falls down and fluctuates up and down absorbing the surges.

ClassificationOfHydropowerPlant



Classificationaccordingtocapacity

LARGE: >100 MW

MEDIUM:25–100 MW

SMALL: 1-25 MW

MINI:100KW-1MW

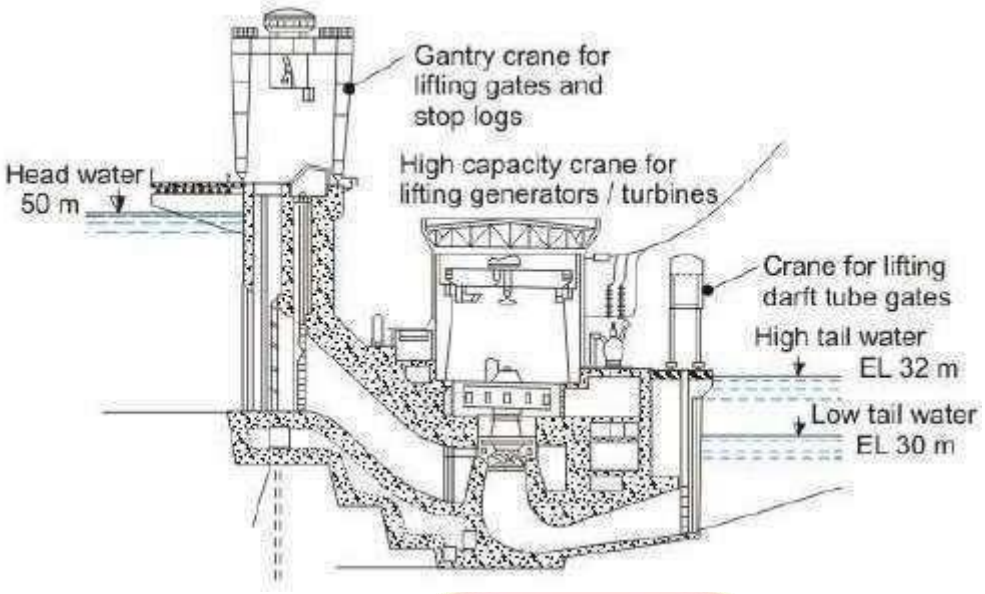
MICRO: 5 – 100 KW

PICO: < 5 KW

ClassifcationAccordingToHead LOW

HEAD:

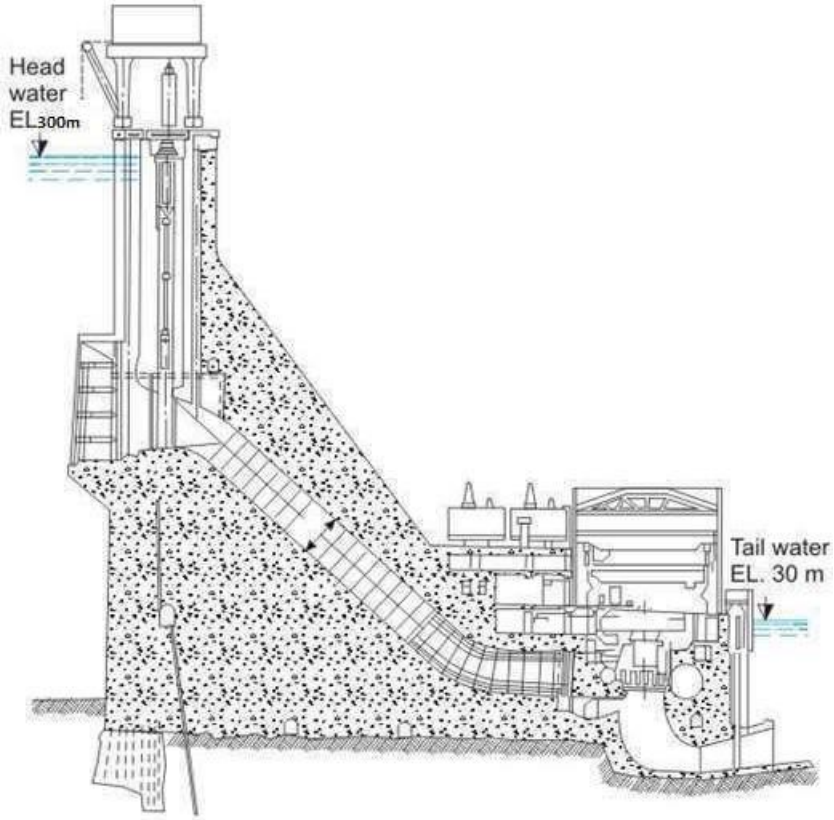
Low head hydro power applications use river current or tidal flows of 30 meters or less to produce energy. These applications do not need to dam or retain water to create hydraulic head, the head is only a few meters. Using the current of a river or the naturally occurring tidal flow to create electricity may provide a renewable energy source that will have a minimal impact on the environment.



SectionalViewOfLowHeadHydropowerPlant

MEDIUMHEAD:

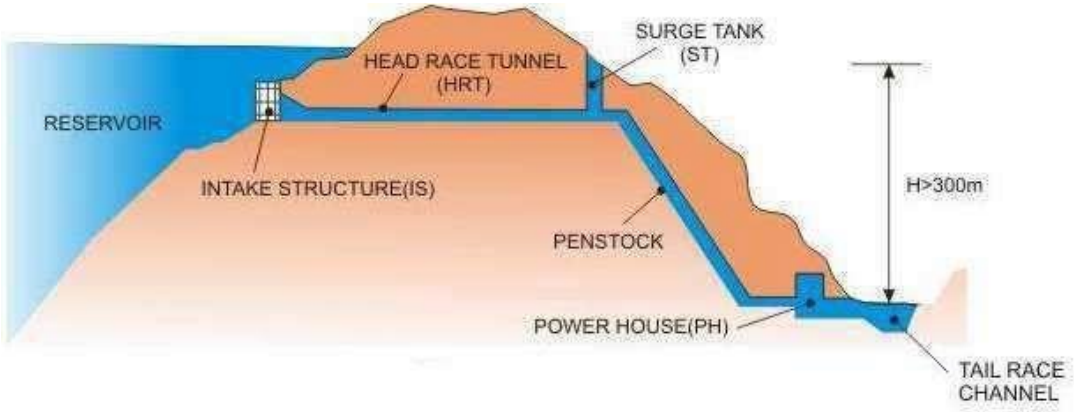
Apowerstationoperatingunderheadsfrom30m to300m.



SectionalViewOfMediumHeadHydropowerPlant

HIGHHEAD:

Apowerstationoperatingunderheadsaboveabout300m.Aheadof200m/250mis consideredasthelimitbetweenmediumandhighheadpower stations.

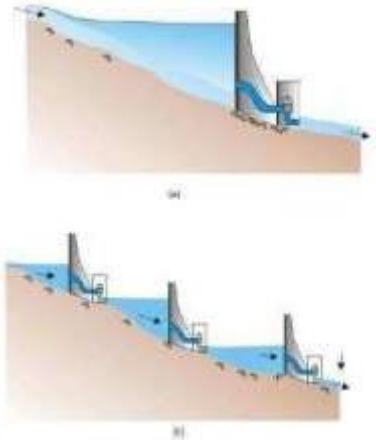


HighHeadHydropowerPlant

Classificationaccordingtohydrologicalrelation

SINGLESTAGE-Whentherunofffromasinglehydropowerplantisdivertedbackintoriver or foranyother purposeotherthan power generation,the setupis knownas Single Stage.

CASCADE SYSTEM-When two or more hydropowerplants are used in series such that the runoffdischargeofonehydropowerplantisused astheisaintakedischargeofthesecond hydro power plant sucha system is known as CASCADE hydropowerplant.



(a)singlestagehydropowerdevelopmentscheme

(b) cascadeormultistagehydropowersystem

Classification According To Purpose

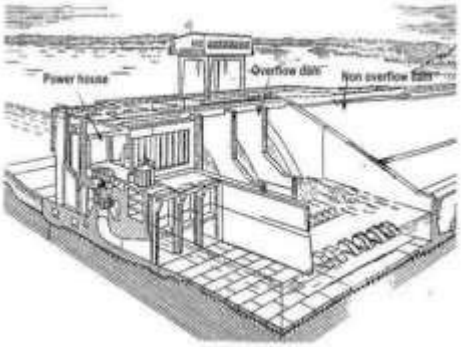
SINGLEPURPOSE:Whenthewholesoulpurposeofaprojectistoproduceelectricity then such a project is known as a Single PurposeHydro Power Project.

MULTIPURPOSE: When the water used in hydropowerprojectis to be used for other purposeslike irrigation,flood controlor fisheriesthensuchaprojectisknownasMulti Purpose Hydro Power Project.

Accordingtofacilitytypes

RUN-OF-RIVERTYPE

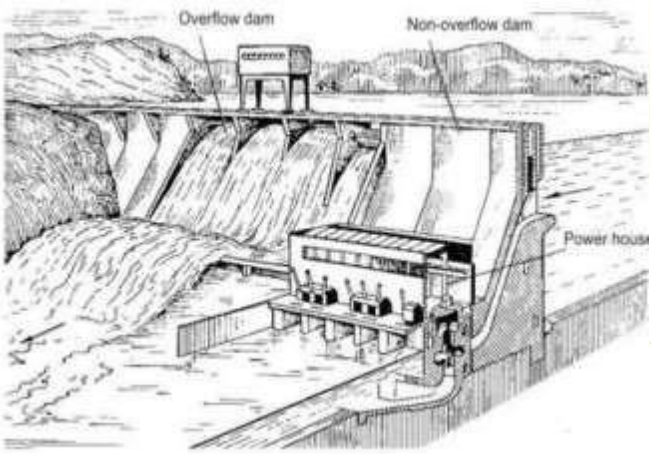
Thesearehydropowerplantsthatutilizethestreamflow asitcomes,withoutanystorage being provided.



STORAGE(RESERVOIR)TYPE

Hydropower plants withstorage are suppliedwithwater from large storage reservoir that have beendeveloped by constructingdams across rivers.

Assuredflowforhydropowergenerationismorecertainforthestorageschemesthanthe run-of-riverschemes.



PUMPEDSTORAGE TYPE

Pumped storage type hydropower plants are those which utilize the flow of water from a reservoir at higher potential to

oneatlower potential.

During off-peakhours, thereversible units aresuppliedwith the excess electricity available in the power grid whichthen pumps part of the water of the tail-water pond back into the head-waterpond.

SARDAR PATEL
UNIVERSITY
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।। ज्ञानेन प्रकाशते जगत् ।।

Whenthevelocityofwateri.ekineticenergyflowinginthestreamisusedforconversion intoelectricalpower,thenthesystemisknownasIn-stream.

Accordingtotrasmissionsystem

ISOLATED: Whenever a hydropowerplant is set up in a remote area inorderto meet the local demands then such a hydropowerplant is known asIsolated System.

CONNECTED TO GRID: Whenever the hydropower plant is set up tomeet the demands of areas which are at a fair distance from the plant, then thetransmission of power takes throughthe grid system. Such a setup is referredto asConnected to grid.

Energystorageorregeneration

Pumped-storage hydroelectricity (PSH), or pumped hydroelectric energy storage (PHES), is a type of hydroelectricenergy storage used by electric power systems for load balancing. The method stores energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to a higher elevation. Low-cost surplus off-peak electric power is typically used to run the pumps. During periods of high electrical demand, the stored water is released through turbines to produce electric power. Although the losses of the pumping process makes the plant a net consumer of energy overall, the system increases revenue by selling more electricity during periods of peak demand, when electricityprices are highest.

Pumped-storagehydroelectricityallowsenergyfromintermittentsources(such assolar,wind) and

other renewables, or excesselectricity from continuous base-load sources

(suchascoalornuclear)tobesavedforperiodsofhigherdemand.Thereservoirs pumped storage are quite small when compared to conventional hydroelectric dams ofsimilar power capacity, and generatingperiodsare often less than half a day.

Pumped storage is the largest-capacity form of grid energy storage available, and, as of 2017, the United States Department of Energy Global Energy Storage Database reports that PSH accounts for over 96% of all active tracked storage installations worldwide, with a total installed nameplate capacity of over 168 GW.[3] The round-trip energy efficiency ofPSHvaries between 70%–80%,with somesources claimingup to87%.[8] Themaindisadvantage of PSH is the specialist nature of the site required, needing both geographical height and water availability. Suitable sites are therefore likely to be in hilly or mountainous regions, and potentially in areas of outstanding natural beauty, and therefore there are also social and ecological issues to overcome. Many recently proposed projects, at least in the U.S., avoid highly sensitive or scenic areas, and some propose to take advantage of "brownfield" locations such as disused mines.

At times of low electrical demand, excess generation capacity is used to pump water into the upper reservoir. When there is higher demand, water is released back into the lowerreservoir through a turbine, generating electricity. Reversible turbine/generator assemblies act as a combinedpump and turbinegeneratorunit (usuallya Francis turbine design).

Types:naturalorman-madereservoirs

In open-loop systems, pure pumped-storage plants store water in an upper reservoir with no natural inflows, while pump-back plants utilize a combination of pumped storage and conventional hydroelectric plants with an upper reservoir that is replenished in part by natural inflows from a stream or river. Plants that do not use pumped-storage are referred to as conventional hydroelectric plants; conventional hydroelectric plants that have significant storage capacity may beable to play a similar role in the electrical grid as pumped storage by deferring output until needed.

Economicefficiency

Taking into account evaporation losses from the exposed water surface and conversionlosses, energy recovery of 70-80% or more can be regained.[10] This technique is currently the most cost-effective means of storing large amounts of electrical energy, but capital costs and the presence of appropriate geography are critical decision factors in selecting pumped- storage plant sites.

The relatively low energy density of pumped storage systems requires either large flows and/or large differences in height between reservoirs. The only way to store a significant amountof energyis by havinga largebody of water located relativelynear,butashigh above as possible, a second body of water. In some places this occurs naturally, in others one orboth bodies of water were man-made. Projects in which both reservoirs are artificial and in which no natural inflows are involved with either reservoir are referred to as "closed loop"systems.

Thesesystems may beeconomicalbecausetheyflatten out load variations on thepower grid, permitting thermal power stations such as coal-fired plants and nuclear power plantsthat provide base-load electricity to continue operating at peak efficiency, while reducing theneed for "peaking" power plants that use the same fuels as many base-load thermal plants, gas and oil, but have been designed for flexibility rather than maximal efficiency. Hence pumped storage systems are crucial when coordinating large groups of heterogeneous generators.Capitalcostsforpumped-storageplantsarerelativelyhigh,althoughthisis

somewhatmitigatedbytheirlongservicelifeofupto75yearsormore,whichisthreetofive timeslongerthanutility-scalebatteries.

Station	Country	Location	Capacity (MW)	Refs
Bath County Pumped StorageStation	United States	38°12'32"N79°48'00"W	3,003	[25]
Guangdong Pumped Storage Power Station	China	23°45'52"N113°57'12"E	2,400	[26][27]
HuizhouPumpedStorage Power Station	China	23°16'07"N114°18'50"E	2,400	[28][29][30][31]
Okutataragi Pumped Storage Power Station	Japan	35°14'13"N134°49'55"E	1,932	[32]
LudingtonPumpedStorage PowerPlant	United States	43°53'37"N86°26'43"W	1,872	[33][34]

Potential technologies

Seawater

Pumped storage plants can operate with seawater, although there are additional challenges compared to using fresh water. In 1999, the 30 MW Yanbaru project in Okinawa was the first demonstration of seawater pumped storage. It has since been decommissioned. A 300 MW seawater-based Lanai Pumped Storage Project was considered for Lanai, Hawaii, and seawater-basedprojectshavebeenproposedinIreland.Apairofproposedprojectsin the Atacama Desert in northern Chile would use 600 MW of photovoltaic solar (Skies of Tarapacá) together with 300 MW of pumped storage (Mirror of Tarapacá) raising seawater 600 metres (2,000 ft) up a coastal cliff.

Undergroundreservoirs

The use of underground reservoirs has been investigated. Recent examples include the proposedSummitprojectinNorton,Ohio,theproposedMaysvilleprojectin Kentucky(underground limestonemine), and the Mount Hope project in New Jersey,which was to have used a former iron mine as the lower reservoir. The proposed energy storage at the Callio site in Pyhäjärvi (Finland)would utilizethe deepest base metal mine in Europe, with

1,450 metres (4,760 ft) elevation difference. Several new underground pumped storage projects have been proposed. Cost-per-kilowatt estimates for these projects can be lower thanforsurfaceprojectsiftheyuseexistingundergroundminespace.Therearelimited

opportunitiesinvolving suitableundergroundspace,butthenumberofunderground pumped storageopportunitiesmayincreaseifabandonedcoalminesprovesuitable.

Decentralised systems

Smallpumped-storagehydropowerplantscanbebuiltonstreamsandwithininfrastructures, such as drinking water networks and artificial snow making infrastructures. Such plants provide distributed energy storage and distributed flexible electricity production and can contribute to the decentralized integration of intermittent renewable energy technologies, such as wind power and solar power. Reservoirs that can be used for small pumped-storage hydropower plants could include natural or artificial lakes, reservoirs within other structures suchasirrigation,orunusedportionsofminesorundergroundmilitaryinstallations. In Switzerland one study suggested that the total installed capacity of small pumped-storage hydropower plants in 2011 could be increased by 3 to 9 times by providing adequate policy instruments.

Underwaterreservoirs

In March 2017 the research project St. EnSea (Storing Energy at Sea) announced their successful completion of a four-week test of a pumped storage underwater reservoir. In this configuration a hollow sphere submerged and anchored at great depth acts as the lower reservoir, while the upper reservoir is theenclosing body of water. Electricity iscreated when water is let in via a reversible turbine integrated into the sphere. During off-peak hours the turbine changes directionand pumpsthe waterout again, using "surplus" electricity from the grid. The quantity ofpower created when wateris let in grows proportionally to the height of the column of water above the sphere, in other words: the deeper the sphere is located the more potential energy it can store, which can be transformed into electric power. On the other hand, pumping the water back out at greater depths also uses up more power, sincethe turbine-turned-pumpmust act on the same entire columnof water.

Assuchtheenergystoragecapacityofthesubmergedreservoirisnotgovernedby the gravitationalenergy in the traditionalsense, but rather by the vertical pressure variation.

While St EnSea's test took place at a depth of 100 m in the fresh water Lake Constance, the technology is foreseen to be used in salt water at greater depths. Since the submerged reservoir needs only a connecting electrical cable, the depth at which it can be employed is limited only by the depth at which the turbine can function, currently limited to 700 m. The challenge of designing salt water pumped storage in this underwater configuration brings a range of advantages:

- Nolandareaisrequired,
- No mechanicalstructure other than theelectrical cableneedsto spanthe distanceof the potential energy difference,
- Inthepresenceofsufficientseabedareamultiplereservoirscanscalethestorage capacitywithoutlimits,
- Shouldareservoircollapse,theconsequenceswould belimited apartfromtheloss ofthe reservoiritself,
- Evaporationfromtheupperreservoirhasnoeffectontheenergyconversionefficiency,
- Transmission of electricity between the reservoir and the grid can be established from a nearby offshore wind farm limiting transmission loss and obviating the need for onshore cablingpermits.

SuperconductingMagneticEnergyStorage(SMES)

SMESsystemsstoreenergyinthemagneticfieldcreatedbytheflowofdirect asuperconductingcoilwhichhasbeencryogenicallycooledtoatemperaturebelow its superconducting critical temperature.

A typical SMES system includes three parts: superconducting coil, power conditioning system and cryogenically cooled refrigerator. Once the superconducting coil is charged, the current will not decay and the magnetic energy can be storedindefinitely.

The stored energy can be released back to the network by discharging the coil. The power conditioning system uses an inverter/rectifier to transform alternating current (AC) power to direct current orconvertDC backto AC power. The inverter/rectifieraccounts forabout 2–3% energy loss in each direction. SMES loses the least amount ofelectricity in the energy storage process compared to other methods of storing energy. SMES systems are highly efficient; the round-trip efficiency is greater than 95%.Due to the energy requirements of refrigeration and the high cost of superconducting wire, SMES is currently used for short duration energy storage. Therefore,SMES is most commonly devoted to improving power quality.

Currentuse

There are several small SMES units available for commercial use and several larger test bed projects. Several 1 MW·h units are used for power quality control in installations around the world, especially to provide power quality at manufacturing plants requiring ultra-clean power, such as microchip fabricationfacilities.

These facilities have also been used to provide grid stability in distribution systems. SMES is also used in utility applications. In northern Wisconsin, a string of distributed SMES unitswere deployed to enhance stability of a transmission loop. The transmission line is subject to large, sudden load changes due to the operation of a paper mill, with the potential for uncontrolledfluctuations and voltage collapse.

The Engineering Test Model is a large SMES with a capacity of approximately 20 MW·h, capableof providing40 MW of power for30 minutes or 10 MWof power for 2 hours.

Calculationofstoredenergy

Themagneticenergystoredbyacoilcarryingacurrentisgivenbyonehalfof the inductanceof the coil times the square of the current.

Where

E=energymeasuredinjoules
L=inductancemeasuredinhenries I
= current measured in amperes

Now let's consider a cylindrical coil with conductors of a rectangular cross section.The mean radius ofcoilis R. a and b arewidth anddepth ofthe conductor. f is called form function which is different for different shapes of coil.Ç(xi) and δ (delta) are two parameters to characterize the dimensions of the coil. We can therefore write the magnetic energy stored in such a cylindricalcoilasshownbelow.Thisenergyisafunctionofcoil

dimensions,numberofturnsand carryingcurrent.

Where

E=energymeasuredinjoules
I=currentmeasuredinamperes
f(Ç,δ)=formfunction,joulesperampere-meter N

= number of turns of coil

SolenoidvsToroid

Besides the properties of the wire, the configuration of the coil itself is an important issue from a mechanical engineering aspect. There are three factors which affect the design andthe shape of the coil - they are: Inferior strain tolerance, thermal contraction upon coolingand Lorentz forces in a charged coil. Among them, the strain tolerance is crucial not because of any electrical effect, but because it determines how much structural material is needed to keep the SMES from breaking. For small SMES systems, the optimistic value of 0.3% strain tolerance is selected. Toroidal geometry can help to lessen the external magnetic forces and therefore reduces the size of mechanical support needed. Also, due to the low external magnetic field, toroidalSMES can be located near a utility or customerload.

For small SMES, solenoids are usually used because they are easy to coil and no pre-compression is needed. In toroidal SMES, the coil is always under compression by the outer hoops and two disks, one of which is on the top and the other is on the bottom to avoid breakage. Currently, there is little need for toroidal geometry for small SMES, but as the size increases, mechanicalforces become more important and the toroidalcoil is needed.

The older large SMES concepts usually featured a low aspect ratio solenoid approximately100 m in diameter buried in earth. At the low extreme of size is the concept of micro-SMES solenoids,for energy storage range near 1 MJ.

Low-temperatureversushigh-temperaturesuperconductors

Under steady state conditions and in the superconducting state, the coil resistance is negligible. However, the refrigerator necessary to keep the superconductor cool requires electric power and this refrigeration energy must be considered when evaluating the efficiency of SMES as an energy storage device.

Although the high-temperature superconductor (HTSC) has higher critical temperature, flux lattice melting takes place in moderate magnetic fields around a temperature lower than this criticaltemperature.Theheatloadsthatmustberemovedbythecoolingsystem include conduction through thesupportsystem,radiation from warmer to colder surfaces, AC losses in the conductor (during charge and discharge), and losses from the cold–to-warm power leads that connect the cold coil to the power conditioning system. Conduction and radiation losses are minimized by proper design of thermal surfaces. Lead losses can be minimizedbygooddesignoftheleads.AClossesdependonthedesignoftheconductor, the duty cycle of the device and the power rating.

The refrigeration requirements for HTSC and low-temperaturesuperconductor (LTSC) toroidal coils for the baseline temperatures of 77 K, 20 K, and 4.2 K, increases in that order. The refrigeration requirements here is defined as electrical power to operate the refrigeration system. As the stored energy increases by a factor of 100, refrigeration cost only goes up by a factor of 20. Also, the savings in refrigeration for an HTSC system is larger (by 60% to 70%) than for an LTSC systems.

Cost

Whether HTSC or LTSC systems are more economical depends because there are other major components determining the cost of SMES: Conductor consisting of superconductor and copper stabilizer and cold support are major costs in themselves. They must be judged with theoverallefficiencyandcostofthedevice.Othercomponents,suchasvacuum vessel insulation, has been shown to be a small part compared to the large coil cost. The combined costs of conductors, structure and refrigerator for toroidal coils are dominated by the cost of the

superconductor.The sametrend is true forsolenoidcoils.HTSC coils cost more

thanLTSCcoilsbyafactorof2to4.WeexpecttoseeacheapercostforHTSCdue refrigerationrequirementsbutthisisnotthecase.

UNIT2

Ecosystems

Concept of an ecosystem; Structure and function of an ecosystem; Producers, consumers and decomposers; Energy flow in the ecosystem; Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and functionof the following ecosystem (a.)Forest ecosystem (b) Grassland ecosystem (c) Desertecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Ecosystem

An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. It refers to both biotic factors as well as abiotic factors. An ecosystem is self-supporting. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows

The term 'environment 'originated from the French word environner or environmentmeaning 'to surround'. From this etymology, environment means the things or events that surround something else. In other words, environment means the area in which something exists or lives. Environment is defined as the social, cultural and physical conditions that surround, affect and influence the survival, growth and development of people, animals or plants. Environment includes everything around us. It encompasses both the living (biotic)and non-living (abiotic) components of the Earth.

ConceptofanEcosystem:

The term ecosystem wascoined in 1935 by the Oxford ecologist Arthur Tansley to encompass the interactions among biotic andabiotic components of theenvironmentat a givensite. The living and non-living components of an ecosystem are known as biotic and abiotic components,respectively.

Ecosystem was defined in its presently accepted form by Eugene Odum as, "an unit that includes all the organisms, i.e., the community in a given area interacting with the physicalenvironmentso thataflowof energyleads toclearly defined trophicstructure,biotic diversityand material cycles, i.e., exchange of materials between living and non-living, within the system".

Smith(1966)hassummarizedcommoncharacteristicsofmostoftheecosystemsasfollows:

1. Theecosystemisamajorstructuralandfunctionalunitof ecology.

2. The structure of an ecosystem is related to its species diversity in the sense that complex ecosystem have high species diversity.

3. The function ofecosystemis related to energyflow andmaterialcycles within and outside the system.

4. Therelativeamountofenergyneededtomaintainanecosystemdependsonitsstructure.
5. Young ecosystems develop and change from less complex to more complex ecosystems, through the process called succession.

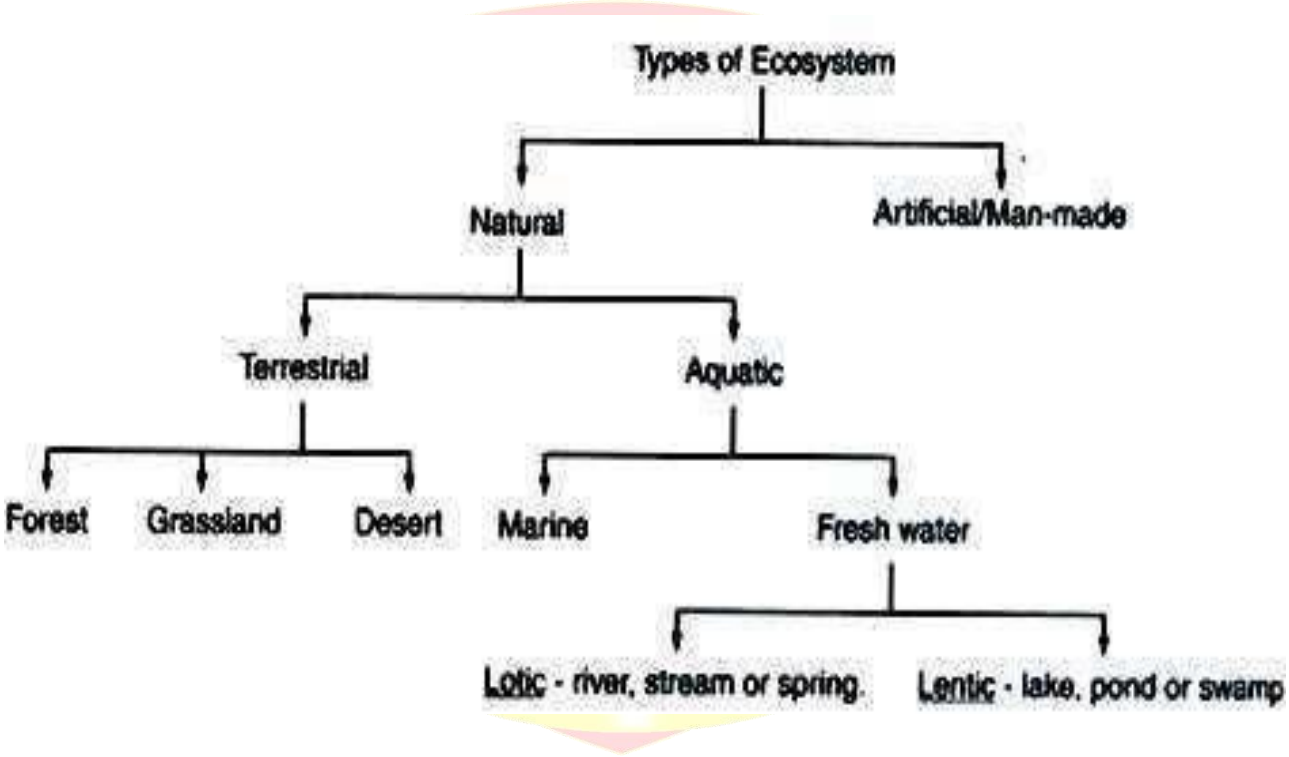
6. Eachecosystemhasitsownenergybudget,whichcannotbeexceeded.

7. Adaptationtolocalenvironmentalconditionsistheimportantfeatureofthebiotic componentsofanecosystem,failingwhichtheymightperish.

8. The function of every ecosystem involves a series of cycles, e.g., water cycle, nitrogencycle, oxygen cycle, etc. these cycles are driven by energy. A continuation or existence of ecosystemdemands exchange of materials/nutrientsto and from the different components.

<u>TypesofEcosystem:</u>

Wecanclassifyecosystemsas follows:



<u>TypesofEcosystem</u>

(a) NaturalEcosystems:

These ecosystems are capable of operating and maintaining themselves without any major interference by man.

Aclassificationbasedontheir habitatcanfurtherbemade:

1. Terrestrialecosystems:forest,grasslandanddesert.

2. Aquatic ecosystems:fresh water ecosystem, viz. pond, lake, river and marine ecosystems, viz. ocean, sea or estuary.

(b) ArtificialEcosystem:

These are maintained by man. These are manipulated by man for different purposes, e.g., croplands,artificiallakes and reservoirs, townships and cities.

BasicStructureofanEcosystem:

Everyecosystemhasanon-living(abiotic)andliving(biotic)components.

Abiotic Components:

Basic inorganic compounds of an organism, habitat or an area like carbon dioxide, water, nitrogen, calcium, phosphorus, etc. that are involved in the material cycles are collectively called as abiotic component. The amount of these inorganic substances present at any given time, in an ecosystemis called as the standingstate or standingquality of an ecosystem.

Whereas, organic components e.g., proteins, amino acids, carbohydrates and lipids that are synthesized by the biotic counterpart of an ecosystem make the biochemical structure of the ecosystem. The physical environment, viz. climatic and weather conditions are also includedin the abiotic structureof the ecosystem.

BioticComponents:

From the trophic (nutritional) point of view, an ecosystem has autotrophic (self-nourishing) and a heterotrophic (other nourishing) components:

(a) **Autotrophiccomponent(Producers):**

This component is mainly constituted by the green plants, algae and all photosynthetic organisms. Chemosynthetic bacteria, photosynthetic bacteria, algae, grasses, mosses, shrubs, herbs and trees manufacture food from simple inorganic substances by fixing energy and are therefore called as producers.

(b) Heterotrophiccomponent(Consumers):

The members of this component cannot make their own food.They consume the matter built by the producers and are therefore called as consumers. They may be herbivores, carnivores or omnivores.Herbivores arecalled as primary consumers whereas carnivores and omnivores are called as secondary consumers.Collectivelywe can call them as macro-consumers.

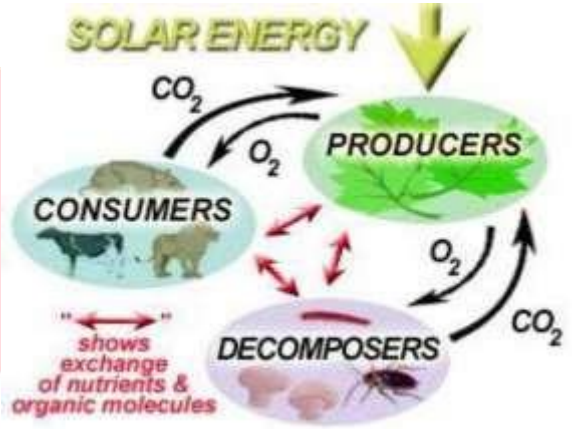
(c) Decomposers:

Heterotrophic organisms chiefly bacteria and fungi that breakdown the complex compounds of dead protoplasm, absorb some of the products and release simple substances usable bythe producers are called as decomposers or reducers. Collectively we call them as micro consumers.

Energyflowin Ecosystem:

Organisms can be either producers or consumers in terms of energy flow through an ecosystem.Producers convertenergy from theenvironment into carbon bonds, such as those found in the sugar glucose. Plants are the most obvious examples of producers; plants take energy from sunlight and use it to convert carbon dioxide into glucose (or other sugars).Algae and cyanobacteriaare also photo- synthetic producers,like plants.

Other producers include bacteria living around deep-sea vents. These bacteria take energy from chemicals coming from the Earth's interior and use it to make sugars. Other bacteria living deep under-ground canalso produce sugars from such inorganic sources. Another word for producers is autotrophs.



RoutesofUsage:

Consumersgettheir energyfromthecarbonbonds madebytheproducers.Another wordfor a consumer is a heterotroph.

Basedonwhattheyeat,wecandistinguishbetween4typesofheterotrophs: Routes of

Usage

A trophic level refers to the organisms position in the food chain. Autotrophs are at the base. Organisms that eat autotrophs are called herbivores or primary consumers. An organism that eats herbivores is a carnivore and a secondary consumer. A carnivore which eats a carnivore which eats a herbivore is a terti-aryconsumer,and so on.

