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UNIT- I

Multi - disciplinary nature of environmental studies

ENVIRONMENT: derived from French word 'environnoi' (to circle)
It is defined as the physical, biological and social conditions that surrounds and affects the growth and development of any organism.

ENVIRONMENTAL STUDIES: It is a scientific study of physical, chemical, biological, social and cultural aspects of the environmental system, and its status which induces changes in the living organisms.

Objectives:

(i) Awareness - about environment and related problems
(ii) Knowledge - understanding the problem clearly
(iii) Attitude - a sense of concern and sensitivity for the environment
(iv) Skill - solution of problem
(v) Participation - doing the needed work

Scope of environmental studies:

- Conservation and management of natural resources (forest, water)
- Conservation of biodiversity at all the levels
- Control over the environmental pollution
- Control of human population
- Enhances sustainable development (judicious use of resources)
- Scope of green advocacy (green benches and environment lawyers)
- Scope of green marketing

Global Environmental problems:

(i) Rapid population growth i.e. population explosion
(ii) Food shortage and famines
  - maldistribution of food
  - less production
(iii) Depletion of fossil fuels (coal, petroleum, natural gas)

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(iv) Water shortage (deficit of potable water)
- domestic use
- agricultural use
- industrial use

(v) Global warming
(vi) Acid Rain (SO_2, oxides of nitrogen come down as rain) } side-effects of pollution
(vii) Ozone depletion
(viii) Deforestation (due to dam construction, tribal settlement, commercial uses)
- Forests are the buffer zones. They negate many unwanted components from the environment.
- They are very important for water cycle.

(ix) Loss of biodiversity - Every living or non-living component is dependent on another components.
The extinction of any species leads to ecological imbalance.
(x) Faulty waste disposal - radioactive, hazardous waste ; if not disposed properly, may harm the environment.

Multi-disciplinary nature of environmental studies

To understand environmental studies, we need inputs from:
(i) Life sciences - botany, zoology, biotechnology
(ii) The physical and the chemical structure of abiotic components needs inputs from Physics, Chemistry, Geology
(iii) The stats and maths inputs are required for environment modelling and management.
(iv) Subjects like education, economics, social sciences are required to study the socio-economic aspect.
(v) The civil and chemical engineering for clean technology for environ-mental protection.
(vi) The inputs from the law education is required so that it can be used as a tool for effective protection of environment.

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Need for Public awareness:

Objectives - (i) Identify and conserve the threatened and endangered species
(ii) Conservation of natural resources
(iii) To maintain ecological balances
(iv) To enhance sustainable development
(v) To develop technologies to deal with environment pollution

Methods -

(i) Environmental education
(ii) Using mass media
(iii) By organising conferences, seminars on the current environmental problems
(iv) Through entertainment - documentaries, movies, street plays
(v) Establishment of eco clubs - mainly intended for school children
(vi) Establishing the science centres in rural areas
(vii) Conducting awareness campaigns by taking favour from public figures

ECOSYSTEM:

- The ecosystem includes the living organisms complex alongwith the physical and chemical factors, which are the part of the environment. These biotic and abiotic components act and react with each other and bring about the structural and functional changes in the environment.

- It is the smallest unit of biosphere, which is able to sustain life; minerals, animals and other nutrients are linked together through the flow of energy or food.

- It is highly variable in size.

- It is the basic structural and functional unit of ecology.

- It gives information about total solar energy available, minerals recycling, biomass and productivity of the ecosystem.

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Structure of ecosystem:

ECOSYSTEM

- Biotic Components
  - Producers
    - 1) Autotrophs
    - 2) Chemotrophs
  - Consumers
    - Heterotrophs
    - 1) Herbivore
    - 2) Carnivore
    - 3) Omnivore (macro consumer)
  - Decomposers
    - Saprotrophs (microbes like bacteria, fungi) (micro consumer)
- Abiotic Components
  - Physical / Climatic factors
    - 1) Light
    - 2) Temperature
    - 3) Rain
    - 4) Wind
  - Edhaphic factors
    - 1) Soil
    - 2) pH
    - 3) Topographic area
    - 4) Minerals

The biotic components consist of different population of the species, which are inter-linked in the ecosystem and each one is separately called as functional or nutritional group or trophic levels.

Decomposers: They feed on dead and decaying organic matter and changes the organic compounds into simpler inorganic material and these nutrients are again used by the producers for their growth so, decomposers are very important for the recycling of nutrients between biotic and abiotic components.

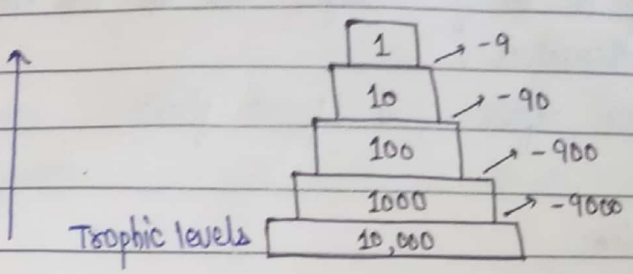
Energy flow in the ecosystem:

It is unidirectional and flows from the environment through the series of organisms and then back to the environment so, this flow of energy is foundation of life.

The energy flow follows the laws of thermodynamics -

- Energy can only be transferred, not created or destroyed.
- Transformation of energy always results in some loss of energy.

Energy flow follows the 10% energy law and it always forms the upright pyramid of energy.



10% energy law

(only 10% energy is transferred from 1 trophic level to another and 90% is lost)

★ Ecological Succession:

It is the orderly and predictable process of biotic changes which involves the changes in species structure and slowly the whole community, then it results in the modification of environment which results in the establishment of stable ecosystem.

Causes:

→ Initial causes

They are of 3 types:

- Climatic
- Biotic - man activities, animals, insect attack
- Ecesis - migration, aggregation, competition

→ Stabilising causes - The climate of the area is the main stabilising cause.

Types of succession:

(i) PRIMARY: It is the initial development of ecosystem where the growth and development of the community begins in the area which is not occupied by any community previously.

eg. newly formed lake
forest developed on lava

(ii) SECONDARY: Re-establishment of previous ecosystem. It occurs when the

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existing community is partly damaged and the new one starts occupying and establishing themselves.
eg. vegetation grown after flux (forest fires)

Process of Succession:
1. Nudation - barren land
2. Invasion - pioneer species invade climax
3. Competition
4. Reaction - change in abiotic factors
5. Stabilization - established climax species

* Food Chain:
- Transfer of food energy from the plants through the series of organisms by repeated eating and being eaten up.
- Maximum no. of links possible is 4 or 5.
- Each stage of transfer of food energy is called trophic level (similar kind of organisms equidistant from energy source).

Types of food chain:
(i) GRAZING food chain -
→ It is the most common and directly depends on sunlight.
→ Producers are the first link.
→ Herbivores are the second link.
→ Carnivores
→ Top carnivores

(ii) DETRITUS food chain -
Organic waste and dead matter of grazing food chain is called detritus. This energy is used by detrivores (decomposers).
eg. beetles, earthworm, bacteria, mites which are then consumed by primary consumers like insects.

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Detritus 1° Detrivore → 2° detrivore
microbes insects

The organisms involved are much smaller and the functional role of each organisms is not clear. It doesn't depend on direct sunlight.

Advantages:

- Regulates population sizes
- Maintains ecological balance (nutrient recycling)
- Maintains the energy flow in the eco-system
- It helps us to clearly understand the process of bio-magnification (heavy metals accumulate - arsenic) because of non-biodegradable nature.

★ Food Web:

The interlocking (-linking) of various food chains in nature which are interacting with each other forms the food web.

Reasons of occurring of food web:

→ due to variety of diets

→ Same organisms operate at more than 1 trophic level so it may eat or be eaten by several organisms of lower and higher trophic levels.

Advantages:

- Maintains the stability of eco-system.
- Complexity of the food relation can be easily understood.

★ Ecological Pyramids (Eltonian Pyramids):

It was given by Charles Elton.

It is the graphical representation of different trophic levels in an ecosystem where producers form the base and top consumers occupy the apex.

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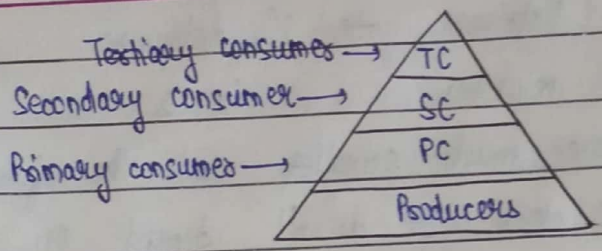
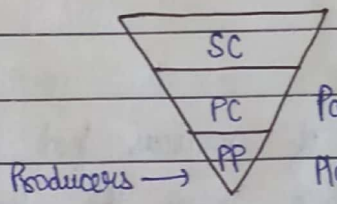


upright

Types:

1) Pyramid of number:
It shows the no. of organisms at each trophic level. It can be upright (as in case of grassland).

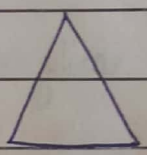
It could be inverted (as in case of parasitic ecosystem).



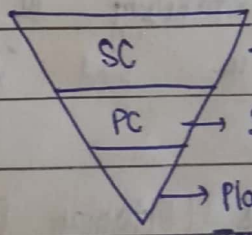
inverted

2) Pyramid of energy:
It is always upright (as in case of pyramid of energy flow).

3) Pyramid of biomass:
Biomass is the total living material present in any organism. It is measured as dry weight per unit area. It can be upright (as in case of grassland).



grassland



Ponds or Lakes

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* Types of Ecosystem:

ECOSYSTEM

Natural			Artificial (man-made)
Terrestrial	Aquatic		eg. zoo, aquarium, agricultural fields
1) Forest	1) Freshwater	lotic (fast flowing), lentic (stagnant)	
2) Desert	2) Marine		
3) Grassland	3) Estuarine		

TERRESTRIAL

1) Forest ecosystem:

Today the present forest cover is 28% in world and 19% in India. Different forest ecosystem exist due to variation in climate, soil type, altitude and their age.

- TAIGA: It includes the coniferous forests present at higher altitudes. Located in northern side of north America, Europe and northern Asia.

Flora- includes spine, spruce, fir, cidar
Fauna- bear, wolves, owls, eagles
Lakes are very common and precipitation is very less.

- TEMPERATE FOREST: Climate is slightly warmer than Taiga; moderate precipitation; located in north central Europe, Eastern Asia and Europe
  flora- maple trees, hickories, oaks
  fauna- bear, snakes, lizards

- TROPICAL RAINFOREST: They have the highest biodiversity.
Heavy rainfall so climate is humid; located in equatorial regions of south and central America, north eastern , Malaysia, Indonesia, Congo basin in Africa

flora- Broad leaves, evergreen tall trees eg. tea, sal
fauna- lots of insects, bats, monkeys

- TEMPERATE SHRUB FOREST (WOODLANDS):
They have drier climate, low precipitation so drought is prevalent.
Located in California, south Africa, south Australia
flora - Broad leaves, herbs and shrubs
fauna- reptiles, small mammals (alligators, rabbits)

- TROPICAL SAVANNA: They are mix of woodlands and grasslands.
The rainfall is high but seasonal. Warm and humid climate.
Located in Africa, Australia, southeast Asia
flora- grasses and scattered trees
fauna- giraffe, zebra, kangaroo, elephants

Canopy
↓
Underlayer
↓
Ground layer
(formed by shrubs)
↓
Forest floor
↓
(formed by herbs)

Vertical division of Forests

Functions of forest ecosystem:
- Recycling of nutrients
- Maintains the levels of O_2 and CO_2
- Maintaining biodiversity hence, ecological balance
- Reduces soil erosion and flood occurrences
- Reduces the pollution level by absorbing pollutants

- Maintain water cycle
- Provide food and shelter
- Reduces sound levels as they are very good sound absorbers

2) Grassland ecosystem:

They occur in the region which is dry for the forest and wet for the desert. Rainfall varies from 50 - 150 cm. Temperature is moderate. Summer droughts are very common with high temp. which leads to fires.

flora - short and tall grasses with some flowering plants with deep root system

fauna - large mammals, wild horses, antelopes

Soil is rich in nutrients like sulphates, phosphates with less and deeper organic matter.

(explain food chain)

Functions of grassland:

- They are food provider. They provide grains.
- Prevent soil erosion
- Maintain nutrient and water cycle
- Maintain O_2 and CO_2 levels
- Maintain biodiversity
- They have recreational values (tourism, camping)

3) Desert ecosystem:

They show extreme climate. Rainfall is less than 25 cm.

Mostly occur in the southwest and western parts of continents like Mexico, western Asia, western Australia, Peru.

Soil is rich in minerals but having very low organic matter.

flora - cacti, acasia (keekar), grass, euphorbia

fauna - cats, rabbits, snakes, lizards, scorpions

(explain structure - biotic, abiotic, food chain)

Functions of desert:

- They are providing the grazing lands for animals.

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- Only area which supports temp. sensitive wide area
- Temperature regulation of area
- The wide varieties are the source of future genetic engg. studies as the species show high adaptability and tolerance.

AQUATIC

1) Ponds | Lakes: (stagnant)

- It is the simplest aquatic ecosystem, which is seasonal.
- The floor is muddy and rich in organic matter.
- Dissolved Oxygen (DO) is less.
- It is rich in minerals.

Biotic components:

- Producer - photosynthesis bacteria, algae, phytoplanktons
- Primary consumers - zooplanktons, snails, worms
- Secondary consumers - small fishes
- Teatiary consumers - large fishes
- Decomposers - bacteria, fungi

Functions of lake | pond ecosystem:

- Maintains nutrient recycling
- Recharging of underground water sources
- Maintains biodiversity and ecological balance
- Used for recreational purposes
- Purification of water

2) Rivers | Steams: (flowing)

- It widely varies according to the volume of water and flow speed, dissolved O_2, organic and inorganic nutrients, availability of light and prevailing temp.
- Mostly they are formed by melting of glaciers, where the biotic components are zero due to high speed and sediments.

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- In the plain areas, where the river flow slows down and temp. rises, the sediment gets deposited on river bed, which leads to addition of biotic components like algae, phytoplanktons which are producers.

Biotic components:

- Producer - phytoplanktons
- Primary consumers - small fishes
- Secondary consumers - big fishes, invertebrates (snails)
- Teertiary consumers - reptiles, other mammals

3) Marine ecosystem:

- High mineral salts
- Variable dissolved O_2 content
- Variation in light intensity and temp.

Biotic Components:

- Producer - phytoplanktons (diatoms, dinoflagellate), ~~seabeads~~ seaweeds (red algae, brown algae
- Primary consumers - mollasc (shells), crustaceans, small fishes
- Secondary consumers - large fishes (herring)
- Teertiary consumers - whales, sharks

Functions of marine ecosystem:

- Means of transportation
- Source of seafood

(rest same as pond / lake ecosystem)

4) Estuarine ecosystem:

- It is a semi-closed water body, connected on one side with river and other side with open sea. Also called protective zones.
- They have highly fluctuating water levels.

- They are zones of highest biodiversity in aquatic ecosystem.
- They are rich in nutrients from the rivers and seas.
- The organisms are tolerant to temp. ranges and salinity.

Biotic components:

- Producers - phytoplanktons, grass, seaweeds
- Primary consumers - fishes, crabs, oyster
- Secondary consumers - big fishes
- Decomposers - bacteria, fungi

★ BIODIVERSITY and CONTENTS OF BIODIVERSITY:

Biodiversity is the variation in biological forms of animals, plants and microbes in a particular region or in the whole world.

- Genetic diversity: Variation in the genes or characters within the same species.
- Species diversity: Variation among the species combination within an ecological community or in a particular region.
- Species: The basic unit of biological classification and occupies the lowest rank in the taxonomy (classification system). It is a group of organisms which interbreed and produce offsprings.
- Biosphere: Global sum of all ecosystems; Zone of life on the planet
- Biogeographic zone: A large region of similar climatic conditions, ecology, community of the species

÷ Types of Species:

(i) ENDEMIC species: These are very restricted in distribution and only confined in specific region. eg. koala (only in Australia)

(ii) EXTINCT species: A species which is no longer present on earth.
eg. dodo, dinosaurs, wooly mammoth

(iii) ENDANGERED species- Species facing high rate of extinction in wild conditions. eg. tiger

(iv) RARE species- They are neither endangered nor vulnerable but they are very small in number naturally. eg. hispid (rabbit)

÷ Types of conservation:

(i) in-situ conservation: It is a conservation of ecosystem and natural habitat for the maintenance and recovery of viable population of species in their natural environment.
eg. national parks, wildlife sanctuaries

(ii) ex-situ conservation: It is conserving the species outside its natural habitat under carefully controlled conditions.
eg. botanical gardens, zoological parks

÷ Biodiversity at 3 different levels:

1. Genetic diversity: • Each cell contains genes, which stores all the information for growth and development and other physical features and variations in the genes within the same species give rise to genetic diversity. It occurs due to high rate of adaptations in living organisms.

• If the no. of individuals of a species is reduced, this diversity is reduced and slowly, it would lead to extinction. Moreover, we need to maintain the gene pool of wild population, also for the production of

tolerant and resistant varieties and needs.

2. Species diversity:
- eg. lions, tigers, horses, bats in a forest area
- Natural undisturbed forests are richest in species diversity as compared to cultivated areas. There are 1.8 million different species on earth. The area which show highest species diversity are called hotspots, eg. India

3. Ecosystem diversity:
- It refers to variations in the structure and functions of different habitat and ecosystem. Eg. grassland, rivers, lakes, ponds etc.

÷ Biogeographical classification of India:
It is based on the pattern of distribution of different landforms according to the variety of climate, topography, space and time.

1. Trans - Himalayan zone:
- altitude - 4500 to 6000 m eg. Siachin, Srinagar
- climate - rich in glaciers and cold
- vegetation - alpine type (mountain type) eg. spines, spruces
- fauna - sheep, goats, snow leopard, Kasturi deer

2. Himalayan zone:
- It includes east, west and central Himalayas eg. Arunachal Pradesh, J & K, Sikkim
- climate - cold and wet
- vegetation - oaks, dhak, fir, pines
- fauna - panda, leopard, sheep, goat

3. North East India:
- It includes Cherapunji, Imphal, Shillong

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- climate - moist due to heavy rainfall
- vegetation - orchids, citrus, bamboo
- fauna - rhino, elephants, mammals

4. Desert zone: (Arid zones)
- It includes Rajasthan, Gujarat, parts of Haryana and Gujarat
- climate - dry and hot summer, dry and cold winter
  rainfall is less than 70 cm
- vegetation - grass, babool, keekar
- fauna - camels, fox, snakes, lizard, cheetal deer

5. Gangatic Planes:
- It includes parts of Bihar, Bengal, Assam valley. It shows high population density and has Agro-based population.
- climate - hot and moist
- vegetation - highly fertile with alluvial sediments rich in organic matter found here are teak, sal, mulberries and
- fauna - tiger, monkey, leopard, elephants

6. Semi-arid zones:
- It includes adjoining areas of desert. It is the transition zone between dense forest and desert zone. Location is Thar to gulf of kuchch.
- vegetation - dry thorny forests, grass, bamboo
- fauna - jackal, eagle, lion, foxes

7. Deccan Peninsula:
- Mainly includes the plateaus like Chhota Nagpur, parts of Tamil Nadu, Andhra Pradesh and Karnataka; doesn't include Ghats
- climate - plateau regions are dry and
  average rainfall is very less
  rainfall is high in wet lands and soil is fertile which shows the presence of tropical and moist desiduous forests.

- fauna - tigers, bears, elephants

8. Coastal Regions:
- It includes southern Gujarat, Malabar, Lakshadweep, Mumbai, Konkan, Odish
- climate - moderate
- vegetation - mangroves, rice, coconut, rubber, bananas
  Back water is very common. It also shows estuarine ecosystem.

9. Ghats:
- Pune, Orissa, Surat
- climate - heavy rainfall
- vegetation - evergreen and mangrove forests
- fauna - Malabar grey hornbill, Nelgiri Langur

10. Island zone:
- India has 325 groups of islands, which includes Andaman and Nicobar islands, rich in coral reefs.
- climate - hot and humid
- vegetation - dense forests of mangroves and evergreen trees
- fauna - water snake, giant crabs, fishes

Value of Diversity

1. Consumptive Use: It includes the varieties we consume daily as direct use of timber, food, fuel, fodder and drugs.

2. Productive Use: It includes all the marketable goods.
- We can use biodiversity for developing better breeds and varieties
- Pharmaceutical applications - drugs manufacture
- Industrial applications - leather, silk, paper and pulp industries

3. Social Use: If the biodiversity is valued for the traditional approaches

like tulsi, peepal, cows etc.

4. Ethical Value: We don't have the right to destroy any lifeforms. It also creates a sense of awareness for maintaining ecological balance.

5. Aesthetic Value: If we appreciate the contribution of biodiversity for learning natural processes and its beauty, which includes imagination and creativity.

6. Option Value: Keeping the future possibility open for the use of bio-diversity for economic benefits. Eg. Katemuf, which is 1600 times sweeter than sugarcane.

Levels of Biodiversity

GLOBAL LEVEL: The warmer, wetter and larger areas show high degree of biodiversity due to variation in the climatic factors and topography. The tropical forest area covers 7-8% of total land but it shows high degree of species richness. Then it is followed by temperate zones - north and south, which show lesser diversity and the least is shown in the Arctic region (Greenland).

NATIONAL LEVEL: India is divided into 10 bio-geographical zones, out of which the Ghats, Northeast India and northeastern Himalayas are rich in species. India is one of the vavilov centres (species are originated here) in the world eg. mango, jute, sugarcane.

LOCAL LEVEL: Rajasthan is considered here for desert zones.

1) Desert zone: low rainfall, high temperature, flora and fauna
2) Hilly areas - Aravali Hills (moderate rainfall)
3) Plain areas - eastern and south eastern of Aravali Hills, receive good rainfall and are productive zones

India as a megadiversity zone (nation)

A megadiversity nation is extremely rich in biodiversity and cultural diversity.

- Geographical diversity - plains, plateaus, hills
- Climatic diversity - rainfall, temp.
- Biodiversity - 10 bio-geographical zones of India
- Habitat diversity - different lifeforms
- Cultural diversity - cultural values, religions, languages, festivities

The Hotspots of Biodiversity

The areas which exhibit high species richness as well as high species endemism and they are constantly under the danger of being destroyed by anthropogenic (human) activities are called as hotspots. These are mainly located in the tropics and are considered as the reservoirs for the threatened species.

CRITERIA:

- The place must support 0.5% or more of the total global species.
- It must have lost 70% of original habitat and the degree of threat to present species must be high.

eg. Western ghats, Northeastern Himalayas

Threats to Biodiversity

1. Species extinction:
   - Due to population risk (like rare species)
   - Environmental risk like natural calamities
   - Genetic risk (genetically unstable)

2. Poaching of wildlife:

   CONTROL: • effective wildlife legislation
   - Spreading awareness
   - reporting of poaching incidents immediately to the authorities

⇒ Endangered Threatened species of India ; endemic species of India

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- refusing the purchase of such products

3. Human and Wildlife conflict:
It occurs due to overlapping of areas and resources by man and wildlife. It disturbs the wildlife conservation, micro and macro economy, safety and the food security of both.

4. Occurrence of risky species:
Rare, endangered, threatened, vulnerable and endemic species

Biodiversity conservation

OBJECTIVES:
- to protect all the risky species
- to protect natural habitats
- to create awareness in society
- to implement strict laws against killing of wildlife
- to use natural resources sustainably
- to maintain ecological balances

÷ in-situ conservation:
In-situ involves the following:

→ National Parks: • They are the large natural areas with defined boundaries to conserve scenery, natural objects, flora and wildlife.
- All forestry operations, grazing, agriculture and hunting is prohibited.
- No human inhabitations.
- Only on-duty people can enter.
- Comprises of only core (central) zones, which is undisturbed and legally protected zone.
- Eg. Gir, Rajaji

→ Wildlife Sanctuaries: • They include the smaller natural areas, whose boundary is not defined. It is established by the central government, but it comes

under state legislation.

- Hunting without permission is inhibited.
- Grazing is regulated.
- Some human activities are allowed.
- It is divided into core, buffer and restoration zones.
- Eg. Gooram Pani in Assam

→ Biosphere Reserves: • These are the natural areas used for scientific studies with no disturbances or regulated disturbances.

- Human activities and inhabitation are allowed. (In the outermost zone called recreational and restoration zones)
- Scientific activities are allowed in buffer zones.
- Core zones are legally controlled and least disturbed.
- Eg. Nanda Devi in UP, Sunderbans in W. Bengal

÷ ex situ conservations:

→ Gene Banks: • Seeds, pollens and vegetative parts can be preserved in gene banks to stop them for future use by cryopreserving them.

→ Zoological Parks and Botanical gardens: • Mainly used for protection of endangered and threatened species

- Used for spreading knowledge and information

→ Aquaria: • Preservation of aquatic ecosystem

- Atleast one side should be transparent

→ Tissue culture techniques: • It is the micro-propagation technique, in which we are using vegetative parts or single cells to grow them into full plants (multiple numbers).

→ DNA technology (genetic engg.): • We are using a part of or whole of DNA for the conservation of the characters so that they

can be introduced in the species which needs them, in future.

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UNIT-2

Resources

Resources are the materials which are required for human survival, comfort and then prosperity. We are taking them directly from the environment.

- On the basis of availability:

(i) Continuous resources: can be used continuously and can't be degraded
eg. Solar energy

(ii) Renewable resources: also called as flow resources
eg. water, soil, plants, animals

(iii) Non-renewable resources: stock resources
eg. fossil fuels, minerals

- On the basis of origin:

(i) Biotic resources: biological origin
eg. plants, animals

(ii) Abiotic resources: eg. sun, wind, water

Forests as a resource

Forests are natural, renewable and biotic resource, which are always in the state of continuous change and constant flux.

USES:

(i) Productive use: food, medicines, fuel, fodder, timber, pulp, gums and resins

(ii) Protective function: They moderate floods, maintain stream flow, reduce

surface runoffs, save lives by protecting soil, wildlife, plants and environment. They also reduce occurrence of droughts.

(iii) Regulative functions: • Atmospheric regulation of temp., O_2 and CO_2 levels
They act as buffer zone for pollution.
They regulate the organic matter and humus content.

(iv) Ecological services:
Nutrient recycling, biodiversity, temp. regulation, water conservation

(v) Accessory functions:
Recreational values, aesthetic and traditional values

Classification of forests

- On the basis of administration:

(i) Reserved forests: They are allotted for one utility permanently and legally protected. 55% of the total are reserved forests.

(ii) Protected forests: They show large ranges of restriction but grazing is allowed. They form 29% of the total forests.

(iii) Unclassed forests: They are so deep that no interventions are possible. They are inaccesible. They form 16% of the total forests.

- On the basis of density:

(i) Dense forests: Canopy cover is more than 40%; form 59% of forests

(ii) Open forests: Canopy cover lies blw 10-40%; form 40% of forests

(iii) Mangrove forests: They have overlapping canopy and are commonly found along the tropical oceans in the shallow water areas like lagoons, rivermouth and along the ocean. The roots of the plant hold them

in the silt and sand. They come outside the land surface for gaseous exchange and are called 'STILTS' (aerial roots). They form 1% of the total forests.

Deforestation

It is the indiscriminate cutting and felling of trees, which leads to destruction of forests permanently.

÷ Causes:

- Population explosion
- Forest fires

(i) Ground fires - due to high humus content
(ii) Surface fires - due to dry twigs and branches
(iii) Crown fires - only in dense forests; starts from canopy
(iv) Accidental fires - as an accident

- Overgrazing
- Pathogen attacks and pests attacks
- Natural forces or calamities - storms, lightning, earthquake
- Jhumming or shifting cultivation - most prevalent in north-eastern side of India

÷ Effects:

- Habitat destruction
- Soil erosion and landslides
- Reduced O_2 and increased CO_2 levels
- Greenhouse effect
- Loss of biodiversity
- Loss of cultural diversity
- Economic losses to tribal people
- Lowering of water table
- Increased frequency of floods and droughts

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Timber Extraction

Timber is highly lignified wood used for building furniture and construction purposes. Their indeterminate cutting is called intensive timber extraction.

÷ Methods of timber extraction:

- Clear felling: When all the trees are destructed at the same time
- Handlogging: Light extraction
- Reduced impact logging: A well-planned method
- Selective logging: Only few large trees are extracted
- Mechanised logging: Machineries are used

÷ Impact of timber extraction:

- Loss of cultural diversity
- Loss of biodiversity
- Ecological imbalances
- Loss of carbon storage capacity

Mining

Mining is done by 2 different methods:

(i) Surface mining

This requires the removal of vegetation cover thoroughly from the surface.

(ii) Underground mining

It is damaging the soil structure so it leads to deforestation and desertification of the area.

÷ Impact of Surface mining:

- It leads to acid mine drainage.
- Sedimentation in water bodies due to surface runoffs.
- It causes floods, landslides, noise and air pollution and land subsidence. (land subsidence is lowering of land surface).

÷ Impact of Underground mining:

- Acid mine drainage (Ores are rich in sulphur which reacts with water and drains out)
- Soil structure destruction
- Environmental pollution due to mine fires
- Lots of impact on human health ; Black lung disease is very common.
- Land subsidence

Dams

Dams have multiplier effect on the forest loss:

- Areas under the threat of submergence are getting cleared in advance.
- It leads to high displacement of people, which are getting rehabitations in forest lands only.
- Construction of houses, roads and other utilities for the newly migrated population leads to deforestation.
- It also leads to forest fragmentation, which changes the whole of ecosystem.
- Soil is eroded and deposited in the reservoirs which raises the water level and also causes floods.
- Disappearance of river flora and fauna due to change in the nature of ecosystem.
- It also leads to various diseases like malaria due to stagnant water.
- They increase the danger of earthquakes (seismicity of the area increases).
- They lead to pollution due to setting up of industries.