It is important to note that many animals do not specialize in their diets. Omnivores (such as humans) eat both animals and plants. Further, except for some specialists, most carnivores don't discriminate between herbivorous and carnivorous bugs in their diet. If it's the rightsize, andmoving at the right distance, chances are the frog will eat it.

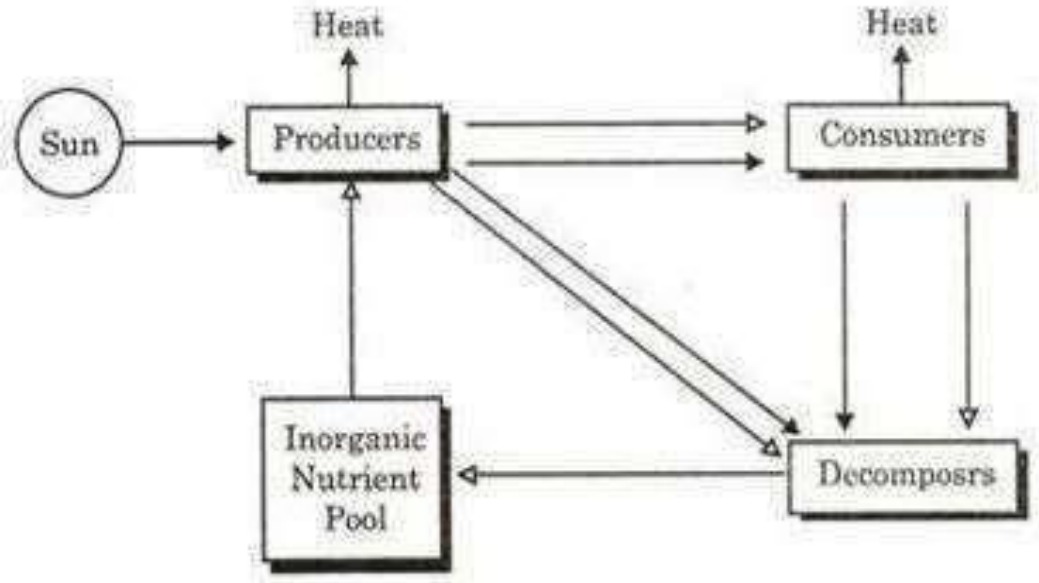
<u>FlowofEnergyanditsUtilisation:</u>

The diagram 3.5 shows how both energy andinorganic nutrients flow through theecosystem. Energy "flows" through theecosystem intheform ofcarbon-carbon bonds.When respiration occurs,the carbon-carbonbonds arebroken and the carbon is combined with oxygen to form

4 carbon dioxide.

This process releases the energy, which is either used by the organism (to move its muscles, digest food, excrete wastes, think, etc.) or the energy may be lost as heat. The dark arrows represent the movement of this energy. Note that all energy comes from the sun, and thatthe ultimate fateof all energyin ecosystemsis to be lostas heat. Energy does not recycle.

The other component shown in the diagram is the inorganic nutrients. They are inorganic because they do not contain carbon-carbon bonds. These inorganic nutrients include the phosphorous in your teeth, bones, and cellular membranes the nitrogen in your amino acids (the building blocks of protein); and the iron in your blood (to name just a few of theinorganicnutrients).



FlowofEnergyanditsUtilisation

The movement of the inorganic nutrients is represented by the open arrows. Note that the autotrophs obtain these inorganic nutrients from the inorganicnutrient pool, which is usually the soil or water surroundingthe plants or algae.

These inorganic nutrients are passed from organism to organism as one organ-ism is consumed by another. Ultimately, all organisms die and become detritus, food for the decomposers. At this stage, the last of the energy is extracted (and lost as heat) and the inorganic nutrients are returned to the soil or water to be taken up again. The inorganic nutrients are recycled, the energy is not.

<u>Ecologicalsuccession</u>

Ecological succession is the process of change in the species structure of an ecological community over time. The time scale can be decades (for example, after a wildfire), or even millions of years after a mass extinction.

Thecommu nitybegins withrelativ elyfewpion eeringplant sandanimal sanddevelo ps

community. The "engine" of succession, the cause of ecosystem change, is the impact of established species upon their own environments. A consequence of living is the sometimes subtle and sometimes overt alteration of one's own environment.

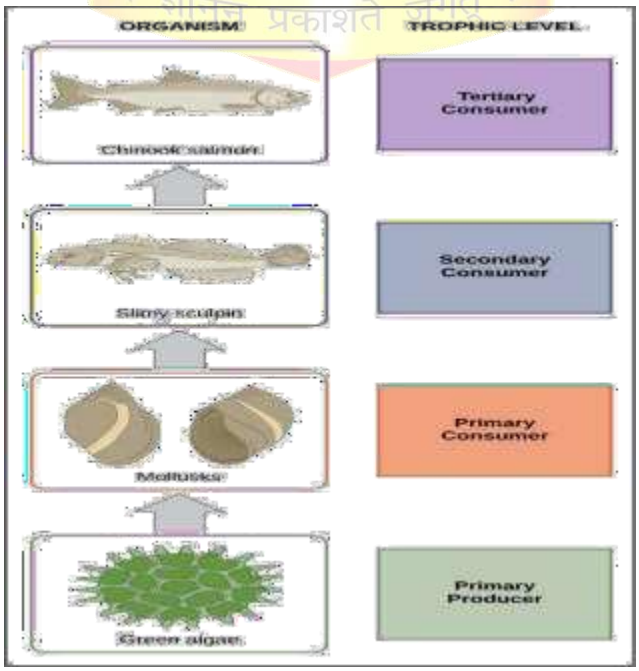
Foodchain

A food chain is a linear sequence of organisms through which nutrients and energy pass asone organism eats another. In a food chain, each organism occupies a different trophic level, defined by how many energy transfersseparateit from the basic input of the chain.

Partsofatypicalfoodchain,startingfromthebottom—theproducers—andmoving upward.

At the base of the food chain lie the primary producers. The primary producers areautotrophs and are most often photosynthetic organisms such as plants, algae, or cyanobacteria. The organisms that eat the primary producers are called primary consumers. Primary consumers are usually herbivores, plant-eaters, though they may be algae eaters or bacteria eaters. The organisms that eat the primary consumers are called secondary consumers. Secondary consumers are generally meat-eaters—carnivores. The organisms that eat the secondary consumers are called tertiary consumers. These are carnivore-eating carnivores,like eagles or big fish. Somefood chains haveadditional levels, such asquaternary consumers—carnivoresthateat tertiary consumers.Organismsatthevery top ofa food chain are called apex consumers.

We can see examples of these levels in the diagram below. The green algae are primary producers that get eaten by mollusks—the primary consumers. The mollusks then become lunch for the slimy sculpin fish, a secondary consumer, which is itself eaten by a larger fish, the Chinook salmon—a tertiary consumer.



Foodweb

Food webs consist of many interconnected food chains and are more realistic representation of consumption relationships in ecosystems. Energy transfer between trophic levels is inefficient—with a typical efficiency around 10%. This inefficiency limits the length of food chains.

Or

Food web can be defined as, "a network of food chains which are interconnected at various tropic levels, so as to forma number offeeding connections amongst different organisms of a biotic community".It is also known as consumer-resource system.It is a graphical description of feeding relationships among species in an ecological community. It is also a mean of showing how energy and materials (e.g., carbon) flow through a community of species as a result of these feeding relationships.

Basicsoffoodweb

A node is oneof the words/picturesthat the arrows go towardor awayfrom. A node may represent an individualspecies, or a groupof related species or different stages of a single species(suchasonenodeforadultfrogsandasecondforjuveniletadpoles).Alinkconnects two nodes. Arrows represent links, and alwaysgo frompreyto predator (asin food chain). ThelowesttrophiclevelarecalledbasalspeciesThehighesttrophiclevelarecalledtop predators.Movementofnutrientsiscyclicbutofenergyisunidirectionalandnon-cyclic.

TypesOfFood WebRepresention

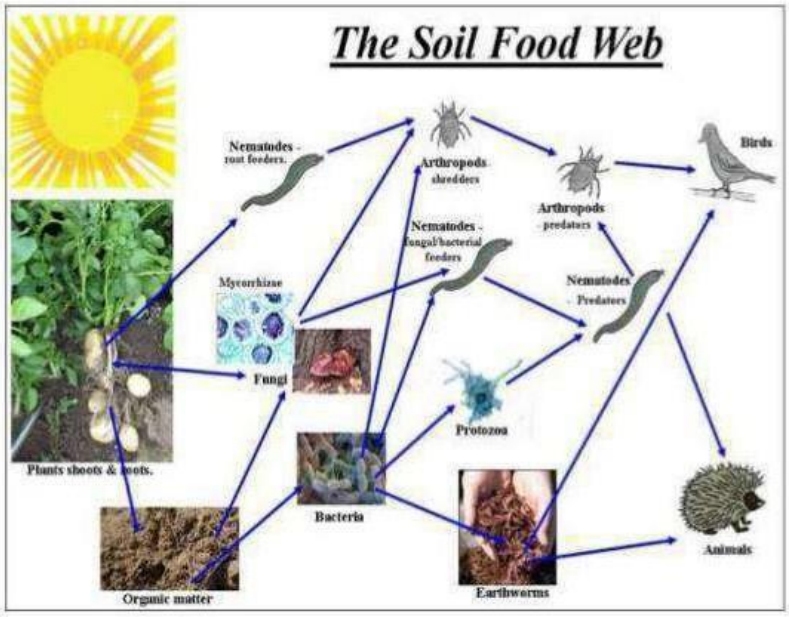
1. **Topologicalweb:-Earlyfoodwebsweretopological.Theysimplyindicateafeeding relationship.**
2. **Flow webs :- Bioenergetic webs, or flow webs, include information on the strength of the feeding interaction. This can be done in one of two ways:Vary the size of the arrow. Thicker arrows represent a larger percentage of the diet. (interactions where**

morepreyareeatenorwheremoreenergyflowsupward).Theamountofenergy

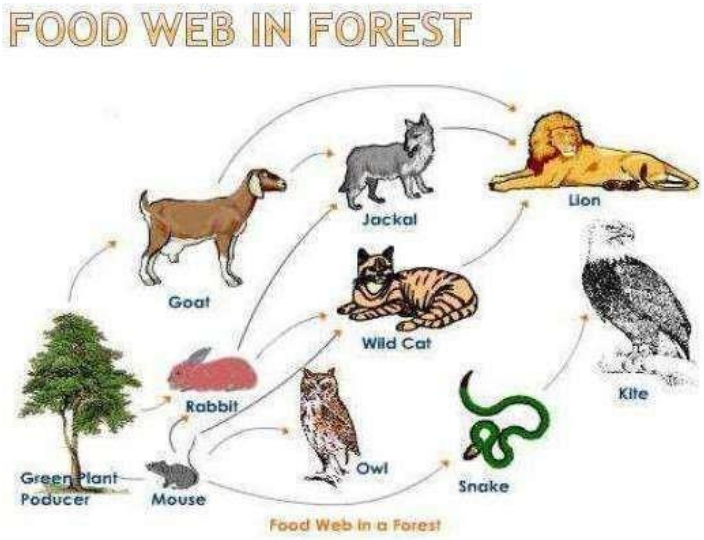
3. **Interaction webs :- An interaction web is similar to a topological web, but instead of showing the movement of energy or materials, the arrows show how one group influences another. In interaction food web models, every link has two direct effects. One of the resource on the consumer and one of the consumer on the resource. The effect of the resource on the consumer is positive, (the consumer gets to eat) and the effect on the resource by the consumer is negative(it is eaten).**

<u>Typesoffood webs</u>

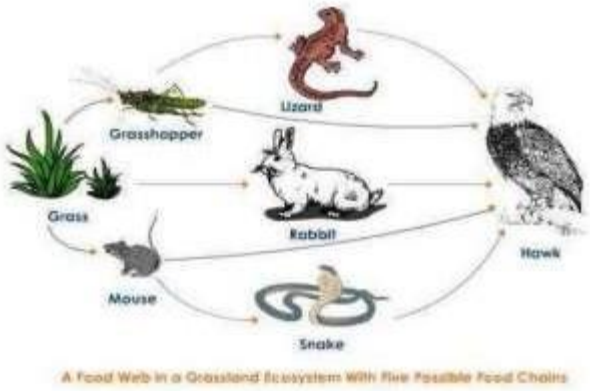
1. **Soil food web:- The soil food web is the community of organisms living all or part of their lives in the soil. It describes a complex living system in the soil and how it interacts with the environment, plants, and animals.**



2. **Aquatic food web:- A balanced food web is essential to any marine or fresh water system,andcan beanindicator of habitat quality. Planktonicalgaeare thefoundation of aquatic food webs. The size and diversity of the planktonic algae community determines the diversity of the zooplankton community that can be supported as well as the small fish community.**
3. **Foodwebin forest:-**

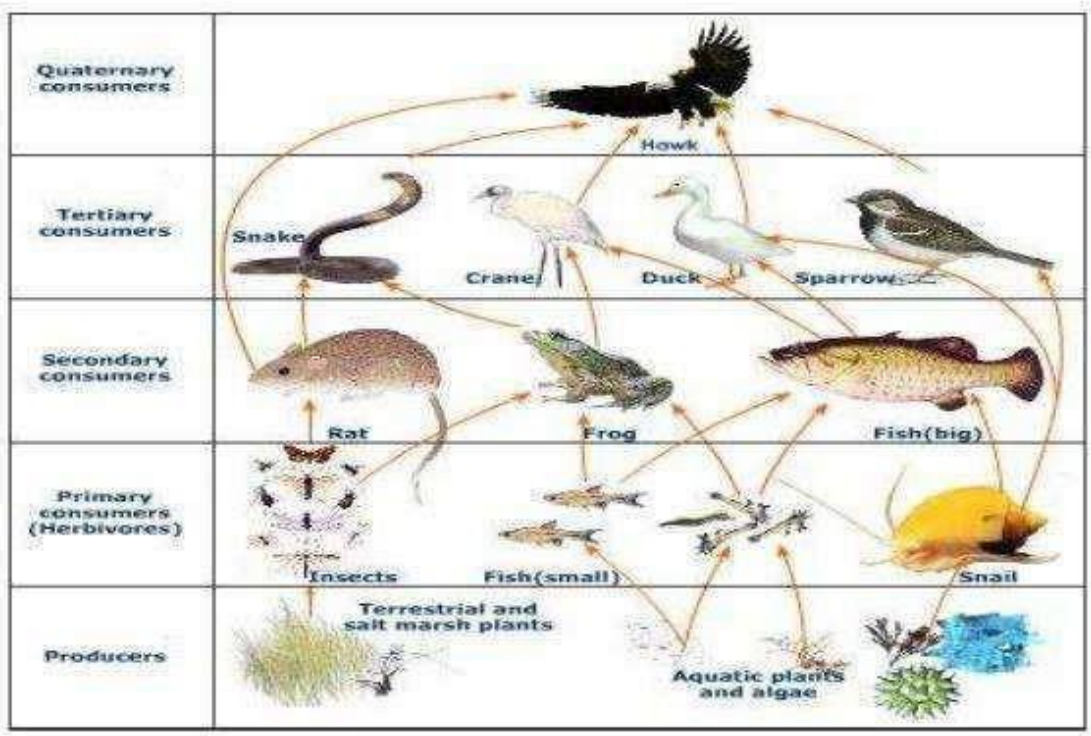


4. **Foodwebof grassland**



5. **Foodwebin terrestrialandaquaticecosystem**

FOOD WEB IN TERRESTRIAL AND AQUATIC ECOSYSTEM



EcologicalPyramid

An ecological pyramid is a graphical representation of the relationship between different organisms in an ecosystem. Each of the bars that make up the pyramid represents a different trophic level, and their order, which is based on who eats whom, represents the flow of energy. Energy moves up the pyramid, starting with the primary producers, or autotrophs, such as plants and algae at the very bottom, followed by the primary consumers, which feed onthese plants, thensecondary consumers,which feedontheprimary consumers,andsoon. The height of the bars should all be the same, but the width of each bar is based on the quantity of the aspect being measured.

TypesofEcologicalPyramidsP

yramid of numbers

This shows the number of organisms in each trophic level without any consideration for their size. This type of pyramid can be convenient, as counting is often a simple task and can be done over the years to observe the changes in a particular ecosystem. However, some types of organisms are difficult to count, especially when it comes to some juvenile forms. Unit: number of organisms.

Pyramidofbiomass

This indicatesthetotal massoforganismsat eachtrophiclevel.Usually,thistypeofpyramid

one trophic level is calculated by multiplying the number of individuals in the trophic level by the averagemass of one individual in a particular area. This type of ecological pyramid solves someproblems of thepyramid of numbers,as itshows a more accurate representation of the amount of energy contained in each trophic level, but it has its own limitations. For example, the time of year when the data are gathered is very important, since different species have different breeding seasons. Also, since it's usually impossible to measure the mass of every single organism,only asample is taken, possiblyleadingto inaccuracies. Unit: gm-2 or Kg m2.

Pyramidofproductivity

The pyramid ofproductivity looksat the totalamount of energy presentat each trophic level, as well as the loss of energy between trophic levels. Since this type of representation takes into account the fact that the majority of the energy present at one trophic level will not be available for thenextone, it is more accurate than theother two pyramids. This idea is based on Lindeman's Ten Percent Law, which states that only about 10% of the energy in a trophic level will go towards creating biomass. In other words, only about 10% of the energy will go into making tissue, such as stems, leaves, muscles, etc. in the next trophic level. The rest is used in respiration, hunting, and other activities, or is lost to the surroundings as heat.What's interesting, however, is that toxins are passed up the pyramid very efficiently, which meansthatas we go up theecological pyramid, the amountof harmful chemicals ismoreand more concentrated in the organisms'bodies. This is what we call biomagnification.

The pyramid of productivity is the most widely used type of ecological pyramid, and, unlike the two other types, can never be largest at the apex and smallest at the bottom. It's an important type of ecological pyramid becauseit examines the flow of energy in an ecosystem over time. Unit: J m-2 yr-1, where Joule is the unit for energy, which can be interchanged by other units of energy such as Kilojoule, Kilocalorie,and calorie.

While a productivity pyramid always takes an upright pyramid shape, number pyramids are sometimesinverted, ordon't take the shape of an actualpyramidat all. To demonstrate,let's take an oak tree, which can feed millions of oakworms. If we consider this ecosystem as our focus, then the producers' level (one tree) will end up much smaller than the primary consumers' level (millions of insects). This is less likely to occur in biomass pyramids, but isnot impossible. The pyramids below show the different types of pyramids and the shapesthey can have in different ecosystems.

EcologicalPyramidExamples

The diagram below is an example of a productivity pyramid, otherwise called an energy pyramid. The sun has been included in this diagram, as it's the main source of all energy, as well the decomposers, like bacteria and fungi, which can acquire nutrients and energy fromalltrophic levels by breaking down dead or decaying organisms.As shown, thenutrients then go back into the soil and are taken up by plants.

EcologicalP
11
yr

The loss of energy to the surroundings is also shown in this diagram, and the total energy transfer has been calculated. We start off with the total amount of energy that the primary producers contain, which is indicated by 100%. As we go up one level, 90% of that energy is used in ways other than to create flesh. What the primary consumers end up with is just 10% of the starting energy, and, 10%of that 10% is lostin the transferto the next level.That's 1%, and so on. The predators at the apex, then, will only receive 0.01% of the starting energy!This inefficiencyin the system is the reason why productivity pyramids are always upright.

FunctionofEcologicalPyramid

An ecological pyramid not only shows us the feeding patterns of organisms in different ecosystems, but can also give us an insight into how inefficient energy transfer is, and show the influence that a change in numbers at one trophic level can have on the trophic levels above and below it. Also, when data are collected over the years, the effects of the changes that takeplace in the environment onthe organisms can bestudied by comparing the data. If an ecosystem's conditions are found to be worsening over the years because of pollution or overhunting by humans, action can be taken to prevent further damage and possibly reverse some of the present damage.

RelatedBiologyTerms

Trophic level – The position that an organism occupies within a food chain or an ecological pyramid, such as a producer, or a primary consumer. Many animals feed at several different trophiclevels.

Species–Agroupoforganismsthatexhibitcommoncharacteristicsandcanbreedamong themselvesto producefertileoffspring.

Ecosystem – A community of interdependent living organisms in association with the nonliving elements surrounding them. The way the living organisms and the physical environmentinteract is by exchange of nutrientsand energy.

Food web – A system of food chains that are interlocked with one another. Unlike in food chains, an organismin a food web can occupy several different trophiclevels.

Or

EcologicalPyramid

An ecological pyramid (also trophic pyramid, energy pyramid, or sometimes food pyramid) isa graphical representation designed to show the biomass or bio productivity at each trophic level in a given ecosystem. Biomass is the amount of living or organic matter present in an organism. Biomass pyramids show how much biomass is present in the organisms at each trophiclevel,whileproductivitypyramidsshowtheproductionorturnoverinbiomass.

E

throughthevarious trophic levels (suchasherbivores thateatplants, then carnivoresthateat herbivores, then carnivores that eat those carnivores, and so on). The highest level is the top of the chain. An ecological pyramid of biomass shows the relationship between biomass and trophic level by quantifying the biomass present at each trophic level of an ecological community at a particular time. It is a graphical representation of biomass (total amount of livingor organic matter in an ecosystem) presentin unit area in differenttropic levels. Typical units are grams per meter2, or calories per meter2.

Generalconcepts

Energy flows through the food chain in a predictable way, entering at the base of the food chain, by photosynthesis in primary producers, and then moving up the food chain to higher trophic levels.Because the transfer of energy from one trophic level to the next is inefficient, there is less energy enteringhigher trophic levels.

It may also be useful and productive to examine how the number and biomass of organisms vary across trophic levels.Both the number and biomass of organisms at each trophic level should be influenced by the amount of energy entering that trophic level. When there is a direct correlation between energy, numbers, and biomass then biomass pyramids and numbers pyramids will result.However, the relationship between energy, biomass, and number can be complicated by the growth form and size of organisms and ecological relationships occurring among trophic levels.Thus, it is possible, and common that biomass pyramidsand numbers pyramids do not look like pyramids at all

<u>Types</u>

Thereare3typesofecologicalpyramidsasdescribedas follows:
Pyramid ofEnergy
Pyramidofnumbers
Pyramidofbiomass.

<u>PyramidofEnergy</u>
The pyramid of energy or the energy pyramid describes the overall nature of the ecosystem. During the flow of energy from organism to other, there is considerable loss of energy in the form of heat. The primary producers like the autotrophs there is more amount of energy available. The leastenergy isavailable in thetertiary consumers. Thus, shorter food chain has more amount of energy available even at the highest trophiclevel.

1. **Theenergypyramidalwaysuprightandvertical.**
2. **Thispyramidshowstheflowofenergyatdifferenttrophiclevels.Itdepictstheenergy isminimumasthehighesttrophiclevelandismaximumatthelowesttrophiclevel.**
3. **At each trophic level, there is successive loss of energy in the form of heat and respiration, etc.**

PyramidofNumbers

The pyramid of numbers depicts the relationship in terms of the number of producers, herbivores and the carnivores at their successive trophic levels. There is a decrease in the number of individuals from the lowerto thehigher trophiclevels. The number pyramidvaries from ecosystem to ecosystem.

Therearethreeofpyramidofnumbers:

1. **Uprightpyramidofnumber**
2. **Partlyuprightpyramidofnumberand**
3. **Invertedpyramidof number.**

1. **UprightPyramid of Number :-This typeof pyramid number isfound in theaquatic and grassland ecosystem, in these ecosystems thereare numerous small autotrophs which support lesser herbivores which in turn support smaller number of carnivores and hence this pyramid is upright.**
2. **Partly Upright pyramid of Number :- It is seen in the forest ecosystem where the number of producers are lesser in number and support a greater number ofherbivores and which in turn supporta fewer number of carnivores.**
3. **Inverted Pyramid ofNumber:- This type of ecological pyramid is seen in parasitic food chain where one primary producer supports numerous parasites which support more hyperparasites.**

PyramidofBiomass

The pyramid of biomass is more fundamental, they represent the quantitative relationshipsof the standing crops. In this pyramid there is a gradual decrease in the biomass from the producers to the higher trophic levels. The biomass here the net organisms collected from each feeding level and are then dried and weighed. This dry weight is the biomass and it represents the amount of energy available in the form of organic matter of the organisms. In this pyramid the net dry weight is plotted to that of the producers, herbivores, carnivores,etc.

Therearetwotypesofpyramidofbiomass,theyare:

1. **Uprightpyramidofbiomass and**
2. **Invertedpyramidof biomass.**

1. **UprightPyramidofBiomass:-Thisoccurswhenthelargernetbiomass ofproducers support a smaller weight of consumers.**

   Example:Forestecosystem.

2. **InvertedPyramidofBiomass:-Thishappenswhenthesmallerweightofproducers supportconsumersoflargerweight.**

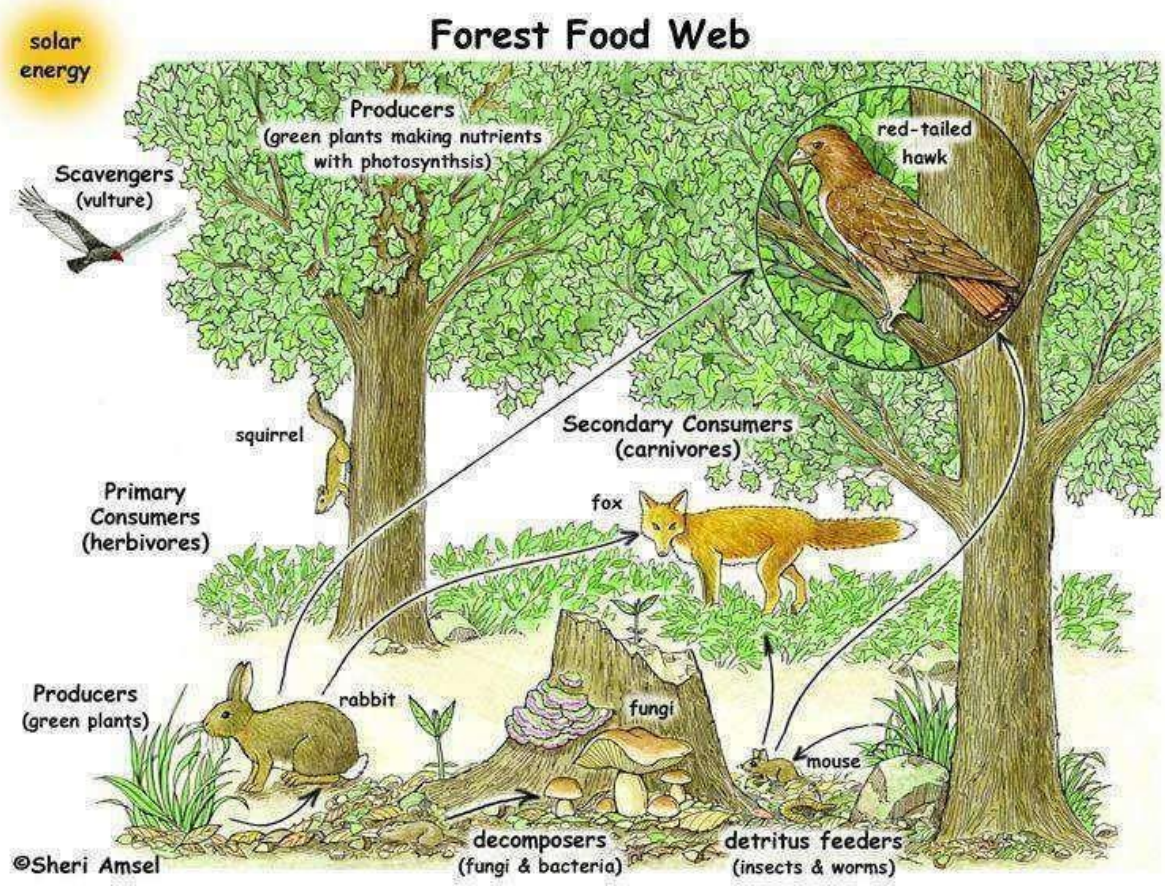
   Example:Aquaticecosystem.

TypesofEcosystem

ForestEcosystem

Thewordforestmeansawoodedarea.ThiswordcomesfromtheLatinwordforuswhich simplymeansoutside(anditiswherewegettheEnglishwordforeign).

However, over the years, via the Latin phrase 'forestis silva' (which means a wood outside) the word forest came to mean a group of trees. An ecosystem is an ecological system: i.e. a group of organisms (this can include animals and plants as well as birds, bacteria and insects) that live together as a community.



Anecosystemisusuallyadistinctsystemwithitsownspecialcharacteristics.So,aforest ecosystemis:

There are many types of forests throughout the world. Below, you can find some of the main categoriesofforestecosystem thatareused byscientists.One thing to rememberthroughout this discussion is that trees in a forest can be either deciduous or evergreen. i.e. they can either shed their leave in autumn and grow them again in the spring or they will keep their flourishing leaves throughout the year.

Taiga: this thin, sparse forest exists at the extreme north of the world, in countries such as

Canadaand Finland and in theArctic Circle. It is characterizedby chilly conditionsand thefact

that the animals and birds and other organisms that live there have adapted to the cold. The taiga is a very ancient forest.

Rain forests: rainforests arehuge, humid highly bio-diverse swathes of forest thatareusually found within the global South. Due to the thick canopy created by their leaves, rain forests usually create their own mini ecosystem that seals off heat and humidity.

Boreal forests: borealforests exist in the sub Arctic zones of the world(i.e. less far north than the Taiga). Here, you can find a mix of deciduous and evergreen trees and plenty of different animals, insects, birds and so on.

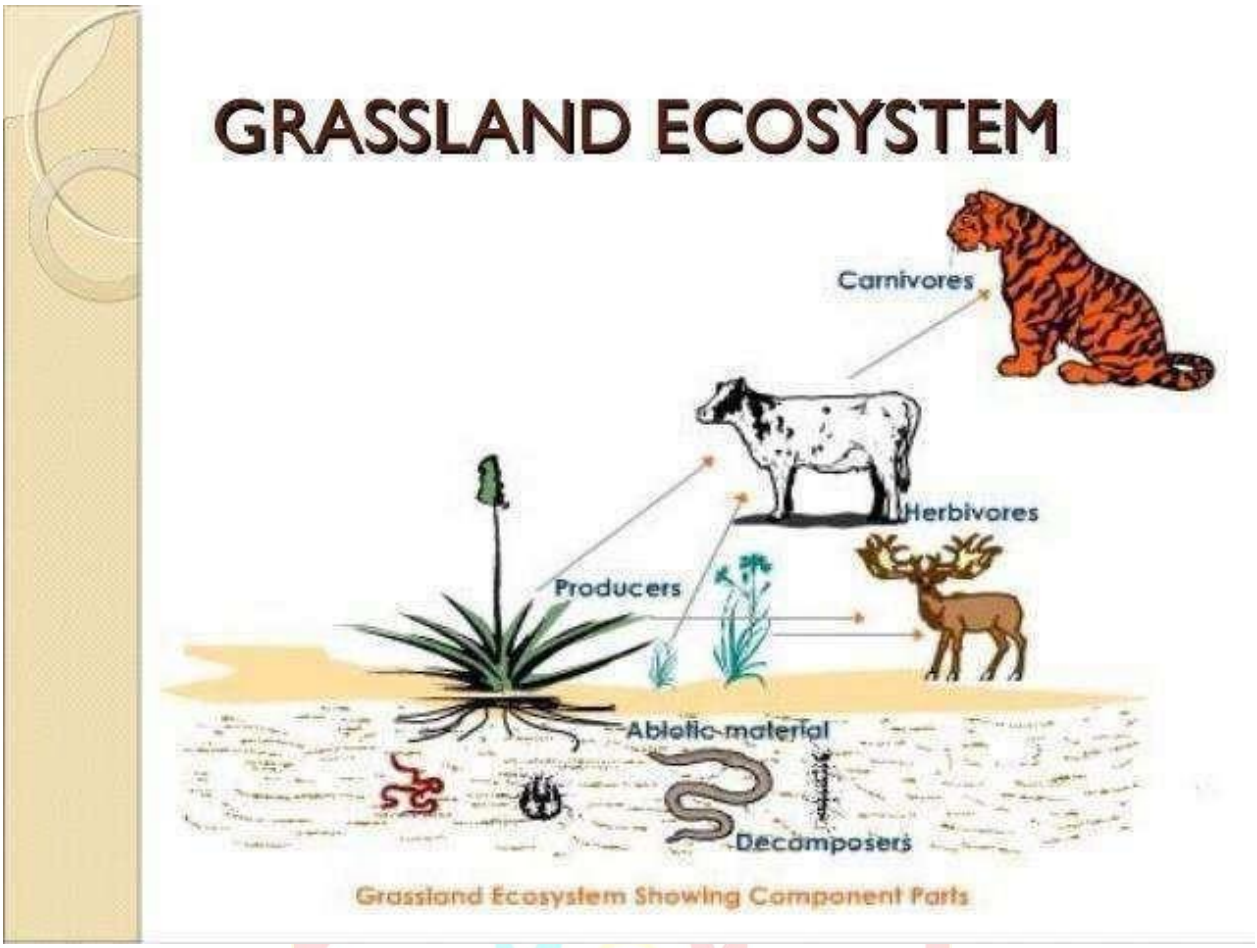
Forests of the temperate zone: located between the freezing cold of the polar zones and the scorching heat of the equator, the temperate zone is somewhere where forests can truly flourish. Some very ancient forests, such as the New Forest in Britain, are example of how in the temperate zoneconditionsare just right for huge amounts ofbiodiversity to occur. Again, in thiszone, forests can be made of a mix of deciduous and evergreen trees– or of mainlyone or mainly the other type of tree.

- **Acommunityoforganismslivingtogetherinaforest.**
- **Adistinctsystem,thatcanbedefinedashavingcertaindistinctivecharacteristics.**
- **Variabledependingonwheretheforestislocated.**
- **Vulnerabletoclimatechangeanddeforestation.**
- **Importanttoprotect.**

GrasslandEcosystem

The word grassland is somewhat self explanatory. A grassland is a wide open grassy space. A grasslandmay also contain low shrubs and other plants, but its predominant feature is thatit is a place where plenty of grass grows.