On the Tribal People:

Migration, ecological, cultural and economic loss.

They are bound to work as labourers as they are not educated enough to shift from one place to another.

÷ Anti-dam movements:

(i) 1920, Maharashtra against Mulshi dam on river Mula by the TATAs

(iii) 1980s, Narmada Bachao Andolan against Sardar Sarovar Project on river Narmada by Megha Patkar.

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Water as a Resource

÷ Sources of water:

(i) Surface water sources - rivers, ponds, reservoirs, lakes
Glacier melt, snow melt and precipitation are the sources.
In India, Indus, Ganga and Brahmaputra contribute 60% of surface water.

Types of rivers:
- Himalayan rivers - perennial
- Peninsular rivers - seasonal

(ii) Ground water sources - wells, tubewells, boring
80% is used for domestic purposes and rest for irrigation.

Causes of overutilisation of water resources:
- Overpopulation
- Expansion of agricultural fields
- Developmental projects (like dams)
- Industrialisation and urbanisation

Effects of overutilisation of water resources:
- Losses of biodiversity which leads to ecological imbalances
- Submergence conditions are prevalent leading to soil erosion and deforestation
- Leads to change in estuaries ecology due to high salt concentration in the estuaries.
- Causes water stress
- Water pollution
- Depletion of water table

Impact of groundwater depletion:

- Leading to fall in water tables
- Drying of surface water
- Leading to land subsidence
- Saltwater inclusion in the coastal areas

Water Conservation & Management

- Avoid pollution
- Proper disposal of waste
- Install the conservation practices like terrace farming, mulches, ponds making. (mulches - small vegetation)
- Always use good quality equipments
- Practise reuse of the water
- Renewal of water (eg. filtration)
- Use water judiciously
- Water harvesting
- Surface runoff harvesting by making divergent channels
- Drip irrigation

Floods

Floods refer to the presence of unusually large amt. of water at any place, which can't be handled by the drainage system of that area.
The occurrence depends on:

- Climate
- Type of vegetation
- Soil type and structure
- Nature of collecting basin
- Amt. of rainfall and snow melt
- Wind and the ocean current

÷ Types of floods:

(i) Flash floods - Sudden occurrence of floods
Cause dam breakage, storms, river blockage

(ii) River floods - These occur due to continuous snow melting and precipitation over a long period.

(iii) Coastal floods - due to cyclonic activities

÷ Causes of floods:

- Urbanisation
- Deforestation
- Construction of riparian dams (temporary dams)
- Man - made structures along the flood plains
- Uncertainty in rainfall
- Unusual tidal activity

÷ Effects of floods:

- Population migration
- Economic losses
- Food insecurity
- Health problems
- Loss of biodiversity
- Soil erosion
- Pollution

Large water bodies renew themselves due to minerals brought by floods.

÷ Flood management:

- Establishment of flood forecasting station
- Construction of riparian dams
- Afforestation
- Settlement of population away from catchment areas

Droughts

It is the deficiency of precipitation over a long period of time, resulting in water shortage and dreier conditions.

÷ Types of droughts:

(i) Permanent drought
(ii) Seasonal drought
(iii) Contingent drought (very erratic)
(iv) Invisible drought

On the basis of availability of water:

(i) Meteorological drought
(ii) Agricultural drought
(iii) Hydrological drought

- Meteorological drought : • Related to deficiency of rainfall as compared to average rainfall in the area
- 10% - more than 50%.

- Agricultural drought: • Insufficient soil moisture unable to meet the needs of crop production at a particular time

- Hydrological drought: • Deficiency of water in the surface and sub-surface of water bodies.

÷ Progression and Recovery of droughts:

Meteorological → Agricultural → Hydrological

÷ Causes of droughts:

- Erratic behaviour of monsoon
- Over exploitation of water sources
- Deforestation

⇒ Impact of dams (+ve and -ve)

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÷ Impact of drought:

- Economic losses
- Environmental losses
- Social losses

Conflicts over water

It arises due to inequalities and maldistribution of water in different parts of basin.

÷ Reasons:

- Infrastructure failures
- Rapid urbanisation
- Population growth
- Pollution
- Climate change

÷ Types of conflict:

- Inter-state
- International
- Economic status

Eg. → Indus water dispute (in 1960, pact was signed)

→ Kaveri river dispute (b/w Karnataka and Tamil Nadu); started in 18th - 19th century

→ Ravi - Vyas dispute (b/w Haryana and Punjab)

Rainwater Harvesting

- definition
- method - rooftop, rain saucer (inverted umbrella shape)
- irrigation, water table
- states in which it is practised

Watershed Management

It is the effective tool to solve various problems of agricultural growth and development, in the fragile or marginal rainfed areas. It is also called drainage basin, in which all the water available is managed to move to a common outlet or channel.

÷ Advantages:

- increased food production
- increased livelihood / economic status
- protection of environment
- maintaining ecological balance and biodiversity

÷ Approaches:

1) Integrated 2) Consortium

Minerals as a resource

- Metallic
  1) Ferrous eg. Fe, Co, Ni
  2) Non-ferrous eg. Cu, Pb, Sn
  3) Precious eg. Ag, Au, Pt
- Non-metallic eg. limestone, marbles, granite
- Energy eg. fossil fuels

÷ Exploration -

1) locating mineral sources
2) Mining (a) Surface mining
   (i) Open-pit mining: A large pit is dig to extract minerals and it is called quarry.
   (ii) Strip mining: A series of strips are dug parallel to each other near the surface.
   (b) Sub-surface mining - deep underground (below 200 kms)
3) Processing

Crushing and grinding → Sorting → Smelting → ~~beneficiation~~ Purification

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4) Decalidation - closing the mines

÷ Uses:

- The slag of mining is used as fertilisers and for landfills.
- It is required by plants and animals for growth and development.
- Sustainance of industrial growth and economy
- It has aesthetic value.
- We also need them for technological developments.

÷ Impacts : (DIY)

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UNIT-3

Green Technology

Technology which is ecologically sustainable, economically viable and socially acceptable is called green technology. It is based on:

- Cradle-to-cradle design, which means the products should be non-toxic, without any bioproducts or with utilisable bioproducts
- Sustainability
- Cost efficiency
- Eco-friendly

eg. unleaded petrol

Green Chemistry: It is environment feiendly, chemical synthesis in which the waste production or the hazaedous chemicals should not be used or produced.

÷ Goals:

- Identify, understand and seplace the unsustainable products and processes with sustainable ones
- Making such chemical products which do not hoem living organisms and environment
- Making process mose efficient to minimise waste
- Prevent pollution befose it happens

÷ Applications / Examples:

- Replacement of lead from paints with safer alternative
- Replacement of tetra-ethyl lead from gasoline
- Safer fire fighting firms (FFF) eg. Pyrocool and ecopol are used
- Perchloroethylene is seplaced by liquid CO_2 for dissolving grease and dirt during drycleaning.
- Manufacturing of ibuprofein is now mose atom economical.
- Manufacturing of biodegradable plastics with the help of plastic
- Using water as a solvent

Atom Economy
Zero waste technology
Carbon credit
Clean development mechanism

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÷ Principles:

The principles were given by Paul Anastas and J. Warner in 1998.

1. Prevention of Waste: The waste includes byproducts and unreacted reactants. So, designing such chemical reactions so that waste is not produced otherwise it would be more taxing on money as well as the environment.

2. Atom Economy: Such chemical synthesis which ensures maximum incorporation of atoms of starting material and the reagents into the final desired product.

3. Minimisation or prevention of hazardous material in a chemical synthesis: It includes products that have negligible or no toxicity on human health and environment.
Eg. For the synthesis of Nylon-66, the adepic acid is synthesized from benzene, which is a carcinogen. We can manufacture the same by using d-glucose as raw material.

4. Design safer chemicals: Thalidomide is a drug given to the pregnant women in case of excessive vomiting, which causes birth defects. But this drug existed in 2 isomeric forms, out of which dextro-rotatory isomer is very safe so it is strictly recommended.

5. Use of safe solvents and auxiliaries: Instead of perchloro-ethylene chloroform or carbontetrachloride, use of liquid CO_2 for the dry cleaning purposes.

6. Design for increase in energy efficiency: • Carrying out reactions at optimum temp. and pressure
• Avoid generating impure products
• The energy source used should be supplied through renewable sources or recycling plants

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7. Selection of renewable field stock (starting material):
- Production of biofuels and biodiesel from vegetable oils and organic waste
- d-glucose to produce adepic acid instead of benzene

8. Use of catalyst and non-stoichiometric reagents: Biocatalysts are highly specific, give higher yields, required in smaller quantity and they are reuseable. It is making the impossible reactions possible.
Eg. conversion of acetylene into acetaldehyde.

9. Products generated should be biodegradable: Insecticides like DDT, aldrin are highly harmful and non-biodegradable so, we should use diacetyl hydrazine which is a biodegradable insecticide.

10. Strengthening of analytical techniques for prevention of pollution:
In-time and real-time monitoring during the reactions help in its better designing to reach to the complete reaction and if unreacted reactants and reagents are present, it should be recycled.

11. Designing the manufacturing plants to minimise the potential for accidents:
Bhopal Gas Tragedy, 1984 in which there was a release of 30 tonnes of methyl isocyanate due to the failure of the vents in the union carbide factory.

12. Avoid unnecessary chemical derivatives: Such as the chemicals which are used as blocking groups or protecting groups as they generate lot of waste.
Eg. In the conversion of hydroxy benzaldehyde into hydroxy benzoic acid, the ~~one~~ benzyl chloride is used as protection group for the -OH group. This generates chlorinated byproducts which are harmful and make the reaction less atom economical.

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Atom Economy

It was given by Barry Trost in 1991.

$$\% \text{ yield} = \frac{\text{Actual yield of Product}}{\text{Theoretical yield of Product}} \times 100$$

$$\% \text{ atom economy} = \frac{\text{Mass of atoms in desired product}}{\text{Mass of atoms in reactants}} \times 100$$

$$A + B \longrightarrow \underset{\hookrightarrow \text{ desired product}}{C} + D$$

$$\% \text{ atom economy} = \frac{C}{A+B} \times 100$$

(i) Rearrangement reaction: They are 100% atom economical and are the most preferred.

(ii) Addition reaction: They are also 100% atom economical.

(iii) Substitution reaction

(iv) Elimination reaction

(v) Oxidation reaction: They are around 40-50% atom economical and are the least preferred.

Tools for green technology

1. Green starting material
2. Green reagent
3. Green reaction
4. Green product
5. Green methodologies

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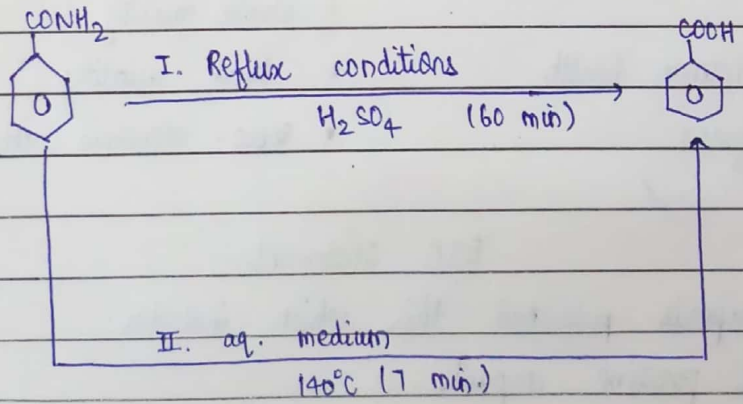
Green Methodologies - These are the alternative methods to the existing methods which help to remove toxic starting material, reagents, by products or atleast minimise their content.

(i) Reactions performed at optimum temp. and pressure
(ii) Reactions performed in aqueous medium instead of organic solvents eg. aldol condensation
(iii) Single step reactions are preferred
(iv) Reactions with max. atom economy are preferred
(v) Specific and safe reactions are preferred
(vi) Natural processes like fermentation are preferred
(vii) Biocatalysed reactions are preferred.

eg. • oxidoreductase
• Transferase
• lyase
• ligase
• isomerase

Eg. • Hydrolysis of benzamide to form benzoic acid showed 90% yield under reflux conditions for 60 minutes but if the reaction occurred in aqueous medium and is assisted by microwave for 7 minutes, the yield increases to 100%.



• Production of polycarbonate (polymer of bis-phenyl-A and phosgene) in the presence of methylene chloride is a traditional method, which generated chlorinated byproducts so, it is not preferred. Instead, when phosgene is replaced by diphenyl carbonate, we negate the production of chlorinated byproducts.

Bis-phenyl A + $COCl_2$ $\xrightarrow{CH_2Cl_2}$ Polycarbonate

Clean development mechanism (CDM)

It is established for project based emission reduction in the developing countries with the help of developed countries, which have invested in eco-friendly projects in the host country to reduce the greenhouse gases production. It is one of the mechanisms offered by Kyoto protocol to reduce CO_2 emissions.

Objectives: Sustainable development

Benefits: • Infrastructure in developing countries is enhanced.
• Developed countries don't have to shut down their projects

Environmental Impact assessment (EIA)

It is the formal process to predict environmental consequences of any proposed developmental project, program or policy.

Parameters:

- air quality
- impact on human health
- flora and fauna
- water quality
- land quality
- socio-economic impact

EIA Statement

Volley of experts published this which includes:

- negative and positive impacts
- mitigation methods
- alternative methods
- summary and conclusion

∴ Advantages and drawbacks

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UNIT - 2

Resources

÷ Increasing demand for energy resources:

- for economic development
- meet up with the growing demands of population
  - → agriculture
  - → household usage
  - → transport sector
  - → industrial development
- energy consumption patterns and distribution of energy resources is non-uniform
- over-exploitation

÷ Types of energy resources:

Renewable energy resources:

(i) Solar energy -

(a) Solar cell is a solid device made of semiconducting material, which converts photons of solar energy into electricity. Assembly of these cells are called solar modules or panels.

WORKING:

Photons heat the solar panel, which are absorbed by semiconductors like Si. The e^- are knocked out of their atoms to flow through the material to generate electricity.

DC is generated, which is either stored in batteries or converted into AC through inverter for immediate use.

Applications:

- lighting purposes - solar lanterns, street lights
- water pumping - irrigation
- power plants
- solar cookers

Merits and demerits

(b) Solar Thermal technology uses a good absorber of heat like metallic plate and paint it black so that it absorbs all the radiations. It is covered by glass top which is used to trap the heat and not letting it dissipate (greenhouse effect).

Applications:

- Solar water heating
- Solar grain dryers
- Solar distillation unit
- Solar cookers
- Solar thermal power generation
- Heating of buildings

(ii) Wind energy -

The air is in continuous motion due to heating and cooling of water and land bodies. The kinetic energy of the air is called wind energy which is harnessed from windmills arranged in windfarms. Windmills are giant electric fans which are very tall. The blades rotate due to wind which turn the turbines and generate electricity.

Applications:

- to do the mechanical work
- generating electricity

Eg. windfarms in Kanyakumari, Gujarat, Maharashtra

Merits:

- non-polluting, eco-friendly, sustainable
- short gestation period
- cheap power generation and input is unlimited

Demerits:

- can be setup only in certain areas
- large and open areas are required

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- produce lots of sound so they should be away from population as well as routs of migratory birds.
- whole structure is always exposed so high degree of maintenance is required
- backup facilities required

(iii) Hydroenergy:

In our country, $\frac{1}{4}^{th}$ electricity is generated through hydro power plants and 80% of these plants are present in Maharashtra, Kerala, Himachal, J & K.

Merits:

- low maintenance cost
- long life
- highly efficient
- labour intensive projects leading to employment
- multi-purpose projects

Demerits:

- high initial cost
- population displacement and damage to environment
- occurrence is non-uniform

(iv) Biomass energy:

Biomass is organic matter, which is a form of stored solar energy, which is producing energy.

SOURCES: (i) largest source is wood (iii) cowdung
(ii) agricultural waste (iv) organic municipal waste

Forms of biomass energy:

- Solid fuel, burnt directly to get energy
- Liquid fuel, like biodesel produced from vegetable oils and has

no sulphur

- Gaseous fuel - biogas made of 75% CH_4

BIOGAS: Decomposition of organic matter in the absence of air which contains predominantly CH_4 produces biogas. The slurry left behind is rich in NPK (nitrogen, phosphorus, potassium) so it is used as manure in the fields.

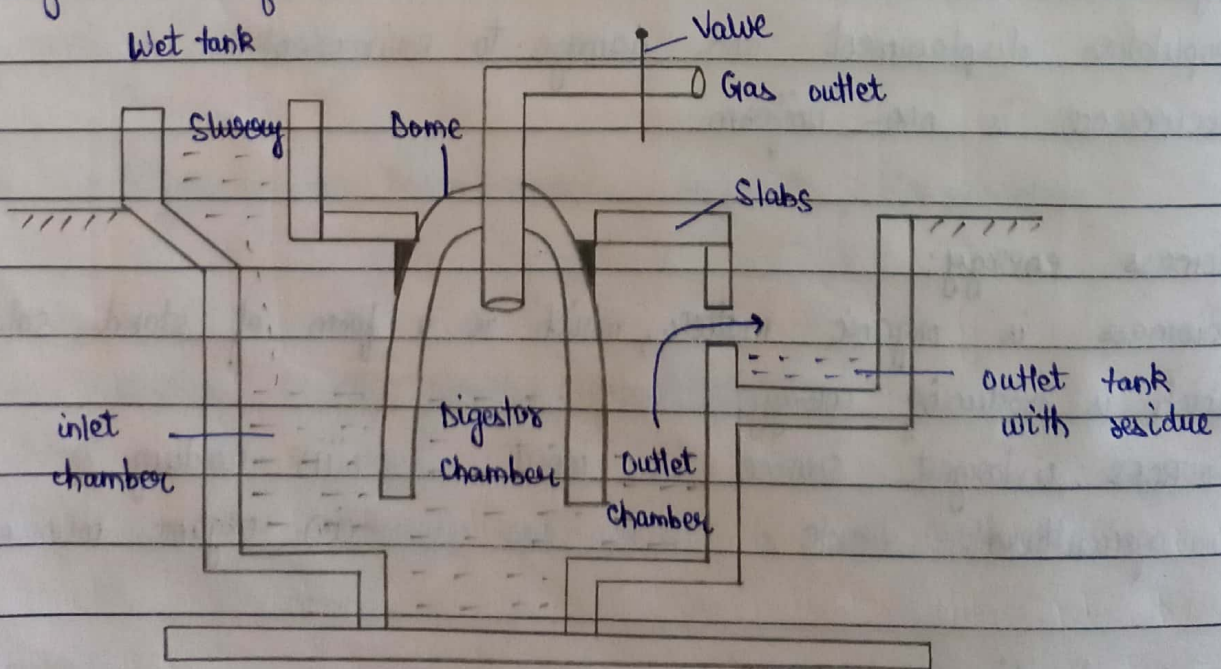
USES:

- for domestic purposes
- running small scale industries
- used as thermal fuel
- lighting purpose

Govt. initiatives:

(i) Biogas pilot plants - started in 1981-82
→ concerning family uses and domestic needs

(iii) Biomass gasifiers for thermal applications
→ high capacity gasifiers → low capacity gasifiers
They were for industries.



BIOGAS PLANT

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(v) Geothermal energy:

Due to the presence of molten core, the earth possesses thermal energy. We can harness this energy through the hotspots like natural geysers, hotsprings, active volcanic region. These hotspots are formed when magma is pushed up and converts water into steam which crack opens the earth's crust.

Extraction:

- Trapping the natural steams through sinking pipes.
- Construction of injection and production wells in which water is pumped in, which travels through a distance and convert it into steam.

Merits:

- Eco - friendly
- 24 hours available
- Power generation efficiency is very high and continuous

Limitations:

- The hotspots are scattered and less in number.
- They have limited lifespan.
- Associated with noise pollution.
- These are fragile and sensitive zones.

(vi) Ocean energy system:

The water level near the coast it moves up and down forming tides

Harnessing method:

Constructing barrridges at the bays and estuaries

∴ Gulf of Khambat, Gulf of Kuchch, Sundarbans

Merits and demerits

(vii) Wave energy:

Harnessed by • floating generators

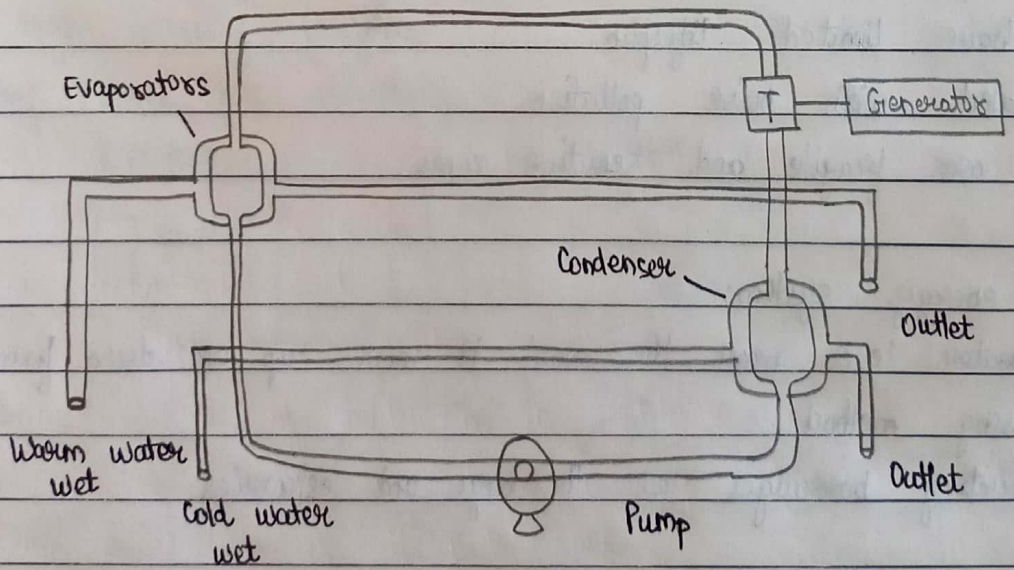
- Partially air filled tubes are used. As the wave water moves in, it compresses the air and moves the turbines.
- Distribution - Trivendarum

Merits:
- eco - friendly
- inexhaustible

Demerits:
- less outcome
- disturbs the marine ecosystem

(viii) Ocean Thermal energy:

Solar radiations increase the temp. of surface layer of oceans and waves are mixing them upto 100 m depth. The lower layers upto 2 kms are cold. When we use these 2 layers to produce energy, it is called OTEC process (Ocean Thermal Energy Conversion).



OTEC is a closed cyclic process where we circulate low boiling pt. liquid like NH_3. The warm water boils the NH_3 and the vapours are used to rotate turbines. The cold water is used to condensed the vapours back to liq. NH_3.

Non - Renewable energy resources:

(i) Coal - It is a mixture of compounds of C, H, O, N and small amount of sulphur.

Different types of coal are:

→ Peat - 11% carbon content

→ Lignite - 38% carbon content

→ Bituminous - 65% "

→ Anthracite - 95% "

÷ Treatments given to coal:

(i) Destructive distillation: It results in the production of useful byproducts like, napthalene, NH_3, tar alongwith increased carbon content of coal.

(ii) Carbonization: improving the carbon content

÷ Applications:

- majorly used in thermal power plants (70 - 75%)
- domestic purposes

÷ Distribute:

J & K, ~~Kas~~ Gujarat, Bihar, Rajasthan, Orissa

(iii) Petroleum - It is also called rock oil. It is a thick black liquid which is a mixture of solid, liquid and gaseous hydrocarbons alongwith water and salts which needs to be fractionally distilled to get the useful compounds like fuel oil, diesel oil, petrol, petroleum gas, paraffin wax.

÷ Applications:

- majorly used in transport sector (38 - 40%)
- domestic applications (25%)
- industrial applications (25%)

- Agriculture (8%)

iii) LPG: It is highly inflammable, odourless gas, which is a mixture of iso-butane, butane, propane and ethane. β-mercaptane is added to the gas to make it odour producing so that accidental leakage can be traced.

÷ Distribution:

Digboi - Assam, Bombay High, offshore regions of the delta of Godavari, Krishna, Kaveri and Mahanadi.

iv) Natural gas: It majorly constitutes CH_4 (95%) alongwith C_2H_6, C_3H_8, N_2 and H_2S. It is highly inflammable and odourless gas. The largest reserve is in Russia, which constitutes 40% of the total natural gas, then middle East, followed by USA.

÷ Distribution:

Tripura, Jaisalmer, offshore areas of Mumbai and delta regions of Krishna and Godavari.

÷ Applications:

- used as domestic fuel
- as industrial fuel
- fuel in the power plants
- major source of hydrogen in fertiliser industry
- source of carbon in rubber industry (tyre manufacturing)
- CNG is used as alternate fuel.

Nuclear energy:

1) Nuclear fission
2) Nuclear fusion

] definition, examples, reactions

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÷ Nuclear power plants in India:

- Tarapur (Maharashtra)
- Narora (U.P.)
- Kalpakam (Tamil Nadu)
- Rana Pratap Sagar (Kota, Rajasthan)
- Kaiga (Karnataka)
- Kakrapar (Gujarat)

÷ Merits:

- produces large amount of energy from small amount of fuel.
- As it is based on chain reactions, once the fuel is loaded, it ensures the electricity production for 2-3 years continuously.
- It is not producing polluting gases.
- It is a reliable method.

÷ Demerits:

- Initial installation is costly.
- It produces radioactive waste, which pollutes the environment.
- It is always at the risk of accidents.
- It causes genetic damages to plants and animals.
- Proliferation of terrorism

Alternate energy sources:

(i) Green fuels: These are biodegradable, non-toxic, non-carcinogenic, eco-friendly, economically viable fuels, which are very safe during transportation and storage, due to their high flash points, which is 179 °C.

÷ Types of green fuels:

(a) Vegetable oil: flower oil

(b) Biodiesel, produced from seed oil of jatropha

(i) oil extraction (ii) Trans esterification

$$\text{Veg. oil} + CH_3OH \xrightarrow[NaOH]{KOH} \underset{\text{(methyl ester)}}{\text{Biodiesel}} + \text{Glycerol}$$

(c) Ethanol, produced by the distillation of energy crops
(d) Methanol, from the pyrolysis of the energy crops
(e) Methane, anaerobic bacterial decomposition of organic matter

÷ Properties:

- They are the carbon sinks as they are mainly obtained from plants.
- Oxygenated fuels so produce less harmful gases
- sulphurless fuels
- Energy positive fuels
- better burning fuels with good cetane number
- These fuels are majorly used as blends (5-10%).

÷ Merits and demerits:

(iii) Hydrogen: • It is formed by the steamed reformation of the natural gas.

- Photolysis of water
- Electrolysis of water

÷ Applications:

- can be burnt directly in the internal combustion engines as fuels
- it generates electricity in fuel cells.
- zero emission fuel.
- thermal applications

÷ Merits and demerits:

Food Resources:

÷ Sources:

- Agriculture (76%) - crop land
- Animal Husbandry (17%) - rangeland
- Fisheries (7%)

÷ Food Problems:

(i) Food insecurity:

Regions suffered (i) South Asia (ii) Sub Saharan Africa

The 3 pillars of food security are

- Food availability
- Food accessibility
- Food utilisation

The lack of any one of these causes food insecurity.

REASONS:

- overpopulation
- unavailability of land
- unequal distribution of food
- geographical location of plates
- poverty
- poor quality soil

Due to food insecurity, the adults show low stamina and high susceptibility to diseases and children under 5 years show high death rates.

(ii) Undernutrition:

It depends upon the calorie intake of an individual which is 2500 - 3000 Kcal / per day for the adults. If a person consumes 80 - 90% less calories over a longer period, he will suffer from undernutrition.

People are usually underweight, show low stamina and the children show high mortality rate.

(iii) Malnutrition:

If an individual doesn't take enough amount of specific essential nutrients like proteins, fats, carbohydrates (macronutrients, vitamins, minerals (micronutrients), water and roughage, which are required for the maintenance of body's essential functions is malnutrition.

Adults show susceptibility to diseases and children show slow growth and development and high impact on cognitive development.

Marasmus	Kwashiorkor
• Term is derived from marasmos which means wasting away	A disease of displaced
• It is protein + energy deficiency disease.	It is only protein deficiency disease.
• Common in children below 1 year of age.	Common in children of 1-5 years
• Slow growth and extreme atrophy of muscles	Characterised by edema (retention of fluids), apathy, protruding (swelling of belly)
• Recovery is fast.	Recovery is very slow.

(iv) Overnutrition:

People having diet rich in fats, sugars, refined flours and processed food and showing obesity, high BP, diabetes, heart ailments shows a condition of overnutrition.

It is common in the regions of developed countries.

÷ Impact of Agriculture:

The changes caused by agriculture are of 2 types

(i) On-site changes:

- Soil compaction
- Soil erosion
- Reduction in organic matter
- Reduction in biodiversity

(ii) Off-site changes:

- Water pollution
- Eutrophication
- Air pollution

÷ Modern Agriculture: completly mechanised ; based on fossil fuels

÷ Subsistence Agriculture: not for commercial purposes eg. shifting cultivation, slash and burn agriculture

÷ Fertiliser Problems:

We are supplying high doses of NPK fertilisers to grow high yielding varieties (HYV).