Agrasslandecosystemisacommunityofcreatureslivingtogetherwithinagrassyspace. Thesecreaturescanincludevarioustypesofgrasses,insects,andanimals,etc.



Theimportanceof grasslandecosystems.

Grasslandecosystemsareveryimportantforawidevarietyofdifferentreasons.Below,you willfindsomeofthemainones.

1. Habitat. Grassland ecosystems are key habitats for huge numbers of different animals including zebras, bison, lions and elephants.

2. Soil quality.Thedelicatebalance ofplantsandanimals ingrassland ecosystemsmaintains a high soil quality. When humans intervene in grasslands and use them for crop based agriculture they alter the mineral composition of the soil and its quality and hence fertility declines.

3. Beauty. Grassland ecosystems should be important to us, too, because they are quite simply very beautiful open spaces.

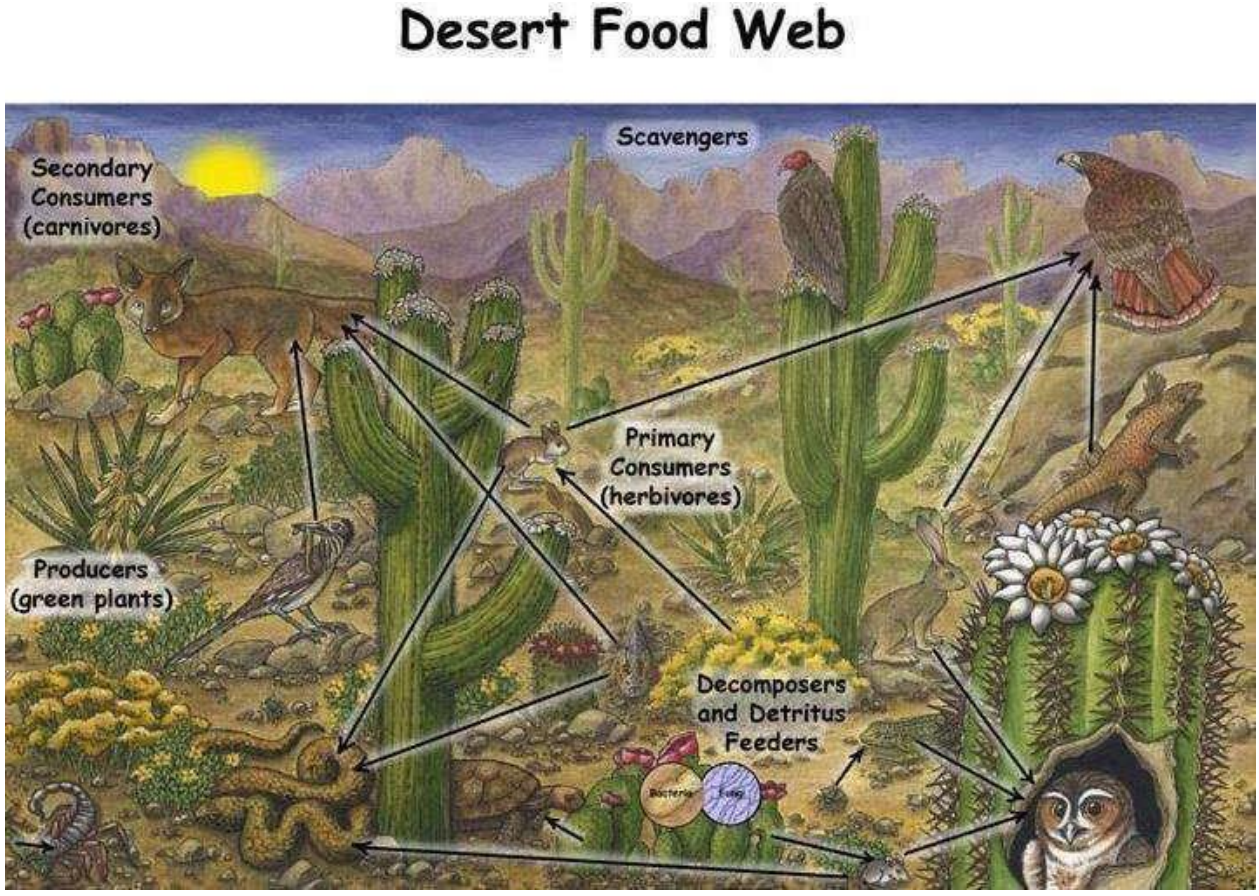
4. Large area. Around a quarter of the earth's total landmass is taken up by grassland ecosystems. That makes the grassland ecosystem one of the largest and most importanttypes of ecosystem in the world.

5. Useful to humans. Grassland ecosystemsare very useful to humans, particularly aspasture forcattle. The prairiesof North America,for example, havetraditionallybeen usedaspasture gr-p u n d sformanycenturies.

DesertEcosystem

Theword desertcomesfromtheLatinword‘desertus’.‘Desertus’meanswaste,orsomething that hasbeen left. Fromthis we get Englishwords such as desert and deserted.

An ecosystem is a system of organisms that live together as a community. So, putting these words together, we can say that a desert ecosystem is a community of organisms that live together in an environmentthat seems to be deserted wasteland.



A desert is any place that is difficult to inhabit. Desert ecosystems can be hot (as in the sandy Sahara) or cold (as on the peaks of mountains where the high altitude makes conditions very harsh) but both hot and cold deserts have in common the fact that they are difficult for organisms to inhabit.

A desert ecosystem is generally witnesses little rainfall, resulting in less vegetation than in more humid areas of the globe. Look closely at any seemingly deserted piece of land and you will usually be able to see:

- **Numerousinsectslivingincommunities.**
- **Anabundanceofplantlife.**
- **Mammalsand birds.**
- **Inaddition,microorganisms suchas bacteriawillalsobe present inthisecosystem, though**

they are not visible to the naked human eye.

In desert ecosystems, the plant and animal life that lives there will have evolved so that they can combat the harsh conditions (for example, they will have evolved to store water supplies in their bodies as water is very scarce in deserts).

Therearesomanydifferenttypesofdesertecosystems.Letuslook ateachofthemin turn. Types

of desert ecosystems.

When we hear the word desert, we usuallythink of a very hot, sandy environment. But, thisis just one type of desert ecosystem. Read on to find out about this, and all the other key types of desert ecosystems.

1. Hotdeserts.

Hot deserts can be found close to the equator. The Sahara is a good example of a hot desert. Hotdeserts tend tofeaturescorching hotgroundwhich many plants maystruggleto growon, little shade, and a shortage of water. The plants and animals that live here have evolved in order toadaptto thesevery hot conditions. Forexample, cacti havegrown a tough outer skin and interiors which can store up any fluid that they absorb so that they can stay hydrated duringdroughts.

2. Colddeserts.

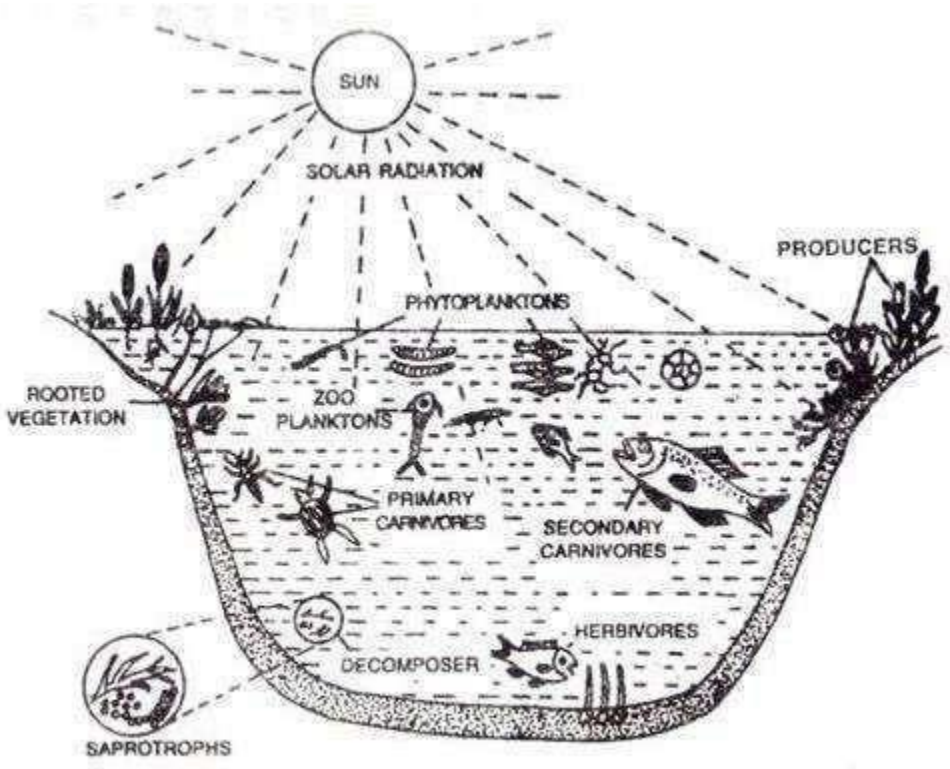
Hot deserts usually exist at low altitudes. Desertification can exist at high altitudes too, however – and when this happens, the desert will be cold. A good example is the deserted rocky peaks of a mountain. A cold desert may be sandy or rocky, but it will be a harsh environment where organisms have adapted in weird and wonderful ways so that they can survive.

3. Icedeserts.

Ice deserts are another type of cold desert. Here, instead of a sandy or rocky wasteland, we have a seemingly uninhabited region that is composed of ice. Ice deserts can be found towards the north and south poles of the planet, though they may also be located high up on mountainpeaks.

Aquaticecosystem

An aquatic ecosystem isanecosystem thatis waterbased.The word‘aquatic’comesfromthe Latin word for water. An ecosystem is a distinct community of organisms in a specific environment.



PONDS AS ECO-SYSTEM

So,wecansaythatanaquaticecosystemisacommunityoforganismsthatlivetogether, interact,andtoanextentdependoneachotherinawaterbasedenvironment.

There are various different types of aquatic ecosystem and this article explains all about four main types of aquatic habitats for animals.So,read on to find out all about them.

Characteristicsofaquaticecosystems.

Characteristicsofaquaticecosystemsinclude:

1. **Beingunderwater,or**
2. **Beingbasedaroundwater.**
3. **Beingacommunityof organisms.**
4. **Beingadistinctcommunitythatismoreorlessselfcontained.**

Typesofaquaticecosystems.

It includes marine ecosystem and freshwater ecosystem – pond ecosystems, lake ecosystems and river ecosystems.

A. Marineecosystems–saltywater

Marineis a word thatcomes from theLatin word for sea –mar.So,a marine ecosystem is any ecosystemthatexists within thesea.Our seas and oceansarevastbodies of salt water and so – while itmaybe arguedthat the whole ocean is one giant ecosystem – it maybe also argued

that several different ecosystems can coexist within a single ocean. A whole host of different organisms live in marine ecosystems. When it comes to plant life, for example, we have seaweeds and marine algae. Invertebrates that live in the marine ecosystem include jellyfish and crustaceans. Meanwhile, there are fish such as sharks and eels, and mammals such as whales and seals. There are also various sea birds in all parts of the sea: they feed off thefish and other organisms that live there. Humans may also form part of the marine ecosystem if they fish in the sea for food.

B. Freshwaterecosystems

Contrary to the marine water ecosystem that contains salty water, freshwater ecosystem has little or no salt. The major types of freshwater ecosystem includes pond ecosystem, lake ecosystem and river ecosystem.

C. Pondecosystems

A pond is discernibly a closed, self contained environment which houses a community of organisms. Ponds are usually freshwater ecosystems, however they can also be made up of brackish (salty or briny) water. Many different plants, fish and animals can live in these types of ecosystems. Frogs, newts, water weedsand water lilies areall examplesof pond creatures. In addition, various types of fish can live in a pond. Ponds can be natural or human made ecosystems; if human made, it is not uncommon for goldfish or ornamental carp (such as koi carp) to live in a pond ecosystem. In addition, certain birds and insects may visit the pond ecosystemwith regularity. Forexample, we might see dragonflies or heronsaround thepond. It may be up for debate whether these visitors are truly part of the ecosystem as they may also visit other ecosystems. But, it iscertain thatthey havean impact on the ecosystem –and that it has an impact on them.

D. Lakeecosystems

Because they tend to be physically enclosed by the earth, rock or mountains around them, freshwater lakes are also identifiable as a distinct habitat that is inhabited by a distinct community of organisms. In a freshwater lake ecosystem, we can find all kinds of different organisms, including crustaceans (such as shrimp and crayfish), fish (like carp, trout and pike) and many birds, reptiles and amphibians. Freshwater lakes can be home to some beautiful plantlife, such as tallpurple irises, and thefloraand fauna thatabound within them may also change with theseasons.Someanimals may only use lakesfor looking after their offspring in, such as frogsthat may leave frogspawnin a lake before leavingto inhabitother ecosystems.

E. Freshwaterriverecosystems

River ecosystems are slightly different to ponds and lakes because whilst the latter two ecosystemsoffer stagnant (static) water, river water is always flowing. That means thatthese river ecosystems are the homes of animals and plants that are best adapted to living in flowing water. Salmon are a key example, as they use the flowing motion of a river to help themwiththeirannualmigration.And,ingeneral,organismsthatprefertomigrate–whethertoseekfoodortoseekapartner–areoftentobefoundinfreshwaterriver

ecosystems because the motion of the river suits their style of life (whilst they, in their turn, have evolved to suit a flowing environment). Rivers tend to flow into the sea, and in this way river ecosystems and marine ecosystems meet each other. It may well, therefore, be up for debate towhatextentriver ecosystemsareclosed systems.Butit isdefinitely clear thatthese are distinct types of fresh water ecosystems.

Importanceof aquaticecosystems.

Thehealth of aquatic ecosystems is crucial to the health of the planetas a whole.Our earth is not called the blue planet for nothing: the seas with their fish, weeds, invertebrates and mammals and the rivers, lakes, streams, swamps and ponds of this world are all precious repositories of biodiversity. The seas help to regulate the world's temperature, too, and to lock carbon away from the atmosphere. Though we should all try and cut down on fish as a food source, there is no denying that fish and other aquatic organisms are irreplaceable links in the food chain for many terrestrialanimals (i.e.animals that live on earth) aswell.

Module 3: Biodiversity and its conservation • Introduction – Definition: genetic, species and ecosystemdiversity;BiogeographicallyclassificationofIndia;Valueofbiodiversity: consumptive use, productive use, social, ethical, aesthetic and option values; Biodiversity at global, National and local levels; India as a mega-diversity nation; Hot-sports of biodiversity; Threatstobiodiversity:habitatloss,poachingofwildlife,man-wildlifeconflicts;Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Biodiversity

ThetermbiodiversitywascoinedasacontractionofbiologicaldiversitybyE.O.Wilsonin1985.Biodiversitymaybedefinedasthevarietyandvariabilityoflivingorganismsandthe ecologicalcomplexesinwhichtheyexist.Inotherwords,biodiversityistheoccurrenceofdifferenttypesofecosystems,differentspeciesoforganismswiththewholerangeoftheir variantsandgenesadaptedtodifferentclimates,environmentsalongwiththeirinteractions and processes.

Biodiversityincludesthegeneticvariability(forwhichdifferentvarietiesofspiceshave appearedinthecourseofevolution)anddiversityoflifeformssuchasplants,animal microbes, etc. living in a wide range of ecosystems.

Thediversitymaybeinterspecific(withinspecies)andinterspecific(inbetweenthespecies) butthesearewellsupportedbyecosystem.Itisseenthatthediverselivingformsofthe ecosystemaremodulatedwiththeglobalenvironmentalchanges.

TypesofBiodiversity:

Therearethreeinterrelatedhierarchicallevelsofbiodiversitynamely,geneticdiversity, speciesdiversityandcommunityorecosystemdiversity.

1. Geneticdiversity:

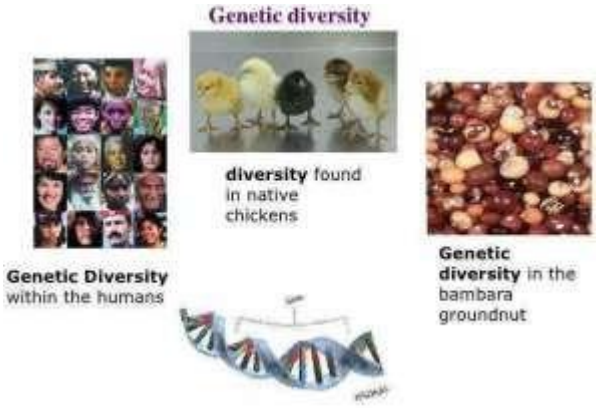
Itdescribesthevariationinthenumberandtypesofgenesaswellaschromosomespresent indifferentspecies.Themagnitudeofvariationingenesofaspeciesincreaseswithincrease insizeandenvironmental parameters of thehabitat.Thegenetic variation arisesbygene and chromosome mutation inindividuals andinsexually reproducing organisms and itisspreadin thepopulationbyrecombinationofgeneticmaterialsduringcelldivisionaftersexual reproduction.

Geneticdiversityhasthefollowingimportance:

(i) Ithelpsinspeciationorevolutionofnewspecies;

(ii) Itisusefulinadaptationtochangesinenvironmentalconditions;

(iii) Itisimportantforagriculturalproductivityanddevelopment.

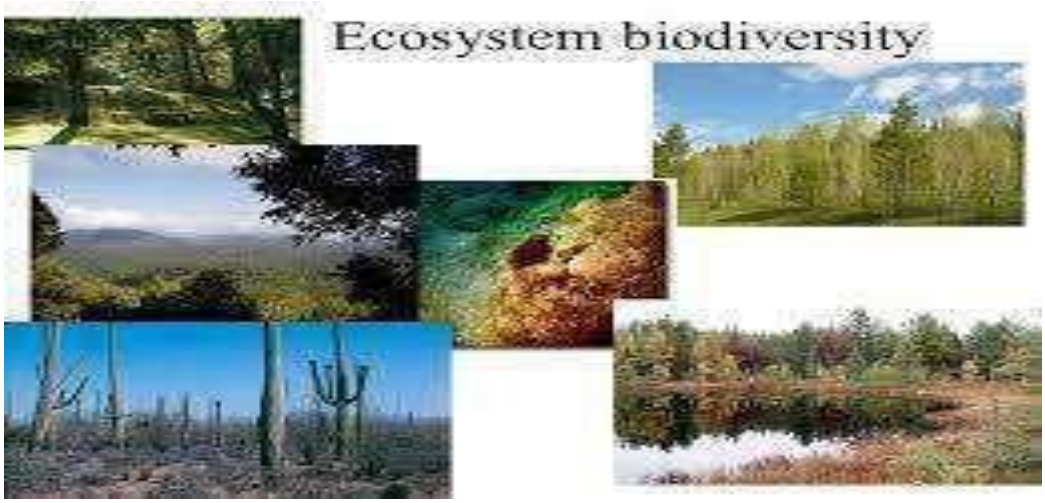


2. Speciesdiversity:

It describesthevarietyinthenumber andrichness ofthespiceswithina region.The species richness may bedefinedasthenumber ofspecies perunitarea. The richness of aspecies tells about the extent of biodiversity ofasiteandprovidesa meansforcomparing differentsites. Thespeciesrichnessdependslargelyonclimaticconditions.Thenumberofindividualsofdifferentspecieswithinaregionrepresentsspeciesevennessorspeciesequitability.The productspeciesrichnessandspeciesevennessgivespeciesdiversityofa region.Whena species isconfined entirely toaparticulararea, itistermedas endemicspecies.

3. Ecosystemdiversity:

Itdescribestheassemblageand Interactionofspecieslivingtogetherandthephysical environmentagivenarea.Itrelatesvarietiesofhabitats,bioticcommunitiesecological processesinbiosphere.Italsotellsaboutthediversitywithintheecosystem.Itisreferredas Land escapediversity because it includes placement andsizeof variousecosystems. Forexample,thelandscapeslikegrasslands,deserts,mountainsetc.showecosystem diversity.Theecosystemdiversityisduetodiversityofniches,trophiclevelsandecological processeslikenutrientcycling,foodwebs,energyflow,roleofdominantspeciesandvarious relatedbioticinteractions.Suchtypeofdiversitycangeneratemoreproductiveandstableecosystemsor communitiescapableoftoleratingvarioustypesofstressese.g.drought,flood etc.



AccordingtoWhittaker(1965),thecommunitydiversitiesareofthreetypes:

(i) α-Diversity:
Ittellsthespeciesdiversityinagivencommunity.Itdependsuponspeciesrichnessand evenness.

(ii) β-Diversity:
It describes a range of communities due to replacement of species which arises due to the presence of different microhabitats, nichesandenvironmental conditions.

(iii) γ-Diversity:
Itdescribesdiversityofhabitatoveratotallandescapeorgeographicalarea.

BiogeographicallyclassificationofIndia
BiogeographicclassificationofIndiaisthedivisionofIndiaaccording to biogeography characteristics.Biogeography isthestudyofthedistributionofspecies (biology),organisms,andecosystemsingeographicspaceandthroughgeologicaltime.There are ten biogeographic zones in India.
(i) TransHimalayas,
(ii) Gangeticplain,
(iii) Desert,
(iv) Semiaridzone;
(v) WesternGhats;
(vi) Deccanpeninsula,
(vii) Northeasternzone,
(viii) Coastallands
(ix) Himalayas,
(x) Islands.Trans

Himalayas

TheHimalayanrangesimmediatelynorthoftheGreatHimalayanrangearecalledtheTrans-

Himalayas.TheTrans-Himalayanregionwithitssparsevegetationhastherichestwildsheep

and goatcommunityintheworld.Thesnowleopardisfoundhere,asisthe migratoryblack- necked crane.

Himalayas

Bio-geographicalrepresentationofhimalayas.

TheHimalayasconsistoftheyoungestandloftiestmountainchainsintheworld.The Himalayas have attained a unique personality owing to their high altitude, steep gradient andrich temperate flora.

The forestsare very dense withextensive growthofgrass and evergreen tall trees.Oak, chestnut,conifer,ash,pine,deodarareabundantinHimalayas.Thereisnovegetationabove thesnowline.SeveralinterestinganimalsliveintheHimalayanranges.Chiefspeciesinclude wildsheep,mountaingoats,ibex,shrew,andtapir.Pandaandsnowleopardarealsofound here.

Semi-AridAreas

Adjoining the desert are the semi-arid areas, a transitional zone between the desert and the denser forests of the Western Ghats. The natural vegetation is thorn forest. This region is characterized by discontinuous vegetation cover with open areas of bare soil and soil-waterdeficit throughout the year.

Thorny shrubs, grasses and some bamboos are present in some regions. A few species of xerophytic herbs and some ephemeral herbs are found in this semi-arid tract. Birds, jackals, leopards, eagles, snakes, fox,buffaloes are found in this region.

WesternGhats

ThemountainsalongthewestcoastofpeninsularIndiaaretheWesternGhats,which constituteoneoftheuniquebiologicalregionsoftheworld.TheWesternGhatsextendfrom thesoutherntipofthepeninsula(8°N)northwardsabout1600kmtothemouth ofthe river Tapti (21°N).

Themountainsrisetoaveragealtitudesbetween900and1500mabovesealevel, intercepting monsoon winds from the southwest and creating a rain shadow in the region totheir East.

Thevariedclimateanddiversetopographycreateawidearrayofhabitatsthatsupport uniquesetsofplantandanimalspecies.Apartfrombiologicaldiversity,theregionboastsof

h

TheWesternGhatsareamongstthe25biodiversityhot-spotsrecognizedglobally.Thesehills are known for their high levels of endemism expressed at both higher andlower taxonomic levels.MostoftheWesternGhat endemicplants areassociated withevergreenforests.

TheregionalsosharesseveralplantspecieswithSriLanka.Thehigheraltitudeforestswere,if at all, sparsely populated with tribal people. Rice cultivation in the fertile valley proceeded gardensofearlycommercialcropslikearecanutandpepper.Theoriginalvegetationofthe ill-drained valley bottoms with sluggish streams in elevations below 100m would be often a special formation, theMyristica swamp.

Expansionoftraditionalagricultureandthespreadofparticularlyrubber,tea,coffeeand forest tree plantations would have wiped out large pockets of primary forests in valleys. The Western Ghats are well known for harboring 14 endemic species of caecilians (i.e., legless amphibians) out of 15 recorded from the region so far.

North-WestDesertRegions

This region consists of parts of Rajasthan, Kutch, Delhi and parts of Gujarat. The climate is characterisedbyveryhotanddrysummerandcoldwinter.Rainfallislessthan70cm.The plantsaremostlyxerophytic.Babul,Kikar,wildpalmgrowsinareasofmoderaterainfall. IndianBustard,ahighlyendangeredbirdisfoundhere.Camels,wildasses,foxes,andsnakes are found in hot and arid parts of the desert.

DeccanPlateau

BeyondtheGhatsisDeccanPlateau,asemi-aridregionlyingintherainshadowofthe Western Ghats. This is the largest unit of the Peninsular Plateau of India. The highlands of the plateau are covered with different types of forests, which provide a large variety of forest products.theDeccanplateauincludestheregionlyingsouthoftheSatpurarange.itextends uptothesoutherntipofpeninsularIndia.Anaimudiisthehighestpeakofthisregion.The Deccanplateauissurroundedbythewesternandtheeasternghats.Theseghatsmeeteach other at the Nilgiri hills. The western ghats includes the Sahyadri, Nilgiris, Anamalai, and cardamom hills.many rivers such as Mahanadi, Godavari, krishna, and kaveri originates from western ghats and flow toward the east.The eastern ghats are broken into small hill rangesbyrivercomingfromthewesternghats.Mostoftheseriversfallintothebayofbengal.The GodavariisthelongestriverintheDeccanplateau.theNarmadaandtheTapiflow westwards and fall into the Arabian sea.

GangeticPlain

IntheNorthistheGangeticplainextendinguptotheHimalayanfoothills.Thisisthelargest unit of the GreatPlainof India.Gangais the mainriverafter whose namethisplainis named. TheaggradationalGreatPlainscoverabout72.4mhaareawiththeGangaandthe Brahmaputra formingthe main drainage axes inthe major portion.

Thethicknessinthealluvialsedimentsvariesconsiderablywithitsmaximumintheganga plains. The physiogeographic scenery varies greatly from arid and semi-arid landscapes of the Rajasthan Plains to the humid and per-humid landscapes of the Delta and Assam valley in theeast.

Topographicuniformity,exceptinthearidWesternRajasthanisacommonfeature throughoutthesePlains.Theplainsupportssomeofthehighestpopulationdensities depending uponpurelyagro-basedeconomyin some ofthese areas.The trees belongingto these forests are teak, sal, shisham, mahua, khair etc.

North-EastIndia

North-eastIndiais one of the richestfloraregions in the country. It has severalspecies of orchids, bamboos, ferns and other plants. Here the wild relatives of cultivated plants such as banana, mango, citrus and pepper can be grown

Islands

The two groups of islands, i.e., the ArabianSea islandsandBayIslandsdiffersignificantly in origin and physical characteristics. The Arabian Sea Islands (Laccadive, Minicoy, etc.) are the founderedremnantsoftheoldlandmassandsubsequentcoralformations.Ontheother hand, the Bay Islands lay only about 220km.

Awayfromthenearestpointonthemainlandmassandextendabout590km.Witha maximumwidthof58kmtheislandforestsofLakshadweepintheArabianSeahavesomeof thebest-preservedevergreenforestsofIndia.Someoftheislandsarefringedwithcoral reefs.Many of themare covered withthick forestsand someare highlydissected.

Coasts

Indiahasacoastlineextendingover7,516.4 km.TheIndiancoastsvaryintheir characteristicsandstructures.ThewestcoastisnarrowexceptaroundtheGulfofCambay and the Gulf of Kutch. In the extreme south, however, it is somewhat wider along the south Sahyadri.

Thebackwatersarethecharacteristicfeaturesofthiscoast.Theeastcoastplains,incontrast arebroaderduetodepositionalactivitiesoftheeast-flowingriversowingtothechangein their base levels.

Extensivedeltasofthe,Godavari,KrishnaandKaveriarethecharacteristicfeaturesofthis coast.Mangrovevegetationischaracteristicofestuarinetractsalongthecoastforinstance, at Ratnagiri in Maharashtra.

Largerpartsofthecoastalplainsarecoveredbyfertilesoilsonwhichdifferentcropsare grown. Riceis themaincrop ofthese areas.Coconut trees growallalongthe coast.

Valueofbiodiversity

The living organisms on earth are of great diversity, living in diverse habitats and possessing diversequalitiesandarevitaltohumanexistenceprovidingfood,shelter,clothing's, medicines etc.

Valueofbiodiversity

1. Productivevalues:

Biodiversity produces a number of products harvested from nature and sold in commercial markets.Indirectlyitprovideseconomicbenefitstopeoplewhichincludewaterqualitysoil

protection,equalizationofclimate,environmentalmonitoring,scientificresearch,recreation etc.

2. Consumptivevalue:

Theconsumptivevaluecanbeassignedtogoodssuchasfuelwoods,leaves,forestproducts etc.whichmaybeconsumedlocallyanddonotfigureinnationalandinternationalmarket.

3. Socialvalue:

The loss of biodiversity directly influences the social life of the country possibly through influencing ecosystem functions(energy flowand biogeochemical cycle). This be easily understood by observing detrimental effects of global warming and acid rain which cause an unfavorable alteration in logical processes.

4. Aestheticvalue:

Aestheticvaluessuchasrefreshingfragranceoftheflowers,tasteofberries,softnessof mossed,melodioussongsofbirds,etc.compelthehumanbeingstopreservethem.The earth'snaturalbeautywithitscolourandhues,thickforest,andgracefulbeastshasinspired thehumanbeingsfromtheirdateofbirthtotakenecessarystepsforitsmaintenance. Similarlybotanicalandzoologicalgardensarethemeansofbiodiversityconservationandare of aesthetic values.

5. Legalvalues:

Sinceearthishomelandofalllivingorganisms,allhaveequalrighttocoexistonthesurface of earth with all benefits. Unless some legal value is attached to biodiversity, it will not be possible to protect the rapid extinction of species.

6. Ethicalvalue:

Biodiversitymustbeseeninthelightofholdingethicalvalue.Sincemanisthemost intelligentamongstthelivingorganisms,itshouldbeprimeresponsibilityandmoral obligationofmantopreserveandconserveotherorganismswhichwilldirectlyorindirectly favour the existence of the man.

7. Ecologicalvalue:

Biodiversityholdsgreatecologicalvaluebecauseitisindispensabletomaintaintheecological balance.Anydisturbanceinthedelicatelyfabricatedecologicalbalancemaintainedby different organisms,willleadtosevereproblems,whichmaythreatenthe survivalof human beings.

8. Economicvalue:

Biodiversityhasgreateconomicvaluebecauseeconomicdevelopmentdependsupon efficientand economic management of biotic resources.

Inthe dayto daylife,human beings aremaintaining their lifestyleatthesacrificeof surrounding species which come from diversity of plants and animals struggling for their existence.

So, itishighly essential forthe human beingstotakecare of theirsurrounding speciesand make optimum use of their service, for better economic development. Thus, it is rightly told, survival of the man depends upon the survival of the biosphere.

<u>BiodiversityatGlobal,NationalandLocalLevels</u>

Global Level: **Conservative estimates of the existing biodiversity is ten million species, but if estimates for insects are correct then it could be around 30 million species, we have till now enlisted about 1.4millionspecies.**

Itincludesamongothersabout98%birds,95%reptilesandamphibians,90%fishandabout 85%higherplants knowntoexistonthisEarth.

Table 4.1 Known and Estimated diversity of life on Earth

Form of Life	Known Species	Estimated Total Species
Insects and other arthropods	874,161	30 Million species, extrapolated from surveys in forest canopy in Panama, most believed to be unique to tropical forests.
Higher plants	248,400	Estimates range from 275,000 to 400,000 at least 10.15% species believed undiscovered.
Invertebrates (excludes arthropods)	116,873	True invertebrates may number millions of species. Nematodes, eelworms, and roundworms may each comprise more than one million species
Lower plants (fungi and algae)	73,900	Not available
Micro organisms	36,600	Not available
Fish	10,056	21,000 assuming that 10% fish remain undiscovered, the Amazon and Orinoco rivers alone may account for 2,000 additional species.
Birds	9,040	Known species probably account for over 98% of all birds.
Reptiles and Amphibians	8,962	Known species probably account for over 95% of all reptiles and amphibians.
Mammals	4,000	Known species probably account for over 95% of all mammals.
Total	1,390,992	10 million species considered a conservative estimate. If insect estimates are accurate, total exceeds 30 million.

NationalandLocalLevel:

India has over 108,276 species of bacteria, fungi, plants and animals already identified and described(Table4.2).Outofthese,84percentspeciesconstitutefungi(21.2percent), floweringplants(13.9percent),andinsect(49.3percent).Intermsofthenumberofspecies, the insectaalone constitute nearlyhalf ofthe biodiversity inIndia(Fig4.1).

These species occur on land, fresh and marine waters, or occur as symbionts in mutualistic or parasitic state with other organisms. In the world as a whole, 16, 04,000 species of Monera, Protista,Fungi,PlantaeandAnimaliahavebeendescribedsofar.However,itisestimated that atleast179, 80,000 species existin the world, butas aworking figure 122, 50,000 species are considered to be near reality.

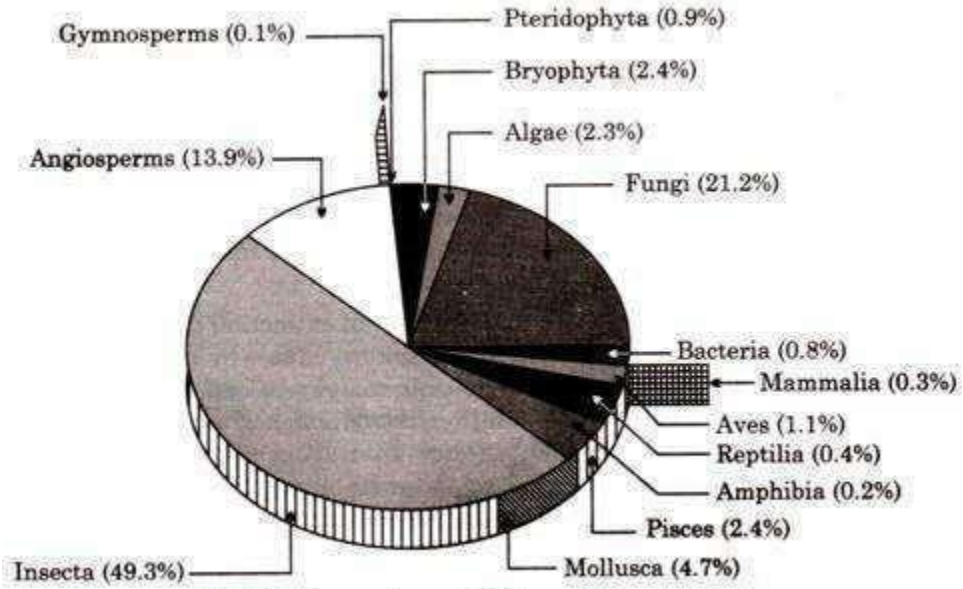


Fig. 4.1. Percentage of Different Biota in India.