Nitrogen fertiliser - biological fixation
Chemical fertiliser - urea, ammonia
Organic manure - cowdung

Phosphorus - supplied in form of superphosphates or phosphoric acid

Potassium - already present in soil in large amt. but also supplied in form of potash

Organic fertilisers - rich in N_2; help in maintaining good soil structure; increases water holding capacity; only preferred for subsistence agriculture and organic farming.

(i) Fertiliser Burns: characterised of yellowing of foliage
(ii) Fertiliser Runoffs: causes eutrophication
Due to high nutrient contents in the water body, there is excessive growth of phytoplanktons and algae leading to accumulation of organic matter in the water bodies, which makes it shallower and warmer and reduces its D.O. levels immensely. Lots of bacteria and detritus population grow well which make the water non-utilisable and with bad odour.
(iii) Increased Pests: due to fragile growth of crops
(iv) Soil damage: depletion in organic matter
(v) Health problems: nitrates are reducing to nitrites and on entering human body combine with haemoglobin to form met-haemoglobin which shows low O_2 carrying capacity and causes a disease called Blue Baby Syndrome. Sometimes, it also causes gastric cancer.

÷ Fertiliser Solutions:

- Regular testing of soil for aeration, nutrient content should be done.
- Only recommended amount of fertilisers should be added.
- Fertiliser should not be applied during or before rain.
- Organic manure should be preferred.

÷ Pesticide Problems:

(i) Organochlorines: also called chlorinated hydrocarbons
eg. DDT, aldrin

- They are non-biodegradable, persistent, affects calcium metabolism, show high degree of bio-magnification.
- They strongly affect the nervous system and cause hormonal imbalances

(ii) Organophosphates: malathion, parathion

- biodegradable and show effect when come in direct contact
- severely damage the muscles and nerve

(iii) Carbamates: polyurethanes

- least effective pesticides; biodegradable
- only cause nausea and vomiting
- applied to fruits

(a) Pesticide Treadmill: Smaller is the organism, better is its adaptation. The pesticides, instead of controlling the pest population, leading to the increased resistance in pests and hence their secondary and tertiary outbreak.

(b) Water pollution: leading to loss of biodiversity in aquatic ecosystem

(c) Weakening and thinning of egg shells of birds: due to effect on calcium metabolism

(d) Human health problems:

→ Endocrine problems - related to hormones
→ Induces neuro toxicity leading to weakening of nerves and muscles and Parkinson's disease in some
→ Cancer causing

÷ Pesticide solutions: (Integrated Pest Management)

- using biodegradable pesticides
- crop rotation
- using bio-pesticides - using biological organisms for pesticides
- using natural pesticides

÷ Salinity:

It is the natural occurrence in dry and arid lands, where the rainfall is low. The soil has high amount of soluble salts.

- Causes:

→ Heavy rainfall followed by high temp. leading to rise in soluble salts content in topsoil layers
→ Excessive use of fertilisers
→ Faulty irrigation practices

- Prevention:

→ improving drainage
→ excessive irrigation to reclaim the saline lands

÷ Waterlogging:

It is a condition when the surface soil is saturated with water so that soil poses are full of water with no air till roots grow.

- Reasons:

→ Period of continuous heavy rains
→ Poor drainage

→ Over-irrigation
→ Increased water table

- Impacts:

→ devegetation of area
→ no oxygen for plants
→ occurrence of vegetational shift

- Prevention:

→ management of drain lines
→ manggement of surface water flow to avoid surface ponding
→ grow more and more deep rootal vegetation

Land Resources

- different zones
- land degradation - direct and indirect causes
- agricultural practices
- devegetation of land
- soil erosion - deforestation, faulty cultivation methods (unscientific) like shifting, cultivation along the slopes without conservation, overgrazing, construction of railway embankments, which lead to divergence in natural drainage system, lack of surface drainage, natural calamities
- loss of fertility by mismanagement
- deterioration of soil structure
- desertification

Desertification: It refers to irreversible formation and expansion of degraded land with extremely less vegetation cover in the dry and arid areas due to climatic conditions or human activities.

Reasons: overcultivation, overgrazing, deforestation, extreme climatic conditions, mining, dams, urbanisation, industrialisation

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Effects :

- Soil looses all organic matter and become infertile.
- Loss of biodiversity
- Negligible productivity

÷ Man induced landslides:

Landslides are the hydrogeological hazards which include downslope physical movement of land due to instabilities.

CAUSES:

- Weathering of rocks, earthquakes - Geological causes
- Morphological causes - slope angle, slope loading, vegetational cover
- Physical causes - high rainfall, snow melt, soil liquifaction
- Anthropogenic causes - deforestation, pollution, human settlements in the fragile zones, heavy structure constructions, mismanaged agricultural practices along the slope and high rate of soil erosion

CONTROL:

- Community education for warning, monitoring and evacuation process
- Human settlement should be away from fragile zones.
- All sustainable activities should be practised.

Eg. Darjeeling floods, 1958

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Pollution

UNIT-3

Water Pollution:

SOURCES:

- Natural - decomposition of organic matter, eroded soil
- Due to human activities - domestic and industrial waste, agricultural waste (surface runoffs, fertilisers, pesticides)

÷ Point and diffused sources

Water pollutants:

(i) Oxygen demanding waste: Decreases the dissolved oxygen levels
They include mainly the organic waste from industries and domestic levels.
Measured by measuring BOD (biological oxygen demand) and COD (chemical oxygen demand) of polluted water sample

(ii) Pathogens: Disease causing organisms coming into water through sewage, waste from tanning, leather and food industries.
They cause 2 types of diseases:

- Water borne diseases - cholera
- Water contact diseases

(iii) Synthetic organic compounds: • Pesticides

- Detergents - They consist of 2 parts (i) Surfactant (30%) (ii) Builders (70%)

Builders cause eutrophication due to high nutrient content and surfactants make the water turbid and full of lather.

(iv) Plant nutrients: Industrial waste, surface runoffs
They reduce the dissolved O_2 and cause eutrophication just like builders.

They are disease-causing and cause diseases like methaemoglobin anaemia.

(v) Inorganic chemicals and minerals:

- Mineral acids - due to acid mine drainage
- Soluble salts - cations increase the TDS of water and after certain permissible limit kills the aquatic life
- Heavy metals like Al, Ag, Pb from thermal power plants and industrial affluents

They cause nervous system damage, cancer, mutations and kidney damage.

(vi) Sediments: They include sand, soil, silt and rock particles, which increases the turbidity of water and block the sunlight. So, photosynthesis and hence, DO are reduced.
They mainly cause asphyxiation (breathlessness) in fishes.

(vii) Radioactive Substances: They come from:

- mining of radioactive substances
- nuclear power plants
- industrial waste
- medicinal and research purposes
- cosmic rays
- production and testing of nuclear weapons

Effects: Through food, they enter into human or animal body and get accumulated in blood and cause leukaemia, mutations, bone cancer, eye defects.

(viii) Thermal discharges: They come from all the industries which use water as a coolant contribute to thermal discharges.

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For ex.- ~~White~~ Coal based power plants, Steel industries, Atomic energy plants
- They rise the water temp. depleting the DO levels.
- They kill the most essential enzymes for aquatic life.

(ix) Oil:
It comes from oil refineries, industrial affluents, automobile based oil, ballast water (used for balancing of tankers while transportation), oil spills.

- Bird population in the area decreases.
- It stops the aeration of water bodies hence depleting DO.

(x) Volatile organic compounds (VOC):
They are used as solvents in most of the chemical industries.
Eg: vinyl chloride causing cancer, CCl_4, which is fatal

Prevention:
- Zero-emission laws
- Conserve clean water supplies
- Avoid littering
- Clean agriculture
- Create awareness
- Use less plastic bags
- Stop deforestation

Wastewater Treatment

Primary treatment: removing the suspended solids
Secondary treatment: removes organic matter in dissolved or colloidal sol^n and microbes are used
Tertiary treatment: removes very fine suspended particles, organic matter and minerals

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* PRIMARY TREATMENT:

Includes pretreatments involving screening and grit removal

Wastewater → Screens → Communitors → Grit chamber → Primary Sludge ← Sedimentation

÷ Sedimentational aids:

(i) Equalization: It involves thorough mixing of the waste water to make it a homogenous solution.

(ii) Flocculation: Slow stirring is done so that the finer particles adhere with each other and settle down fast.

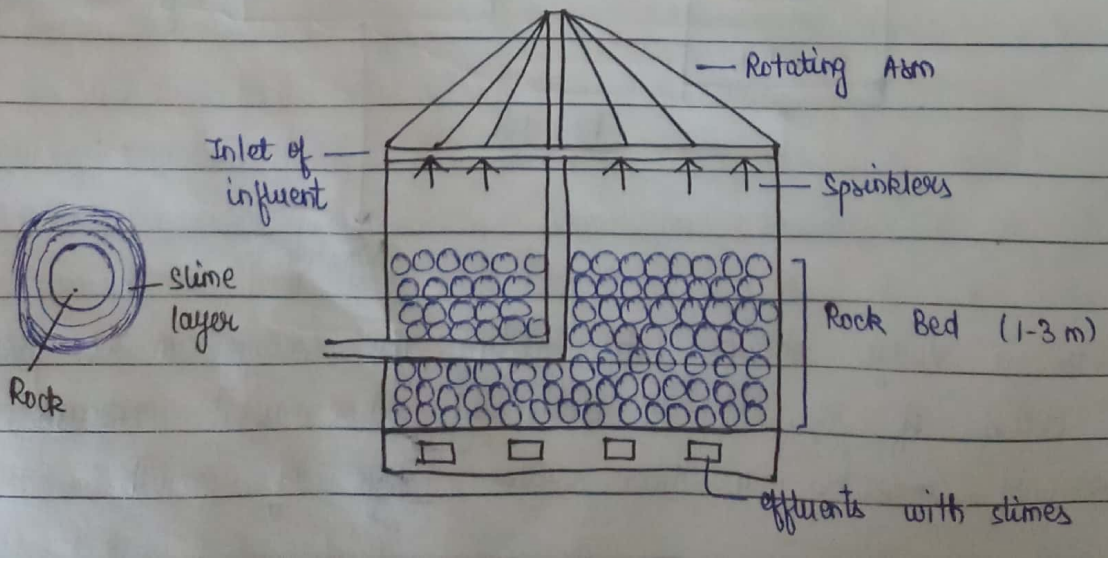
(iii) Chemical coagulation: We use coagulants like lime or alum to coagulate the colloidal substances that will settle down fast.

(iv) Neutralisation: We add lime or acid to neutralise the waste water and sometimes the acidic and alkaline wastewater are mixed together.

* SECONDARY TREATMENT:

It is used to remove all the oxygen demanding waste which is in the soluble or colloidal forms by using biological processes.

(i) Trickling filters: They are also called biological towers.



Individual rocks are covered with slime layer which consists of aerobic microbes. When the influents are introduced to the rock, they trickle the slime layer and the organic matter is decomposed aerobically and CO_2 is produced, which comes out with the effluents initially but as the slime layer thickens, it gets detached from the rocks and comes out with effluents in the form of humus which can be collected as sludge sent to the digesters and finally used as manure.

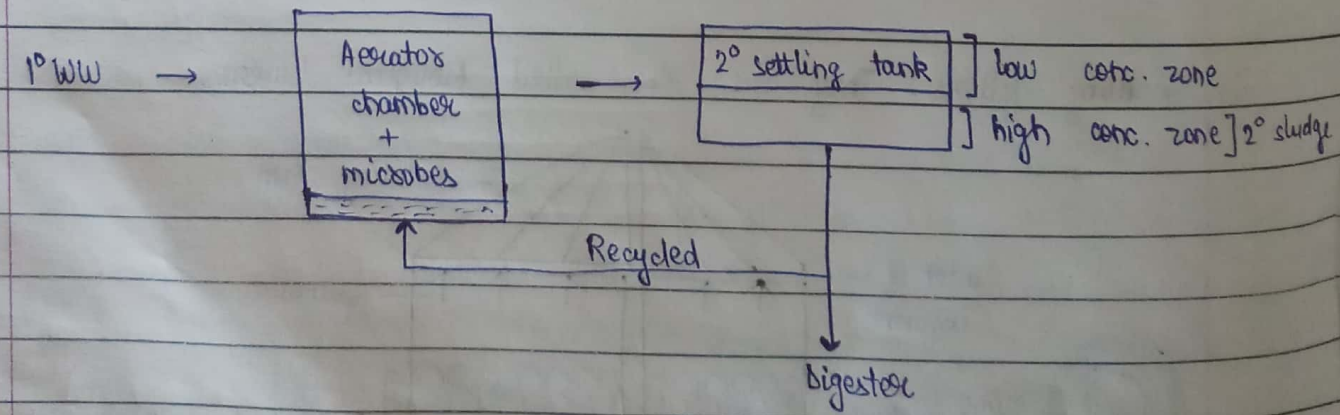
Advantages:

- It reduces the BOD of wastewater by 60-80%.
- It has low operating cost.
- Constant monitoring is not required.
- Effluents are of better quality.

Disadvantages:

- Initial installation is costly.
- Setup is sensitive to change in pH, temp.

(ii) Activated Sludge Process:



It is a sludge obtained by settling the sewage in the presence of excess of O_2. It is biologically active as it contains high conc. of microbes in their active stage of growth.

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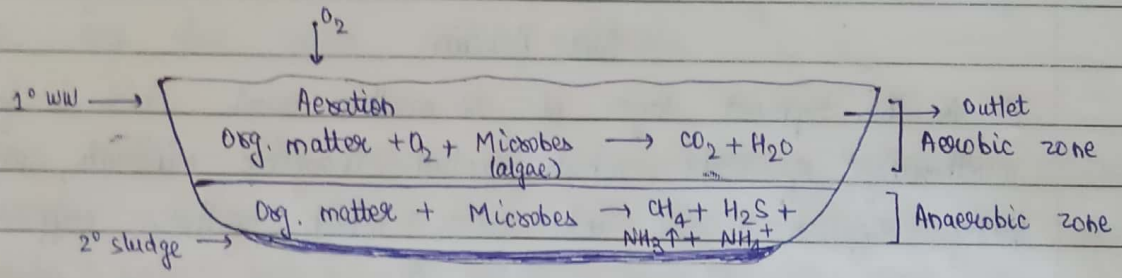
Advantages:

- Cheaper process
- Requires small area
- Reduces BOD

Disadvantages:

- 1-5 ppm of O_2 has to be maintained so constant monitoring is required.
- The process is very sensitive to high temp. and pH value.
- Not able to remove non-biodegradable organic matter.

(iii) Oxidation Ponds:



These are the large but shallow ponds, only 1-2m deep, in which the wastewater enters through one side and being collected from other side. The organic matter decomposition in upper zone is aerobic while anaerobic decomposition takes place in lower zone, producing bad odour gases. So, these are called facultative ponds.

★ TERTIARY TREATMENT:

(i) For the removal of finer solids, MICROSTRAINING : A filter mesh is used.

(ii) For the removal of dissolved solids:

- Using activated carbon filters for adsorption of soluble organic matter.
- Solvent extractions, mainly done for phenolics as they form a separate layer when aqueous.
- Ion-exchange method
- Reverse osmosis
- Chemical precipitation

(iii) For the removal of nutrients:

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- Ammonia Stripping, involves conversion of NH_4^+ into NH_3 by raising the pH
- Nitrification, NH_3 is converted into nitrates by nitrifying bacteria and then nitrates are converted into nitrites and N_2 gas, with the help of denitrifying bacteria.
- Phosphorus removal through precipitation

(iv) For the removal of microbes:

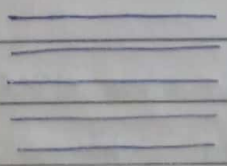
- Chlorination
- Ozonation
- Retaining water in legumes for longer duration

Soil Pollution

It is the topmost layer of the earth's crust which is formed by weathering of rocks which contain inorganic minerals, organic matter, living organisms, air and water which together support vegetation.

Factors responsible for soil formation:

- Weathering of rocks due to temperature changes due to chemical weathering
- Biological weathering of lichens
- Soil profile - a cross sectioned view of soil which shows different horizontal layer



- O horizon - It has freely fallen leaves, dead organisms alongwith microbes.
- A horizon - It consists of partially decomposed organic matter alongwith high microbes population and worms.
- B horizon - It consists of high inorganic matter, very less organic matter and negligible microbes.
- C horizon - It consists of weathered parent rock which helps in

maintaining soil pH.

- Composition of soil - Different soil particles
  1) Clay - 0.002 mm
  2) Silt - 0.002 - 0.02 mm
  3) Sand - 0.02 - 0.2 mm
  4) Gravel - 0.2 - 2mm
  5) Stones - more than 2mm

  These particles give colours and composition depending on %ge.

- Inorganic matter - It includes 1) silicates of Na, K, Ca, Al
  2) oxides of Fe and Mn 3) carbonates of Ca and Mg
  These are also called plant materials.

- Organic matter - It consists of polysaccharides, nucleotides, organosulphur compounds and is rich in humus. It helps in maintaining soil porosity, water holding and retention capacity.

- Living organisms - These are responsible for making soil fertile and well-aerated.

- Soil water and air - The poses of soil are filled with air or water which is controlling the pH of soils as well as responsible for oxidation of organic matter.

÷ Soil Pollution:

It is contamination of soil by the chemical substances which changes the physical, chemical and biological properties, making it unfit for usage.

SOURCES:

1) Industrial waste, which are rich in heavy metals dioxides, coloured compounds and microbes

2) Urban waste - It includes plastics, glasses, metals, sheets, fibres and paper. They add solid waste to soil.
3) Agricultural chemicals - fertilisers and pesticides
4) Biological microbes - through faulty sanitation, municipal waste and excreta.
5) Radioactive waste
6) Soil erosion - eroding topmost layer of soil
7) Coal based power plants which generate fly ashes and bottom ashes which are sources of heavy metals

÷ Effects of soil pollution:

÷ Control of soil pollution:

- The waste should be dumped only after proper treatment and dumped in landfills.
- The toxic persistent chemicals should be banned. Instead biodegradable substances should be used. Biopesticides are the ones which use microbes to kill organisms.
- Proper awareness campaigns should be run regularly.
- Crop rotation should be practised.
- Bio - remediations and phytoextractions should be done regularly for polluted soils.
- Afforestation programs should be run.
- Use of integrated pest management should be done.
- Organic farming should be practised.
- Organic waste should be utilised for biogas & manure production.

Marine Pollution

Sources:

1) Rivers - drainage basins
2) Catchment areas - coastline with human settlement activities
3) Oil drilling operations by water transport system

- Chemicals - invisible part of marine system
- Industrial and agricultural waste - sources of chemicals
- Radioactive waste
- Dessipating waste

1) Heat: depletes the DO levels and kills the aquatic life
2) Acids and alkali: showing less impact due to large buffering capacity of seawater

- Eutrophication - The phytoplankton population increases which has DMS in them. On degradation, it is converted into H_2SO_4 which causes acidification.

Control:

- Control at source level: • Foster such technologies which generate no waste
  • Avoid using toxic material

- Control at disposal level: • Waste should always be treated first and then disposed off as per the set principles

- Legal Control: • A specific license or consent should always be required to start any production or development projects
  A detailed EIA of the new discharges should be given to continue or stop its production.

- Coastal zone management: It controls the population activities, treatment and disposal strategies of coastal area by working on detailed EIA.

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Noise Pollution

Pollutants:

(i) NATURAL: Storms, thunder, volcanic eruptions

(ii) MAN MADE: Domestic equipments, industrial machineries, mining, transport system, defence equipments and practicing, entertainment devices

Effects:

(i) Auditory effect:

- Exposure to the high intensity sound for short duration causing temporary deafness.
- Permanent hearing loss due to continuous exposure to the high intensity sound.
- Decreased ability of ear to respond to loud sounds.

(ii) Non-auditory effects:

- Physiological disorders - anxiety, insomnia, fatigue, headache, strained eyes, nervous breakdown
- Increased irritability
- Effects on the wildlife - It increases the mortality rate by interfering in prey-predator detection.
- Effects on aquatic life - The creatures use sound for communication and navigation and high noises destruct all these processes.
- Migratory birds population is declining fast as they are avoiding noisy paths.

Control:

(i) Road transport noise control: Smoothening of roads, using silencers, avoid listening to music while driving, avoid use of horns

(ii) Air traffic control: • Engine designing should be improved and can be placed in the acoustic chambers.

• Altering the path of flights away from population and timings should be well regulated.

(iii) Afforestation programmes: As the belts of trees are good absorbers of sound.

(iv) Legal control- Noise regulation rules are amended under Environment Protection Act 1986 in the year 2000, which limits the noise levels sector wise.

Thermal Pollution

Control:

(i) Legal control- established by clean water act, 1972
Instead of discharging hot water into the water bodies immediately, it should be passed through cooling towers where they get colled down due to evaporation.

(ii) Special artificial lakes are made for storing heated water, where the water is coled, recycled and reutilized.

(iii) Heated water can be used as a source of heat for industrial and domestic purposes and this is called co-generation.

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Solid Waste Pollution

SOURCES: • from the urban communities like plastics, metal cans, glass, papers, rubbers, tyres
• accumulation of agricultural, industrial and mining waste

CLASSIFICATION:

(i) Garbage: It includes degradable waste with high moisture content approximately 17% with a heating value of 6×10^6 J/kg.
Eg. leftover meat, vegetables, fruits

(ii) Rubbish: It consists of non-degradable waste with 25% moisture and heating value of 15×10^6 J/kg. It is divided into combustible (like paper, wood, rubber) and non-combustible (glass, metal, ceramics).

(iii) Pathological: It includes dead animals and plants, disposable syringes, bandages, moisture content is 85% with a heating value of 2.5×10^6 J/kg. It is highly infectious.

(iv) Industrial (v) Agricultural

(vi) Ashes: • fly ash (light weight) • bottom ash (heavy weight)

EFFECTS:

- It increases pathogens and vectors, like flies and mosquitoes.
- It leads to soil pollution and water pollution.
- Burning of waste leads to air pollution.
- It degrades the aesthetic value of land and non-biodegradable waste in sewage act as obstruction.

TREATMENTS:

(i) Dumping: It requires no planning. It is a cheap process, where the waste is left untreated and uncovered and is not segregated, so it becomes the breeding house for the flies and mosquitoes and also cause land and water pollution.

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(ii) Sanitary landfills: The pit is dug and garbage is dumped. The waste is covered with a soil layer. The waste is compressed and a new layer is added constantly which fills the entire cell. But when the water sweeps through it, it contaminates the surrounding soil and water so, they are supplied with 2 layers of filter, the compacted clay layer followed by a plastic filter layer, which is supplied by the drain pipes to take out the leaches. Initially, the decomposition is aerobic, which utilises all the O_2 available and then the anaerobic decomposition starts, which predominantly produces CH_4 with the help of CH_4 producing bacteria. Their activity slows down when the decomposition is about to end and the aerobic conditions revert back.

Advantages:

- No infectious diseases are spread.
- Air, water and soil pollution are prevented.
- As the structure is supplied with proper vents connected with pipes, no fire hazard is possible.

(iii) Incineration:

- Liquid injection incinerator
- Rotatory kiln incinerator

Incineration is burning of waste in large furnaces, supplied with excess O_2 and supplemental fuel to increase the rate of combustion. Firstly, the waste is segregated. Recylable material is sent back and rest is burnt.

It consists of 2 burners - primary combustion chamber, which is rotating and secondary combustion chamber called after burner. Both liquid and solid waste are introduced into first chamber and burnt 1800° F. The kiln is constantly rotating to ensure the best combustion efficiency. The ashes left in the first burner

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are called fly ashes and bottom ashes. The gaseous components are condensed and atomised through nozel into after burner, supplied with supplemental fuel and O_2. The waste is burnt at 20-100° F. The bonds blw the gases also break down and these atoms combine with O_2 to form stable products and this unit is always attached with scrubbers and filters.

Advantages:

- The volume of waste is reduced by 75-80%.
- Fly ashes can be used for making bricks, tiles and road material.
- The high heat of incinerator is used to produce electricity.

(iv) Composting:

It is the natural aerobic decomposition of organic matter with the help of microbes and worms which yields compost, rich in C and N.

STEPS:

- Waste preparation and segregation
- Digestion - takes 4 to 6 weeks
- Product upgradation, which includes grinding, curing

CONDITIONS:

- Temperature is 40-50° C.
- pH: 4.5 to 9.5
- Moisture: 50-70%.
- Air: 0.3-0.8 m^3 / day / kg

(v) Recycling and reusing: Segregation into biodegradable and non-biodegradable waste

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Nuclear accidents and holocaust

REASONS:

- lost, stolen or abandoned radioactive source
- Human error during research, testing, medical treatment
- Equipment failure
- Transport accidents
- Natural calamities

Nuclear Hazard: It is caused by high amount of ionising and non-ionising radiations leading to degradation of environment on the life on the planet.
These hazards form huge clouds of radioactive particles, which can transfer to distant places with wind and get deposited on soil and water causing their pollution, through which it enters into animal system.

EFFECTS:

(i) Schomatic effects: More than 10 RAD (radiation absorbed dose) shows schomatic effects like cancer, cataract, hair loss.

(ii) Genetic effects: More than 600 RAD causes damages which are inheritable.

Types of doses:

(i) Acute dose: It is the dose at or more than 10 RAD, which shows detrimental impact on the environment and human health.
50 RAD leads begnin cancer, which does not spread.
> 100 RAD damages bone marrow, spleen tissues.
200 - 300 RAD skin rashes and hair loss.
> 600 RAD sterilization.
> 1000 RAD damages slow dividing cells.

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> 5000 RAD damages nerve cells and reproductive cells.

(ii) Chronic dose: It is a small dose over a long period from which the cells can easily recover.

CONTROL:

- Nuclear power plants should be located away from population with suitable radiation absorbing zones.
- strict safety measures
- Waste disposal should be well planned and according to the policies like high level waste are converted to inert solids and disposed deep undersea or underground; medium level waste are solidified, mixed with concrete and disposed; low level waste which only have the traces of radioactivity. They can be put directly in the containers and disposed.

Air Pollution

Pollutants:

(i) CO: It is most abundant. Sources are incomplete combustion of fuels, industrial and automobile exhaust, volcanic eruptions, natural and marsh gas emissions. The sink is microbes in the soil, which convert them into CO_2. Haemoglobin also acts as sink.

Effects:

It has high affinity for haemoglobin, so it forms complex with Hb, which leads to asphyxiation, headache and laziness.

Control:

- Modification in engine designs
- A low fuel to air ratio reduces the amount of NO_x (oxides of N) but Ises CO production, so high O_2 proportions supports the complete combustion and prevent its formation.
- Fuel modification
- Lightweight hydrocarbons like CH_4, CNG

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- treatment of exhaust gases before emitting as exhaust through catalytic convertors

(ii) Hydrocarbons: low molecular weight

Effects:

- They are carcinogenic causing respiratory problems.
- Produce photochemical smog
- CH_4 has narcotic effects on humans
- VOCs are highly toxic and lethal.

Control:

- They get oxidised ; washed away with rains.
- Adsorption by using the bed of activated carbon filters.
- Modification in the storage tank design to prevent evaporation.

Impacts:

Acid rain

Photochemical smog:

NO_x generates atomic oxygen

↓

Atomic oxygen generates free radicals

↓

Free radicles produce HC radicles

↓

HC radicles generate HC Peroxide / Peroxy radical

↓

Aldehydes / Aldehyde Peroxide

↓

AP forms Peroxy acetyl Nitrate (PAN)

(PAN + O_3 + HC + Aldehydes + Ketones)

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Sources:

- Plants
- Anaerobic decomposition of organic matter
- Fossil fuel exhaust
- Evaporation from the organic solvents and paints

(iii) Oxides of nitrogen: NO_x (NO, NO_2)

- NO

It is colourless and odourless gas which is not directly harmful to humans but is converted to NO_2 which is harmful.

- NO_2

It is reddish brown, pungent and irritating gas.

Sources:

(a) Natural sources:

→ $N_2 + O_2 \longrightarrow 2NO$

→ Nitrogen fixation

→ Aerobic decomposition of nitrogenous organic matter

(b) Anthropogenic:

$$N_2 + O_2 \xrightarrow{1200-1700^\circ C} 2NO$$

$$2NO + O_2 \longrightarrow 2NO_2$$

$$NO + O_3 \longrightarrow NO_2 + O_2$$

NO_2 is not stable in presence of UV lights.

It leads to photodissociation of NO.

$$NO_2 \xrightarrow[UV]{h\nu} NO + O$$

It forms ozone.

Sink:

Sink is the acid rain.

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

$$2NO_2 + O_3 \longrightarrow N_2O_5$$

$$N_2O_5 + H_2O \longrightarrow HNO_3$$

Acid rain is getting neutralised by bases such as lime.

Effects:

- NO_2 reacts with hydrocarbons in presence of sunlight to form photochemical smog (which is irritating).
- Formation of acid rain
- At the higher levels, NO_2 is the lung irritant and also causes bronchitis.

Control:

- Modification of engine design
- If combustion takes place at low temp. and high O_2 content, there is immense reduction with NO_x emissions.
- Scrubbing of flue gases with H_2SO_4 in the scrubber.
- Using catalytic converters to convert NO_x into nitrogen gas or NH_3N_2.

(iv) Oxides of sulphur: SO_x (SO_2, SO_3)

These are colourless and pungent gases. These are required by plants in very small amount. If level increases, it acts as strong air pollutant.