Table 4.2 : Number of Species of Bacteria, Fungi, Plants and Animals

Taxon	Number of Species	Percentage
Bacteria	850	0.8
Fungi	23,000	21.2
Algae	2,500	2.3
Bryophyte	2,564	2.4
Pteridophyta	1,022	0.9
Gymnosperms	64	0.1
Angiosperms	15,000	13.9
Insecta	53,430	49.3
Mollusca	5,050	4.7
Pisces	2,546	2.4
Amphibian	204	0.2
Reptilia	446	0.4
Aves	1,228	1.1
Mammalian	372	0.3
Total	108,276	100.00

Indiais10th amongthep lantrichcou ntriesofthe world,fourt hamongthe Asiancount ries, eleventhac cordingtoth enumberof endemicsp eciesofhigh ervertebrat es(amphibi a,birds a n d m a m m a l s) , a n d t e n t h i n t h e w o rldasfarasrichnessinmammalsisconcerned.Outofthe 10‘Hotspots’identifiedintheworld,Indiahasfour.TheseareEasternHimalaya,NorthEast

The crops which first grew in India and spread throughout the world include rice, sugarcane, Asiatic vignas, jute, mango, citrus, and banana, several species of millets, spices, medicinal, aromaticsandornamentals.Indiarankssixthamongthecentresofdiversityandoriginin terms of agro-biodiversity.

Indiaasamega-diversitynation

Amega-diversecountryisonethatharborsthemajorityoftheEarth'sspeciesandis thereforeconsideredextremelybiodiverse.Indiaisrichinbiodiversityfromnorthtosouth and from east to west. India contains many species that world's gone country have. It has 14 majorbasinsthroughwhichdrainnumerousrivers.Theannualrainfallvariesfromlessthan 37 cm in Rajasthan to 1500m in Cherapunji. The country experiences three different seasons – winter,summer,andmonsoons.Ithastwoglobalterrestrialbiodiversityhotspots–the North-easternStatesandtheWesternGhats.TheWesternGhatshavemoistdeciduous forests and rainforests. The region shows high species diversity as well as high levels ofendemism.Around62%ofreptileand77%ofamphibiansarefoundinhere.TheNorth-easternStatesdepictshighaltitudinalvariations.Thisareahasatleast163globally threatened species like one-horned rhinoceros and the wild Asian water buffalo. The Relict Dragonfly, an endangered species found here. This zone houses the Himalayan Newt the only salamander species found within Indian limits.

1. **Thegreatvarietyofecologicalconditions prevailinginIndia,tropicallocation,climate andphysicalfeaturesallaidin supportinganenormousdiversityofwildlife,including, hot desert forms, like wild ass and the cold desert forms, like the Tibetan antelope: animalsofopenscrubland,liketheblackbuckandofgrassyswamps,likethe rhinoceros; animals of the deciduous forests like the wild gaur and of the tropical rainforests,likethelion-tailedmacaque.India'sbio-geographicalcompositionisuniqueasitcombineslivingformsfromthreemajorbio-geographicalrealms,namely – Eurasian, Agro-Tropical, and Indo-Malayan. India lies at the confluence of Ethiopian, Palaearctic,andIndo-Malayanfaunasandpossessessomeinterestingcomponents.Thechinkara,thehyena,andtherates representtheEthiopianelement;thelynx, wolf,hangulrepresentthePalaearctic;theChinesebyredpandaandthemusk-deer; the Indo-Malayan by the hoolock gibbon, the goat-antelope, and the mouse deer. The endemicvarietiesincludeslothbear,antelopeorblackbuck,four-hornedantelope and Boselaphus or nilgai. 15,000 species of flowering plants, 53,430 species of insects; 5050 species of mollusks, 6,500 species of other invertebrates; 2,546 species of fishes; 1228speciesofbirds,446speciesofreptiles,372speciesofmammalsand204species of amphibians have been identified. India's biodiversity is estimated to be over 45,000 plantspecies representing about7%of theworld'sflora andIndiastandstenthin25 mostplant-richcountriesoftheworld.Itsvarietyofanimalliferepresents6.5percent of world's fauna.**
2. **It has great marine diversity due to its 7500km long coastline. The near shore coastal waters of India are extremely rich fishing grounds. The marine environment of India**

supports coralreefsintheGulfofKutch,offthesouthernmainlandcoast,andaround

value.OntheGulfofMannarandGulfofKutchreefscorals,coraldebrisandcoral sandsarewidelyexploited,andornamentalshells,sharks,andpearloystersarethe basis of an important reef industry in the south of India. Five species of marine turtleoccurinIndianwaters:GreenturtleCheloniamydas,LoggerheadCarettacaretta,Olive RidleyLepidochelys olive, Hawksbill Eretmochelys imbricate, and Leatherback Dermochelyscoriacea.Seagrassbedsareimportantfeedingareasfortheдugong dugon, plus several species of marine turtle.

3. To preserve the rich biodiversity, nine biosphere reserves have been set up in specific biogeographic"zones:thebiggestbeingintheDeccanPeninsulaintheNilgiris coveringTamilNadu,AndhraPradesh,andKarnataka.OthersincludetheNandaDevi in Uttarakhand in the Western Himalayas, the Nokrek in Meghalaya, Manas, and Dibru Saikhowain Assam, the Sunderbans in the Gangetic plain in West Bengal, Similar inOrissa,theGreatNicobarandtheGulfofMannarinTamilNadu.Aspersatellite imaging,about19percentofthelandareaofthecountrycompriseofforests.Ithas 80nationalparksatpresent,whichhousesthelargestnumberoftigersandone- horned rhinos found in the world, Asiatic lions and a large percent of elephants. Six significantwetlandareasofIndiahavebeendeclaredas"'amsarSites"underthe RamsarConvention.UndertheWorldHeritageConvention,fivenaturalsiteshave been declared as "World Heritage Sites."
4. Thereisavital,butoftenneglectedfactorwhenwefocusonbiodiversity.Itmaybea matterofsurprisetounderstandthatthetribalpeoplewhoofficiallyconstitute7.5 percentofIndia'spopulationhavepreservedaround90percentofthecountry's bioculturaldiversity.Toalargeextent,thesurvivalofourbiodiversitydependsonhow best the tribal are looked after.
5. IndiaaccreditedtheInternationalConventiononBiodiversity(CBD)on18February1994andbec amePartytotheConventioninMay1994.TheCBDisaninternational legalinstrumentforfosteringconservationandsustainableuseofbiologicaldiversity andthefairandequitablesharingofthebenefitsarisingfromcommercialandother utilizationofgeneticresources.ItistheresponsibilityofTheMinistryofEnvironment andForestinIndiatooverseeenvironmentalpolicyandproceduresandtheadministrationofthe nationalparksofthecountryaswell.Indiahasworkedon creating'landscapeconversion'thatincludewildlifereserves,communalforest,and some private lands.

Indiaisoneofthetwelvemegadiversitynationsoftheworldduetothefollowingreasons:

(i) Ithas7.3%oftheglobalfaunaand10.88%ofglobalfloraasperthedatacollectedby MinistryofEnvironmentandforest.

(ii) Ithas350differentmammals,1200speciesofbirds-453differentreptiles,182 amphibians and 45,000plants spices.

(iii) Ithas50,000knownspeciesofinsectswhichinclude13,000butterfliesandmoths.

(iv) Ithas10differentbiogeographicalregionsand25bioticprovinceshavingvarietiesof landsandspecies.

(v) Inadditiontogeographicaldistribution,geologicaleventsinthelandmassprovidehigh level of biological diversity.

(vii) Thereiswidevariety ofdomesticanimalslikecows,buffaloes,goats, sheep,pigs,horses etc.

(viii) Themarinebiotaincludesseaweeds,fishes,crustaceans,molluses,corals,reptilesetc.

(ix) Thereareanumberofhotspots(namelyEasternGhats,WesternGhats,NorthEastern hillsetc.).

Hot-spotsofbiodiversity

Hot spots are the areas with high density of biodiversity or mega diversity which are most threatened at present. There are 16 hot spots in world, out of which two are located in India namely North-East Himalayas andWesternGhats.

Thehotspotsaredeterminedconsideringfourfactors:

(i) Degreesofendemism;

(ii) Degreeofexpectation

(iii) Degreesofthreattohabitatduetoitsdegradationandfragmentationand

(iv) NumberofSpeciesdiversity.

The British biologist Norman Myers coined the term "biodiversity hotspot" in 1988 as a biogeographicregioncharacterizedbothbyexceptionallevelsofplantendemismandby serious levels of habitat loss. In 1990 Myers added a further eight hotspots, including four Mediterranean-typeecosystems.ConservationInternational(CI)adoptedMyers'hotspotsas itsinstitutionalblueprintin1989,andin1996,theorganizationmadethedecisionto undertakeareassessmentofthehotspotsconcept.Threeyearslateranextensiveglobal review was undertaken, which introduced quantitative thresholds for the designation of biodiversity hotspots.

AccordingtoCI,toqualifyasahotspotaregionmustmeettwostrictcriteria:itmustcontain atleast1,500speciesofvascularplants(>0.5%oftheworld'stotal)asendemics,andithas tohavelostatleast70%ofitsoriginalhabitat.In1999,CIidentified25biodiversityhotspots inthebook"Hotspots:Earth'sBiologicallyRichestandMostEndangeredTerrestrial Ecoregions".

Collectively,theseareasheldasendemicsabout44%oftheworld'splantsand35%of terrestrialvertebratesinanareathatformerlycoveredonly11.8%oftheplanet'sland surface. The habitat extent of this land area had been reduced by 87.8% of its original extent,suchthatthiswealthofbiodiversitywasrestrictedtoonly1.4%ofEarth'slandsurface.In 2005 CI published an updated titled "Hotspots Revisited: Earth's Biologically Richest and Most Endangered TerrestrialEcoregions".

GLOBALBIODIVERSITYHOTSPOTS:WORLD

1. **AFRICA**

Atotalof8HotspotsinAfricancontinentholdadiversityofplantandanimallife,manyof which are found nowhere else on Earth.

2. **ASIA-PACIFIC**

Composed of large land areas as well as islands dotting the Pacific seas, these 14 Hotspots represent important biodiversity.

3. **EUROPEANDCENTRALASIA**

FromtheMediterraneanBasintotheMountainsofCentralAsia,thesefourHotspotsare unique in their diversity.

4. NORTHANDCENTRALAMERICA

NorthandCentralAmericaplayhosttothousandsofacresofimportanthabitat.

5. SOUTHAMERICA

From Brazil's Cerrado to the Tropical Andes, South America has some of the richest and most diverse life on Earth.

LifeonEarthfacesacrisisofhistoricalandplanetaryproportions.Unsustainableconsumption in many northern countries and crushing poverty in the tropics are destroying wild nature. Biodiversityisbesieged.Extinctionisthegravestaspectofthebiodiversitycrisis:itis irreversible. While extinction is a natural process, human impacts have elevated the rate of extinction by at least a thousand, possibly several thousand, times the natural rate. Mass extinctionsofthismagnitudehaveonlyoccurredfivetimesinthehistoryofourplanet;the lastbroughttheendofthedinosaurage.Inaworldwhereconservationbudgetsare insufficient given the number of species threatened with extinction, identifying conservation priorities is crucial.

Thebiodiversityhotspotsholdespeciallyhighnumbersofendemicspecies,yettheir combinedareaofremaininghabitatcoversonly2.3%oftheEarth'slandsurface.Each hotspotfacesextremethreatsandhasalreadylostatleast70%ofitsoriginalnatural vegetation.Over 50%of the world'splantspecies and42%of allterrestrialvertebratespecies are endemic to the 35biodiversity hotspots.

World's35BiodiversityHotspots

I.Africa CapeFloristicRegion Coastal Forests of Eastern AfricaEastern Afromontane Guinean Forests of West AfricaHorn of Africa MadagascarandtheIndianOceanIslands Maputaland-Pondoland-AlbanySucculent Karoo **II. Asia-Pacific** EastMelanesianIslands 1. Himalaya 2. Indo-Burma 3. Japan 4. MountainsofSouthwestChina 5. NewCaledonia 6. NewZealand 7. Philippines 8. Polynesia-Micronesia 9. SouthwestAustralia	**III.EuropeandCentralAsia** 3. Caucasus 4. Irano-Anatolian 5. MediterraneanBasin 6. MountainsofCentralAsia **IV.NorthandCentralAmerica** 7. CaliforniaFloristicProvince 8. CaribbeanIslands 9. MadreanPine-OakWoodlands 0.Mesoamerica **V.SouthAmerica** 1. AtlanticForest 2. Cerrado 3. ChileanWinterRainfall-ValdivianForests 4. Tumbes-Chocó-Magdalena 5. TropicalAndes

9.ForestsofEasternAustralia(new) 1. Sundaland 2. Wallacea 3. WesternGhatsandSriLanka	

GLOBALBIODIVERSITYHOTSPOTS:ASIA-PACIFIC

1. EastMelanesianIslands

Oncelargelyintact,the1,600EastMelanesianIslandsarenowahotspotdue,sadly,to acceleratinglevelsofhabitatloss.

2. Himalaya

TheHimalayaHotspotishometotheworld'shighestmountains,includingMt.Everest.

3. Indo-Burma

Encompassingmorethan2millionkm²oftropicalAsia,Indo-Burmaisstillrevealingits biological treasures.

4. Japan

TheislandsthatmakeuptheJapaneseArchipelagostretchfromthehumidsubtropicsinthe southtothe boreal zone inthe north, resultinginawidevarietyofclimates and ecosystems.

5. MountainsofSouthwestChina

Withdramaticvariationsinclimateandtopography,theMountainsofSouthwestChina supportawidearrayofhabitatsincludingthemostendemic-richtemperateflorainthe world.

6. NewCaledonia

AnislandthesizeofNewJerseyinthe SouthPacificOcean,NewCaledoniaisthe home ofno less than five endemic plant families.

7. NewZealand

Amountainousarchipelagooncedominatedbytemperaterainforests,NewZealandharbors extraordinary levelsof endemic species.

8. Philippines

Morethan7,100islandsfallwithinthebordersofthePhilippineshotspot,identifiedasoneof theworld'sbiologicallyrichestcountries.

9. Polynesia-Micronesia

Comprising4,500islandsstretchedacrossthesouthernPacificOcean,thePolynesia- Micronesia hotspot isthe epicenterof the current globalextinction crisis.

10. SouthwestAustralia

Theforest,woodlands,shrublands,andheathofSouthwestAustraliaarecharacterizedby high endemism among plants and reptiles.

11. ForestsofEasternAustralia

ForestsofEastAustraliaHotspotconsistsofadiscontinuouscoastalstretchalongthe Australian states of Queensland and New South Wales, extending inland and further west, although it includes the New England Tablelands and the Great Dividing Range. This region contains more than 1500endemic vascular plants.

12. Sundaland

The spectacular flora and fauna of the Sundaland Hotspot are succumbing to the explosivegrowth of industrial forestry inthese islands.

13. Wallacea

ThefloraandfaunaofWallaceaaresovariedthateveryislandinthishotspotneedssecure protectedareastopreservetheregion'sbiodiversity.

14. WesternGhatsandSriLanka

Faced with tremendous population pressure, the forests of the Western Ghats and Sri Lankahave beendramatically impacted bythedemandsfortimberandagricultural land.

BIODIVERSITYHOTSPOTSININDIA

1. **Himalaya: IncludestheentireIndianHimalayanregion(andthatfallinginPakistan,Tibet, Nepal, Bhutan, China and Myanmar)**
2. **Indo-Burma: IncludesentireNorth-easternIndia,exceptAssamandAndamangroupof Islands(andMyanmar,Thailand, Vietnam, Laos,Cambodia andsouthernChina)**
3. **Sundalands: IncludesNicobargroupofIslands(andIndonesia,Malaysia,Singapore,Brunei, Philippines)**
4. **WesternGhatsandSriLanka:IncludesentireWesternGhats(andSriLanka)**

Threatstobiodiversity

Biodiversity is considered as a reservoir of resources to be used for the manufacture of food, medicine, industrial products, etc. But with an increased demand of rapid population growth, biodiversityisgraduallydepleting.Anumberofplants"andanimalspecieshavealready become extinct and many are endangered.

Thedifferentfactorsresponsibleforcausingthreattobiodiversityareasfollows:

1. Habitatdestruction:

The primary cause ofloss ofbiodiversityis habitatloss or destruction which is resulted due to thelargeindustrialandcommercialactivitiesassociatedwithagriculture,irrigation, construction of dams, mining, fishingetc.

2. Habitatfragmentation:

With increased population, the habitats are fragmented into pieces by roads, fields, canals,power lines, towns etc. The isolated fragment of habitats restricts the potential of species for dispersalandcolonization.Inaddition,thehabitatfragmentationalsobringsabout microclimatic changes in light,temperature, wind etc.

3. Pollution:

Themostdreadedfactorinducinglossofbiodiversityisenvironmentalpollutionwhich include air pollution, Water pollution, industrial pollution, pollution due to chemical Pastes, pesticides radioactive materials etc.

4. Overexploitation:

Thenaturalresourcesareoverexploitedtomeetgrowingruralpoverty,intensive technological growth and globalization of economy. All thesefactors together may beresponsible for the extinction of a number of species.

5. Introductionofexoticspecies:

Theintroductionofexoticspeciesaredueto:

(i) horticulture

(ii) agriculture;

(iii) Europeancolonisationand

(iv) accidentaltransport.

It is seenthat someexotic species may kill or eat the nativespeciesthereby causingits extinction.

6. Diseases:

Sincetheanimalsaremorevulnerabletoinfection,theanthropologicalactivitiesmay increasetheincidenceofdiseasesinwildspecies,leadingtotheirextinction.

7. ShiftingorJhumcultivation:

TheshiftingorJhumcultivationbypoortribalpeoplegreatlyaffectstheforeststructure which is a store house of biodiversity.

8. Poachingofwildlife:

Anumberofwildlifespeciesarebecomingextinctduetopoachingandhunting.

<u>Conservationofbiodiversity</u>

Biodiversityisbeingdepletedbythelossofhabitat,fragmentationofhabitat,over exploitation of resources, human sponsored ecosystems, climatic changes, pollution invasive exoticspices,diseases,shiftingcultivation,poachingofwildlifeetc.Sincethehumanbeings areenjoyingallthebenefitsfrombiodiversity,theyshouldtakepropercareforthe preservation of biodiversity in all its form and good health for the future generation i.e., the human being should prevent the degradationand destruction of the habitats therebymaintainingthebiodiversityatitsoptimumlevel.Conservationofbiodiversityisprotection, upliftmentandscientificmanagementofbiodiversitysoastomaintainitatitsthreshold

level and derive sustainable benefits for the present and future generation. In other words, conservation of bio-diversity is the proper management of the biosphere by human beings insuch a way that it gives maximum benefits for the present generation and also develops its potential so as to meet the needs of the future generations.

Mainlytheconservationofbiodiversityhasthreebasicobjectives:

(a) Tomaintainessentialecologicalprocessesandlifesupportingsystems.

(b) Topreservethediversityofspecies.

(c) Tomakesustainableutilisationofspeciesandecosystems.

StrategiesforConservationofBiodiversity:

Thefollowingstrategiesshouldbeundertakeninordertoconservebiodiversity:

(1) Allthepossiblevarieties(oldornew)offood,forageandtimberplants,livestock, agriculture animals and microbes should be conserved.

(2) Alltheeconomicallyimportantorganismsinprotectedareasshouldbeidentifiedandconserved.

(3) Criticalhabitatsforeachspeciesshouldbeidentifiedandsafeguarded.

(4) Priorityshouldbegiventopreserveuniqueecosystems.

(5) Thereshouldbesustainableutilisationofresources.

(6) Internationaltradeinwildlifeshouldbehighlyregulated.

(7) Thepoachingandhuntingofwildlifeshouldbepreventedasfaraspracticable.

(8) Careshouldbetakenforthedevelopmentofreservesandprotectedareas.

(9) Effortsshouldbemadetoreducethelevelofpollutantsintheenvironment.

(10) Publicawarenessshouldbecreatedregardingbiodiversityanditsimportanceforthe livingorganisms.

(11) Priorityshouldbegiveninwildlifeconservationprogrammetoendangeredspeciesover vulnerable species andtovulnerable species over rare species.

(12) Thehabitatsofmigratorybirdsshouldbeprotectedbybilateralandmultilateral agreement.

(13) Theoverexploitationofusefulproductsofwildlifeshouldbeprevented.

(14) Theusefulanimals,plantsandtheirwildrelativesshouldbeprotectedbothintheir natural habitat (in-situ)andinzoological botanical gardens (ex-situ)

(15) EffortsshouldbemadeforsettingupofNationalparksandwildlifesanctuariesto safeguardthegeneticdiversityandtheircontinuingevolution.

(16) Environmental laws should bestrictly followed.

<u>ConservationMethods:</u>

Therearetwotypesof conservation methods namelyin-situand ex-situconservations. Let us discuss the different conservation methods along with their importance.

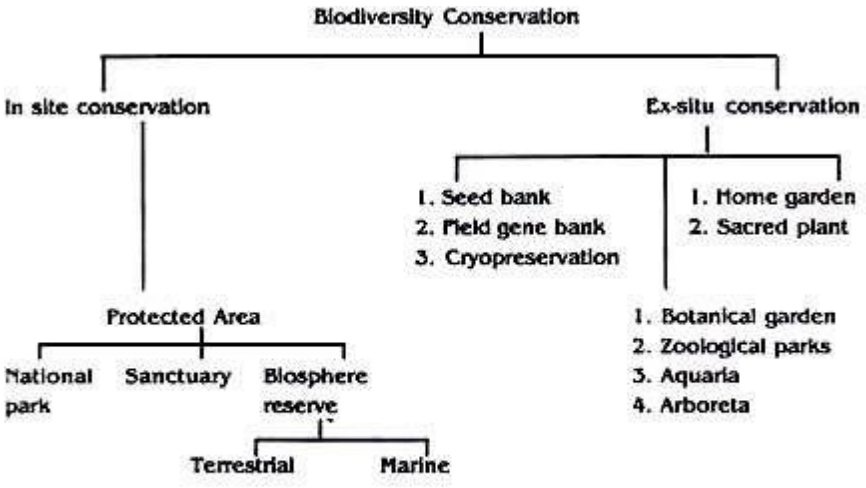


FIG. 5.1 : SCHEME SHOWING BIODIVERSITY CONSERVATION MANAGEMENT SYSTEMS.

(a) Insituconservation:

The conservation of species in their natural habitat or natural ecosystem is known as in situ conservation.Intheprocess,thenaturalsurroundingorecosystemisprotectedand maintainedsothatalltheconstituentspecies(knownorunknown)areconservedand benefited. The factors which are detrimental tothe existence of species concerned areeliminated by suitable mechanism.

Thedifferentadvantagesofinsituconservationareasfollows:

(a) Ifisacheapandconvenientwayofconservingbiologicaldiversity.

(b) Itoffersawaytopreservealargenumberoforganismssimultaneously,knownor unknown to us.

(c) Theexistenceinnatural ecosystemprovides opportunitytothelivingorganismstoadjust to differed'environmental conditions andto evolveintoabetterlifeform.

Theonlydisadvantageofinsituconservationisthatitrequireslargespaceofearthwhichis often difficult because of growing demand for space. The protection and management of biodiversitythroughinsituconservationinvolvecertainspecificareasknownasprotected areas whichinclude national parks,Sanctuaries and Biosphere reserves.

1. Protectedareas:

Theprotectedareasarebiogeographicalareaswherebiologicaldiversityalongwithnatural andculturalresourcesareprotected,maintainedandmanagedthroughlegaland administrative measures.The demarcationofbiodiversityineachareaisdeterminedonthe basis of climatic and physiological conditions.

In these areas,hunting,firewood collection, timber harvesting etc. are prohibitedso that the wild plants and animals can grow and multiply freely without any hindrance. Some protected areasare:Colddesert(LadakhandSpiti),Hotdesert(Thar),SalineSwampyarea(Sunderban andRannofKutch),Tropicalmoistdeciduousforest(WesternGhatsandnorthEast)etc.

protectedareasthroughouttheworld.AsperWorldConservationMonitoringCentre,India has 581 protected areas, national parks and sanctuaries.

2. Nationalparks:

These are the small reserves meant for the protection of wild life and their natural habitats.Thesearemaintainedbygovernment.Theareaofnationalparksrangesbetween0.04to 3162 km. The boundaries are well demarcated and circumscribed. The activities like grazing forestry,cultivationandhabitatmanipulationarenotpermittedintheseareas.Thereare about 89 national parks in India.

SomeimportantnationalParksofIndiaare:

(i) BiologicalPark,Nandankanan,Orissa,

(ii) CorbettnationalParkNainital,U.P.(FirstnationalPark)

(iii) KoziranganationalPark,Jorhat,Assam

(iv) TudulanationalPark,Maharashtra

(v) HazaribaghnationalPark,Hazaribagh,Bihar

(vi) Bandhavgarhnationalpark,M.P.

(vii) Bandipurnationalpark,Karnataka.

(viii) KanhaNationalPark,M.P.

(ix) ReibulLamjaoNationalPark,Manipur

(x) NawgaonNationalPark,Maharashtra

3. Sanctuaries:

Thesearetheareaswhereonlywildanimals(fauna)arepresent.Theactivitieslikeharvesting oftimbers,collectionofforestproducts,cultivationoflandsetc.arepermittedaslongas these do not interfere with the project. That is, controlled biotic interference is permitted in sanctuaries,whichallowsvisitingoftouristsforrecreation.Theareaunderasanctuary remains in between 0.61 to 7818 km.

SomeimportantsanctuariesofOrissaareasfollows:

(i) NandankananZoologicalPark

(ii) ChandakaElephantreserve

(iii) SimlipalTigerReserve

(iv) BhitarkanikaWildlifeSanctuary

(v) GharialprojectatTikarpada

(vi) Chilika(Nalaban)Sanctuary

4. Biosphererereserves:

Biosphere reserves or natural reserves are multipurpose protected areas with boundaries circumscribedbylegislation.Themainaimofbiosphererereserveistopreservegenetic diversity in representative ecosystems by protecting wild animals, traditional life style of inhabitantanddomesticatedplant/animalgeneticresources.Thesearescientifically

managed allowingonlythetouriststoi

Someimportanceofbiosphererereservesareasfollows:

(a) Thesehelpintherestorationofdegradedecosystem.

(b) The main role of thesereservesistopreserve geneticresources,species, ecosystems,and habitats without disturbingthe habitants.

(c) Thesemaintaincultural,socialandecologicallysustainableeconomicdevelopments.

(d) These support education and research invarious ecological aspects,

Some important biosphere reservesare:

Simlipal,(Orissa),Sunderban(WestBengal),Kanha(M.PKaziranga(Assam)etc.The biosphere reservenet work was introduced by UNESCO1971.

TABLE 5.2 : BIOSPHERE RESERVES OF INDIA

S. No.	Date notified	Name of the site	Area in sq.km.	Location (state)
1.	0.1.08.86	Nilgiri	5,520	Parts of Wynad, Nagarhole, bandipur and Mudumalai, Nilambur, Silent Valeey, and the Siruvani Hills (Tamil Nadu, Kerala and Karnataka)
2.	18.01.88	Nanda Devi	5,860.69	Parts o the Chamoli, Pithoragarh, and Almorae dis tricts Uttaranchal)
3.	01.09.88	Nokrek	820	Part of Gora Hills (Meghalaya)
4.	14.03.89	Manas	2,837	Parts of the Kokrajhar, Bongaigaon, Parpeta, Nalbari, Kamprup, and Daarang districts (Assam)
5.	29.03.89	Sunderbans	9,630	Parts of the Brahamaputra and Ganga deltas (West Bengal)
6.	18.02.89	Gulf of Mannar	10,500	Indian part of Gulf of Mannar between India and Sri Lanka (Tamil Nadu)
7.	06.01.89	Great Nicobar	885	Southernmost islands of the Andaman and Nicobar islands.
8.	21.06.94	Similpal	4,374	Partof Mayurbhanj district (Orissa)
9.	29.07.97	Dibru-Saikhowa	765	Parts of the Dibrugarh and Tinsukia districts (Assam)
10.	02.09.98	Dehang Debang	5,112	Parts of Siang and Debang Valley (Arunachal Pradesh).
11.	03.03.99	Pachmarhi	4,926.28	Part of the Betul, Hoshangabad, and Chindwara dis tricts (Madhya Pradesh)
12.	07.02.00	Kanchanjanga	2,619.92	Part of Kanchanjanga Hills (Sikkim)

(b) Ex-situconservation:

Ex-situconservationinvolvesmaintenanceandbreedingofendangeredplantsandanimals underpartiallyorwhollycontrolledconditionsinspecificareaslikezoo,gardens,nurseries etc. That is, the conservation of selected plants and animals in selected areas outside theirnatural habitat is known as ex-situ conservation.

Thestressesonlivingorganismsduetocompetitionforfood,water,spaceetc.canbe avoided by ex-situ conservation there by providing conditions necessary for a secure life and breeding.

Someimportantareasundertheseconservationare:

(i) Seedgenebank,

(ii) Fieldgenebank;

(iii) Botanicalgardens;

(iv) Zoos.

Thestrategiesforex-situconservationsare:

(i) Identificationofspeciestobeconserved.

(

(i) Long-termcaptive breedingand propagationforthespecies whichhave losttheir habitats permanently.

(ii) Short-termpropagationandreleaseoftheanimalsintheirnaturalhabitat

(iii) Animaltranslocation

(iv) Animalreintroduction

(v) Advanced technology inthe service of endangered species.

The different advantages of ex-situconservationare:

(a) Itgiveslongerlifetimeandbreedingactivitytoanimals.

(b) Genetictechniquescanbeutilisedintheprocess.

(c) Captivitybreedspeciescanagainbereintroducedinthewild.

Somedisadvantagesofthismethodare:

(a) Thefavourableconditionsmaynotbemaintainedalways.

(b) Mewlifeformscannotevolve.

(c) This technique involves only fewspecies.

Endangered and Endemicspecies of India

1. **EndangeredspeciesofIndia**

A plant, animal or microorganism that is in immediate risk of biological extinction is called endangered species or threatened species. In India, 450 plant species have been identified as endangeredspecies.100mammalsand150birdsareestimatedtobeendangered. India's biodiversity isthreatened primarilydue to:

1. **Habitatdestruction**
2. **Degradationand**
3. **Overexploitationofresources**

TheRED-databookcontainsalistofendangeredspeciesofplantsandanimals.Itcontainsa list of species of that are endangered but might become extinct in the near future if notprotected.

Someoftherarestanimalsfoundin Indiaare:

1. **Asiaticcheetah**
2. **AsiaticLion**
3. **AsiaticWildAss**
4. **BengalFox**
5. **Gaur**
6. **IndianElephant**
7. **IndianRhinocerous**
8. **MarbledCat**
9. **Markhor**

Extinctspeciesisnolongerfoundintheworld.Endangeredorthreatenedspeciesisone whosenumberhasbeenreducedtoacriticalnumber.Unlessitisprotectedandconserved,it is in immediate danger of extinction. Vulnerable species is one whose population is facing continuousdeclineduetohabitatdestructionoroverexploitation.However,itisstill abundant.Rarespeciesislocalizedwithinarestrictedareaoristhinlyscatteredoveran

extensivearea.Suchspeciesarenotendangeredorvulnerable.Afewendangeredpeciesin the world are listed below:

1. WestVirginiaSpringSalamander(U.S.A)
2. GiantPanda(China)
3. GoldenLionTamarin(Brazil)
4. SiberianTiger(Siberia)
5. MountainGorilla(Africa)
6. PineBarrensTreeFrog(Male)
7. ArabianOryx(MiddleEast)
8. AfricanElephant(Africa)

Otherimportantendangeredspeciesare:

1. Tortoise,GreenseaTurtle,Gharial,Python(Reptiles)
2. Peacock,SiberianWhiteCrane,Pelican,IndianBustard(Birds)
3. Hoolock gibbin, Lion-tailed Macaque, Capped mokey, Golden monkey (Primates)
4. Rauvolfiaserpentina(medicinalplant),Sandalwoodtree,etc

FACTORSAFFECTINGENDANGEREDSPECIES

1. Humanbeingsdisposewastesindiscriminatelyinnaturetherebypollutingthe air, land and water. These pollutants enter the food chain and accumulate in living creatures resulting in death.
2. Over-exploitationofnaturalresourcesandpoachingofwildanimalsalsoleads to their extinction.
3. Climate change brought about by accumulation of green houses gases in the atmosphere.Climatechangethreatensorganismsandecosystemsandtheycannot adjusttothe changing environmental conditions leadingtotheirdeathand extinction.

An international treaty to help protect endangered wildlife is, "Convention on InternationalTrade inEndangered Species 1975"(CITES).Thistreatyisnow signedby 160countries.

1. CITESlists 900species that cannot be commerciallytraded as live specimens or wildlife products as they are in danger of extinction.
2.
3. CITES restricts trade of 2900other species as they are endangered.

DRAWBACKS OF CITES

1. Thistreatyislimitedasenforcementisdifficultandconvictedviolatorsget awaybypayingonlyasmallfine.
2. Membercountriescanexemptthemselvesfromprotectinganylistedspecies.

EndemicspeciesofIndia

Speciesthatarefoundonlyinaparticularregionareknownasendemicspecies.Almost60% theendemicspeciesinIndiarefoundinHimalayasandtheWesternGhats.Endemicspecies are mainly concentrated in:

1. North-EastIndia
2. North-WestHimalayas

3. **WesternGhatsand**

4. **Andaman & Nicobar Islands.**

Examples of endemic Flora species are

1. **SapriaHimalayana**
2. **OvariaLurida**
3. **Nepenthiskhasianaetc**

Endemicfaunaofsignificanceinthewesternghatsare:

1. **Liontailedmacaque**
2. **Nilgirilangur**
3. **Brownpalmcivetand**
4. **Nilgiritahr**

<u>Factorsaffectingendemicspecies:</u>

1. **Habitat loss and fragmentation due to draining and filling of inland wetlands.**
2. **Pollution also plays animportant role.**

Ex:

1. **Frogeggs,tadpoles andadultsareextremelysensitivetopollutants especially pesticides.**
2. **Over-huntingand**
3. **Populationscanbeadverselyaffectedbyintroductionofnonactivepredators andcompetitors.Diseaseproducingorganismsalsoplayanimportantadversaryin reducingpopulationsofendemicspecies.**

Module 4: Environmental PollutionDefinition, Cause, effects and control measures of Air pollution, Water pollution,•Soil pollution, Marine pollution, Noise pollution, Thermal pollution,Nuclear hazards;SolidwasteManagement: Causes,effectsand control measures of urban and industrial wastes; Role of an individual in prevention of pollution; Pollution case studies; Disaster management: floods, earthquake,cyclone and landslides.

Pollution

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light.

Airpollution

Air pollutionincluded harmfulgases,dustparticles, smokefumeswell asbiologicalmolecules presentin the earth atmosphere which creates harmful effect on human health as well as environment comes in the categoriesof Air pollutions.Normally pollution can be natural originor man mad.

Smokefromindustriesandautomobiles,domesticandcommercialsewage,radioactivesubstancesfrom nuclearplantsanddiscardedhouseholdarticles(tins,bottles, brokencrockeryetc.)comeunderthecategory of pollutants.

Classificationofpollutants

Dependingontheexistenceofthenaturewe canbroadlyclassifypollutantintwocategories.

1. Quantitative pollutant: The quantitativepollutant isthose pollutant whose concentrationlevel is high due tomanmadeuncontrolledactivitycomesinthiscategory.Forexample,carbondioxide,ifpresentinthe atmosphereinconcentrationgreaterthannormalduetoautomobilesandindustries,causesmeasurable effects on humans, animals, plants or property, then it is classified as a quantitativepollutant

2. Qualitative pollutant:Thesearethosesubstanceswhichdonotnormallyoccurinnaturebut areaddedby man,forexample, insecticides. Depending upon the formin which theypersistafterbeing released into the environment,the pollutantsare categorizedinto two types, namely primary and secondarypollutants.

PrimaryPollutants:

(a) These are those which are emitted directly from the source and persist in the form in which they were added to the environment. Typical examples of pollutants included under this category are ash, smoke, fumes, dust, nitric oxide, sulphur dioxide, hydrocarbonsetc.

(b) Secondary Pollutants: These are those which are formed from the primary pollutants by chemical interaction with some constituent present in the atmosphere. Examples are: Sulphur trioxide, nitrogen dioxide, aldehydes, ketones, ozone etc.

Nitrogen oxides and hydrocarbons are two primary pollutants released from automobiles but in thepresence ofsunlight, they reactto form peroxyacyl nitrate(PAN)and ozone,two secondary pollutantswhich are far more toxic than the primary pollutantsfrom which they are derived.

This phenomenon of increased toxicity by chemical interaction among the pollutants is knownasSynergism.

Secondary air pollution: Secondary air pollutant generally produced when in the air when two or more primary air pollutantinteracts with each other with normalatmospheric constituent.

Exampleof somesecondary air pollutantisozone, formaldehyde, PAN(proxy acetyl nitrate),Smog, acid and

mist etc.

S.No.	PrimaryPollutants	SecondaryPollutants
1.	Carbonmonoxide(CO)	Ozone(O3)
2.	NitrogenOxide(NOx)	Peroxyactylnitrate(PAN)
3.	SulphurOxide(SOx)	Aldehydes
4.	Hydrocarbon(HC)	Ketones
5.	Particulates	Sulphurtrioxide

Harmfuleffects

CO can cause oxygen deprivation (hypoxia), displacing oxygen in bonding with haemoglobin, causing cardiovascular and coronary problems, increasing risk of stroke, and impairing learning ability, dexterityand sleep. CO is mostly hazardous in relatively confined areas such as tunnels under bridges andoverpasses, and in dense urban settings. In unconfined areas or away from population centres, it will stabilize into CO2 before damage to human health is likely.

Itcirculates directly intobloodthrough lungs.Carbonmonoxide binds to haemoglobin(Hb)in redblood cells,reducingtheirabilitytotransportandreleaseoxygenthroughoutthebodybecauseofCarboxyl haemoglobin(COHb).TheaffinityofCarboxylhaemoglobinis210timesgreatertothatofoxygen.Low exposures can aggravate cardiac ailments, while high exposures cause central nervous system impairment or death. It also plays a role in the generationofground-levelozone.

CausesofAirpollution

1. **Burning of Fossil Fuels: Sulfur dioxide emitted from the combustion of fossil fuelslike coal, petroleum and other factory combustibles is one the major cause of air pollution. Pollutionemitting from vehicles including trucks, jeeps, cars, trains, airplanes cause immense amountofpollution.Werelyonthemtofulfillourdailybasicneedsoftransportation.But,there overuse is killing our environment as dangerous gases are polluting the environment. Carbon Monooxidecausedbyimproperorincompletecombustionandgenerallyemittedfrom vehicles is another major pollutant along with Nitrogen Oxides, that is produced from bothnatural and man made processes.**
2. **Agriculturalactivities: Ammoniaisaverycommonbyproductfromagriculturerelated activitiesandisoneofthemosthazardousgasesintheatmosphere.Useofinsecticides, pesticidesandfertilizersinagriculturalactivitieshasgrownquitealot.Theyemitharmful chemicals into the air and can also cause water pollution.**
3. **Exhaust from factories and industries: Manufacturing industries release large amount of carbon monoxide, hydrocarbons, organic compounds, and chemicals into the air thereby depletingthequalityofair.Manufacturingindustriescanbefoundateverycornerofthe**

earth and there is no area that has not been affected by it. Petroleum refineries also release hydrocarbonsand various other chemicals that pollute the air and also cause land pollution.

4. Miningoperations:Miningisa processwhereinminerals belowtheearthare extracted using large equipments. During the process dust and chemicals are released in the air causing massiveairpollution.Thisisoneofthereasonwhichisresponsibleforthedeteriorating health conditions of workers and nearby residents.

5. Indoorairpollution:Householdcleaningproducts,painting suppliesemittoxic chemicalsin theairandcauseairpollution.Haveyouevernoticedthatonceyoupaintwallsofyour house, it creates some sort of smellwhich makes it literallyimpossiblefor you to breathe. SuspendedparticulatematterpopularbyitsacronymSPM,isanothercauseofpollution. Referringto the particlesafloat in the air, SPMis usually caused by dust, combustionetc.

Effects of Air pollution

1. Respiratory and heart problems:The effects of Air pollution are alarming. They are known to create several respiratory and heart conditions along with Cancer, among other threats to thebody.Severalmillionsareknowntohavediedduetodirectorindirecteffectsof Air pollution.Childreninareasexposedtoairpollutantsaresaidtocommonlysufferfrompneumonia and asthma.

2. Globalwarming:Anotherdirecteffectistheimmediatealterationsthattheworldis witnessing due to Global warming. With increased temperatures world wide, increase in sea levels and melting of ice from colder regions andicebergs, displacement and loss of habitathavealreadysignaledanimpendingdisasterifactionsforpreservationandnormalization aren't undertaken soon.

3. Acid Rain: Harmful gases like nitrogen oxides and sulfur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combineswith these airpollutants,becomes acidicand thenfallson the ground inthe formof acid rain. Acid rain can cause great damage to human, animals and crops.

4. Eutrophication:Eutrophicationisaconditionwherehighamount ofnitrogenpresentin some pollutants gets developed on sea's surface and turns itself into algae and and adversely affectfish,plantsandanimalspecies.Thegreencoloredalgaethatispresentonlakesand ponds is due to presence of this chemical only.

5. EffectonWildlife:Justlikehumans,animalsalsofacesomedevastatingaffectsofair pollution. Toxic chemicals present in the air can force wildlife species to move to new place and change their habitat. The toxic pollutants deposit over the surface of the water and can also affect sea animals.

<u>CONTROLMEASURES</u>

Theatmosphere has several built-in self cleaning processes such as dispersion, gravitational settling,flocculation,absorption,rain-washout,etctocleansetheatmosphere.However, controlofcontaminantsattheirsourcelevelisadesirableandeffectivemethodthrough preventive or control technologies.

Sourcecontrol:Somemeasuresthatcanbeadoptedinthisdirectionare:

1. **Usingunleadedpetrol**

2. Usingfuelswithlow sulphurandashcontent
3. Encouragingpeopletousepublictransport,walkoruseacycleasopposedto privatevehicles
4. Ensure that houses, schools,restaurants and playgrounds are not located on busy streets
5. Planttreesalongbusystreetsastheyremoveparticulates,carbondioxideand absorbnoise
6. Industriesandwastedisposalsitesshouldbesituatedoutsidethecity preferably on the downwind of the city.
7. Catalyticconvertersshouldbeusedtohelpcontrolemissionsofcarbon monoxideandhydrocarbons

Controlmeasuresinindustrialcenters

1. Emissionratesshouldberestrictedtopermissiblelevelsbyeachandevery industry
2. Incorporationofairpollutioncontrolequipmentindesignofplantlayout must bemademandatory
3. Continuous monitoring of theatmospherefor pollutants should becarried out to know the emission levels.

EQUIPMENTUSEDTOCONTROLAIR POLLUTION

Thefollowingequipmentisusedtocontrolairpollution:

1. **Control ofSPMbygravitation**

GravitationalSettlingChamberAtypicalgravitationalchamberisshownbelow.

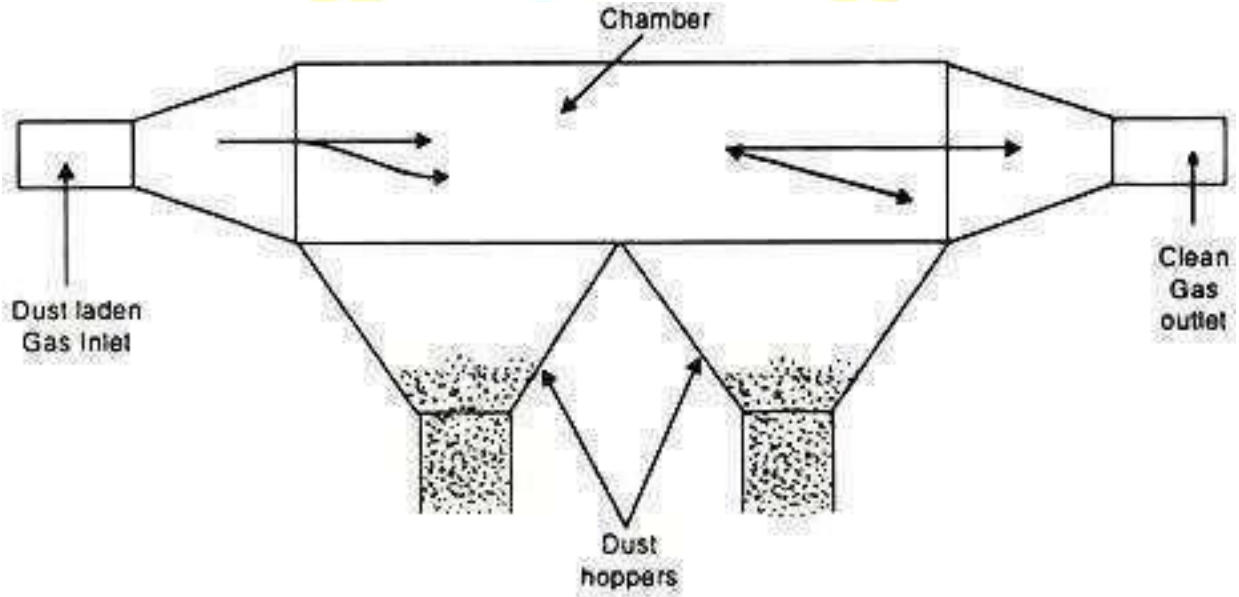


Fig. 6.4. Horizontal Flow Settling Chamber.

Thedustladengasentersattheinletandduetothesuddenincreaseincross-sectionthe

particulatematter settles at the bottom andcanbe removed fromthe dust hoppers as shown The clean gas free from particulate matter exits from the outlet

IMPORTANTFACTS:-

1. **Simpletoconstructandmaintain**
2. **Efficienttoremoveparticlesofdiametergreaterthan50mmfromgasstreams**
3. **Theyareusedaspre-cleanersbeforepassing gasesthroughhighefficiencycollection devices**
4. **They rely on gravitationalsettling and are the simplest and oldest mechanical collectorsforremovalofparticulatesfromgasstreamsFlowwithinthechambermust be uniform without macroscopic mixing**
5. **Dustremovalsystemmustbesealedtopreventproductionofturbulenceduetoair fromleakinginto chamber**
6. **Efficiencyoftheequipmentincreaseswithincreasedresidencetimeofthewastegas. Hence, the equipmentis operated at lowest possible gas velocity**
7. **Thesizeoftheunitdependson:gasvelocitywhich shouldpreferablybelessthan0.3 m/s**

1. **ADVANTAGES**
   1. **Lowcapitalandenergycost**
   2. **Lowmaintenanceandoperatingcosts**
   3. **Lowpressuredrop**
   4. **Reliableand Pollutantsarecollectedindrystate**
   5. **Equipmentisnotsubjectedtoabrasionduetolowgasvelocity**
   6. **Equipmentprovidesincidentalcoolingofgasstream**
   7. **Temperatureandpressurelimitationsdependonmaterialofconstruction**

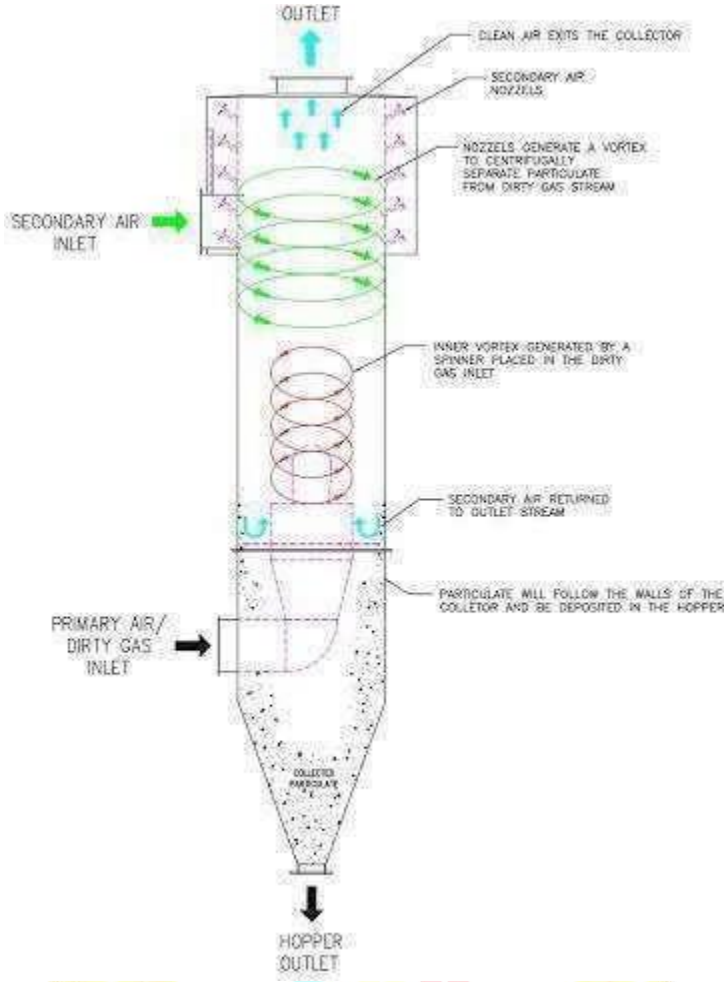
DISADVANTAGES

1. **Lowparticulatemattercollectionefficiency**
2. **Unabletohandlestickymaterials,Largesize**
3. **Traysinmultipletraysettlingchambermaywarpunderhigh temperatures.**

2.<u>ControlofSPMbycentrifugation</u>

Equipmentused:Cyclonicseparator:-

Centrifugation is a process that involves the use ofcentrifugal force for sedimentationof a heterogeneousmixture with a centrifuge. It involves removal ofparticulatesfromair, gas or a liquidstreamwithoutuseoffilterswithavortexseparation.Whenremovingparticulates fromagaseousstream,agascycloneisusedwhileahydrocycloneisusedtoremoveparticulates from a liquid stream. This method can also be used to separate fine droplets ofliquidfromagaseousstream.Ahighspeedrotatingairflowisformedinacylindricalor conicalcontainercalledacyclone.Airflowsinahelicalpatternfromthetoptoanarrow bottom as show,



Cyclones use theprincipleof inertia to removeparticulatematterfrom agas stream.Several cyclonesoperatinginparallelis knownasmulticyclone.Inacycloneseparator,dirtygasisfed into a chamberwhere aspiral vortexexists. The large particles hit the inside walls of the containerand drop down into the collectionhooper.The cleanflue gas escapesfrom the top of the chamber.Cyclones can be used efficiently to removeparticlesof size 10 microns or more. High efficiencycyclones can removeparticles of dimeter as small as 2.5 microns.They arethe leastexpensiveof allparticulatecollectiondevices. Theyareusedasroughseparators before the gas is passed throughfine filtrationsystems. Their efficiencyis between50-99%. Cycloneseparatorsworkbestonfluegasesthatcontainlargeamountofbigparticulate matter.

ADVANTAGES:

1. Cyclonesarelessexpensivetoinstallormaintainastheydonot containanymovingparts

2. Itiseasytodisposeparticulatematterasitiscollectedinthedrystate

3. Spacerequirementisveryless

DISADVANTAGES:

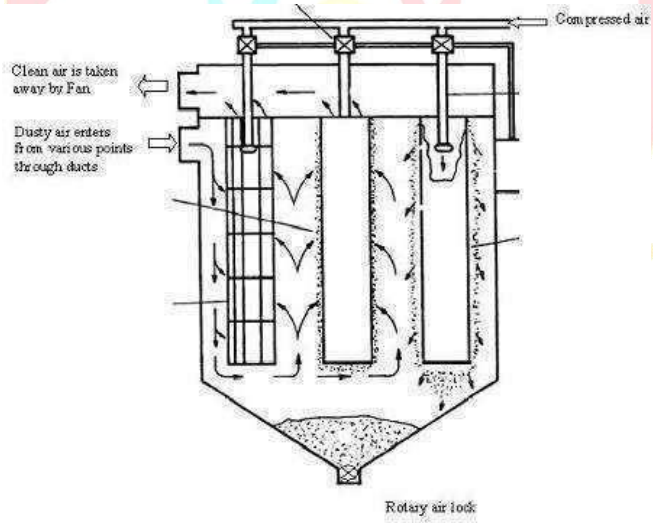
1. Theyarenotefficientin collectingparticulatemattersmallerthan10microns

2. Theycannothandlestickymaterial

3. **Controlof SPMbyfiltration**

In a fabric filter system, a streamof the pollutedgas is madeto pass througha fabricthat filters outtheparticulatepollutantand allowstheclear gasto passthrough.Theparticulate matterisleftin theformofathindustmatontheinsides ofthebag.Thisdustmatactsasa filteringmediumforfurtherremovalofparticulatesincreasingtheefficiencyofthefilterbag to sieve more sub micron particles(0.5 µm).

Atypicalfilterisatubularbagwhichisclosedattheupperendandhasahopperattachedat the lower end to collectthe particleswhen they are dislodgedfrom the fabric. Many such bags are hungin abaghouse.For efficientfiltration and a longer life the filter bags must be cleaned occasionallyby a mechanical shaker to prevent too many particulatelayers from buildinguponthe insidesurfacesofthebag.Atypicalbaghousefilterisshowninthefigure below.



ADVANTAGES:

Bagfilterisahighqualityperformanceinstrumenttoeffectivelycontrolparticulateemissions and its efficiency is as high as 99%

Collectionefficiencyisnotaffectedbysulphurcontentinfuel It is

not sensitive to particle size distribution

Itdoesnotrequirehighvoltage

Itcanbeusedtocollectflammabledust

Specialfiberorfilteraidscanbeusedtosub-micronlevelsmokeandfumes

DISADVANTAGES:

Fabriclifeisreducedduetopresenceofhighlyacidicoralkalineatmospheres,especiallyat hightemperatures

Maximumoperatingtemperatureis500 F

Collectionofhygroscopicmaterialsorcondensationofmoisturecanleadtofabricplugging, loss of cleaning efficiencyand large pressure losses.

Certaindustsmayrequirespecialfabrictreatmentstoaidinreducingleakageortohelpin cakeremoval

Fabricbagsarepronetoburningormeltingatextremetemperatures.

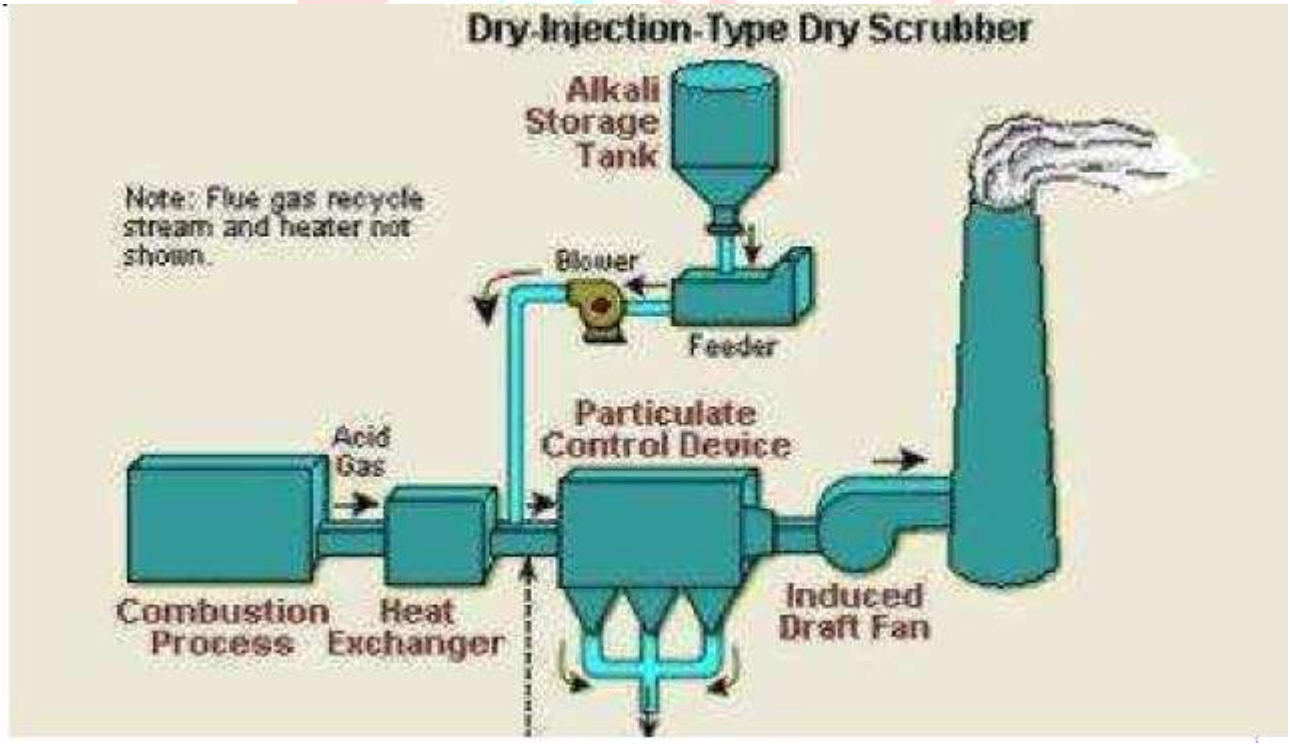
4. **ControlofSPMbyscrubbing**

Ascrubberisasystemusedtoremoveharmfulmaterialsfromindustrialexhaustgasesbefore they are released into the environment.The two main ways to scrub pollutantsout of exhaustare:

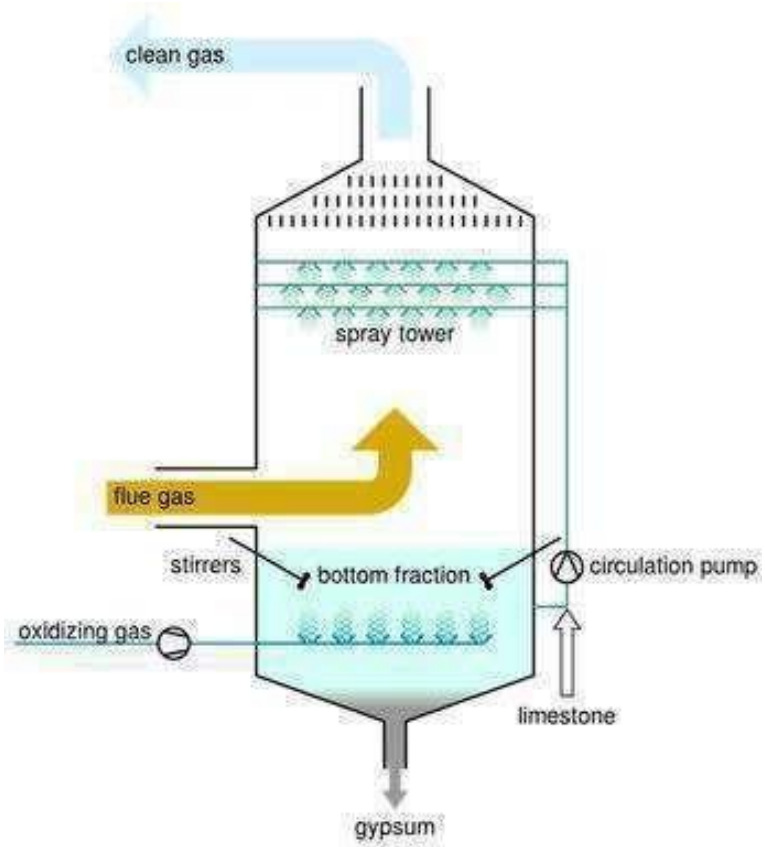
1. Dryscrubbingand

2. Wetscrubbing

Indryscrubbing,harmfulcomponentsofexhaustedfluegasareremovedbyintroducinga solidsubstance(usuallyinthepowderedform)inthegasstream.



Wetscrubbinginvolvesremovalofharmfulcomponentsfromexhaustbyspraying aliquid substancethroughthegas.



Both methods work similarly and perform the same process of removing pollutants. The difference lies in the materials they use to remove the pollutant from the gas stream. By removing acidic gases from the exhaust before it is released into the atmosphere, scrubbers help in the prevent the formation of acid rain. Scrubbing is sometimes referred to as flue gas desulfurization.

Scrubbing is the most effective technique for the removal of oxides of sulphur and is widely used. Scrubbers remove sulphur oxides from flue gases by passing the gases through a spray ofwaterinawetscrubberthatcontainsmanychemicals,mainlycalciumcarbonate. If a dry scrubber is used, the flue gas comes in contact with pulverised limestone. The chemicalreaction betweensuphurdioxideand calcium carbonateyields calcium sulphite.The calcium sulphite either falls out of the gas stream or is removed with other particulates. Scrubbers are highly efficient and remove almost 98% of sulphur from flue gases. However, they areexpensive to maintain and install.Theyare also energy intensiveas theflue gas must bereheated after coming into contact with water vapour in thewet scrubber to makethegas buoyant to exit the smoke stacks.

5. Control of SPM by Electrostatic precipitator

An Electrostatic precipitator is mainly used to control particulate matter. An Electrostatic precipitator uses electrostatic forces to separatedust particles from exhaust gases. A number of high-voltage, direct-current discharge electrodes are placed between grounded collecting

electrodes. The contaminated gases flow through the passage formed by the discharge and collectingelectrodesas shown in the figure below.

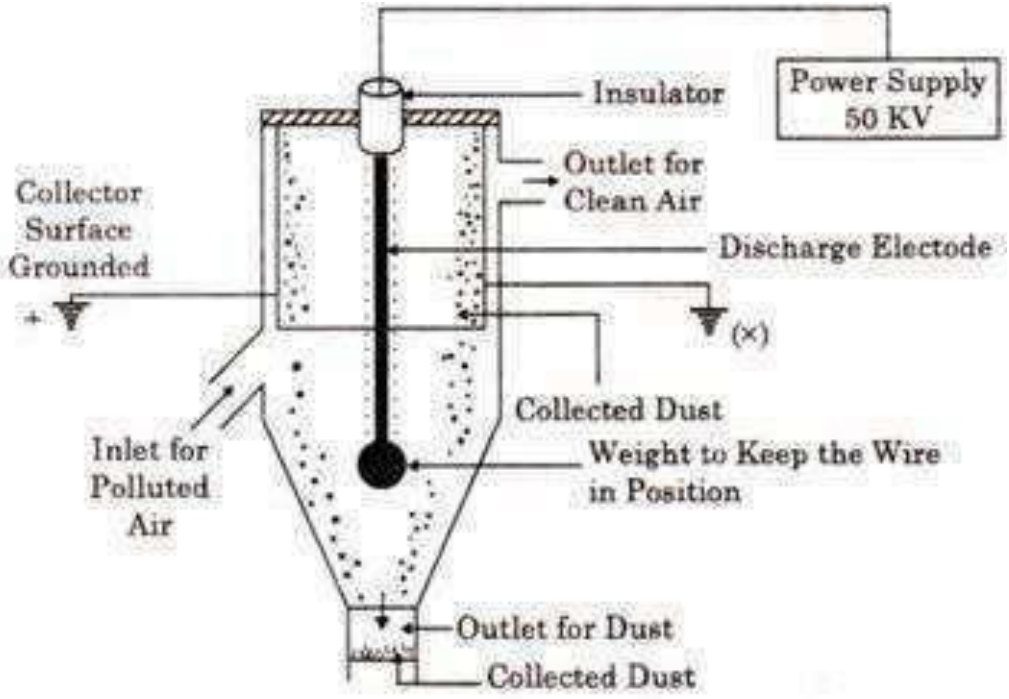


Fig. 5.4 Electrostatic Precipitator

Air borne particles receive a negative charge as they pass through the ionized field between the electrodes. These charged particles are then attracted to the oppositely chargedelectrode and stick to it. The collected material is then removed by rapping or vibrating the electrodes.Cleaningtheelectrodesisdonewithoutinterruptingtheairflow.Themaincomponentso fallelectrostaticprecipitatorsare:

- **apowersupplyunittosupplyhighvoltageDCpower**
- **ionizingsectiontoimpartachargetotheparticulatesinthegasstream**
- **anattachmenttoremovethecollectedparticulates**
- **ahousingto enclosetheprecipitatorzone**

Thefollowingfactorsinfluencethecollectionefficiencyofelectrostaticprecipitators:

- **Larger collection surface areas and lower gas flow rates increase efficiency of electrostatic precipitators due to increased time for the electrical activity to collect the dust particles**
- **Thedustparticlemigrationvelocitytothecollectingelectrodescanbeincreasedby:**
- **Decreasinggasvelocity**
- **Increasinggastemperatureand**
- **Increasingthevoltagefield**

Therearetwotypesofprecipitators:

1. Single-stage precipitators that combine an ionization and collection step also known as cottrellprecipitators.It is mainly used in mineral processing operations.
2. Low voltage, two stage precipitators that use a similar principle, but in this case, the ionization section is followed by collection plates. It is mainly used for filtration in air-conditioning systems.

Electrostatic precipitators may be:
Plate precipitators in which particles are collected on flat parallel surfaces about 20 to 30 cm apartwitha seriesofdischargeelectrodesspaced along the centerline oftwoadjacentplates. The contaminated particles pass through the passage between the plates and the particlesget charged and adhere to the collection plates. The particles are eventually removed by rapping the plates and the dust is collected in the hoppers or bins placed at the base of the precipitator.

Tubularprecipitatorsconsistofcylindricalcollectionelectrodeswithdischargeelectrodes locatedontheaxisofthecylinder.Thecontaminatedgasesflowaroundthedischargeelectrode and through the inside of the cylinders. The charged particles are collected on the groundedwallsofthecylinder.Thecollecteddustisremovedfromthebottomofthecylinder.Theyar egenerallyusedforcollectionofmistorfogorforadhesive,sticky, radioactive or extremely toxic materials.

Airpollutioncanbereducedbyadoptingthefollowingapproaches.

1. Ensuring sufficient supply of oxygen to the combustion chamber and adequate temperaturesothatthecombustioniscompletetherebyeliminatingmuchofthe smoke consistingof partly burnt ashes and dust.
2. To use mechanicaldevices such as scrubbers, cyclones, bag houses and electro-static precipitators in manufacturing processes. The equipment used to remove particulates from the exhaust gases of electric power and industrial plants are shown below. All methods retain hazardous materials that must be disposed safely. Wet scrubber can additionallyreduce sulphur dioxide emissions.
3. The air pollutants collected must be carefully disposed. The factory fumes are dealt with chemical treatment.

<u>WaterPollution</u>

Waterpollutionmaybedefinedas“thealterationinphysical,chemicalandbiological characteristicsofwaterwhichmaycauseharmfuleffectsonhumansandaquaticlife.”

TypesofWaterPollution

Surface Water Pollution

When hazardous substances come in contact with different sources of water, it leads to surface water pollution. The harmful contaminants from different sources mix or physically dissolve with lakes, lagoons,oceans and lead to surface water pollution.

GroundWaterPollution

Pesticidesandchemicalsappliedoncropsandsoilarewasheddeepintothegroundwhenit

rains.Thepesticidesmixwithundergroundwaterandleadtogroundwaterpollution.

SuspendedMatterPollution

In this type of pollution, the pollutants enter into water and don't mix with the water molecules. The suspended particles in water form a silt on the waterbed that remove the nutrients from water and make it polluted.

MicrobialPollution

A natural form of water pollution,microorganismscausethis type of water pollution.Most of themicroorganisms.Thoughmostofthemicroorganismsareharmless,howeversome bacteria and viruses may cause serious health problems.

ChemicalWaterPollution

Many industries and farmers use chemicals when working which end up polluting water that weuse.Pollutantsusedtocontrolweeds,insectsandpestsleechintowaterandleadto pollution.In addition,metals and solventsfrom industriesalso lead to water pollution.

Sewage

Disposing sewage in water is one of the major reasons of water pollution. Sewage disposed into the sea from households as well as factories can cause water pollution. Sewage disposal lead to anumber of water-related illnesses suchas diarrheawhich is a leading cause ofdeath amongchildren.

IndustrialWaste

Many factories and manufacturers pour industrial waste such as toxic chemicals into the water bodies before treatment which leads to water pollution. As a result of dumping toxic chemicals, the oxygen levels in water decreases leadingto pollution.

Dumpingof Solid Waste

Another major reason of water pollution is littering by humans. Dumping solid waste such as plastics,cardboards,Styrofoamcontaminatewaterandmakewaterunsuitablefor consumption.Massdumpingofsolidwasteclogthewaterbodiesandleadtowater pollution.

RadioactiveWastes

Dischargingofradioactivewastes(wastefuelthatcomesfromnuclearpower plants)into the sea is also one of the water pollution causes. High concentrations of radioactive wastes can lead to anumber of health problemssuch as cancer and other serious illnesses.

Thosewereonlysomeofthecausesofwaterpollution.Inadditiontothesourcesmentioned above, there are many other reasons that contaminate water and lead to a number of health problems. Now, that we have understood about the causes, let us study about the effects of water pollution as well. This will help you comprehend, the consequences of water contamination.

Effects of Water Pollution

Groundwatercontamination

Pesticides and fertilizers used for the cultivation of crops and vegetables contaminate the groundwater, which damages the ecosystem. This can also pollute the nearby lands and waterwhenit rains,asrainwaterwashesthesechemicalswhich is soakedbygroundwateror

takes them to marine areas. If this groundwater is supplied to your home through bore-wells or tube-wells, it can lead to a number of health problems.

AffectsAquaticLife

Solid wastes that we throw in the river/lakes or in sea can have an impact on the aquatic animals. This not only disrupts the eco-system as many species of aquatic animals are in danger of extinction. People who consume sea food are also at a risk of facing health issues when they consume the contaminatedfood items.

HighTDSinwater

Water is a best solvent which easily dissolves a variety of substances. The amount ofdissolved solids present in water determine whether water is suitable for consumption. The TDS level in water needs to be less than 500 mg/litre to make it suitable for consumption. Presenceof high amount of TDS can lead to anumber of health problemsin human beings.

Pollutants include:

1. Sewage
2. Industrialeffluentsandchemicals
3. Oilandotherwastes

Chemicals in air dissolve in rain water,fertilizers, pesticides and herbicides leached from land pollute water.

TYPES, EFFECTS AND SOURCES OF WATER POLLUTION Water pollution is any chemical, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.

Infectious agents

Ex: Bacteria, Viruses, Protozoa, and parasitic worms.

Human sources

Human and animal wastes

Effects: Variety of diseases.

Oxygen demanding wastes (Dissolved oxygen): This degradation consumes dissolved oxygen in water. Dissolved Oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular pressure and temperature.

Thesaturated point ofDO varies from 8to15mg/LEx: Organic wastes such as animalmanure andplantdebrisathatcanbedecomposedbyaerobic(oxygen-requiring)bacteria.

Humansources:Sewage,Animalfeedlots,papermillsandfoodprocessingfacilities.

Effects: Large populations of bacteria decomposing these wastes can degrade water qualityby depleting water of dissolved oxygen. This causes fish and other forms of oxygen- consuming aquatic life to die.

Inorganic chemicals

Ex: Water soluble inorganic chemicals:

1. **Acids**
2. **Compoundsoftoxicmetalssuchaslead(Pb),arsenic(As)andselenium(Se)**
3. **SaltssuchasNaClinoceansandfluoride(F^-)foundinsomesoils**

Humansources:Surfacerunoff,industrialeffluentsandhouseholdcleansersEffects:Inorganic chemicals can:

1. **Makefreshwaterunusablefordrinkingandirrigation**
2. **Causeskincancerandneckdamage**
3. **Damagenervoussystem,liverandkidneys**
4. **Harmfishandotheraquaticlife**
5. **Lowercropyields**
6. **Acceleratecorrosionofmetalsexposedtosuchwater**

Organic chemicals

Ex: Oil, Gasoline, Plastics, Pesticides, Cleaning solvents and Detergents. HumanSources:Industrialeffluents,householdcleansersandsurfacerunofffromfarms.

Effects:

1. **Canthreatenhumanhealthbycausingnervoussystemdamageandsome cancers.**
2. **Harmfishandwildlife.**

Plant nutrients

Ex:Watersolublecompoundscontainingnitrate,PhosphateandAmmoniumions. Human sources:Sewage, manure and runoff of agricultural and urbanfertilizers.

Effects:

1. **Cancauseexcessivegrowthofalgaeandotheraquaticplants,whichdie, decay, deplete dissolvedoxygen in water thereby killing fish**
2. **Drinkingwaterwithexcessivelevelsofnitrateslowertheoxygencarrying capacity of the blood and can kill urban childrenand infants.**

Sediment

silt, etc.

Ex: Soil, erosion

Human Sources:Land

Effects:

1. Causescloudywatertherebyreducingphotosyntheticactivity
2. Disruptionofaquaticfoodchain
3. Carriespesticides,bacteriaandotherharmfulsubstances
4. Settlesanddestroysfeedingandspawninggroundsoffish
5. Clogsandfillslakes,artificialreservoirs,streamchannelsandharbours.

Radioactive materials:

Ex: Radioactive isotopes of:

1. Iodine
2. Radon
3. Uranium
4. Cesium and
5. Thorium

Humansources:Nuclearpowerplants,miningandprocessingofuraniumandotherores, nuclear weapon production and natural sources.

Effects: Genetic mutations, birth defects and certain cancers.

Heat(Thermal pollution)

Ex: Excessive heat

Human sources: Water cooling of electric power plants and some types of industrial plants. Almosthalfof whole waterwithdrawnin United States eachyearis forcoolingelectric power plants.

Effects

1. Lowdissolvedoxygenlevelstherebymakingaquaticorganismsmore vulnerabletodisease,parasitesandtoxicchemicals.
2. When a power plant starts or shuts down for repair, fish and other organisms adapted to a particular temperature range, can be killed by an abrupt temperature change known as thermal shock.

Point and non-point sources of water pollution:

Point sourcesThese are pollutants that are discharged at specific locations through pipes, ditches or sewers into bodies of surface waters.

1. Ex: Factories,sewagetreatmentplants, abandonedundergroundminesand oil tankers.
2. Non point sourcesThese pollutants cannot be traced to a single point of discharge. They are large land areas or air-sheds that pollute water by runoff, subsurface flow or depositionfrom the atmosphere.

Ex: Acid deposition, runoff of chemicals into surface water from croplands, livestock feedlots, loggedforests, urban streets, lawns, golf courses and parkinglots.

Control measures of water pollution

1. Administrationof water pollutioncontrol should be in the hands of state orcentral government
2. Scientifictechniquesshouldbeadoptedforenvironmentalcontrolof catchment areas of rivers, ponds or streams
3. Industrialplantsshouldbebasedonrecyclingoperationsasithelpsprevent disposalofwastesintonaturalwatersbutalsoextractionofproductsfromwaste.
4. Plants,treesandforestscontrolpollutionastheyactasnaturalair conditioners.
5. Treesarecapableofreducingsulphurdioxideandnitricoxidepollutantsand hencemoretreesshouldbeplanted.
6. Notypeofwaste(treated,partiallytreatedoruntreated)should bedischarged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewagemust be used for irrigation.
7. Qualifiedandexperiencedpeoplemustbeconsultedfromtimetotimefor effectivecontrolofwaterpollution.
8. Publicawarenessmustbeinitiated regardingadverseeffectsofwaterpollution using the media.
9. Laws,standardsandpracticesshouldbeestablishedtopreventwaterpollution and these laws should be modified from time to time based on current requirements and technological advancements.
10. Basicandappliedresearchinpublichealthengineeringshouldbe encouraged.

Followingarethecontrolmeasuresofwater pollution:

1. Stabilisationofecosystem:

Itinvolvesfollowingpractices:

(a) Reductionofwasteatsource

(b) Harvestingandremovalofbiomass

(c) Trappingofthenutrients.

(d) Fishmanagement.

2. Usingwaterhyacinthtoremovewaterpollutants:

Waterhyacinthisextremelyefficientinabsorbingandconcentratingdissolved nutrientsfrom water in which it lives.

3. Usingchemicalmethods:

Severalchemicalmethodshavebeendevisedforthetreatmentofindustrialeffluentsbefore dischargingtheminwaterbodies,like

(a) IonExchange:

It is areversiblereactionwherein an iron fromsolutionisexchangedforasimilar chargedion attached to an immobile solid particle which is either naturally occurring inorganic zeolite or synthetically produced organic resins.

(b) ReverseOsmosis:

It involves the purification of water with the semipermeable membrane. When used as pre-treatment steps for deionization systems, reverse osmosis will remove feed water bacteria, organics and silica and reduce the dissolved saltcontent by greater than 95% only.

(c) Precipitation:

This process transform dissolved contaminants into an insoluble solid, facilitating the contaminant's subsequentremoval from the liquid phase by sedimentation or filtration.

(d) Coagulation:

Chemicalcoagulationenhancestheremovalofcolloidalparticlesbydestabilisingand chemicallyprecipitatingthemandaccumulatingtheprecipitatedmaterialintolargerfloe particles which can either removedby gravity setting or filtration.

4. Coolingmethods:

Forpreventingthermalpollutionsuchmethodsareusedlikecoolingwastewatereffluent, evaporationtower, coolingponds, dry coolingtowers, wet cooling towers etc.

5. Recycling,Renovation,RechargeandReuse(4Rconcept)ofwastewater:

The waste water consisting of domestic sewage industrial effluents, thermal and radioactive pollutants receive some sort of treatment before mixing into water bodies. Urban sewageand sludgeetc maybe recycled and reused to generatecheaper fuel, gas and electricity.

Soilpollution

Soil pollution

Soilpollution is defined as, "contamination of soil by human and natural activities which may cause harmful effect on living organisms".

Or

Soilpollutionistheadditionofchemicalstothesoilinquantitiesthataretoxictotheenvironment anditsresidents.Thisadditionismostly byhumanactivitiessuchasmining, modern practices in agriculture, deforestation, indiscriminate dumpingof human generated trash and unregulateddisposalof untreated wastes of various industries

Pollution by agriculturalpractises has come up ever since the demand for food has increased, proportionaltotheincreaseinpopulation.Toincreasetheyieldoffarmsandfieldsthe farmershavehadtoresorttoadditionalchemical fertilizers, pesticides,weedicides,hormonal treatments for the animals, nutrient laden feed and many such practices which changed the way farming was done traditionally.

Composition of soil

Organic COMPONENT

mineral **matter** **below:**

%

45

Organic	matter	05
Soil	water	25
Soil	air	25

TYPES, EFFECTS AND SOURCES OF SOIL POLLUTION

Soil pollution mainly occurs due to the following:

1. Industrialwastes
2. Urbanwastes
3. Agriculturalpractices
4. Radioactivepollutants
5. Biologicalagents

Industrialwastes – Disposalof Industrialwastes is the major problem for soil pollution Sources: Industrialpollutantsare mainlydischargedfromvarious originssuchas pulpand papermills,chemicalfertilizers,oilrefineries,sugarfactories,tanneries,textiles,steel,distilleries,fertilizers,pesticides,coalandmineralminingindustries,drugs,glass,cement, petroleum and engineering industries etc. Effect:These pollutantsaffect and alter the chemical and biologicalproperties of soil.As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb thebiochemicalprocessandfinallyleadtoseriouseffectson livingorganisms.

Urban wastes – Urban wastes comprise of both commercial and domestic wastes consistingof dried sludge and sewage. All the urban solid wastes are commonly referred to as refuse. Constituents of urban refuse: This refuse consists of garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Urbandomestic wastes though disposed off separately from industrial wastes, can still be dangerous. This happens because they are not easily degraded.

Agricultural practices – Modern agricultural practices pollute the soil to a large extent. With the advancing agro-technology, huge quantities of fertilizers, pesticides, herbicides and weedicides are added to increase the crop yield. Apart from these farm wastes, manure, slurry, debris, soil erosion containing mostly inorganic chemicals are reported to cause soil pollution

Radioactive pollutants/ - Radioactive substances resulting from explosions of nuclear testing

laboratories and industries giving rise to nuclear dust radioactive wastes, penetrate the soil

and accumulate giving rise to land/soil pollution.
Ex:

1. RadionuclidesofRadium,Thorium, Uranium,isotopesofPotassium(K-40)and Carbon(C-14)arecommonlyfoundinsoil,rock,waterandair.
2. Explosion of hydrogen weapons and cosmic radiations include neutron, proton reactions by which Nitrogen (N-15) produces C-14. This C-14 participates in Carbon metabolismof plants which is then into animalsand human beings.
3. Radioactive waste contains several radio nuclides such as Strontium90, Iodine-129, Cesium-137 and isotopes of Iron which are most injurious. Strontium get deposited in bones and tissues instead of calcium.
4. Nuclear reactors produce waste containing Ruthenium-106, Iodine-131,Barium-140, Cesium-144 and Lanthanum-140 along with primary nuclides Sr-90 with a half life 28 years and Cs-137 with a half life 30 years. Rain water carries Sr-90 and Cs- 137 to be deposited on the soil where they are held firmly with the soil particles by electrostatic forces. All the radio nuclides deposited on the soil emit gammaradiations.
5. Biological agents – Soil gets a large amount of human, animal and bird excreta which constitutea major source of land pollution by biologicalagents.

Ex:1.Heavyapplicationofmanuresanddigestedsludgecancauseseriousdamageto plantswithinafewyears

Controlmeasuresofsoilpollution:

1. Soilerosioncanbecontrolledbyavarietyofforestryandfarmpractices. Ex:

Planting trees on barren slopes

Contourcultivationandstripcroppingmaybepracticedinsteadofshifting cultivation

Terracingandbuildingdiversionchannelsmaybeundertaken.

Reducingdeforestationandsubstitutingchemicalmanuresbyanimalwastesalsohelpsarrest soil erosionin the long term.

2. Proper dumping of unwanted materials: Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal.The surface so obtained is used for housingor sports field.
3. Production of natural fertilizers: Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may beused to prepare compost manure instead of throwing them wastefully and polluting the soil.

4. **Proper hygienic condition: People should be trained regarding sanitary habits.**

Ex:Lavatoriesshouldbeequippedwithquickandeffectivedisposalmethods.

5. **Public awareness: Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education.**

Ex: Mass media, Educational institutions and voluntary agencies can achieve this.

6. **Recycling and Reuse of wastes: To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrialeffluents etc should be recycled and reused.**

Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

7. **Ban on Toxic chemicals:Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improperdisposal of radioactivewastes should be banned.**

CausesofSoil Pollution

- **IndiscriminateUseofChemicalfertilizers**

These are mostly nitrogen and phosphorus based chemicals like ammonia and nitrates that are most often than not, used in larger than required quantities and tend to accumulate in the soil.

- **Chemicalpesticides**

Controlling pests are a farmer's need if a good crop is to be reaped.Pesticides andinsecticides like organochlorines, organophosphates and carbonates are used regularly.These also contaminate the ground not only in the fields, but also in the places of manufacture, storage and disposal. They also tend to bio accumulate i.e. they collect in the body of the insects and then enter the food chain and lead to chronic poisoning of the higher level animals. Some pesticides also are absorbed naturally by the plants themselves and stored their different parts.

- **Heavymetals**

Cadmium,fluoride,radioactiveelementslikeuraniumareregularlyfoundintheparent mineralsfromwhichthefertilisersareobtained.DangerousmetalssuchasMercury,Lead, Arsenic, Chromium, and Nickel are seen in traces in Zinc rich wastes from the steel industries which are used as fertilizers. These are often not removed from the because of the high cost involved.

- **Excessivetillageoftheland**

Overturning, digging or stirring leads to release of greenhouse gases produced in the ground such as nitrous oxide

- **Soilerosion**

Loss of soil material due to poor management causes soil to become infertile. Soil erosion is followedbydeforestation,stormwaterrunoff,overgrazingandexcessofagriculture practices,constructions,mining.Thesoilsedimentssettlingelsewhereonlandorinwater cause differences to occur in the environments there. In water it causes murkiness reducingvisibilityforfishandotheranimalssourcingtheirfood.Itleadstoreducedpenetrationof sunlight and affects the process of photosynthesis causing reduction in oxygen levels of thewater.Heavy pollutants and nutrients are bound to the sediment particles and carried intothe water contaminatingit. Faster rate of soil erosionchanges the topographyof a place.

- **Animalmanagement**

The disposal of manure and other associated waste material from animal farms are also a reason for soil pollution. They cause pollution of the air as well as the water. 18 per cent of Greenhouse gases are said to be generated by farm animals. The large amounts of manure created, carry pathogensthat are harmful for humans too.

- **Landfillsandotherwastedumpingissues.**

Human generated sewage is a major cause for soil pollution. At the same time wasteproducts such as plastics, glass, metals, Batteries, paper, fibres and rubber etc. add to the contamination as most of these are non-biodegradable. Much of the trash can be recycled such as paper, metal and glass, etc. Leaching of toxic materials occur at landfills. The more dangerous substances found in landfills are oils, battery metals, heavy metals from smelting industries and organic solvents.

- **Acid rain**

Air pollutants,sulphurdioxides,nitrous oxide andothers combine with rain water, formacids and reach the soil. This is called acid rain. It reduces the pH of the soil ie it makes it acidic. It changes the nutrient content of the soil. These changes have adverse effects on the plants growinghere,theinsectsandtheotheranimal'sdependantontheland.

Mechanisms(TypesofSoilpollution)

Leachingand GroundWater Poisoning

Whenchemicalsaccumulateinthesoil,dependingonitswatersolubilityandsoilstructureit percolates through reaching the ground water, causing its contamination. This also depends on the rainfall. For example after applying pesticides on crops in sandy areas, if excessive irrigation is done , the pesticide chemicals leach into ground. Leaching occurs not only in the fields, but also at the manufacturing,mixing and disposalsites.

Waterrunoff

Only a fraction of fertilisers and other chemicaladditives are utilised on the fields. The major bulk mixes in the runoff water and flows into the nearby watercourses. This is mainly in theform of nitrates and phosphates.

Barrennessoftheground

Many times the ground becomes barren and cannot support any flora or fauna on it. Use of excessive fertilizer progressively reduces the nutrient content of the foods such as proteins and vitamins in grains and vegetables.

Preventionofsoil pollution

- **Managing and regulating the chemical waste disposal by industries is vital to soil health. Treatment of the wastes before disposal to remove chemicals and heavy metals at any cost must be done**
- **Prevention can never be a solo effort. The state governments, farmers' organisations, collectives and cooperatives, educational institutionsandconservationgroups needto work together for regulatingand reducingfarmingrelated soil pollution.**
- **Planning the application of fertilizer at the right time, in the right quantity with the correct methods can reduce the accumulationof chemicals.**
- **Plantingcertaingrassesandcloversthatcanabsorbandrecycletheadditional nutrients and preventsoilerosion.Planting rowsoftreesandshrubsaround fieldsand along the borders of the stream or lake also help in the same way.**
- **Overtillingofthesoilmustbeavoidedtopreventsoilerosionandsoilcompaction.**
- **Managing the correct disposal of human and animal wastes and treating the sewage before release makes a big differencein the magnitudeof soil and water pollution**
- **Composting, solid liquid separation, anaerobic digestion and lagoons are different ways of managing animal manure. Of these anaerobic digestion is the most effective.It involves the use of anaerobic bacteria and heat. The products of this process are nutrient rich liquid used as fertiliser and methane gas that can be burned to produce electricity and heat. Anaerobic digestion is a best method for controlling odour associated with manure management.**
- **Afforestationorplantingofmoretreesis alwaysgoodforbindingthesoil.**

Effectsofsoilpollution

Since soil pollution is not a lone standing entity, its effectsare carried over as water pollution and air pollution. It affects every aspect of the environment and every organism from the earthworm to humans.Some of the adverse effects are as follows:

Humanhealth

Since we are dependent on the land forour food, pollution fromthe soil is transferred to usin this manner. Bio accumulation of toxins occurs in our bodies, causing chronic poisoning,and leading to various diseases. Reproductive health, birth and developmental defects, neurologic effects, malnutrition, and mutations in the cells of the body leading to cancers; all these are on the increase today.

Growthofplants

Plants will not be able to adapt to sudden changes occurring in the soil. Fungi and bacteria foundinthe soilscannot bindthesoildue tochemical changesand thiscauses soilerosion.

Large tracts of land become barren; unable to support any life on it. Even the plants that do grow on these landswill absorb the toxins and transfer to the food chain.

Airpollution

Toxicdustrisesfromlandfillsalongwithfoulodour, pollutestheairandcausesadverse effects to the people who live near them.

Marinepollution

Marine pollutionrefers tothe contamination orpresence of pollutantsin oceans and seas. The word 'marine' comes from the Latin word for 'sea' and it is related to similar words, such as 'mariner'. Ocean pollutionis become ever more of a problem in the present day.

Marinepollutioncanbedefinedasanythingthatcontaminatesthesea.Commonmarine pollutants include chemicals, small plastic beads in exfoliants and also toxic bio-matter (such assewage).But,noise–duetoexcessivetrafficaroundtheocean–canalsobedefinedas pollution if it disrupts marine life.

Pollution can vary depending on the context and the purpose for which seawater is being used. For example, normal seawater has some small particles of plants or sand in, and when the sea is considered as the habitat of marine animals, one would not think of these particles as pollutants – whereas one would definitely define toxic chemicals as pollutants. However if somebody wanted to use this brine for cooking in, they might see the sand and plants as polluting our cooking water.

Causes/SourcesofMarinePollution

1. Toxicchemicalsinwater.

Chemical runoff from industry can really endanger marine life. Industrial waste pumped into the sea, household cleaners poured down the sink, and even chemicals in the atmosphere(for instancedueto thedischargeof industrial wastes throughfactorychimneys) thatdissolve into the sea can pollute our oceans significantly.

2. Oilspillages.

This is usually an accidental form of industrial dumping, whereby leaks in oil tankers cause vastquantitiesof oil to pour into the ocean. Accidentaloil spills candevastate marine life.

3. Smallparticles.

The tiny plastic beads in exfoliating creams and other small particles that we pour down the drain without thinking wind up polluting the ocean.

4. Plastic,Litter,andhumanwaste.

Plasticbags,aluminumcans,trashandotherhumanwasteconstituteamajorpollutant ofthe world's oceans. A huge 'island' of trash roughly the size of Texas was recently found in the Pacific ocean for instance, demonstratingthe vast scale of this problem.

5. Sewage.

Whether or not it is treated with toxic chemicals, sewage pollutes the clear, clean water ofthe oceans. This is another type of industrial dumping. Sometimes, sewage is not pumped directly into the sea but into rivers, and then the untreated water of rivers carries it into the sea.

6. Theshippingindustry.

Gases(whichdissolveinthesea),chemicalsandsewagefromcontainershipsaremajor pollutants.

7. Dissolvedgreenhousegases.

Greenhousegasesfromhumanfossilfuelconsumptionaremakingtheseamoreacidic. Effects of Marine Pollution

1. Oxygendepletion.

Seawater is full of dissolved oxygen, however decomposing sewage and other biomatter in oceans can result in a condition known as 'hypoxia' or oxygen depletion. This makes it hard for oxygen loving marinelife – plants, fish and animals – to survivein the oceans.

2. Higheracidity.

Toxic chemicals make our oceans more acidic. Again, this makes them poisonous to marine life and causesharm to fish and marine mammalsaswell as marineplants and corals.

3. Chokingmarinelife.

Small piecesofplasticandotherlitterare increasinglybeingfoundinthestomachoffish, turtlesandothermarineanimals.Thesepiecesoftrashchokemarineanimalsandhamper their digestion, with an often fatal result.

4. Spoilingbirds'feathers.

Oil spills coat the feathers of marine birds and strip them of the natural oils that birds use to keep theirfeathers waterproofand tomaintaintheirownbodytemperatures. As a result, marinebirds can overheat orgettoo cold, and they find ithard to stayafloatas their feathers get soggy.They will also find it difficultto fly when their feathersarecloggedwith oil.

5. Blockingoutthesunlight.

Pollutants such as oil or litter can block out the sunlight from sea plants which need sunlight for photosynthesis.

6. Dangerstohumanhealth.

Humanswimmersandwatersportsloverscanbecomeendangeredbyswimmingina polluted sea.

ControlMeasures/SolutionsforMarinePollution

1. Becarefulwithourchemicals.

Climate change and marine pollution are both results of excess human interference in the natural world. If we choose eco-friendly household cleaners and takemeasures to reduce the fumes we release into the air (for instance, by choosing public transport over cars) we can reduce the impact of our lives on the oceans.

Further, careful site monitoring to prevent or stop any chemical or oil spills at all times will reduce the instances of oil spills.

2. Don'tflush orrinseawayharmfulparticles.

If we do not flush plasticsdown the toilet,and if we do not pour oilsand exfoliating beads down the faucet, we prevent these particles from reaching our oceans. Switch to exfoliantsthat usenatural materialslike seeds, sugar or sand instead – and recycleall plastics!

3. Campaign.

Influence the decisions of policymakers and factory bosses to make them more eco-friendlyby lobbying,writingletters, spreadingthe word on social media andcampaigning.Motivating

the shipping companies to use safe and environmentally friendly vessels are among the key measures that can be taken here.

4. Volunteeratanoilspillsite.

Volunteersare always needed atoilspill sites to save thelives of marine birds by washing the oil from their feathers and caring for them until they are ready to fly, swim and dive under water again. Intervention is always needed as soon as possible to ensure that these birds do not suffer any ill effects to their health.

5. Volunteeratabeachcleanup –ororganizeoneyourself.

Rid your local beach of litter by getting together with the rest of the community to pick upthe trash left behind by careless picnickers, boat crews and more. Joining together as a community to care for the natural world is a wonderful way to remind everyone how intimately we are connected to nature, and how much we depend on it. Working together with other people also helps to keep us motivated and reminds us that we are not alone in our quest to care for the environment.

6. Ensuringnodebrisisreleasedintotheocean.

Recycling our plastics and other recyclable, and disposing of our waste responsibly is key here.

<u>Noisepollution</u>

Noiseis defined as, "theunwanted, unpleasant or disagreeable sound thatcauses discomfort to all living beings". Sound intensity is measuredin decibels (dB), thatis the tenth partof the longestunitBel.OnedBisthefaintestsoundthatahumanearcanhear.

<u>TYPES OF NOISE:</u>Environmental noise has been doubling every ten years. Noise is classified as:

1. **IndustrialNoise**
2. **TransportNoiseand**
3. **Neighbourhoodnoise**

<u>Industrial Noise:</u> It is sound with a high intensity sound causedby industry machines. Sources of such noise pollution is caused by machines from machines in various factories, industries and mills. Noise from mechanical saws and pneumatic drills is unbearable and a nuisance to the public.

The Indian Institute of Oto-Rino Laryngology, Chennai reported that increasing industrial pollution damages the hearing ability by atleast 20%.

Workers in steel industry, who work close to heavy industrial blowers are exposed to 112dB for eight hours suffer from occupational pollution.

<u>Transport Noise</u>: Transport noise mainly consists of traffic noise from road, rail and aircraft. The number of automobiles on roads like motors, scooters, cars, motor cycles, buses, trucks and diesel engine vehicles have increased enormously in the recent past further aggravating the problem of transport noise.

Noise levelsinmost residentialareasinmetropolitan cities is hoveringaround theborder line due to increased vehicular noise pollution. This high level of noise pollution leads todeafening

in the elderly.

Neighbourhood noise: This type of noise includes disturbance from household gadgets and community. Common sources being musical instruments, TV, VCR, Radios, Transistors, Telephones, and loudspeakers etc. Statistically, ever since the industrial revolution, noise in the environment has been doubling every ten years.

CausesofNoisepollution

Noisepollutioncanbe causedbyseveralphenomenon includingindustrial activity,and social activity(such as explosion of fire crackers,loud parties), andsurfacetravel. The manycauses of noise pollution are discussed below:

1. Fire crackers:Fire crackers are exploded to make huge sound during celebrations and festive occasions.It is common sight to witness the firing of crackers at live concerts. These high levels of soundis extremely problematicfor people, especiallyelderly and sick people.

2. Transportationvehicles: Noisepollutionisseverestinthecities.Allformsofmachine powered vehicles cause noise pollution. The different modes of transportation (land, air and water),producesenoughsoundandcollectivelycausesmassivedisturbancetothehuman mindandbody.Duringthelastfewdecades, theworldismovingat unprecedentedspeed. Peopleusesurfacetransportationvehiclessuchascars,vans,buses,trams,bullettrains. There aremetro rails in major cities. Long distances are very often covered in an airplane or a bullet train. Airports and railway stations are busy throughoutday and night. Far away places canbereachedinhours.Peopletakethewaterroutetotravelviamotorshops,boats, yacht,and helicopters. Many people even own private air-crafts. Theever-increasing usage of various modes of transportis the major cause for noise pollution.

3. Microphones and Loud Speakers:Loud speakers and microphones are used during social, politicalandotherspecialevents.Largepublicgatheringsareheld.Tomakesurethatthe announcements and speeches are audible a large audience, microphones and loud speakers ate used. Though these public gatherings are generally held for welfare and entertainment of the public, the nearby residents suffer from loud noise.

4. Factoriesandindustries: Inlargecities,therearelargenumberoffactories,millsand industries.Industriessuchassteelindustry,shippingindustry,aircraft,wires,switchgears and automobiles cause industrial noise. Theseindustrial sites produce immense environmentalnoise to disturb the habitats of nearby residential areas. Large scale industries are often sites as a major cause of NIHL – Noise Induced Hearing Loss (read more about NIHL inWikipedia).Theworkersandemployeesworkinginfactoriessufferfromoccupational noise(readmoreaboutoccupationalnoiseinWikipedia).Theyareconstantlyexposedto noiseoftheworkingmachinery.Theirauditorysystemisatrisk.Long-termexposureto industrialnoise may lead to hearing disability.

5. Domestic household appliances: A majority of domestic household appliances that we use in everyday life causes noise pollution. Home theaters and televisions are played non-stop. The air cooler is supported by a large and powerful fan. The mixer grinders are used in grinding food materials. The juicer extracts juices from the fruits. The air purifier is used to purify the air. Washing machines are used for washing clothes. Loud music are played on

advanced music systems. The smart phone keeps ringing.

6. Building and construction sites near residential areas: The building and construction activity involves use of sound producing equipment such as cement-mixer, road-roller, crane, etc. Cement mixers uses a revolving drum to mix cement, sand, small stones and water to create concrete. The sound of cement mixers are annoying.

7. OfficeEquipment:Inoffices,awidevarietyofequipmentisused.Manyoftheoffice equipment make noise. Paper shredders are used to cut papers. Printers are widely used for printing textsand pictures. Amanual type writer, is used for typing. Faxmachines are used to sendorreceivescannedtextsorimagesthroughtelecommunicationlines.Phoneskeep ringing. Andpeople keeptalkingtobusinesspartners,and clientsoverphone.Whendoors are opened and shut hard, it makes noise.

Alltheaboveactivitiesproduceenoughnoisetodisturbthehealthandmindofhuman- beings and other living bodies.

Effects of Noise pollution

1. **Noisepollutionaffectsbothhumanandanimalhealth. Itleadsto:**
    1. **contractionofbloodvessels**
    2. **makingskinpale**
    3. **excessiveadrenalininthebloodstreamwhichis responsibleforhigh bloodpressure.**
    4. **Blaringsoundsareknowntocausementaldistress**
    5. **Heartattacks,neurologicalproblems,birthdefectsand abortion**
2. **Musclecontractionleadingtonervousbreakdown,tension,etc**
3. **Theadversereactionsarecoupledwitha changeinhormonecontentofblood, which in-turn increasesheart beat, constriction of blood vessels, digestive spams and dilation of the pupil of the eye.**
4. **Adverseaffectshealth,workefficiencyandbehaviour.Noisepollutionmay causedamagetotheheart,brain,kidneys,liverandmayproduceemotional disturbance.**
5. **The most immediate and acute effect of noise is impairment of hearing that diminishes some part of the auditory system. Prolonged exposure to noise of certain frequency pattern leads to chronicdamage to the inner ear.**
6. **Impulsivenoisemaycausepsychologicalandpathologicaldisorders**
7. **Ultrasonicsoundcanaffectthedigestive,respiratory,cardiovascularsystem andsemicircularcanalsof theinternalear.**
8. **Thebrain is adverselyaffectedby loud andsudden noise byjets and airplanes. People are subjected to psychiatric illness.**
9. **Recentreportssuggestthatbloodisthickenedbyexcessivenoise.**
10. **The optical systemof human beings is also affected by noise pollution. Severe noise pollution causes:**
    1. **Pupullarydilation**
    2. **Impairmentofnightvisionand**
    3. **Decreaseinrateofcolourperception**

Or

Effect on Human beings: Noise pollution affects the humanmind and body negatively. The ill-effects of noise pollution are many. It is the major cause for several ailments. The quality of human life gets disrupted. The lives of the children, the aged or the ailing people become miserable.

1. **Loss of hearing and deafness: Noise above the tolerable threshold is the leading causefor loss of hearing and deafness.**
2. **Cardiac disturbance: Noise increase the risk of cardiac disturbance including coronary artery disease or ischemic heart disease (IHD).**
3. **Sleeplessness:Noisemaymakepeoplerestlessandtired. It maycausedisrupted sleeping pattern or may keep people away from sound sleep. In the long-term, due to tiredness and lack of sleep, the immune system may get compromised.**
4. **Headache: Human mind can tolerate sound only to a limited extent. Excess noise causes headache.**
5. **Stress, tension and aggressiveness:Loud noises can be very stressful. Constant exposure to irritating sound may cause stress and tension. The behavior of people often becomes aggressive. Other than psychological imbalance, is causes physical illness such as increased blood pressure, cardiac disturbanceand insomnia.**
6. **Irregular blood pressure:For good health, it is very important to maintain normalpressure in the arteries both duringthe heartbeat and betweenthe heartbeat. Noise may contributeto fluctuationsin the levels of blood pressure.**
7. **Mentalimbalanceandnervousdebility:Mentalillnessisamongtheworstnegative effects of noise pollution. People may find it difficult to cope with their normal routine life. Human mind cannot accept sound beyond a certain level. Excess sound may lead to mental imbalance and nervous disability.**
8. **Psychologicalimbalance:Itmayalsocausepsychologicalimbalance.**
9. **Difficulty in talking: Due to excessive noise, it becomes very difficult to talk on roads or inside malls**

Effect on Animals: Noise pollution is hazardous for animals, both wild and domestic. Itimpairs hearing. Sometimes, it changes the reproductive behavior of the animals. Noise disrupts the communication among animals. Some animals cannot live in noisy atmosphere resulting in loss of habitat. In the presence of noise, some animals raise the level of their voice. For example, many marine animals raises their voice when large ships passes near them. The increased voice further adds to the noise already present. Marine animals are sensitive to noise.

Control measures:

1. **SOURCECONTROL: Thisincludessource modificationsuchasacoustic treatment to machine surface, design changes, limiting operationaltimings,etc**

2. **TRANSMISSION PATH INTERVENTION:** This includes containing the sourceinside a sound insulating enclosure, constructing a noise barrier or provision of sound absorbing materials along the path.

3. **RECEPTOR CONTROL:** This includes protection of the receiver by altering the work schedule or provision of personal protection devices such as ear plugs for operating noisy machinery. The measure may include dissipation and deflection methods.

4. **OILING:**Properoilingwillreducenoisefromthemachine.

Preventive measures:

1. Prescribingnoiselimitsforvehiculartraffic
2. Banonhonking(usageofhorns)incertainareas
3. Creationofsilencezonesnearschoolsandhospitals
4. Redesigningbuildingstomakethemnoise proof
5. Reductionoftrafficdensityinresidentialareas
6. Givingpreferencetomasspublictransportsystem.

Some effective measures should be taken to solve the problem. The following measures can be taken to prevent noise pollution:

- Better town planning and ensuring that residential towns are set up at places away from heavy industrialunits can help in combatingthe problem of noise pollution.
- Significant control over noise pollution caused by transportation vehicles can be controlled by making smooth roads, and by disallowing heavy carriage vehicles on roads near residential units.
- Toprevent and control noisepollutionit isnecessary to create public awareness. Only lawisnotsufficient.Peoplemustbemadeawareoftheharmfulconsequencesand irreversibleinjuriescaused of noise pollutionsuch as deafness,mental illness, etc.
- Thereshouldbeminimumuseofsoundproducinginstruments.Thereshouldbeproper regulationsfortheuseofloudspeakers,microphones,andotherdevicesthat producenoisebeyondthatarebeyondthetolerationlimitsofhuman-beings.
- The PollutionControl Boardand the High Court havealreadytaken effectivemeasuresto bringsoundpollutionundercontrol.Adequatemeasuresshouldbetakentoensure that noise related restrictionsare not violated.
- Anti-pollutionlawsshouldbeenactedandenforced.
- Banonfirecrackersshouldbeimposedandelectrichornsshouldbereplacedby bulb horns. Further,use of horns in residentialareasshouldbe monitoredand regulated.
- Usageof quietermachineryshouldbeencouraged.

Thermalpollution

Thermalpollutioncanbesimplyexplainedastheadditionofsurplusheattowaterand

ejectingitbacktothewaterbodies.Sohowdoesithappen?Well,numerousindustriestake

water from natural water resources for their industrial purposes. Maximum of this water isused as coolantas it is used to cool down the machines of any factoryor plant.
Afterwards, this used water with altered and much high temperature is ejected back to the naturalresourcesincludinglakes,ponds,seas,etc.Thiscausessuddenincreasein temperature of natural water bodies too. The altered water also creates disturbance in theoxygenlevelofwaterbodies.Thisinturn,harmsthemarinelifeandlocalecosystems. Therefore, thermal pollution caused in water by spilling back the industrial waste and usedwater in it, causing adverse effects, is known as thermal pollution.
Thermalpollutionisnotonlycausedbythehotwaterbutalsobythecoldwaterthatis dischargedby various industriesinto the rivers or seas containingwarm water.
Or
An increase in the optimum water temperature by industrial process (steel factories, electric power houses and atomic power plants) may be called as "Thermal Pollution." Many industriesgenerate their own power and use water to cool their generator.
Or
Thermal pollution is defined as the addition of excess of undesirable heat to water thereby makingitharmfulto man,animaloraquaticlife.Thermalpollutionmayalso causesignificant departures from nor activities of aquatic communities.

Sources of Thermal Pollution:

The following sources contribute to thermal pollution.

1. **Nuclearpower plants**
2. **Coalfiredplants**
3. **Industrialeffluents**
4. **Domesticsewage**
5. **Hydro-electricpower**

1. **Nuclearpowerplants:Nuclearpowerplantsincludingdrainagefromhospitals, research institutions, nuclear experiments and explosions, discharge a lot of heat that is not utilized along with traces of toxic radio nuclides into nearby water streams. Emissions from nuclear reactors and processing installations are also responsible for increasing the temperatures of water bodies. The operations of power reactors and nuclear fuel processing units constitutes the major contributor of heat in the aquatic environment. Heated effluents from power plants are discharged at 10 C higher than the receiving waters that affects the aquaticflora and fauna.**
2. **Coal-fired power plants: Coal fired power plants constitute a major source of thermalpollution.Thecondensercoilsinsuchplantsarecooledwithwaterfrom nearby lakes or rivers. The resulting heated water is discharged into streams thereby raisingthewatertemperatureby15C. Heatedeffluentdecreasesthedissolved content of water resultingin death of fish and other aquatic organisms. The suddenfluctuation of temperature also leads to "thermal shock" killing aquatic life that have become acclimatized to living in a steady temperature.**
3. **Industrialeffluents: Industries liketextile,paper,pulp and sugarmanufacturing**

release huge amounts of cooling water along with effluents into nearbynatural water

bodies. The waters polluted by sudden and heavy organic loads result in severe dropin levels of dissolvedoxygenleading to death of several aquatic organisms.

4. Domestic Sewage: Domestic sewage is discharged into rivers, lakes, canals or streamswithminimaltreatmentorwithoutanytreatment.Thesewasteshavea higherorganictemperatureandorganicload.Thisleadstodecreaseindissolved oxygen content in the receiving waters resulting in the set-up of anaerobic conditions causingreleaseoffoulandoffensivegasesinwater.Eventually,thisleadsto developmentof anoxic conditionsresultingin rapid death of aquatic organisms.

5. Hydro-electric power: Generation of hydroelectric power sometimes leads to negative thermal loading in water systems. Apart from electric power industries, various factories with cooling requirementcontributeto thermal loading.

Thermal pollution in streams by human activities

1. Industries and power plantsuse water to cool machinery and discharge the warm water into a stream

2. Streamtemperatureriseswhentreesandtallvegetationprovidingshadeare cut.

3. Soilerosioncausedduetoconstructionalsoleadstothermalpollution

4. Removalofstreamsidevegetation

5. PoorfarmingPracticesalsoleadtothermalpolloution

Causes of Thermal Pollution

1. **Waterusedascoolant&ejectedbackintowaterbodies–Mainly,thewaterthatis used as coolant and transferred back to natural water bodies is the chief reason for thermal pollution. This kind of activity is mostly done by production; manufacturingand power plants. These plants use water to cool down their machines and eject back the hot water into water bodies. Thus, the natural water goes through a sudden rise in temperature.**

2. Release of cold water – Just as we mentioned before, many industries liberate very cool water from their reservoirs. This water when mixed up with warm water rivers, lakes or ponds creates a disbalancein the flora and fauna of affected water bodies.

3. Growing industrial activities – It gives a repenting feeling to know that thermal pollutants are increasing day by day because of the growing industrial activities. Therefore, thermal pollution is also growing each day.

4. Chemical pollutants discharged into water – There are copious factories that discharge their chemical waste directly into natural water bodies. This does not only causes thermal pollution but also makes the water poisonous.

5. Livestock waste mixed into water – This is another major cause of thermal pollution. Many industries dispose their livestock waste into water without analyzing upon the hazardous consequences of this act.

6. Water discharged from urban areas – Many urban areas like parking places, roads,etc., deposit rain water and discharge the heated water back into water bodies. The heated water disturbsthe normal temperatureof natural water bodies.

7. Humanwaste,household&personalcareproducts–Theseproductsgointosewage waterwhichpollutesthewaterinponds,seasandotherwaterbodies.

8. Deforestation & soil erosion – Soil erosion makes natural water bodies to rise beyond their normal level. Thus, they get moreexposed to sunlight.Hence, the temperature of water rises. Forests absorb much of sun rays and save water bodies from getting too much heat. However,deforestationdisturbsthis cycle and provides augmentedtemperature of water.

9. Natural Geo-thermal activities – Natural geothermal activities can stimulate lava and can cause a rise in water temperature, makingway for thermal pollution.

10. Unawareness among people – Growing thermal pollution is also the result of unawareness among people. Even after knowing the hazardous effects of thermal pollutionon environment, there are abundant industries which are continuously using ways that encourage this pollution.

EffectsofThermalPollution

1. **Thermal shock resulting in rise in temperature of water bodies – When industries and factories dispose the water, used as coolant, back into water bodies the temperature suddenly raises to an abnormal level. The sudden and abnormal temperature level actsas a thermal shock for aquatic life, which is adapted to living in a specific temperature and cannot,handlethe abrupt change in water temperature.**

2. Depleted level of oxygen in natural water – When warm water discharged byindustries enters the natural water bodies, they get heated up. The warm water causes an unusual growth of plants and expansion of algae. The algae expansion in water reduces the level of oxygen in water.

3. Contamination of water – Thermal pollution also results in contamination of water because various chemicals and other wastes get mixed up with the water that is disposed off back to rivers, ponds, lakes, etc., byvarious factories. If thiscontamination of water keeps on increasing,humans can suffer from shortage of water.

4. Reduced solubility of oxygen –Reducedsolubilityof oxygen in waterbodies isanother disappointing effect of thermal pollution. This less solubility of oxygen in water mainly affects the metabolismof water animal.

5. Adverse effect on water plants – Change in temperature levels is extremely harmfulfor the aquatic plants. These plants cannot cope up with the sudden alteration in water temperature. Hence, more and more aquatic plants are depleting each day because ofthermalpollution

6. Adverse effects on water animals – The whole marine life gets disturbed because of thermal pollution. The contaminated water makes the natural water poisonous and has an adverse effect on animals living in it. Also, the reduced level of oxygen makes it difficult for water animals to survive.

7. Effect on population of water animals – When the temperature in natural waterbodies gets disturbed because of thermal pollution, the cycle of animal population gets disturbed too. For example, sometimes thefish start laying eggs toosoon and sometime they do it too late. The wholeproductivityof river gets disturbedtoo.

8. Disturbance in biological activities of water animals – Thermal pollution leads to a disturbance in quality and temperature of water in various water bodies. This altered quality and temperature directly affect all the biological activities of animals, thus disturbing thecycle of nature.

9. Unfavorable Effect on Water Biodiversity – Thermal pollution largely affects the water bio diversity. The rise in temperature of water results in increased metabolic activity of some water animals. Hence, they start consuming more food in short time. This also leads to shortage of certain water resources. Some animals which are unable to stand the raised temperature start moving to other regions. Therefore, the whole natural system of water bio diversity gets disturbed.

10. Unexpected Migration of Water Animals – When water animals find it difficult to survive in the changed water because of thermal pollution, they start for an unexpected migration,making way for a disturbed ecosystem.

ControlMeasuresforThermalPollution

After reading about so many harmful effects of thermal pollution, and the disturbance that it causes in nature's cycle, you must definitely be wondering that whether there is any solution forthesame.Thegoodpointisthatofcourse,thereisasolutionforthermalpollution.Asman has createdthe problem of thermal pollution,he should be the one to work out for itssolutiontoo! The best part about the solution for thermal pollutionproblem is that we candefinitely make a huge and positive difference if we start following just few steps. Without discussing thesesolutions, we cannot reach a positive conclusion.

Soletusglancethroughsomeeffectivewaysthatcanhelpreducethermalpollutionata significant extent:

1. **Use less electricity – All of us know that power plants are the main reasons behind growing thermal pollution. This is so because power plants use water as a cooling agent for cooling down their machines. This used water, which is much higher in temperature,is discharged back into therivers,seas orlakes.We canmakeasignificantcontribution in controlling thermal pollution by consuming lesselectricity,.The use of less electricity will lead to less workload on power plants and these plants will not have to use their machines too much, meaning controlled use of water as coolant. Hence, switch off fans when you are not sitting in that room, switch off unnecessary lights, use solar products and techniques.All such steps will help us use lesser electricity.**

2. Use of Better Technologies – Science has gifted us with plentiful inventions, discoveries, techniques and knowledge. Incorporating good techniques ensure a goodlifestyle for human race. Use of better technologies is strongly recommended for solving the problem of thermal pollution. There are technologies available which help in the coolingdown of machines. If machines will be cooled down with the help of technologies, the use of water as coolant will come to a much reduced level. Various industries and power plants should look out for appropriate technologies that serve the purpose without encouraging the steady problem of thermal pollution.

3. Holding back the water for good – If factories or plants cannot stop using water as a coolant, there is another option available for them. After using the water as coolant, they should store that water somewhere else for a temporary period. Instead of discharging back the heated water into water bodies, the temporarily collected heated water can be used for various other purposes too. Storing the heated water for a particular time will help inbringingback the high temperature of water to a normal level.

3. Plantation of more trees upon the banks of rivers, seas & other water bodies – This is also a good way to control thermal pollution. The trees around sources of water help in absorbing the harsh sun raysand prevent them from falling directly upon the water. This helps in prevention of heating of water bodies. Planting more trees also helps in controlling the problem of soil erosion because the strong roots of trees hold the soil firmly and stop it from erosion. Trees do not only help in controlling thermal pollutionbut also aid in a better environment including fresh air and peaceful scenic views. We should also encourageour cominggenerationsto plant more and moretrees.

5. Artificial Lakes – Industries, factories or plants which are serious about storing and reusing the heated water, used as coolant, can work out on artificial lakes. These are artificial lakes where the heated water can be stored easily. These lakes are very helpful for normalizing the temperature of hot water. This way, the hot water will not be disposed back to the lakes, rivers, etc., and will be used in other suitable tasks. Actually, the artificial lakes or ponds use evaporation or convection technique for cooling downthe water. These artificial lakes or ponds generally contain two ends. From one end, the

hotwateristransferredintothelake;itisprocessedthroughevaporationorother

techniqueandfinally,whenitcoolsdown,itistakenoutfromtheotherend.The evaporated heat dissolves in the air.

5. Recycling used water – Smart people always find intelligent solutions for even themost difficult of problems. If people start working upon the ideas of recycling the used water in plants and factories, the problem of thermal pollution will definitely belessened to a significant extent. Every plant or industry should make it a rule that water used as coolant will not be spilled back into water bodies. Rather, it will be recycled for further tasks. In today's era, we often hear news about the shortage of water andthousands of people dying because of the same. Just ask yourself that isn't it our duty tosave water and use it for good?

7. Spreading awareness among people – Environment can be made better with a united effort. Making more and more people aware about the problem of thermal pollution will be very beneficial in the long run. Groups of people can initiate a discussion withdifferent plants and industries. These groups can discuss the harmful effects of thermal pollution on aquatic life and our environment. We can also aware others about the consistent problem of thermal pollution by gaining the right knowledge about thermal pollution.

8. Suitable arrangements in urban places – Places like parking spaces, drainage pipes, sewerage tanks, etc., should have proper arrangements so that the water does not get collected at those spaces. When the water isaccumulated at thesespaces, it gets heated up and gets mixed with seas, ponds, lakes, etc., thus making way for thermal pollution. Hence, by making appropriate arrangements at such places, we can stop water from getting accumulated.

9. Co-generation – Co-generation is also a wonderful idea to combat thermal pollution.In the process of co-generation, the useless heat from hot water can be recycled andused smartly in many tasks by industries.

10. Cooling towers – Cooling towers is also a good idea when talking about the solutions for thermal pollution. The purpose of using cooling towers is the same as artificial lakes. The cooling towers also use the hot water of industries, process it by transferring its heat and transform hot water into cold water. This cool water can be recycles and used again for different industrialpurposes.

Generally, the cooling towers are of two types. This includes the wet cooling tower and the dry cooling tower. In wet cooling tower, the heated water gets spread upon the flow-directing panels. Afterwards, the high-speed cold air is passed upon it. Henceforth, the hot water gets cooled down.

In drycoolingtowers, the heatedwater is madeto flow in circular elongatedpipes. Again,the cold air blows arepasseduponthesepipes thathelp in bringing downthetemperature of hot water.

NUCLEARPOLLUTION

Nuclear radiation has catastrophic effects on the health of humans such as foetus damage, leukemia, permanent physical deformation, skin burns and even death in case if the person comes in contact with severe radiations. It also releases toxic minerals in the environment causingpollution

CAUSESOFNUCLEAR POLLUTION

- **Nuclearweaponstesting-**

Beginning with the Second World War when Japan was subdued after the use of the nuclear bombson the citiesof Hiroshimaand Nagasaki,countries have beenin the race to develop theirownnuclear arms,inthenameofdefence,butmoretothreatenrivalnations.These were led by US, Russia, Britain, France and China. Nowadays N. Korea, Iran and many of thedevelopingcountriesare equippedto build these weapons as well.

Testingthe weaponsinvolves explosionsisthe atmospheric layer calledstratosphere. The explodeddebrisemittingradiationthenfallsbacktotheearth.Someoftheradiationis absorbedbyouratmosphere.Butsomeofitreachestheearthfallingonareasthatarefar awayfromthesitewheretheweaponwasreleasedinitially.ThisiscalledFallout.When theseparticlessettleonthevegetationandareconsumedbyanimalstheyenterintothe foodchain.Whenfalloutsettlesoverthesea,theecosystemoftheseagetsaffectedand again entering the food chain.

- **NuclearPowerPlants**

Intense Nuclear energy from radioactive fuel is used to heat water to steam. The steam is then used to turn the turbines that in turn work the generators to produce electricity. Small amountsof radiationarereleasedduring this processinto thewaterwhich maythen dispose off indiscriminately causing nuclear pollution.

- **Improperdisposalofspentnuclearfuel.**

Spent nuclear fuel contains very active radioactive atoms that remain so sometimes almostfor600yrsormore.Thesemustbedisposedofinaverycarefulmanner,withstrict regulations in well designated spaces. But the fact is many governments tend to approve of dumping nuclear fuel as far from their country as possible. The favourite dumping ground of many countrieswas the Pacific Ocean. Greenpeace an organisation dedicated to preservingtheenvironmentandsavingtheearthfrompollutionhasbroughtattentiontothisactivity and opposes it with fervour.

Some plants store spent fuel in underground water pools as these release a high amount of heatandneedtobecooleddown.Thereisalwaysthedangerofseepageintotheland nearby, contaminating ground water and surrounding lands.

- **Accident/DamagetoNuclearpowerplants**

This most famous of these was the Chernobyl Nuclear Disaster in Russia in 1986. The fallout of this accident was felt over three countries- Russia, Ukraine and Belarus. The area surroundingthe reactor is still pollutedand not suitable for inhabitationor farming.

The other more recent accident was the Fukushima Daichii nuclear disaster on March 11th, 2011. An earthquake followed by a tsunami caused the main reactors and supplementary generators severe damage. Inadequate preparation to deal with an incident of this scale was also a factor that leads to hydrogen explosions and the seepage of radioactive material in the ground water.

EffectsofNuclearPollution

The effect of nuclear pollution is seen on every organism in the environment from thebacteria to plants to human beings. Nothing is spared.

- **The immediate and closest to the source, experience Radiation Sickness. In smalldoses of 75-200 rems. One experiences vomiting, fatigue and loss of appetite. Athigher exposures of 300 rem and more changes in the blood cells and bleeding occurs. Above 600 rems there is loss of hair, loss of immunity usually resulting in death in a few days to weeks. Radiation causes changes in the cell and gene structure of rapidly multiplying cells of the body, such as bone marrow, skin, intestines, lymphoid tissue and embryo.**
- **Those exposed from a distance may not show any immediate symptom. But the tendency to develop various forms of cancersand have a shortened life span is seen. Radiation also causes cell mutations which canbe transferredto the next generation.**
- **Foetusesareaffectedwithbirthdefects andcancers.Theymayalsohaveashorterlife span.**
- **Plantsdieandsomeshowgeneticchangesandstuntedgrowth.Animalsarealso affected and do not survive for too long.**
- **Theradiation in the atmospherewill not dissipatequickly. Everywater sourcewill also be affected. In fact it may take years or centuries to reach a point where such a space may become habitable.**
- **An average person will be exposed to about 180 milli rem of radiation in a year from exposure to natural radiation, medical and dental X rays, Colour TVs, airport baggageX rays etc.**

PreventionofNuclearpollution

- **Whilst undergoing procedures for X rays or radiation therapy, correct protection gear such as lead aprons must be worn. This includes pregnant women. Using leadsheathed walls in imagingfacilities is also mandatory.**
- **As a lay person one must be aware of the dangers of nuclear pollution. If living in the vicinity of a nuclear plant or hearing of one being planned, one should use one's right to make sure the governing bodies are planning thoroughly on the building, implementing and disposal of the wastes. Make certain that the authorities are prepared in case of a disaster, to handle all the situations such as containing the**

contamination to arranging an evacuation.

- **While working ataradiation facility orin nuclear plantworkers arealwaysmonitored for the amount of radiationthey have been exposed to.**
- **Radioactive wastes areactually recyclableto agood extent because usable fuelis still being created in the wasted material which can then be reprocessed.**
- **Governments are authorising research on developing better means for disposal of radioactive wastes. The most feasible method now appears to be deep underground storage of wastes.**
- **Powerplantsmustensurethattheradioactivefuelandwastesare beingtransported anddisposedofinsafecontainerswhicharelonglastingandunbreakable.**
- **Governing agencies need to make sure that radioactive material does not fall into wrong hands that will, for aprofit sell these to people who arein the business of war mongering.**

Nuclearenergyisacleansourceofenergy,inexpensiveandextensivetoo.Withasmall amount of fuel a large amount of energy can be generated. Though there have been mishaps inthepastandwrongfuluseofthisenergy,thereisstillgreatpotentialforit.Anywell intentionedeffortmustbebackedby good research, a well-designed planand proper back up plansfor any setbacks.The safetyof the environmentand the people mustalways come first.

<u>Solidwastemanagement</u>

Rapid populationgrowth and urbanizationin developingcountrieshas led to people generatingenormousquantitiesofsolidwasteandconsequentenvironmentaldegradation. The waste is normally disposedin open dumps creatingnuisanceand environmental degradation.Solid wastes cause a major risk to public health and the environment. Managementofsolidwastesisimportantinorderto minimizetheadverseeffectsposedby their indiscriminate disposal.

Typesofsolidwastes:Dependingonthenatureoforigin,solidwastesareclassifiedinto

1. **URBANORMUNICIPALWASTES**
2. **INDUSTRIALWASTES and**
3. **HAZARDOUSWASTES**

<u>SOURCESOFURBANWASTES</u>

Urbanwastesincludethefollowingwastes:

Domesticwastescontainingavarietyofmaterialsthrownoutfromhomes

Ex: Food waste, Cloth,Waste paper, Glassbottles, Polythene bags, Waste metals, etc.

Commercialwastes:Itincludeswastescomingoutfromshops,markets,hotels,offices, institutions, etc.

Ex:Wastepaper,packagingmaterial,cans,bottle, polythenebags,etc.

Constructionwastes: It includes wastes of construction materials.

Ex:Wood,Concrete,Debris,etc.

Biomedicalwastes:Itincludes mostlywasteorganicmaterials

Ex:Anatomicalwastes,Infectiouswastes, etc.

Classificationofurbanwastes

Urbanwastesareclassifiedinto:

Bio-degradablewastes-Thosewastesthatcanbedegradedbymicroorganismsarecalled bio-degradable wastes

Ex:Food,vegetables,tealeaves,dryleaves,etc.

Non-biodegradablewastes:Urbansolid wastematerialsthatcannotbedegradedbymicro organismsarecallednon-biodegradablewastes.

Ex:Polythenebags,scrapmaterials,glassbottles,etc.

SOURCESOFINDUSTRIALWASTES

Themainsourceofindustrialwastesarechemicalindustries,metalandmineralprocessing industries.

Ex:

Nuclearplants:It generatedradioactivewastes

Thermalpowerplants:Itproducesflyashinlargequantities

ChemicalIndustries:Itproduceslargequantitiesofhazardousandtoxicmaterials.

Otherindustries:Otherindustriesproducepackingmaterials,rubbish,organicwastes,acid, alkali,scrapmetals,rubber,plastic,paper,glass,wood,oils,paints,dyes,etc. EFFECT OF

IMPROPER SOLID WASTE MANAGEMENT

1. **Duetoimproperdisposalofmunicipalsolidwasteontheroadsandimmediate surroundings,biodegradablematerialsundergodecompositionproducingfoulsmell and become a breedingground for disease vectors.**
2. **Industrialsolid wastes are the source for toxic metals and hazardouswastes thataffectsoilcharacteristicsandproductivityofsoilswhentheyaredumpedonthe soil**
3. **Toxicsubstancesmaypercolateintothegroundandcontaminatethe groundwater.**
4. **Burningofindustrialordomesticwastes(cans,pesticides,plastics,radioactive materials and batteries) produce furans, dioxinsand polychlorinatedbiphenylsthat are harmful to human beings.**

Solidwastemanagementinvolveswastegeneration,modeofcollection,transportation, segregation of wastes and disposal techniques.

STEPSINVOLVEDINSOLIDWASTEMANAGEMENT:

Twoimportantstepsinvolvedinsolidwastemanagementare:

Reduce,ReuseandRecycleofRawMaterials

Discardingwastes

Reduce-Ifusageofrawmaterialsisreduced,thegeneration ofwastealsogetsreduced

Reuse-Refillablecontainersthat arediscardedafterusecanbereused

Rubberringscanbemadefromdiscardedcucletubesandthisreduceswaste generationduring manufactureofrubberbands.

Recycle-Recyclingisthereprocessingofdiscardedmaterialsinto newusefulproducts

Ex: Oldaluminiumcansandglassbottles aremeltedandrecastintonewcansandbottles

Preparation of cellulose insulation from paper

Preparationofautomobilebodyandconstructionmaterialfromsteelcans

Thismethod(Reduce,Reuse&Recycle),i.e,3R'shelpsavemoney,energy,rawmaterialsand reducespollution.

DISCARDINGWASTES:

Thefollowingmethodsareadoptedfordiscardingwastes:

1. **Landfill**
2. **Incinerationand**
3. **Composting**

LANDFILL: Solid wastesareplaced inasanitarylandfillin whichalternatelayersof80cmthick refuse is covered with selected earth-fill of 20 cm thickness. After 2-3 years solid waste volume shrinks by 25-30% and land is used for parks, roads and small buildings. This is the mostcommonandcheapestcheapestmethodofwastedisposalandismostlyemployedin Indian cities.

Advantages:

It is simple and economical
Segregation of wastes is not required
Landfilled areas can be reclaimed and used for other purposes
Converts low-lying, marshy waste-land into useful areas.
Natural resources are returned to soil and recycled.

Disadvantages:

Large area is required
Land availability is away from the town, tansportation costs are high
Leads to bad odour if landfill is not properly managed.

Landfilledareaswillbesourcesofmosquitoesandfliesrequiringapplicationofinsecticides and pesticides at regular intervals.
Causes fire hazard due to formation of methane in wet weather.

INCINERATION:

It is a hygenic way of disposingsolid waste. It is suitable if waste contains more hazardousmaterial and organic content. It is a thermal process and very effective for detoxification ofallcombustiblepathogens.Itisexpensivewhencomparedtocompostingorland-filling. In this method municipal solid wastes are burnt in a furnace called incinerator. Combustibesubstancessuchasrubbish,garbage,deadorganismsandnon-combustibemattersuchas glass,porcelainandmetalsareseparatedbeforefeedingtoincinerators.Thenon-combustible materials can be left out for recycling and reuse. The leftover ashes and clinkers may account for about 10 to 20% which need further disposal by sanitary landfill or some other means.

The heat produced in the incinerator during burning of refuse is used in the form of steam power for generation of electricity through turbines. Municipal solid waste is generally wet and has a high calorific value. Therefore, it has to be dried firstbefore burning.Wasteis dried in a preheater from where it is taken to alarge incinerating furnace called "destructor" which can incinerate about 100 to 150 tonnes per hour. Temperature normally maintained in a combustion chamber is about 700 C which may be increased to 1000 C when electricity is tobe generated.

ADVANTAGES

Residueisonly 20-25%oftheoriginalandcanbeusedasclinkeraftertreatment
Requires very little space
Cost of transportationisnothighif from theincineratoris locatedwithin citylimits
Safest hygenic point of view
Anincineratorplantof3000tonnesperdaycapacitycan generate3MW ofpower.

DISADVANTAGES

Its capital and operating cost is high
Operation needs skilled personnel
Formationofsmoke,dustandashesneedsfurther disposalandthatmay causeairpollution.

COMPOSTING

It is another popular method practiced in many cities in our country. In this method, bulk organicwasteisconvertedintofertilizerbybiologicalaction. Separated compostible waste is dumped in underground trenches in layers of 1.5m andfinally covered with earth of 20cm and left for decomposition. Sometimes, actinomycetes are introduced for active decomposition. Within 2 to 3 days biological action starts. Organic matter is destroyed by actinomycetes and lot of heat is liberated increasing the temperature ofcompostby 75Cand therefuseisfinally converted into powdery browncolouredodourless mass called humus that has a fertilizing value and can be used in agriculture. Humus contains lot of Nitrogen essential for plant growth apart from phosphates and other minerals. ADVANTAGES

Manureadded tosoilincreaseswaterretentionandion-exchangecapacity ofsoil.
This method can be
Manure can

Non-consumables have to be disposed separately

The technology has not caught-up with the farmers and hence does not have an assured market.

RoleofanIndividualinPreventionof Pollution!

Overpopulationandpollutionarepotentecologicalforcesimpinginguponmanbyaffecting the quality of the environment.All efforts aimed at bringingmore and more people above the poverty line actually increase the pressure on natural resources.

Carelessmanagementofnaturalresourcesisdisruptingtheecologicalprocessessomuchso that earth's life supportingcapacity is being substantiallythreatened.

Unmindfulexploitationof the finite resources of the biosphere has a severe ecological backlash because no developmentis sustainableunless it is environmentallycompatible.

Environmentalcompatibilitydemandsthattheeconomicandsocialdevelopmentshouldbe linked with environmental management.

- **(a) Controlofenvironmentalpollution**
- **(b) Conservationofnaturalresources**
- **(c) Landmanagement**
- **(d) Developmentofnonpollutingsourcesofenergy**
- **(e) Environmentaleducation**
- **(f) Environmentallaws.**

Pollutionistheburningissueofthedayatthe globallevel.Acombinedeffortto controlpollution hasto be madeby all governmentagencies, technologists,industrialists,agriculturistsand last but not the least the common man.

5. **Aninternationalconferenceon"HumanEnvironments"washeldinStockholmin 1971, to emphasise the need to controlpollution.**

Effortsarerequiredtobemadebyeachindividualtocontrolpollution.Theseeffortsinclude:

6. **(a)Installationofpropersewagedisposalmethods.**
7. **(b)Dumpingofnonbiodegradablewastesinlowlying areas.**
8. **(c)Installationofgobargasplantsinareasofhighavailabilityofcowdung.**
9. **(d)Reductionofsmokeemissionandtreatmentofchimneysmoketoremovesolid carbonparticles.**
10. **(e)Judicioususeoffertilisers,pesticidesanddetergents(Detergentsoflow-level phosphate content are less harmful).**
11. **(f) Growingplants like Pyrus (apple),Pinus (chir) and Vitis (grapes)is advocated because of their capabilityof metabolizinggaseous nitrogenouspollutants like nitrogendioxideetc.andplantslikecoleus,ficus(banyan)canfixCarbonmonoxide.**
12. **Skilled personnel with know-how to tackle the problemsarising frompollutionandfor devising environmentalpollutioncontrol measuresareworkingin manyinstitutionsin India. Important ones amongst them are:**
13. **(a)NationalEnvironmentalEngineeringResearchInstitute(NEERI),Nagpur.**
14. **(b)BhabaAtomicResearchCentre(BARC),Mumbai**
15. **(c)NationalCommitteeofEnvironmentalPlanningandCo-ordination(NCEPC),New Delhi.**
16. **(d)CentralDrugResearchInstitute(CDRI),Lucknow.**
17. **(e)CouncilsofScientificandIndustrialResearch(CSIR).**
18. **(f)CentralPublicHealthEngineeringResearchInstitute(CPHERI),Nagpur.**

19. Scientistshaverightlysaidthat,'inthecourseofourprogressfromoneageto another,wehavesimplypassedfromasay-agetosew-age.

Disastermanagement

Disaster is a naturalor human , caused phenomenon, which causes serious disruption of the functioning of a community or a society causing widespread human, material,economic and environmental losses which elicited the ability of the affected community, society to cope using its resources.

FLOODSARENATURALPHENOMENA.FLOODSAREWATERRELATEDDISASTER

A flood occurs when the Geomorphic Equilibrium in the river system is disturbed because of intrinsic or extrinsic factorsor when asystemcrossesthegeomorphic threshold. (a)Flooding in a river due to aggradations of river bed (intrinsic threshold); (b) Flooding in a river due to heavy rainfall (extrinsic threshold)

Floodsin majorcities especially during rainyseason areproving to disastrous notonly to the environmentbut also have serious implicationsfor human life and property.

Typesoffloods

- Flashfloods
- Riverfloods
- CoastalFloods
- UrbanFlood

According to their duration flood can be divided into different categories: •Slow-Onset Floods: Slow Onset Floods usually last for a relatively longer period, it may last for one or more peeks, or even months. •Rapid-Onset Floods: Rapid1Onset Floods last for a relatively shorter period, they usually last for one or two days only. •Flash Floods: Flash Floods may occur within minutes or fe1w hours after heavy rainfall, tropical storm, failure of dams or levees or releases of ice dams. And it causes the greatest damages to society.

FLOODSIMPACTS

- HumanLoss
- PropertyLoss
- AffectstheMajorRoads
- DisruptionofAir/Train/Busservices
- SpreadofWater-borneCommunicableDiseases
- CommunicationBreakdown
- ElectricitySupplyCutoff
- EconomicandSocialDisruption
- IncreaseinAir/WaterPollution6/11/2013Floods-DisasterManagme

Floodforecasting

- Anticipating floods before they occur allows for precautions to be taken and people to be warned so that they can be prepared in advancefor floodingconditions.
- Forexample,–Farmerscanremoveanimalsfromlow-lyingareasandutilityservicescan putin placeemergencyprovisionsto re-routeservicesifneeded.Emergencyservicescanalso

make provisions to have enoughresources available ahead of time to respond toemergencies as they occur.

• In order to make the most accurateflood forecasts for waterways, it is best to have a long time-seriesof historicaldata that relates stream flows to measured past rainfall events

• Radarestimatesofrainfallandgeneralweatherforecastingtechniquesarealsoimportant componentsofgoodfloodforecasting.FloodControl

• In many countries around the world, waterways prone to floods are often carefully managed. Defences such as levees, bunds, reservoirs, and weirs are used to prevent waterways from overflowing their banks.

• In the riparian zone near rivers and streams, erosion control measures can be taken to tryand slow downor reverse the natural forces that cause many waterways to meander overlong periods of time.

• Floodcontrols,suchasdams,canbebuiltandmaintainedovertimetotryandreducethe occurrenceandseverityoffloodsaswell.Floodbenefits

• Floods (in particularmore frequent or smallerfloods) can alsobring manybenefits, such as – Rechargінggroundwater, – Makingsoil more fertile and increasingnutrientsin some soils.

• Flood waters provide much needed water resources inarid and semi-arid regions whereprecipitationcan be very unevenly distributed throughoutthe year.

• Freshwater floodsparticularlyplayan importantroleinmaintainingecosystems inriver corridorsand are a key factor in maintainingfloodplain biodiversity.

• Floodingcanspreadnutrientstolakesandrivers,whichcanleadtoincreasedbiomassand improvedfisheriesforafewyears.

• Forsomefishspecies,aninundatedfloodplainmayformahighlysuitablelocationfor spawningwith few predators and enhanced levels of nutrients or food.

• Fish,suchastheweatherfish,makeuseoffloodsinordertoreachnewhabitats.Bird populationsmay also profit from the boost in food productioncaused by flooding

Earthquake

Earthquake is a natural disaster that can be broadly defined as a series of vibrations that are induced from the earth's crust. A sudden movement of the earth's crust, suddenrelease ofextreme energy, shaking or trembling of the crust of the earth due to shifting of rocks under the earth's surface or underground volcanic forces can be called as earthquakes. This is often accompaniedbyterriblenoise.Thesewavescansometimestraversehalfahemispheredestroyingth ecitiescompletely. The location whereearthquakestartsiscalled hypocenteror focus.Thelocationjustabovethehypocenteriscalledepicenter.Themainearthquakeis called mainshock. Therearemanyaftershocksthatoccurafterthemainshock. Theamount of energy released during earthquake is called magnitude.

CAUSESOFEARTHQUAKES

Most of the scientists believe that earthquakes are formed due to the movement of the earth's plates. It is a very natural phenomenon and a theory commonly known as plate

tectonics. As,we all know earthis divided into 3layersnamely – Crust, Mantle and Core. The

outermost layer of earth is known as the crust which is made up of granite and basalt. About 70% of the crust is ocean. The crust has several continental plates which drift every year. The second layer is called mantle. 80% of the earth is mantle. The mantle consists of lithosphere which is the upper mantle and asthenosphere which is the lower mantle. The core is the innermost layer of the earth. One third of the mass of the earth is core. The core has a liquid outer core made up of iron and it is very dense. It also has a solid inner core made of nickel and iron. The magnetic field of the earth is created when the liquid outer layer spins. So, as discussed above, the earth's crust is made up of several large and hard plates. These plates move slowly and continuously above the mantle. So collision and stress is caused among the plates. The stress among the plates can also occur when one plate goes over the other or when the sides if the plates collide. As the stress increases, the crust breaks and theenergy is released. This released energy moves to and fro in the form of waves called seismic waves. Thus these naturally created waves shake the earth formingearthquakes.

MEASUREMENTOFEARTHQUAKES

The first widely used gadget for measuring earthquakes were the Richter scale which was developed by aCharles Richter in the year 1934. According to this scale, the largest wave was recorded in a seismometer and then the distance between the earthquake and the seismometer was measured. But unfortunately, the measurements in this Richter scale were not accurate. Main 2 devices are used by seismologist to measure earthquakes. They are: seismograph and seismoscope. Seismograph is an instrument to measure seismic waves ofthe earthquakes. Seismoscope is an instrument to measure the time or occurrence of earthquakes. Nowadays earthquakes are calculated by its magnitude and intensity. Logarithmic scale is the base for calculating magnitudes. This means that the higher thewhole number on the magnitude, the motionrecorded by the seismograph goes up tentimes. This scale has no upper limit. Thus, magnitude is the amount of seismic energy at the hypocenter of the earthquakes. Intensity on the other hand is observed by the groundshaking of the people and buildings. This varies from place to place. According to the U.S geological center, the earthquakes are assigned to a class as per their magnitude. The classes are as under-

- **Great:magnitudeis8.0orabove-tremendousdamage**
- **Major:magnitude7.0–7.9-heavydamage**
- **Strong:magnitude6.0–6.9-severedamage**
- **Moderate:magnitude5.0–5.9-considerabledamage**
- **Light:magnitude4.0 –4.9-moderatedamage**
- **Minor:magnitude3.0–3.9-lightdamage**
- **Micro:magnitudelessthan3.0-slighttreble.**

TYPESOF EARTHQUAKES

Therearemanyclassificationsforearthquakes.Someof theclassificationsareasunder:

- **Onthebasisoforigin**

- Onthebasisofdeptoffocus
- Onthebasisof magnitudeandintensity

Origin:

On the basis of origin, earthquakes are divided into tectnotic and non tectnotic earthquakes. Tectnotic earthquakes occur when the earth's plates shift due to some geographical force. Non tectnoticearthquakesoccur due to the surfacesand collapseof the cavity roofs.

Dept of focus:

Here the depth of the focus is measured and further analyzed by seismograph. Here the further sub divisions are:

- **Surfaceearthquakes :theseearthquakeshavedepthoffocusoflessthan10,000 metersandarecalledsurfaceearthquakes.**
- **Normalearthquakes:theseearthquakeshavedepthoffocusbetween10-50 kilometers and are called normal earthquakes.**
- **Intermediate earthquakes: theseearthquakes have depthof focus between50-300 kilometers and are called intermediate earthquakes.**
- **Deepearthquakes:theseearthquakeshavedepthoffocusbetween500-700 kilometersandarecalleddeepearthquakes.**

Magnitude and intensity:

Sometimes earthquakes are measured on the basis of magnitude i.e. the amount of seismicenergy attheepicenterandintensityi.e.thetotaldamage anddestructioncauseddueto earthquakes.

Earthquakescanbeagainclassifiedinto:

- **Shallow fault earthquakes : When therock breaks under the feetit is called a fault. So earthquakes occur within and through these faults. These faults are close to the surface of the earth, a small quake can cause a lot of damage.**
- **Subduction zone earthquakes: These earthquakes happen in the Subduction area of theearthalongtheSubductionzone.Hugeshiftinlandlevelhappensduringthis earthquake.Thewavesthatoccuraretremendouslyhighandspreadoveralarger area.**
- **Deepearthquakes:Theseearthquakesoccurinthedeepoceanslabsbeneaththe continentalcrustoftheearth.**

EFFECTSOF EARTHQUAKES

1. **Causeswidespreaddamageandlossofhumanlife.**
2. **Causesgrounddisplacementalongthefault.**
3. **Theshakingofthegroundcauseslandslidesandavalanches.**
4. **Causesrupturingof damsandcancausefloodsandtsunami.**
5. **Thebrokenelectriclinesandgaslinesduetotheearthquakescancausefire.**
6. **Killsandinjureshundreds.**
7. **Theentirecitycanbedevastated.**

8. Liquefactionofthesoiltakes place

To conclude, earthquakes are the most powerful and destructive natural force which is hazardous to mankind. Earthquakes are unpredictable disasters that arise with no warning and have plagued humans throughout history. The energy released earthquakes fracture the surface of the earth. Forecasting earthquakes are a bit difficult but earthquake warning systems have been developed. Earthquake engineering and earthquake insurance have to be developed in a larger angle so as to prepare for the aftereffects. But not all earthquakes are bad. Sometimes when earthquakes are created, it has even created notable landmarks in the world.So the place of occurrenceis veryimportant before stampingit as good or bad.

Landslides

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soiland rock under the direct influence of gravity. The term "landslide" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Debris flows (commonly referred to as mudflowsor mudslides)and rock falls are examples of common landslidetypes.

Causes of LandslidesNaturalCausesofLandslidesClimate

Long-termclimaticchangescansignificantlyimpactsoilstability.Ageneralreduction inprecipitationleads to lowering of water table and reduction in overall weight of soil mass, reduced solution of materials and less powerfulfreeze-thaw activity.

Earthquakes

eismicactivitieshave,foralongtime,contributedtolandslidesacrosstheglobe.Anymoment tectonic plates move, the soil coveringthem also moves along.

3. Weathering

Weatheringis the natural procedure of rock deterioration that leads to weak, landslide-susceptivematerials.Weathering isbroughtabout by thechemicalaction of water, air, plants and bacteria.

4. Erosion

Erosioncausedbysporadicrunningwatersuchasstreams,rivers,wind,currents,iceand waveswipesoutlatentandlateralslopesupportenablinglandslidestooccureasily.

5. Volcanoes

Volcanic eruptionscantrigger landslides.If an eruption occurs in a wet condition,the soil will start to move downhill instigating a landslide. Stratovolcano is a typical example of volcanoresponsiblefor most landslides across the globe.

6. Forestfires

Forestfiresinstigatesoil erosionandbringaboutfloods,whichmightleadto landslides

7. Gravity

Steeperslopescoupledwithgravitationalforcecantriggeramassivelandslide.

Humancausesoflandslides

1. **Mining**

Mining activities that utilize blasting techniques contribute mightily to landslides. Vibrations emanatingfromtheblastscanweakensoilsinotherareassusceptibletolandslides.The weakeningof soil means a landslidecan occur anytime.

2. **Clearcutting**

Clear cutting is a technique of timber harvesting that eliminates all old trees from the area. This technique is dangerous since it decimates the existing mechanical root structure of the area.

Effectsof Landslides

1. **Leadto economicdecline**

Landslideshavebeenverifiedtoresultindestructionofproperty.Ifthelandslideis significant, itcould drain theeconomy of the regionor country. After a landslide, the area affectednormallyundergoesrehabilitation.Thisrehabilitationinvolvesmassivecapital outlay. For example, the 1983 landslide at Utah in the United States resulted in rehabilitation costofabout$500million.Theannuallossasaresultoflandslidesin U.S.standsatan estimated $1.5 billion.

2. **Decimationofinfrastructure**

The force flow of mud, debris, and rocks as a result of a landslide can cause serious damageto property. Infrastructure such as roads, railways, leisure destinations, buildings and communicationsystems can be decimated by a single landslide.

3. **Lossoflife**

Communitieslivingatthefootofhillsandmountainsareatagreaterriskofdeathby landslides. A substantial landslide carries along huge rocks, heavy debris and heavy soil with it.

4. **Affectsbeautyoflandscapes**

The erosion left behind by landslides leaves behind rugged landscapes thatare unsightly. The pile of soil, rock and debris downhillcan cover land utilized by the community foragricultural or social purposes.

5. **Impactsriverecosystems**

The soil, debris, and rock sliding downhillcan find way into rivers and block their natural flow. Many river habitats like fish can die due to interference of natural flow of water. Communitiesdependingon theriver waterforhouseholdactivities and irrigation willsufferif flow of water is blocked.

TypesofLandslides

- **Falls**

Falls are sudden movements of loads of soil, debris, and rock that break away from slopes and cliffs. Falls landslides occuras aresult of mechanicalweathering, earthquakes,and force of gravity.

- **Slides**

This is a kind of mass movement whereby the sliding material breakaways from underlying stable material. The kinds of slides experienced during this type of landslide includerotational and transitional. Rotational slides are sometimes known as slumps since theymove with rotation.

Transitionalslidesconsistofaplaneror2dimensionalsurfaceofrupture.Theyinvolve landslidemassmovementfollowingaroughlyplanarsurfacewithreducedrotationorbackwardslanting.Slidesoccurwhenthetoeoftheslopeisundercut.Theymove moderately, and the consistencyof material is maintained.

- **Topples**

Topplelandslidesoccurwhenthetopplefails.Topplefailureencompassestheforwardspinning and movement of huge masses of rock, debris, and earth from a slope. This type of slope failure takes place around an axis near or at the bottom of the block of rock. A topplelandslidemostlyleadtoformationofadebrisconebelowtheslope.Thispileofdebrisis known as a Talus cone.

- **Spreads**

Theyarecommonlyknownaslateralspreadsandtakesplaceongentleterrainsvialateral extension followed by tensile fractures.

- **Flows**

Thistypeoflandslideiscategorizedintofive;earthflows,debrisavalanche,debrisflow, mudflows,and creep, which include seasonal, continuousand progressive.

Flows arefurther subcategorized depending upon thegeologicalmaterial,for example,earth, debris, and bedrock.The most prevalent occurringlandslidesare rockfalls and debris flow.

Unit-V

:Social Issues and the Environment

• From Unsustainable to Sustainable development; urban problems related toenergy; Water conservation, rain water harvesting, watershed management;Resettlement and rehabilitation of people; its problems and concerns. CaseStudiesEnvironmental ethics: Issues and possible solutions. Climate change, globalwarming, acid rain, ozone layer depletion, nuclear accidents and holocaust. CaseStudies Wasteland reclamation; Consumerism and waste products; EnvironmentProtection Act; Air (Prevention and Control of Pollution) Act; Water(Prevention and control of Pollution) Act; Wildlife Protection Act; ForestConservation Act; Issues involved in enforcement of environmental legislation;Public awareness.

Introduction

Theactivitiesofhumanarecontinuouslylaidlowwithourvalues.Thoughtheenvironmentalcrisishas beenledtobytheactivitiesofhumanitisinfactacrisisofvalues.It'sregardingtheconceptofrealizingthevaluesof thesurroundingsandacceptingit.Humansproduceculturalvaluessupportednature(i.e.natural values).However,peopleusedtobelievethatsolelyhumanshadvalueswhereastheatmospheredidn't.We recognized solely cultural values, however not environmental values. Moreover, we often realized cultural values by damaging environmental values. Those behaviors have caused the loss of environmental valuesand harm to the natural basis on that humans produce cultural values that has light - emittingdiode to the matter of non-sustainability. It is under such circumstances that the problem of environmental values hasarisen.

Humanvaluesforenvironment

Environmental ethicsisthatthephilosophical discipline thatconsiders theethicalandmoralrelationship offolkstothesurroundings. Environmentalethicshelpsoutlineman'sethicalandmoralobligations toward thesurroundings.howeverhumanvaluesbecomeanelementonceobservingenvironmentalethics.Human values area unit the items thatarea unit vital to people that they then use to gauge actions or events. Inalternativewords, humans assign worth to bound thingssouse this assignedworthto form selections regarding whether one thing is correct or wrong. Human values area unit distinctive every to every} individual because of not everybody places a similarimportance on each component oflife.

Impactofwestonsociety:

Modernization and progress has had its share of disadvantages and one in every of the most aspects of concern is that the pollution it's inflicting to the world – be it land, air, and water. With increase within the international population and the rising demand for food and alternative necessities, there has been an increasewithinthequantityofwastebeinggenerateddailybyeverymenace.Thiswasteisultimatelythrown into municipal waste assortment centers from wherever it's collected by the world municipalities to be any thrown into the landfills and dumps. However, either attributable to resource crunch or inefficient infrastructure,notallthiswastegetscollectedand transportedtotheultimatedumpsites.Ifat thisstage the management and disposal is wrongly done, it will cause serious impacts on health.

Waste that's not properly managed, particularly waste product and alternative liquid and solid waste from households and the community, square measure a significant jeopardy and cause the unfold of infectious diseases.Unattendedwastelyingaroundattractsflies,rats,andalternativecreaturesthatsuccessively unfold malady. Commonly it's the wet waste that decomposes and releases a nasty odor. Thisendsupin insanitaryconditionsandtherebytoanincreasewithinthehealthissues.TheplaguenaturaleventinSuratcould be an ideal of a town suffering attributable to the callous perspective of the native body inmaintaining cleanlinesswithinthetown.Plasticwasteisanothercauseforpathologicalstate.Therefore,excessivesolid

wastethat'sgeneratedoughttobecontrolledbytakingboundpreventivemeasures.

Impact on Health:

Modernizationandprogresshashaditsshareofdisadvantagesandoneamongthemostaspectsofconcernisthat thepollutionit'sinflictingtotheworld–beitland,air,andwater.Withincreasewithintheworld populationandthereforetherisingdemandforfoodandalternativenecessities,therehasbeenanincreasewithin the quantity of waste being generated daily by every house. This waste is ultimately thrownintomunicipal waste assortment centersfrom whereverit's collected by the worldmunicipalities tobe any thrownto the landfills and dumps. Impacts of solid waste on health.

Thecluster in danger fromthe unscientific disposal of solid wasteembrace – thepopulation in areas wherever there's no correct waste disposal methodology, particularly the pre-school children; waste employees; and workers in facilities manufacturing noxious and infectious material. Alternative unsound cluster embrace population living near a waste dump and people, whose water system has become contaminated either thanks to waste merchandising or outflow from lowland sites. Uncollected solid waste additionally will increase risk of injury, and infection.

Inexplicit,organicdomesticwasteposesaheavythreat,sincetheyferment,makingconditionsfavorableto thesurvivalandgrowthofmicroorganismpathogens.Directhandlingofsolidwastemayresultinnumerous forms ofinfectiousandchronicdiseaseswiththewasteemployeesandthereforetheragpickersbeingthe foremostvulnerable.Exposuretounsafewastewillinfluencehumanhealth,kidsbeingalotofproneto thesepollutants.Infact,directexposurewillcausediseasesthroughchemicalexposurebecausethe unharnessedofchemicalwasteintothesurroundingsresultsinchemicalpoisoning.severalstudiesare dispensed in numerous components of theglobe.

Solidwastemanagement

Rapid increment and urbanization in developing countries has light-emittingdiode to folks generating monumentalquantitiesof solid waste andsequentenvironmentaldegradation.The waste isoften disposed in open dumps creating nuisance and environmental degradation. Solid wastes cause a significant risk topublic health and therefore the surroundings. Management of solid wastes is vital to attenuate the adverse effects exhibit by their indiscriminatedisposal.

Typesofsolidwastes:countingonthecharacteroforigin,solidwastesareclassified into Urban or Municipal Wastes

IndustrialWastes

HazardousWastes

SOURCESOFURBANWASTES

Urbanwastesembodythesubsequentwastes:Domesticwastescontainingaspreadofmaterialsthrown out from homesick: waste matter, Cloth, paper, Glass bottles, synthetic resin baggage, Waste metals, etc.

Commercial wastes: It includes wastes starting upfromoutlets, markets, hotels, offices,establishments. Ex: paper, packaging material, cans, bottle, synthetic resin baggage, .

Classificationofurbanwastes

Urbanwastesareclassifiedinto:

Bio-degradablewastes-Thosewastesthatmaybedegradedbysmallorganismsarereferredtoas bio-degradable wastesEx: Food, vegetables, tea leaves, dry leaves, etc.

Non-biodegradablewastes:Urbansolidwastematerialsthatcan'tbe degraded by small

organisms are referred to non-biodegradable wastes.

Ex:syntheticresinbaggage,scrapmaterials, glassbottles,etc.

Sourceofcommercialwaste:

Themainsupplyofcommercialwastesarechemicalindustries,metalandextractionindustries. Uninuclear plants: It generated radioactive wastes, Thermal power plants: It produces ash in giantquantities.

ChemicalIndustries:Itproducesgiant quantitiesofdangerousandcyangeneticmaterials.

Otherindustries:alternativeindustriesmanufacturepackingmaterials,rubbish,organicwastes,acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

STEPSconcernedINSOLIDWASTEMANAGEMENT:

Twovitalstepsconcernedinsolidwastemanagement are:

Reduce, utilize and Recycle of Raw Materials Discarding wastes

Reduce-Ifusageofrawmaterialsisreduced,thegenerationofwasteadditionallygets reduced Reuse - Refillable containers that are discarded once use may be reused Rubberringsmaybemadeofdiscardedcycletubesandthisreduces waste generation throughout manufacture of rubber bands.

Recycle-usageisthatthereprocessingofdiscardedmaterialsintonewhelpfulmerchandise Ex:previousatomicnumber13cansandglassbottlesareliquidandrecastintonewcansand bottlesPreparationofpolysaccharideinsulationfrompaper

Preparationofautomobilebodyandconstructionmaterial fromsteelcans

Thistechnique(Reduce,utilize&Recycle),i.e.,3R'sfacilitateeconomize,energy,rawmaterials and reduces pollution.

INCINERATION:

Itisahygienicmannerofdisposingsolidwaste.it'sappropriateifwastecontainsalotofdangerous material and organic content. it's a thermal method and effective for detoxification of all flammable pathogens.it'scostlyincomparisontocompostingorland-filling.Inthistechniquemunicipalsolidwastes are burnt in an exceedingly chamber referred to as furnace.Combustible substances like rubbish, garbage, deadorganismsandnon-combustiblematterlike glass,ceramicwareand metala separatedbefore feeding toincinerators.Thenon-combustiblematerialsmaybeomittedforusageandutilize.Theleftoverashes and clinkers might accountfor concerning ten to twenty which require any disposal by landfill or another suggests that.

Theheatmadewithinthefurnacethroughoutburningofrefuseisemployedwithinthestyleofsteam powerforgenerationofelectricitythroughturbines.Municipalsolidwasteismostlywetandincorporates ahighhotprice.Therefore,it'stobedriedinitialbeforeburning.Wasteisdriedinanexceedingly preheated from wherever it's taken to an oversized incinerating chamber referred to as "destructor" which might incinerate concerning a hundred to a hundred and fifty tones perhour.Temperature commonly maintained in an exceedingly combustion chamber is concerning 700 C which can be hyperbolic to one thousand C once electricity is to be generated.

ADVANTAGES

Residue is barely 20-25% of the first and may be used as clinker once treatment requires little or no house Costoftransportationisn'thighifthefurnaceisfoundatintervalstownlimitsSafestfromhygienic

purposeofread.Afurnaceplantof3000tonsperdaycapabilitywillgenerate3MWofpower.

DISADVANTAGES

ItscapitalandoverheadarehighOperationwantsexperiencedpersonnelFormationofsmoke,mudand ashes wants any disposal which might cause pollution.

Examplesof moralthings

A patient has kidneys that square measure failingand desires chemical analysis (a medical treatment to get rid of waste merchandise from blood) to survive. The patient is refusing chemical analysis. Hisspousecaresthatherhusbanddoesn'tnoticetheresultsofhiscall.oughttochemicalanalysisbe given?

Apatient recently olda systole (heart stoppedbeating). thoughhis heart wasrestarted, he sufferedbrain injury that's probably permanent. he's within the medical aid unit connected to aventilator. The patient has antecedently expressed that he wouldn't wish to measure connected to machines. ought to the machine be disconnected?

A loved one observes a staffer treating anotherpatient in what seems to be a disrespectful manner. Whatought to happen next?

Apatienthasbeendiagnosedwithaterminalunhealthiness.Herfamilydoesn'twishheraucourantofthe identification.Oughttothepatientbeinformed?

PreliminarystudiesregardingEnvironmentalProtectionActs

CHAPTERI-PRELIMINARY

1.Shorttitle,extentandcommencement-(1)ThisActcouldalsobereferred toasthesurroundings(Protection) Act,1986.

(2) ItextendstothefullofAsiannation.

(3) It shall get force on such date because the Central Government might, by notification within the Official Gazette, appoint and totally different dates could also be appointed for various provisions of thisActand for various areas**.**

Definitions-duringthisAct,unlessthecontextotherwiserequires-

(a) "environment"includeswater,airandlandandalsotheinter-relationshipthatexistsamongand betweenwater,airandland,andmortals,alternativelivingcreatures,plants,micro-organismand property;

(b) "environmentalpollutant"suggeststhatanysolid,liquidorvaporizedsubstancegiftinsuch concentration as could also be, or tend to be, injurious toenvironment;

(c) "environmental pollution" suggests that the presence within the surroundings of any environmental pollutant;

(d) "handling",aboutanysubstance,suggeststhatthemanufacture,processing,treatment,package, storage,transportation,use,collection,destruction,conversion,providingpurchasable,transferorvariety of suchsubstance;

(e) "hazardoussubstance"suggeststhatanysubstanceorpreparationthat,becauseofitschemicalor physic-chemicalpropertiesorhandling,ispronetocausedamagetomortals,alternativelivingcreatures, plant, micro-organism, property or theenvironment;

(f) "occupier",aboutanyworksorpremises,suggeststhatanindividualUNagencyhasmanagementoverthe affairsoftheworksorthepremisesandincludesaboutanysubstance,thepersoninpossessionofthesubstance;

(g) "prescribed"suggests thatprescribedbyrulescreatedbeneaththisAct.

Top6environmentActinIndia

Wildlife Act, a landmark within the history, was enacted for providing protection to wild animals and birds.Wildlife was transferred from State list to synchronal list in 1976, therefore giving powers to the Central governmenttoenactlegislation.TheActadditionallyprovidestheconstitutionofIndianBoardoflife (IBWL), that actively took up the task of putting in place life National parks and sanctuaries.

ObjectivesoftheAct:

1. Restrictionandprohibitiononsearchingandtrappingslife.
2. Rehabilitationofvulnerableandvulnerablespecies.
3. Preservationofbiologicaldiversitybyestablishingsanctuaries,nationalparksandregionreserves.
4. Grant ofa special allow to hunt a life forresearch, scientific management and assortment ofspecimens for zoological gardens, museumsetc.
5. Regulationofexchangelifeandnationalconservationstrategy.
6. CollaborationwithvoluntarybodiesandNGO's.

EnvironmentalAct#twopairof.Forests(Conservation)Act,1980:

TheAct covers every kind of forests together with reserveforests, protectedforests orany wooded land nomatterits possession. TheActhascreatedample provisions toseedeforestationandencourageconversion ofnon-forestareas.TheNationalForest Policy(1980)prohibitsState governmentsfordeclaringanyportion offorestsasnon-reservedwhilenotapprovalofCentralgovernment.Thepolicyadditionallyprohibits authoritiesforallottinganyforestlandfornon-forestfunctions.TheamendedAct(1988)prohibits leaseof forestlandtoanybodyapartfromthegovt.Itenhancesconservation,plantationandincreaseofforest cowl to a median of half-hour.

EnvironmentalAct#three.Water(PreventionandmanagementofPollution)Act,1974:

TheActoutlinedtermslikepollution,seweragеeffluent,tradeeffluent,streamandboards.Thesalient optionsandprovisionsoftheActareaunitsummedupasfollows:

1. TheActprovidesformaintenanceandrestorationofqualityofeverykindofsurfaceandwellwater.
2. ItprovidesfortheinstitutionofCentralandState Boardsforpollutionmanagement.
3. TheActassignspowers andfunctionstothoseBoardstoregulatepollution.
4. TheCentralandStatePollutionManagementBoardsareaunitgivencomprehensivepowerstoadvise, coordinate and supply technical help for hindrance and management ofpollution.
5. TheActhasprovisionsforfunds,budgets,accountsandauditoftheCentralandStatePollution ManagementBoards.
6. The Act prohibits disposal of any toxic, harmful or polluting touch the flow of water in an exceedinglystream. However, selling of any material into a stream for the aim of reclamation of land isn't thought of anoffence.
7. TheActprovidesforsevereanddeterrentpunishmentsforviolationoftheActwhichhasfineand imprisonment.

The main regulative bodies area unit the Pollution Management Boards, that are bestowed the subsequent functions and powers.

EnvironmentalAct#four.TheWater(PreventionandmanagementofPollution)Act,1977:

1. ThisActempowerstheCentralWaterBoardtogatheraccessonwaterconsumedbypersons carrying on sure regular industries and by native Authorities liable for supplywater.
2. Theaccessandthereforetheconsentfeesfromtheforemostsourcesofrevenuetoruntheentral andStateWaterBoards.
3. TheActhasbeenamendedin1991withareadtoenhancetheresourcesoftheBoardsbyremoving the lacunae within the Act and to supply rebate to the industries for obliging with the consumption and effluent qualitycustomary.

EnvironmentalAct#five.Air(Preventionand management ofPollution)Act,1981: TheAirActwaspassed belowArticle253oftheConstitution ofIndia andinpursuance of selections of national capital Conference.

1. thetargetofthisActistosupplymeansthatfortheinterference,managementand abatement of pollution to preserve the standard ofair.

plants.3.TheActadditionallyincludesvehicles,dieselvehicles,transport,railways anddomesticfuels.
4. TheActprovides,asperSectionnineteen,thedeclarationofboundheavilyimpurespaces aspollutionmanagement areaandnoworksshallbeoperatedinthesareaswhile notpreviousconsent of the State Pollution control panel.
5. TheCentralandStateWaterBoardsareentrustedwiththetaskofdominantand preventingpollutionandconsequentlytheyneedbeenredesignedasCentralPollutioncontrolpanel and State Pollution control panel severally.

EnvironmentalAct#half-dozen.settingProtectionAct,1986:

The setting Protection Act, Gregorian calendar month nineteen, 1986 was enacted as per the spirit ofthe national capital Conference command in June 1972 to require acceptable steps for the protection and improvement of the surroundings and to stop hazards to persons, living creatures and property. The Act consists of twenty-six Sections distributed among four chapters and extends to the complete country.

1. commonplaceofqualityofair,waterandsoilforvaried areasandforvariedfunctions.
2. mostpermissiblelimitsofconcentrationforvariedenvironmentalpollutants(includingnoise) for variousareas.
3. Proceduresandsafeguardsforhandlingofventuresomesubstances.
4. Prohibitionandrestrictionsontheplacementofindustries andconcludingoperations.
5. Proceduresandsafeguardsforhindranceofaccidentswhichcancauseenvironmentalpollution and6.Providingforremedialmeasuresjustincaseofaccidents.

EnvironmentalEducation

Environmentaleducationbringstheimportantworldintothelanguageschoolroom,empoweringlearners tocreatepositivechangeswithintheirnativecommunitiesandintheworld.LanguageacademicsUN agency introduce environmental topics like rain forest destructionand vulnerable animal species into their lessons realize that student's area unit fascinated by problems these issues gift. Besides serving as a fashionable and stimulating supply of real-world content, environmental education:

- providesanefficient frameworkfordesegregationlanguage skills;
- bridgesthegapbetweenEnglishanddifferentfacultysubjects;
- developsimportantandartisticthinkingskills;
- fosterstheeventofproblem-solvingskills;
- providesopportunitiesforexploringsocietyattitudesandvalues;
- engagesmultipleintelligences;
- encouragesstudentinteraction.

Another reason, and therefore the most vital, for conveyance environmental problems into the language schoolroom is that the urgency of the environmental scenario itself. If student's area unit to participate absolutely in resolution the environmental issues of these days and therefore the future, environmental educationisimportant.issueslikeplantandanimalextinctionareaunitpressing.Alleducatorshave associate moral and private responsibility to contribute to students' awareness of environmental problemsand to foster in their students the event of skills thatpromote property development.

AGlobalApproach

besides providing follow on specific language skills like speaking or reading, every of activities bestowedduring this volume incorporates one or a lot of thesubsequent international objectives associated with the environment:

- Awareness:Promotingawarenessofaspecificenvironmentaldrawbackandwhatpeoplewilldo

toassistsolvethematter.

- Concern:Encouragingstudentstoexploretheirownvaluesandfeelingsof concern regarding the surroundings.
- Skills:servingtostudentstoamassanddeveloptherequiredskillstounravelenvironmental issues.
- Action: Providing opportunities for college students to induce actively concerned in doing one thingto remedy environmental issues.

Self-exploration

The world's forests are being consumed speedily. Trees ar bog down for paper and wood product, for preparationfuel,toclearlandfordevelopment,andtoexpandfarmingareas.Thelandleftbehindis strippednotsolelyofitstrees,howevertheplants,animals,andinsectsthatlivedinthisschemefurther. With no plant roots to carry it in situ, valuable soil washes away with eachprecipitation and lands up withinthe rivers and streams upon which individuals rely for his or her water. In extreme cases, a whole bunch or thousands of individuals lose their homes or change state in landslides once deforested slopes become unstable.
Forestsconjointlyplayaveryimportanthalfinregulationworldclimate.Treestakeawaydioxide,a significantgreenhouseemission,fromtheatmosphere,whereasathleticsatomicnumber8intoit.Once trees are bog down, however, the dioxide is free once more. It’s calculable that up to twenty fifth of the full quantityofdioxidegoingintotheatmosphereeachyearisfreefromtreesbeingcutandburned.It'sclear that protective the world's forests is a very important a part of determination the worldwide global climate change drawback.

ExplanationaboutSWASTHYA

Ifwetend to choosetheliteralthat meansofswasthya, thenit meansthat health.however, ourhealth itself contains plenty of things, like our thoughts, wellbeing of our physical state, moreover as mental one, etc. we tend to ne'er notice the manner we tend to breathe, inhale, however would our lungs bebehaving throughoutthis?whatallshouldbegoingwithinour body.Whathappenstothefoodonceit goesdown theesophagus?thereareboundquerieshoweverwetendtone'ercaretoseemorfeelthem.just because we all know ton overabundant} concerning digestion n have seen lot several things. however, isso?? my purpose here is that's it extremely all through? are not we tend to totally different fromthe representedrepresentation.AssaidearlierSWASTHYAconjointlydealswithourconditionandits wellbeing. what wepredict, however we predict and why we predict area unit the queries that area unit answered by the individual on his or her own. all has their own perceptions relating to their thinkingmethod. as it's their own and that we might need our own opinion concerning that isn't accepted by the thinker.

ExplanationaboutSANYAMA

Sanyama deals with self-control, it’s essentially the soul half. Our soul is that the in-built god precociousenergy that provide the primary and therefore the basic most construct of our existence. Except for the superficialthoughtsthatsoulisthatthis–thatandbounddifferenttaboos,it'sgloriousprovenfactthat soul is main interface between the heavenly energy and organic structure.