Sources:

- Volcanic eruptions
- Petroleum refining
- Cement manufacturing
- Copper smelting
- Burning of fossil fuels
- SO_2 is converted into SO_3 through photolytic oxidation

Sink:

→ Ozone

$$SO_2 + O_3 \rightarrow SO_3$$

$$SO_3 + H_2O \rightarrow H_2SO_4$$

→ Acid rain - which are neutralised by bases

Effects:

- Acid rain
- Strong respiratory irritants
- Causing chronic bronchitis
- Causes chlorosis in plants
- Severe damage to marble buildings
- Rotting of protein fibres like cotton, wool, leather etc.
- Paper becomes brittle and pale

Control:

- Using sulphurless fuel
- Using chemical scrubbers to remove SO_2
- Using citric acid which forms a citrate complex from which the pure sulphur can be precipitated after passing H_2S gas

(v) Particulate matter:

Any dispersed solid or liquid matter of Si_3C 0.002 μ - 500 μ (diameter)

Types:

→ Aerosols - These are tiny liquid or solid particles.

→ Dust - These are fine solid particles generated by crushing and grinding.

→ Fumes - These are the solid particles formed after condensations of papers.

→ Mist

→ Smog or soot - Soot mainly consists of C, produced due to incomplete combustion.

→ Fly ashes

Sources:

- Volcanic eruptions
- Wind
- Dust storms
- Burning of solid, liquid and gases
- Industrial processes
- Smelting and mining
- Forest fires
- Thermal power plants

Effects:

- Causing bronchitis, lung cancer
- Damaging buildings, soil
- Corrosion of material

Control:

- Using devices like gravity settling chamber
- Cyclonic collectors - centrifugal force works
- Fabric filters
- Scrubbers
- Electrostatic precipitators

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Types of Photochemical smog:

(i) London fog: A reducing type of fog which had killed 4000 people in London in 1952, alongwith the respiratory problems and bronchitis in the population. After sunrise, its ant. rises due to fast conversion of SO_2 into SO_3. The droplets of H_2SO_4 get deposited on the carbon particles and smog is produced.

(ii) Los Angeles Smog (1950): It is a haze which is formed due to photochemical reactions taking place when the air has NO_x, HCs, in the presence of sunlight and temp. is above 1800° C. It has oxidising nature. The worst ingredient is ground level O_3 and PAN.

$$N_2 + O_2 \rightarrow 2NO$$

$$NO + O_2 \rightarrow NO_2$$

$$NO_2 \xrightarrow{h\nu} NO + [O]$$

$$RCH_3 + [O] \longrightarrow RCH_2^{\bullet} + \text{by products}$$

$$RCH_2^{\bullet} + O_2 \longrightarrow RCH_2O^{\bullet}$$

$$H_2O + O \rightarrow H_2O_2 \rightarrow {}^{\bullet}OH$$

$$RCH_2O^{\bullet} + O_2 \longrightarrow RCHO + HO_2^{\bullet}$$

$$RCHO + HO_2^{\bullet} \longrightarrow RCO^{\bullet} + H_2O$$

$$RCO^{\bullet} + O_2 \longrightarrow R-\overset{\overset{O}{\|}}{C}-O-O^{\bullet}$$

$$RCOOO^{\bullet} + NO_2 \longrightarrow R-\overset{\overset{O}{\|}}{C}-O-O-\overset{\overset{O}{\|}}{\overset{+}{N}}-O^{-} \quad \text{(PAN)}$$

Greenhouse Effect

gases: CO_2 (55%), O_3 (16-17%), CH_4, N_2O

Effects:

- On the basis of computer modelling, doubling of GHGs leads to rise in earth's temp. by 5 - 6° C.
- Lowers the food production

- Regional climate change

Ozone layer depletion

90% of O_3 forms a thick blanket in the stratosphere as ozone layer, which blocks UV radiations. Process starts with O_2 photo-dissociates and forms atomic oxygen.

$$O_2 \xrightarrow{h\nu} 2[O]$$

$$O_2 + [O] \xrightarrow{N_2} O_3$$

Functions:

- As it absorbs UV B-radiations, it protects plants and animals life.
- Leads to global warming
- Stratospheric O_3 leads to photochemical smog, a strong air pollutant causing chest pain, throat irritation

Depletion:

- due to CFC, NO, hydroxyl radicals, atomic oxygen

(a) CFCs:

→ Sources:

- Coolants of refrigerators, ACs.
- Propellant in the aerosol sprays
- Blowing agent in thermocol and styrofoam production

$$CFCl_3 \xrightarrow{h\nu} CFCl_2 + Cl$$

(Freon II)

$$CF_2Cl_2 \xrightarrow{h\nu} CF_2Cl + Cl$$

(Freon 12)

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow O_2 + Cl$$

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Cl atoms are regenerating and can attack the fresh O_3 molecules which are predominantly responsible for O_3 depletion.
1 molecule of cfc can damage 1 lakh molecules of O_3.

→ Substitutes:

(i) Montreal Protocol, includes 185 countries to reduce the production and consumption of CFCs.

(ii) CFCs can be substituted with hydro CFCs as coolants and as propellants and can be easily removed from the troposphere.

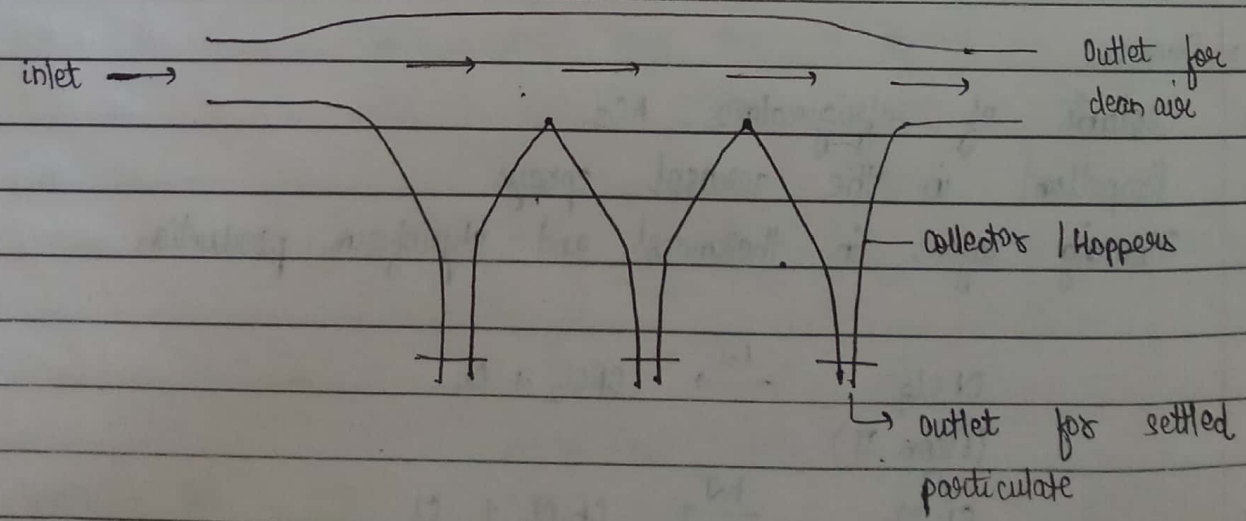
(iii) HFCs

★ Control of air pollution:

(i) at source level:

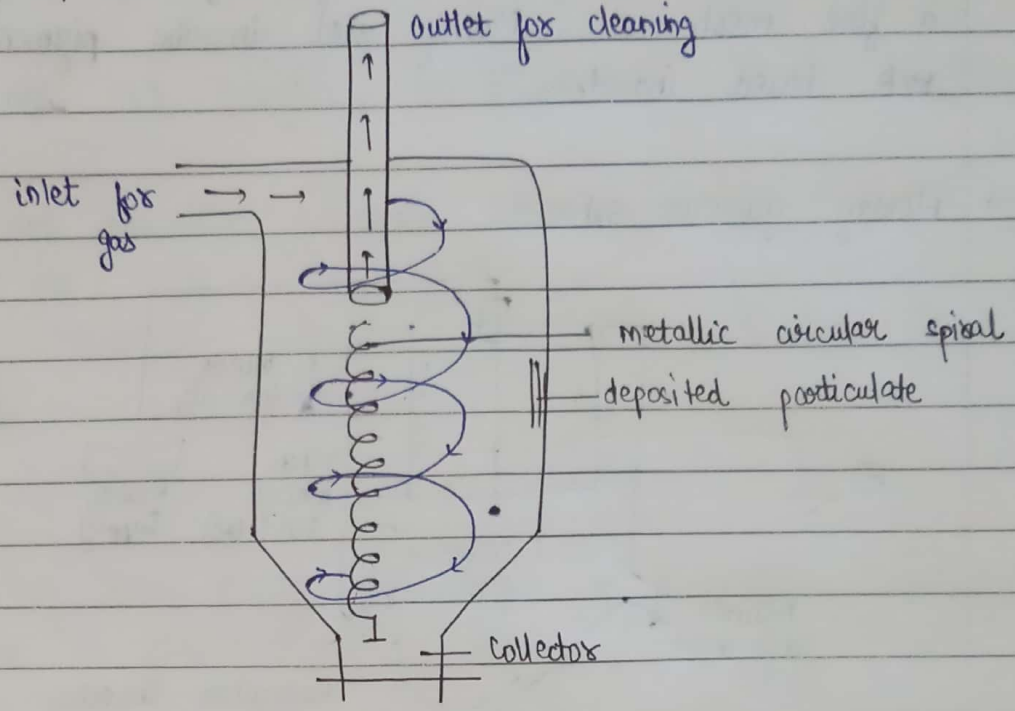
- Substitution of raw material with pure and natural substances
- Process modification for industrial technologies
- Alteration in equipments' design
- using devices

→ gravitational settling chamber



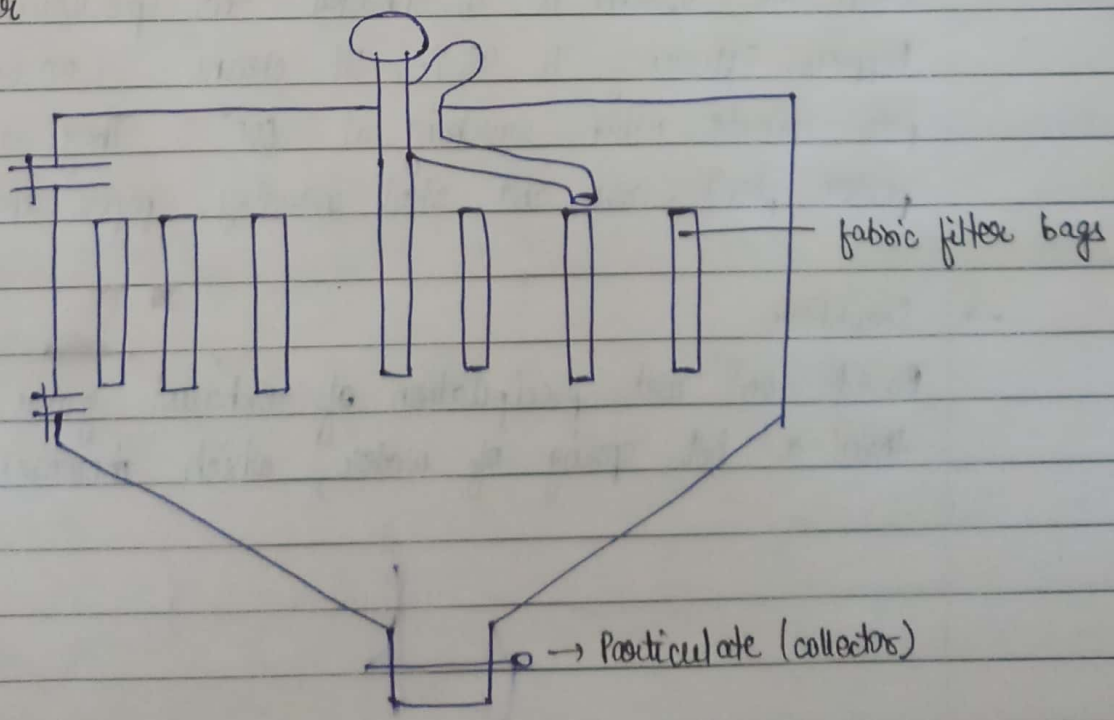
It is used to remove the particulate matter less than 50 microns from the gases.
Velocity of horizontally flowing gas is reduced so that particles settles down due to gravity. Efficiency can be improved by dividing into trays.

→ cyclonic separator



It separates particles of size 5-20 microns. The polluted air flows into the chamber in the circular and spiral manner. The particulate fall towards the walls of chamber as they experience greater centrifugal force. The clean air moves out by reversing from basil plate and can be collected at upper outlet.

→ fabric filter



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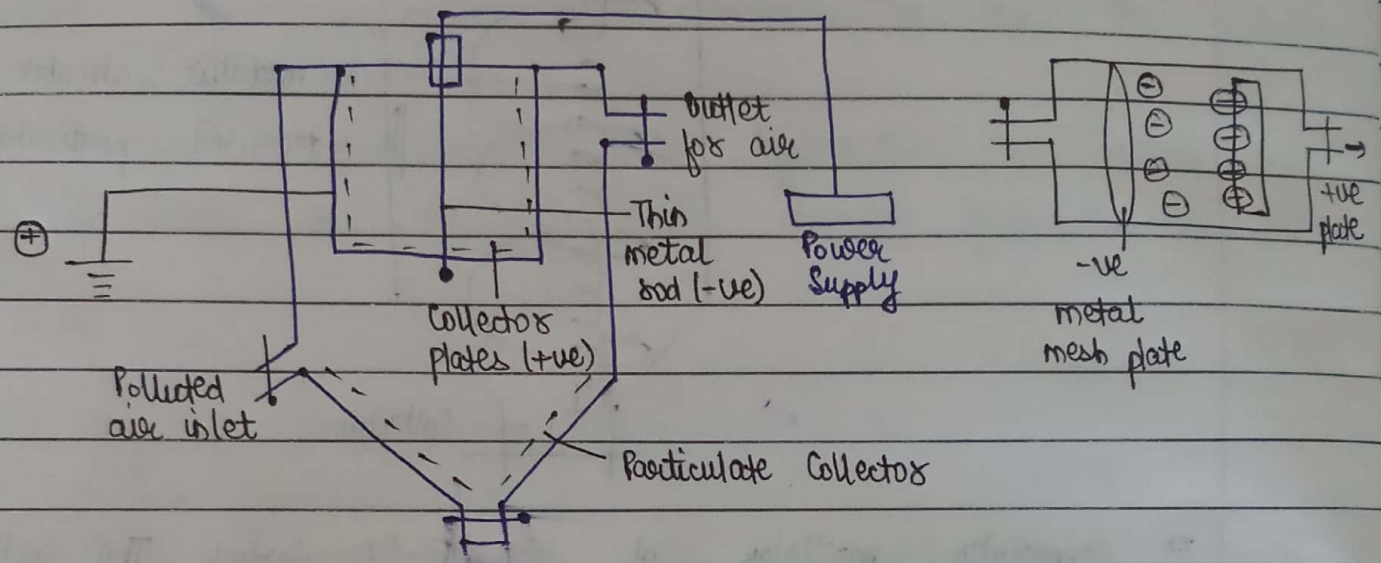
Exhaust gases are forced with fabric filters i.e. bags of fabric with a fine mesh size. Mainly used in the pigment industries and rock based industries.

→ Flowing gaseous exhaust:



Particles flowing in flowing gaseous exhaust are firstly charged electrically and then are separated from gas under the influence of electric field. It consists of series of grounded thin plates and charged through high voltage. Particles approaching these plates get charged and deposit on the opposite charged plate. When the system is disconnected, the particulate is collected in hoppers. Efficiency is 98%. It cleans 1,50,000 litres of gas per minute when working at 600° C. They are mainly used in power plants, iron and steel industry, paper and pulp industry.

→ Scrubbers

Based on wet precipitation of exhaust gases. When passed thru' a hot spring of water, which increases the size of particulate.

÷ For gaseous pollutants:

(i) Combustion: Gases having organic vapours are burnt to convert them into CO_2 and H_2O. Catalytic convertors are used at low temp.

(ii) Absorption and adsorption: • Solvents like NaOH for SO_x, NH_4HCO_3 for N_{ox} are used.

• For dry scrubbing, carbon filters and activated carbon filters are used.

C | CO_2 Sequestration

It is a long term storage of carbon in terrestrial, undergeround or in ocean to reduce CO_2 in air.

÷ Major Sinks:

• OCEANS - By adding ferrous sulphate and FeO as it increases phytoplanktons population and hence photosynthesis

• PLANTATIONS - afforestation, reforestation

• SOIL - By no-tilling farming, cover cropping, crop rotation

→ Artificial Sequestration:

(i) Capturing is done then they are pumped into oceans to form a lake of liquid CO_2 at the bottom, which should not be disturbed as it can form carbonic acid immediately.

(iii) Geosequestration: It involves injecting CO_2 directly into undergeround sites like declining oil fields, saline aquifiers.

(iii) Biosequestration: Using plantation of biodiesel crops Jatropha curcas and some algae.

(iv) CDM (clean dev. mechanism) based on Kyoto Protocol

Toxicology

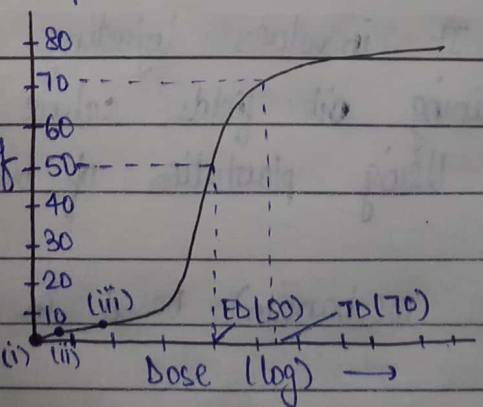
- Toxicology
- Toxic - effects
- Toxicant - causes toxicity
- Toxin - naturally occurring substances
- Toxicity - degree of adverse effects
- Types of toxicities:

(i) Acute - prolonged / cumulative effect
(ii) Chronic - immediate effect
(iii) Selective - a substance is toxic for one system but not for another

- Toxic effects:

(i) Local effect - at the point of contact eg. acid burns
(ii) Systemic effect - for distant from the point of contact
(iii) Acute effect - higher dose in shorter duration
(iv) Chronic effect
(v) Cumulative effect
(vi) Lethal effect

- Dose response relationship



(i) Threshold dose: No adverse effect at or below it
(ii) NOAEL: No observed adverse effect level
(iii) LOAEL: Low observed adverse effect level
(iv) LD: Lethal dose
(v) LC: Lethal concentration

(vi) ED: Effective dose (therapatic)
(vii) TD: Toxic dose (showing toxicity)

- Chemical interactions

(i) Additivity - sum up
(ii) Antagonism - against each other
(iii) Potentiation - increases potential
(iv) Synergible

- Chemicals entry into the body

(i) Inhalation
(ii) Skin absorption
(iii) Ingestion
(iv) Injuries, vaccination

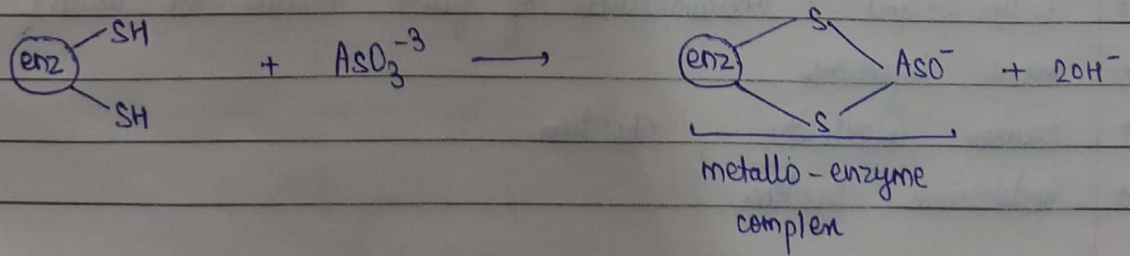
- Heavy metals

(i) Arsenic — As(0) - non toxic
As(III) - most toxic (arsinites)
As(V) - toxic (arsinates)

affects kidney (renal), neural defects

Biochemical effects:

→ Enzyme deactivation as they react with sulpha group (-SH) and make enzyme - metal complex.



metallo - enzyme complex

→ coagulation of proteins due to breakage of sulphur bonds
→ As gas damages RBCs, through haemolysis.
→ Uncoupling of phosphorylation, which stops ATP synthesis.

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- Glyceraldehyde 3 phosphate $\xrightarrow{PO_4^{2-}}$ 1,3 diphospho glycerate $\xrightarrow[\text{synthesis}]{ATP}$ ATP + 3 phospho glycerate

- Glyceraldehyde 3 phosphate $\xrightarrow{AsO_3^{-}}$ Arseno-3-phospho glycerate $\xrightarrow{\text{hydrolysis}}$ Arsenate + 3 phosphoglycerate (NO ATP)

(ii) Cadmium
→ Ouch-ouch disease - joint pain
→ Renal disfunctioning

(iii) Mercury - elemental, inorganic, organic
→ inactivates the enzymes
→ mad hatter disease
→ organic Hg spreads uniformly
→ inorganic Hg was localised

(iv) Lead
→ pain, nausea, vomiting, neuro infections
→ enzyme deactivation
→ replace the essential cations
→ destruct sodium-potassium pump alongwith ATP
→ haematological effects (blood-related)
→ brain edema (accumulation of fluid around the brain)
→ renal infections
→ causes infertility, abortion
→ endocrine system

(v) Chromium (0, 3, 6)
↓ nutrient form → slightly harmful

Eco- friendly polymers

- Degradation starts from chain end resulting in monomeric units.
- If degradation happens randomly along the chain, smaller fragments are formed.

Types of degradation

(ii) Thermal degradation: depends on C-C bond
More C-C bonds in the backbone ensures thermal stability.
Bulkier substituents decrease stability.
Aromatic gps. in backbone ↑se thermal stability.
The presence of O_2 reduces stability.
Breaking of substituent gps. also reduces stability. For eg. release of HCl from PVC.

(iii) Oxidative degradation: The double bonds in the polymers lead to generation of free radicals, which can be easily attacked by molecular O_2 and degraded into smaller fragments.

High mol. wt. Polymer $\xrightarrow{\text{Heat } /O_3/O_2}$ Low mol. wt. Polymer

(iii) Mechanical degradation: When polymer is subjected to mechanical stress, most fragile parts get ruptured leading to fragmentation.
Eg. natural rubber, in which mastication increases its processibility by reducing its elasticity and viscosity.

(iv) Biodegradation: Could be aerobic or anaerobic
Eg. proteins

(v) Photodegradation: Carried out in sunlight, mainly UV radiations leading to breaking of $-C-H-$, $-C-C-$, $-C=C-$ bonds and

generation of free radicals, which can be easily attacked by molecular O_2. Photostabilisers are added to protect polymers.

Environment friendly polymers

(1) Biodegradable Polymers :

→(i) Compostable Plastics - These plastics are degraded in a compost system which is maintained at 50°C for 10-12 weeks and generate eco-friendly residue.

(ii) Hydrobiodegradable and Photobiodegradable Polymers:

(2) Biocerodable Polymers:

(i) Photobiodegradable Polymers: These polymers always have a photon absorbing groups called chromophores.

Eg. carbonyl groups, metal complexes, peroxides, hydroperoxides.

They are also called promoters.

→ Carbonyl group - Mainly the olefins are copolymerised with ketones or aldehydes to introduce carbonyl gp. in the backbone. This is the most preferred way.

→ Metal complexes - They are introduces while the polymers are already being made by using metalloporphyrins. These metal complexes lead to the formation of peroxide by the attack of molecular degradation.

The photostabilisers are added to protect photodegradable polymers.

Eg. - 2,4 - dihydroxy benzophenone.

The degradation with the generation of free radical, which can be easily attacked by O_2 and forms macroperoxy radical.

$$PH \xrightarrow{UV} P^{\cdot} + H^{+}$$

$$P^{\cdot} + O_2 \longrightarrow POO^{\cdot}$$

This peroxy radical abstracts H_2 from polymeric backbone, leading to formation of hydroxy peroxide group, alongwith new free

radical.

$$POO^{\cdot} + PH \longrightarrow POOH + P^{\cdot}$$

$$POOH \xrightarrow{UV} PO^{\cdot} + {}^{\cdot}OH$$

(3) Hydrolysis and Hydro biodegradable polymers:
This is a 2 step process - hydrolysis due to ester gp. in the backbone and biodegradation. The other groups which favour this are amyles, alcohol, acetal gp. and polyurethanes, leading to production of amines, alongwith alcohols and acids.

Properties:

- Polymer should be amorphous.
- It should have high hydrophilicity.

Biopolymers

Eg. i) cellulose

→ used for making plastics
→ soye protein as an adhesive ; coating papers
→ starch as an adhesive in textiles, paper production
→ casein, used as binder and for coating different articles

Biopolymers are the raw materials which polymerise further to produce bioplastics.

(a) Lactic acid - It polymerises to give polylactic acid.
(b) Triglycerides - Polymerises to give bioplastics
(c) Bioplastics - known as green plastics derived from renewable resources (biomass). They are biodegradable, strong, flexible, elastic, durable, quickly renewable, quick degradibility and produce least amt. of waste.

Production:

i) Fermentation: Breaking down of longer molecules into smaller molecules

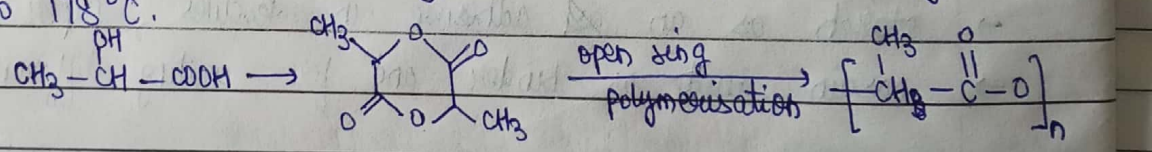
(a) Bacterial Polyester fermentation: Ralstonia eutropha are used to fermenting plants sugars mainly corn sugars and produce polyesters as bioproduct which is then separating from cells.

(b) Lactic acid fermentation: The final product is lactic acid which can be polymerised to PLA (Polylactic acid).

(c) Growing plastic in plants: Genetically modified 'Arabidopsis Thaliana' which has the enzyme from the bacteria which is used to make plastics. The plant uses its cellular processes to generate the polyester plastic which are then harvested using specific solvents then the solvents are separated by distillation.

÷ Important Bioplastics:

(a) Polylactic acid: Lactic acid is produced as a result of fermentation of sugars which dimerises into lactide and through the ring-open polymerisation, it produces polylactic acid. It is an aliphatic hydrolysiable transparent biodegradable, thermoplastic having M.P. of 173 to 178 °C.



Applications:

→ easily processible into films and fibres so have important role in textile

→ used for drug encapsulation

→ produces biodegradable medical devices

→ They are used as surgical suichers, stents, and dialysis media. They are also used as tissue engineering material for cartilage and skeleton repairs.

→ They are used as loose filling material, compost bags and disposal paper bags.

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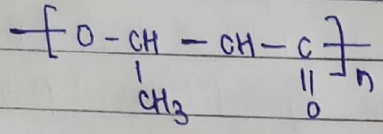
(b) Polyhydroxy butyrate (PHB): 'P3HB' → most common name
These are thick, brittle biodegradable, non-toxic thermoplastic which are heavier by weight.
They are produced by micro-organisms under physiological stress during carbon assimilation.
(digestion)



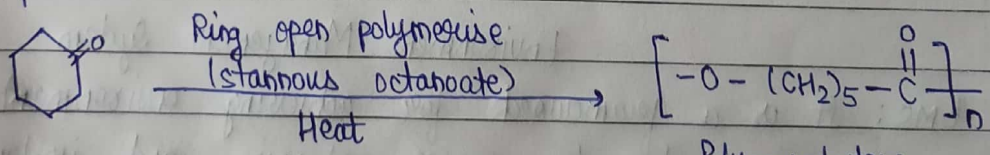
Properties:

→ MP → 180°C highly crystalline, insoluble in water, therefore resistant to hydrolytic degradations but when present as sediments, rapid anaerobic degradation starts.

Applications:

→ Manufacturing of shampoo bottles: They are used as matrices for the controlled drug release.

(c) Polycaprolactone:
∈ Caprolactum



Polycaprolactone
(PCL)

Properties:

→ Melting point - 60°C, resisting to water, solvents and chlorine
→ They quickly degrade in air.

Uses:

→ Used as implanting material
→ Used as suichers material
→ Drug delivery device

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→ as adhesion barriers so scaffold tissues during repair
→ used in root canal filling

Bioremediation

Types: (a) Biostimulation
(b) Bioaugmentation
(c) Bioventing
(d) Biosparging

Phytoremediation

→ Chinese ladder fern arsenic
→ Vetiver grass for cadmium
→ Indian mustard
→ Cyleria
→ Cotton wood trees for mercury

Phytotransformation:
Phytostabilisation:
Phytodegradation:

Environment Management System

EMS: It is a framework for achieving environmental goals of any organisation by proper planning and implementing environment protection measures.

EMS elements:

- Responsibility
- Authorities
- Relationships
- Procedures
- Training
- Resourcing
- Revuse
  → which helps to establish the environment policies and objectives.
  → develop various methods to apply these policies and achieving objective.

EMS working model: based on PDCA cycle

P - Plan - planning result - oriented objectives

D - Do - implementation of procedures

C - Check - monitoring and evaluating reports

A - Action - always taken by higher authorities

Characteristics of EMS objective:

- They are specific and short-term environmental goals.
- They are consistent and are to the environment policies.
- They should be measurable so that, they can be easily evaluated

Components:

Benefits:

EMS ISO 14000 Series: