



# **ENVIRONMENTAL STUDIES**

# WHAT IS ENVIRONMENT

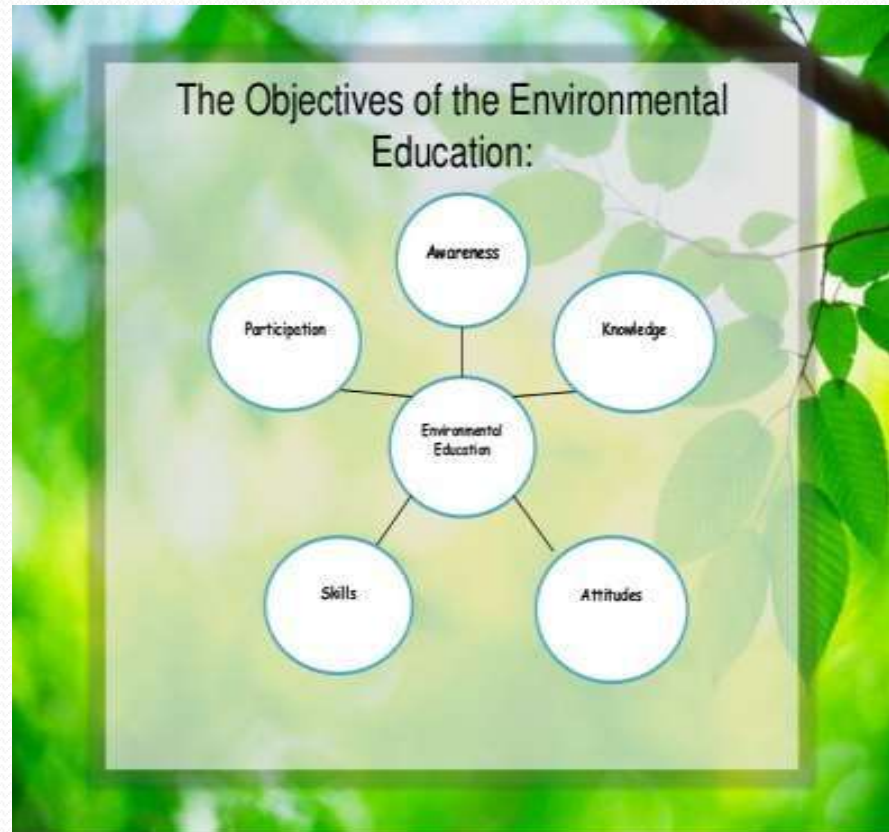
- The sum total of air, water and land and inter-relationships among them with human beings other living organisms and materials is known as environment.
- The surroundings or conditions in which a person, animal, or plant lives or operates.

# What is Environmental Education.

Environmental education is the process that allows individuals to explore environment issues and take actions to improve the environment. It is the scientific study of basic components of our surroundings and their interactions This helps to develop a deeper understanding of environmental issues and have the skills to make responsible decisions.

# Environment Education - Objectives

- Awareness
- Knowledge
- Attitudes
- Skills
- Participation



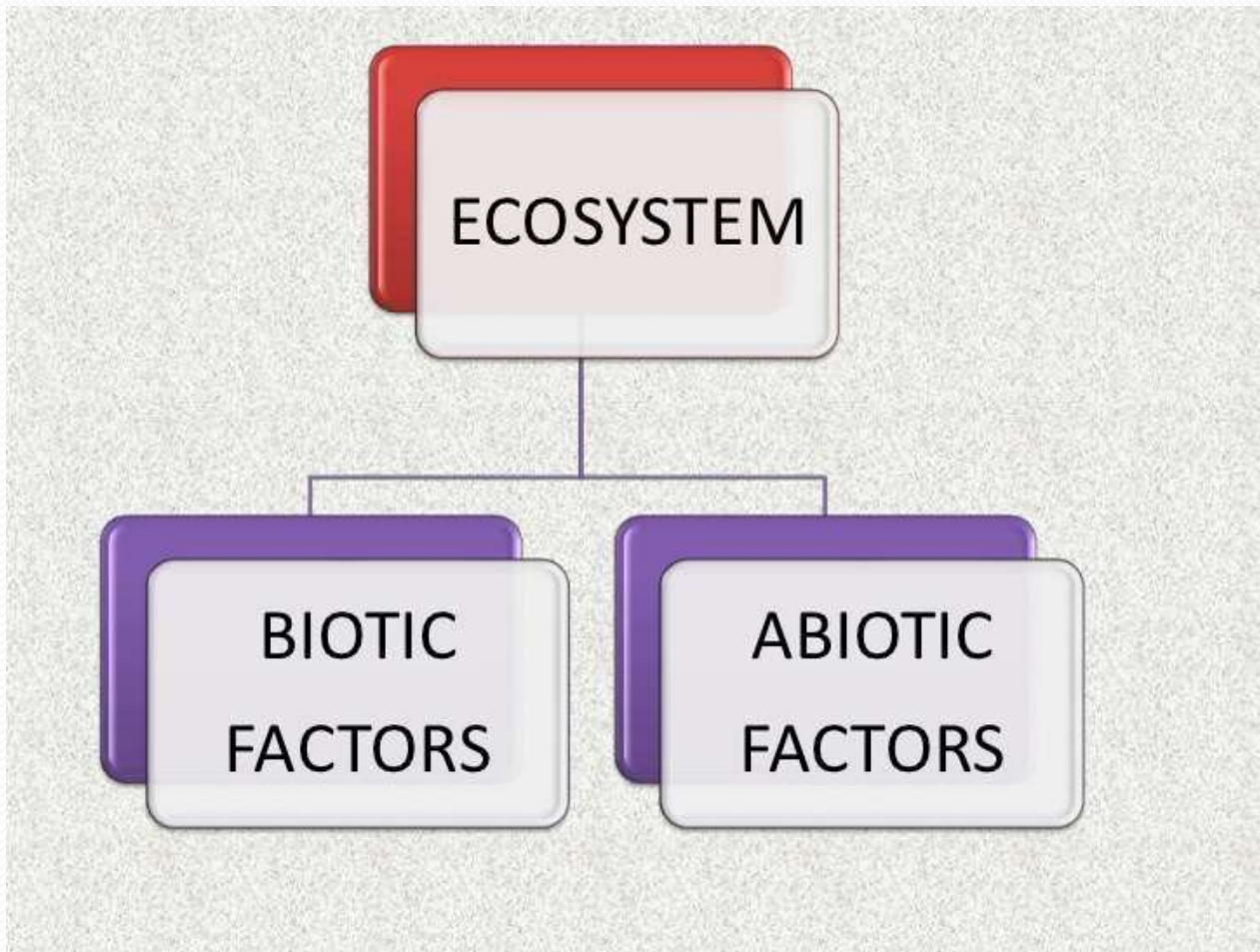
# Ecology

- Ecology is study of the interactions among organisms and their environment.
- Ecology is the scientific study of the distributions, abundance and relations of organisms and their interactions with the environment.
- Ecology includes the study of plant and animal populations, plant and animal communities and ecosystems.

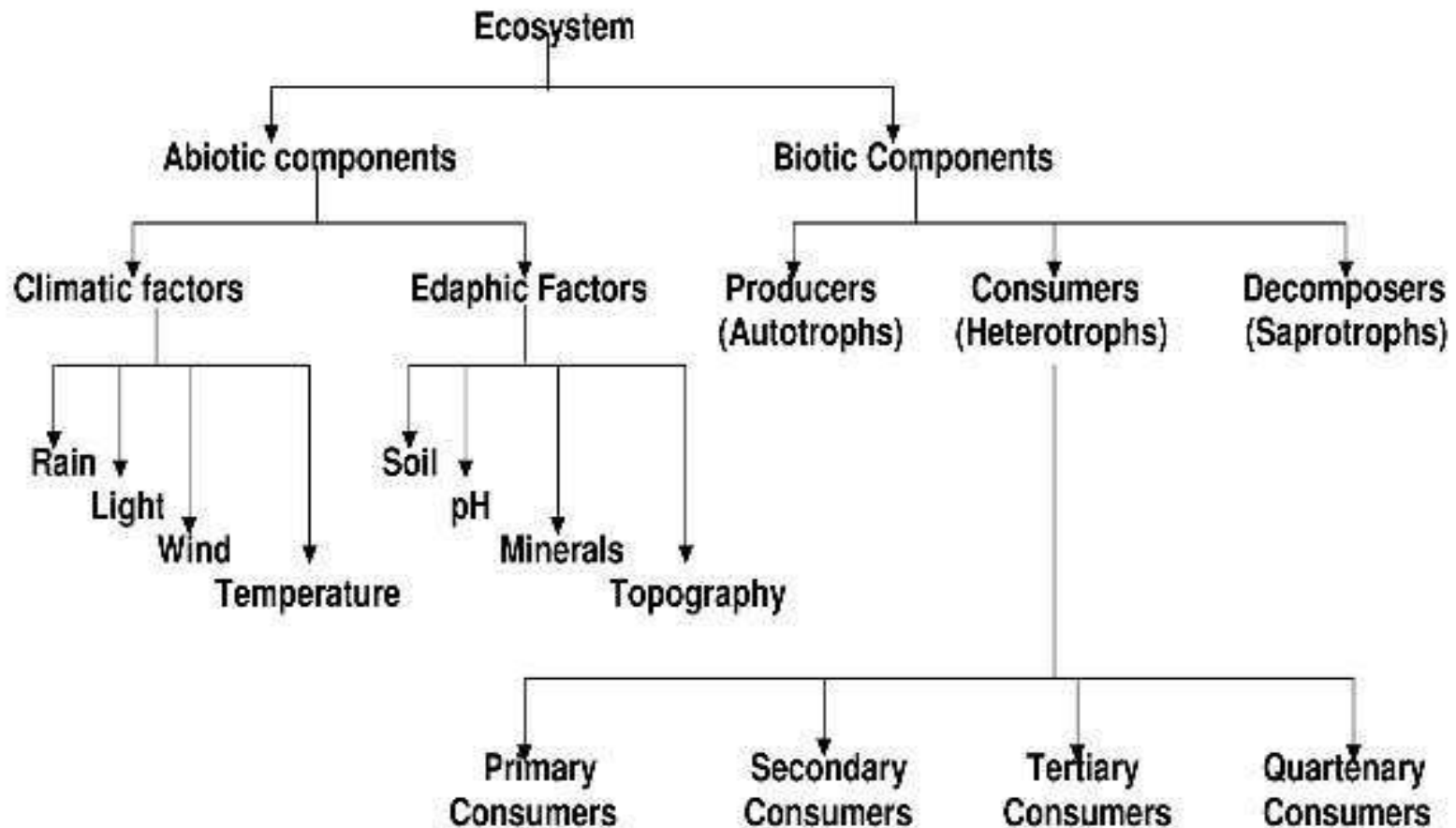
# ECOSYSTEM

- An **ecosystem** is a self regulating group consisting of all the living organisms or **Biotic component**, in a particular area, and the nonliving, or **Abiotic component** such as air, soil, water and sunlight with which the organisms interact.
- Ecosystem is a system of living things that interact with each other and with the physical world.

# Structure of Ecosystem



# Components of Ecosystem





# Importance of Ecosystem

- Ecosystems are important to human life
- Ecosystems clean and store fresh water, maintain air quality, regulate climate and prevent erosion.
- Ecosystems maintain biological and genetic diversity, provide medicines and pharmaceuticals.

# Sustainable Development

- The use of renewable and nonrenewable resources in a manner that satisfies our current needs but does not compromise the future availability of resources.
- Sustainable development “meets the needs of the present without sacrificing the ability of future generations to meet their own needs.”

# Sources of Energy

- Renewable Sources of Energy (Non-Conventional): Renewable energy can be generated continuously practically without decay of sources.

Some examples are: solar energy, wind energy, Geothermal energy, Hydro energy,

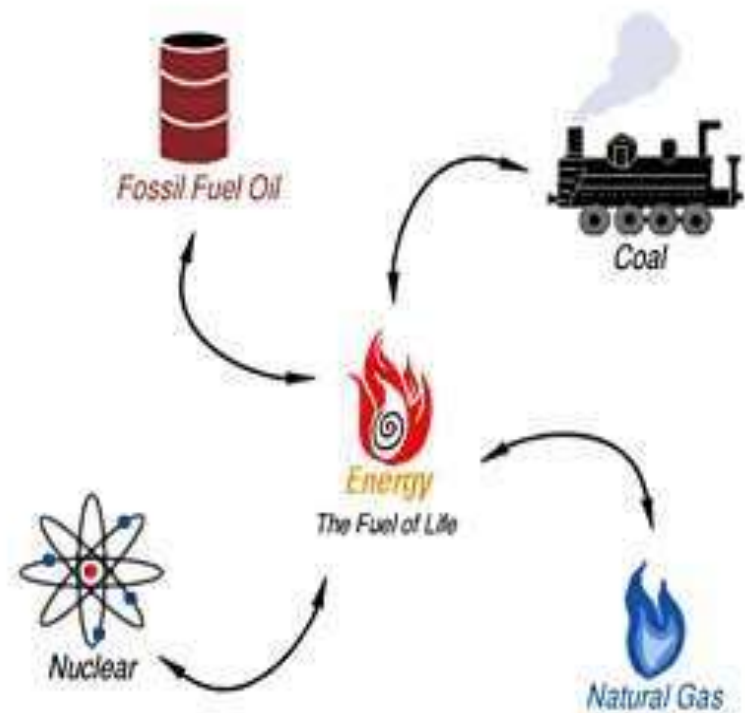
- Non-Renewable Sources of Energy (Conventional): Non-renewable energy sources are in limited quantity and are not replaced in a relatively short amount of time.

For example: energy generated from combustion of fossil fuels, Coal, Natural Gas, Nuclear power etc.

## Renewable Energy



## Non-Renewable Energy



# Advantages of Renewable Resources

- Renewable sources of energy are available in abundant quantity and free to use.
- They have low carbon emissions and are therefore considered as green and environmental friendly.
- No need to rely on other country for the supply of renewable sources as in case of non renewable sources.
- These are less expensive and pollution free.

# Limitations of Renewable Resources

- Initial costs of setting up of a plant are very high.
- Solar energy can be used during the daytime and not during night or rainy season.
- Geothermal energy may have side effects such as toxic chemicals.
- Building dams across the rivers is quite expensive and can affect natural life.
- Wind turbines can be used on the suitable sites where strong winds are available.

# Environmental Pollution

- Any undesirable change in the physical, chemical or biological characteristics of the air, water and land that may harmfully affect the human life, desirable species, industrial processes, living conditions and cultural assets.
- The main sources of pollution are
  1. Natural sources
  2. Man made sources

# Types of Environmental Pollution

- Air pollution.
- Water pollution.
- Soil pollution.
- Radioactive pollution.
- Noise pollution.



# Air Pollution

- The addition of foreign particles, fumes, gases, mist, odour, smoke etc into the air which cause an adverse effect on human beings, plants, animals, buildings and other objects.
- Main sources of air pollution are:
  1. Stationary combustion sources
  2. Mobile combustion sources
  3. Industrial processes and other sources
  4. Secondary air pollutants



# Effects of Air Pollution

- Effect on human health
  1. Dust and smoke cause respiratory problems such as asthma, lung cancer etc.
  2. Lead compounds released from automobile exhausts affect children's brain.
  3. High concentration of NO<sub>2</sub> in the air causes internal bleeding, pneumonia, lung cancer.
  4. High concentration of SO<sub>2</sub> in the air causes nasal discharge, sneezing etc.



- Effects on plants

1. SO<sub>2</sub> bleaches the leaf surface and causes loss of chlorophyll.
2. NO<sub>2</sub> causes premature leaf fall.
3. Ozone causes dead areas on the leaf structure.
4. Dust smoke settle on the leaves and hence retard the process of photosynthesis.

- Effects on animals

1. When animals eat lead and arsenic coated plants, they get affected with arsenic/lead poisoning that leads to bronchitis.
2. Higher amount of fluorine leads to abnormal growth of bones.
3. Ozone contamination in air causes various diseases in animals.
4. Acid rain affects aquatic life.
5. UV radiations in excess may cause cancer in wildlife.

- Effects on buildings

1. Acid rains damage the building materials
2. Corrosion and tarnishing of metals occurs due to  $\text{SO}_2$ .
3. Ozone in atmosphere causes cracking of rubber.
4. Paper becomes brittle and Leather undergoes disintegration by acid gases.

- Effects on climate

1. Increased CO<sub>2</sub> content in the atmosphere will also increase the temperature of the earth. It results in melting of glaciers that causes flooding of coastal areas.
2. Excess of UV rays in the atmosphere causes blindness, Sunburn, inactivation of proteins etc.

## Economic effects of air pollution

1. Corrosion:  $\text{SO}_2$  is converted to Sulphuric acid in the presence of oxygen, which deposits on the metal parts of the building roofs, railway tracks and other structures causing loss due to corrosion.
2. Damage to building materials: the acid deposition reacts with limestone, marble and other building materials to cause deterioration.
3. Damage to Paints and protective covering:  $\text{SO}_2$ ,  $\text{O}_3$ ,  $\text{H}_2\text{S}$  and aerosols damage the protective covering and paints of the surfaces.



4. Damage of textile fibres: the fading of textile dyes and deterioration of natural and synthetic textile fibres is caused by SO<sub>2</sub> and others pollutants.
5. Rubber cracking: rubber cracking of tyres and electrical insulation is caused by ozone.
6. Deterioration of leather and paper: SO<sub>2</sub> causes the disintegration of leather.
7. Ill effects on glasses and ceramics
8. Damage to the objects of art and architecture: like Taj Mahal, Belur Temple etc.

## Air Pollution Control Methods

- Preventive measures:
  1. Selection of suitable fuel and its effective utilisation to reduce the amount of pollutants.
  2. Selection of suitable manufacturing site for industries to be set up.
  3. Modification in equipments and processes for manufacturing to reduce emissions.
  4. Shifting to less polluting fuel such as CNG and LPG.
  5. Planting more and more trees to reduce air pollution.
  6. Replacing old vehicles buy new ones.

- Control measures:
  1. Destroying the pollutant thermal or catalytic combustion.
  2. Changing the pollutants to less toxic form.
  3. Collecting the pollutants by using equipments to prevent their escape into the atmosphere.



# CONTROL OF PARTICULATE MATTER FROM STATIONARY SOURCES

# 1. Gravitational Settling Chambers

- Settling chambers use the force of gravity to remove solid particles.
- The gas stream enters a chamber where the velocity of the gas is reduced.
- Large particles drop out of the gas and are recollected in hoppers.
- They are used in conjunction with a more efficient control technique.

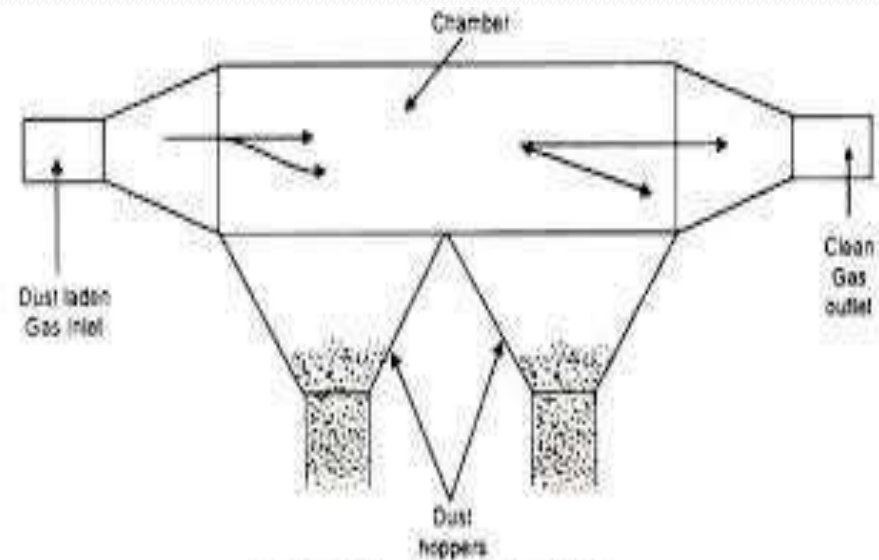
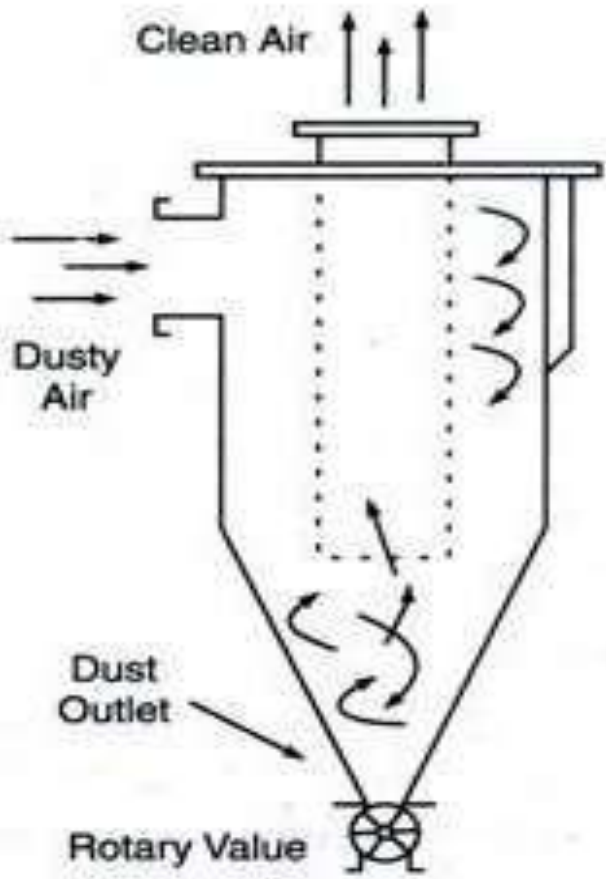


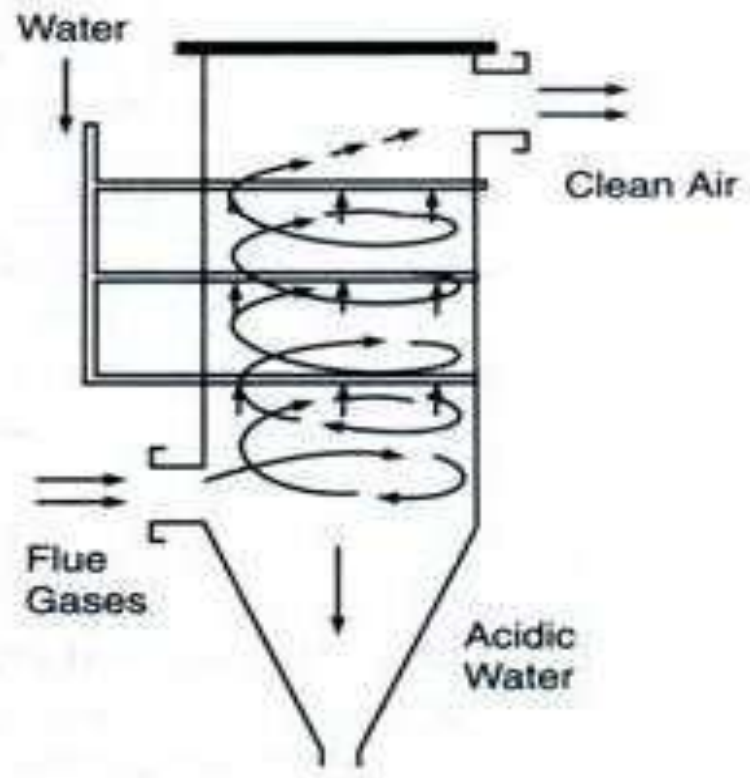
Fig. 6.4. Horizontal Flow Settling Chamber.

## 2. Cyclone Separators

- Separators use centrifugal force to separate the particulate matter from the polluted gas.
- The polluted gas enters the separator tangentially, receives a rotating motion and generates centrifugal force due to which the particulate matter is thrown to the cyclone walls.
- The particulate matter slides down the walls and is removed from the outlet.
- The gas spirals upwards inside the cone and leaves the separated from the outlet.



Cyclone Separator



Wet Collector

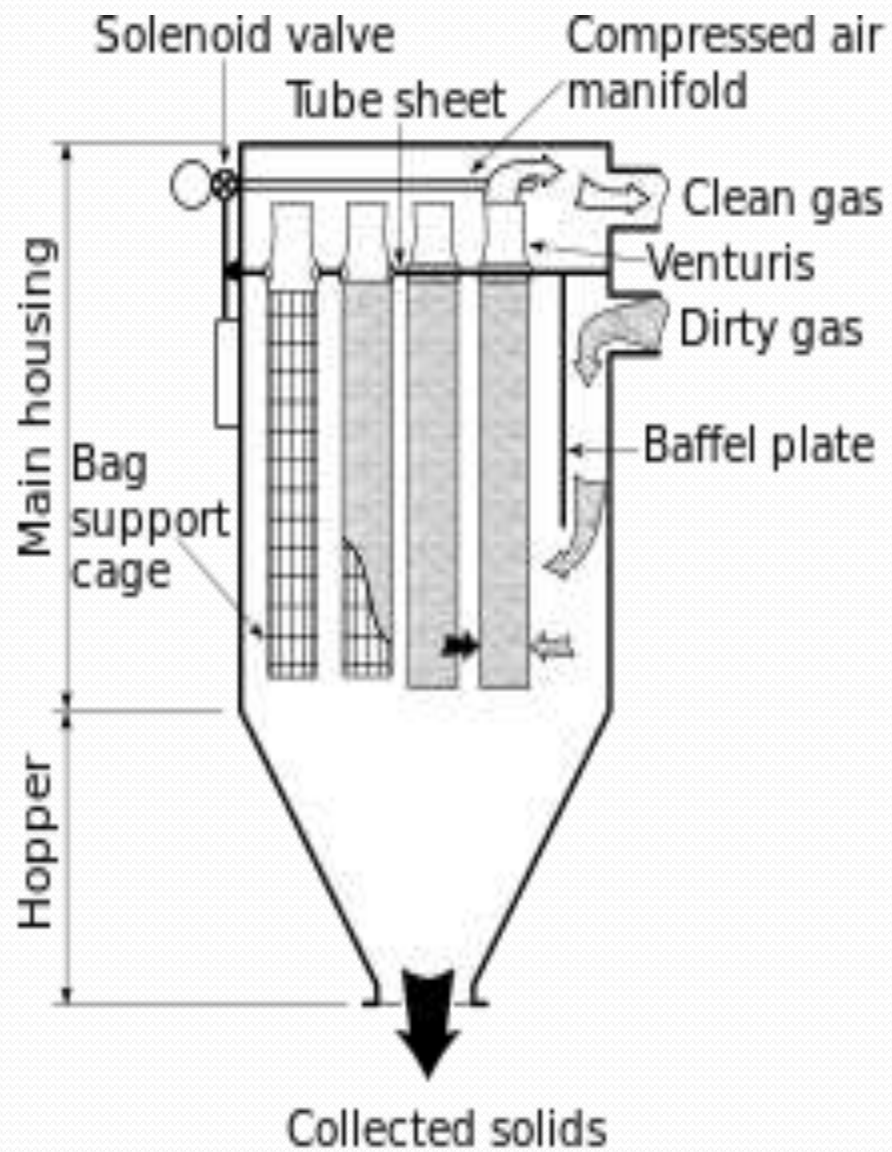
### 3. Wet Collectors

- In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid or by forcing it through a pool of liquid, so as to remove the pollutants.
- Flue gas is funneled through an area and sprayed with a wet substance.
- Water is used when dust and particulate matter is to be removed, but other chemicals can be added. These chemicals are chosen to specifically react with certain airborne contaminants.



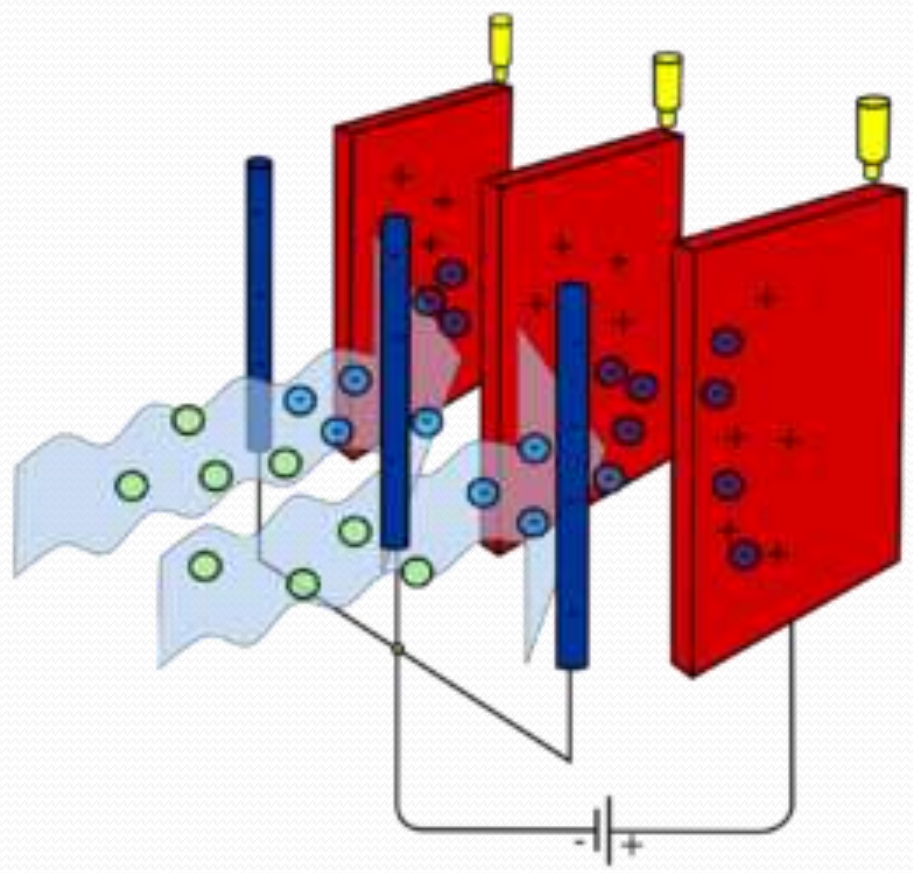
## 4. Fabric Filter

- Fabric filters or bag houses, remove dust from a gas stream by passing the stream through a porous fabric.
- The fabric filter is efficient at removing fine particles and has efficiencies of 99 percent in most applications.
- The selection of the fiber material and fabric construction is important to bag house performance.



## 5. Electrostatic Precipitator

- The ESP works on the principle of electrostatic precipitation.
- When the polluted gas enters the electrostatic precipitator, the large sized particles settle down due to gravity.
- The small size charged particles settle on the oppositely charged electrode surface and fall down gradually.
- The removal efficiency for ESPs is about 99 percent.
- Electrostatic precipitators are not only used in utility applications but also other industries such as cement, pulp & paper, petrochemicals.



# Control of Gaseous Pollutants

- In combustion, oxidizable gaseous pollutants are completely burnt at a high temperature. This combustion technique is used in petrochemical, fertilizer, paint and varnish industries.
- In absorption, gaseous air pollutants are absorbed in suitable absorbent material.
- Adsorption technique is used to control toxic gases, vapours and inflammable compounds. Such air pollutants are adsorbed on large solid surfaces.

# Control of Automobile Exhaust

- The unburnt hydrocarbons in auto-emissions can be reduced by the use of efficient engines.
- Catalytic converters in the vehicles can convert NO to nitrogen to reduce the potential hazards.
- The toxic contaminants can be reduced by using good quality automobile fuels.
- The toxic contaminants can be minimised by the use of automobile engines operating on CNG, LPG etc.

# Water Pollution

- Water pollution is the contamination of water bodies, usually as a result of human activities. Water bodies include lakes, rivers, oceans and groundwater.
- Water pollution results when undesirable organic, inorganic or biological substances are introduced into the natural environment.
- This can lead to health problems for people. Water pollution is the leading worldwide cause of death and disease.





# Impurities in Water

- Physical: Waste heat from industries, dyes and pigments, sand, metal pieces, plastic, sewage etc.
- Chemical: Synthetic detergents, tars, fertilizers, organic effluent from industries, nitrates, phosphates, chlorides, chlorides etc.
- Biological: Bacteria, fungi, virus, worms etc.

# Sources of Water Pollution

- 1. Community waste:** It includes discharge from houses, commercial and industrial establishments . It is rich in organic matter.
- 2. Industrial waste:** The major source of water pollution is the waste water discharged from the industries into the water bodies, for example, chemical, metallurgical industries, food processing plants, textile mills, paper and sugar mills, rubber and plastic industries, oil refineries etc.

## Sources of Water Pollution

- 3. Agricultural sources:** Artificial fertilizers and pesticides have become a potential source of water pollution. Pesticides contain chlorinates, hydrocarbons, metallic salts, carbonates etc.
- 4. Underground water pollution:** Groundwater is contaminated due to seepage from Industrial and Municipal wastes, sewage channels etc.

## Sources of Water Pollution

- 5. Thermal pollution:** Its main sources are the thermal and nuclear power plants. These plants release hot water to the water sources.
- 6. Marine pollution:** The sewage and garbage dumped into the sea causes its pollution. Other sources are navigational discharge of oil, grease, detergents and radioactive wastes.

# Effects of Water Pollution

- The polluted water containing pathogens is responsible for various water borne diseases like jaundice, cholera, typhoid etc.
- The consumption of highly contaminated water can cause injury to the heart and kidney.
- The water contaminated with heavy metals can result in serious health problems.
- Excess nitrate present in drinking water can cause Blue baby syndrome.
- Excess of fluoride in drinking water causes teeth and bone problems.

# Important Terms

- 1. Dissolved oxygen:** It is the amount of oxygen present in the aquatic system that is available for aquatic life for sustaining life.
- 2. Biochemical oxygen demand (BOD):** It is a measure of the oxygen required by aerobic microorganisms to oxidize biochemically the organic matter present in the water. It is expressed in milligrams of oxygen per litre of water.
- 3. Chemical oxygen demand (COD):** It is a measure of the oxygen required by chemical oxidants to oxidize chemically the organic matter present in the water. COD of waste is higher than its BOD.

# Water Treatment

Water treatment is any process that improves the quality of water to make it appropriate for a specific end-use. It removes contaminants and undesirable components, or reduces their concentration.

<b>Constituent</b>	<b>Unit Processes</b>
Turbidity and particles	Coagulation/ flocculation, sedimentation, granular filtration
Major dissolved inorganics	Softening, aeration, membranes
Minor dissolved inorganics	Membranes
Pathogens	Sedimentation, filtration, disinfection
Major dissolved organics	Membranes, adsorption

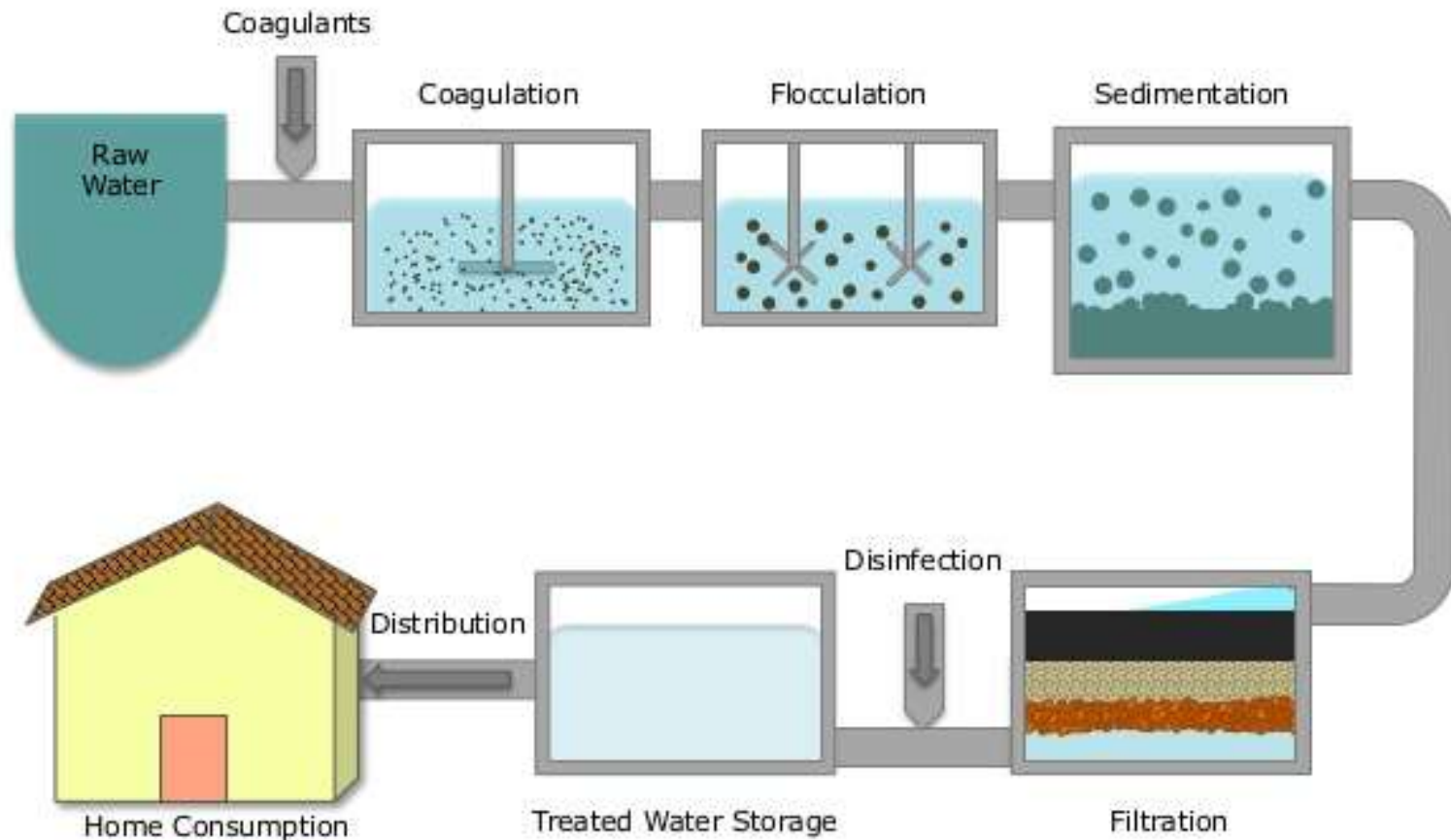
# Objectives of Water Treatment

- The purpose of waste water treatment is to remove contaminant from water so that the treated water can meet the acceptable quality standard.
- Other purpose of waste water treatment includes;
  - To reduce strength of sewage
  - To make waste water less offensive
  - To prevent public health from toxic effect of pollutant
  - To conserve nature
- Methods of waste water treatment depends on composition of waste water and required quality for treated water.



- Treatment processes are broadly classified as physical, chemical and biological treatments.
- Physical treatment methods utilize physical separation of pollutants such as by filtration etc.
- Chemical treatment methods utilize chemical characteristics of pollutants for purification. For eg. Coagulation etc.
- Biological treatment methods utilize biological characteristics of pollutants such as bacteria, viruses by purification.

# Water Treatment Process



# 1. Screening

- The process in which a protective device is provided in the front of the pumps, in order to exclude large sized particles such as leaves, large objects, bushes, dead animals etc. is called as screening.
- The purpose of screening is to prevent the entry of undesirable large particles into the intake works.
- Two main types of screening are: Course screening and Fine screening

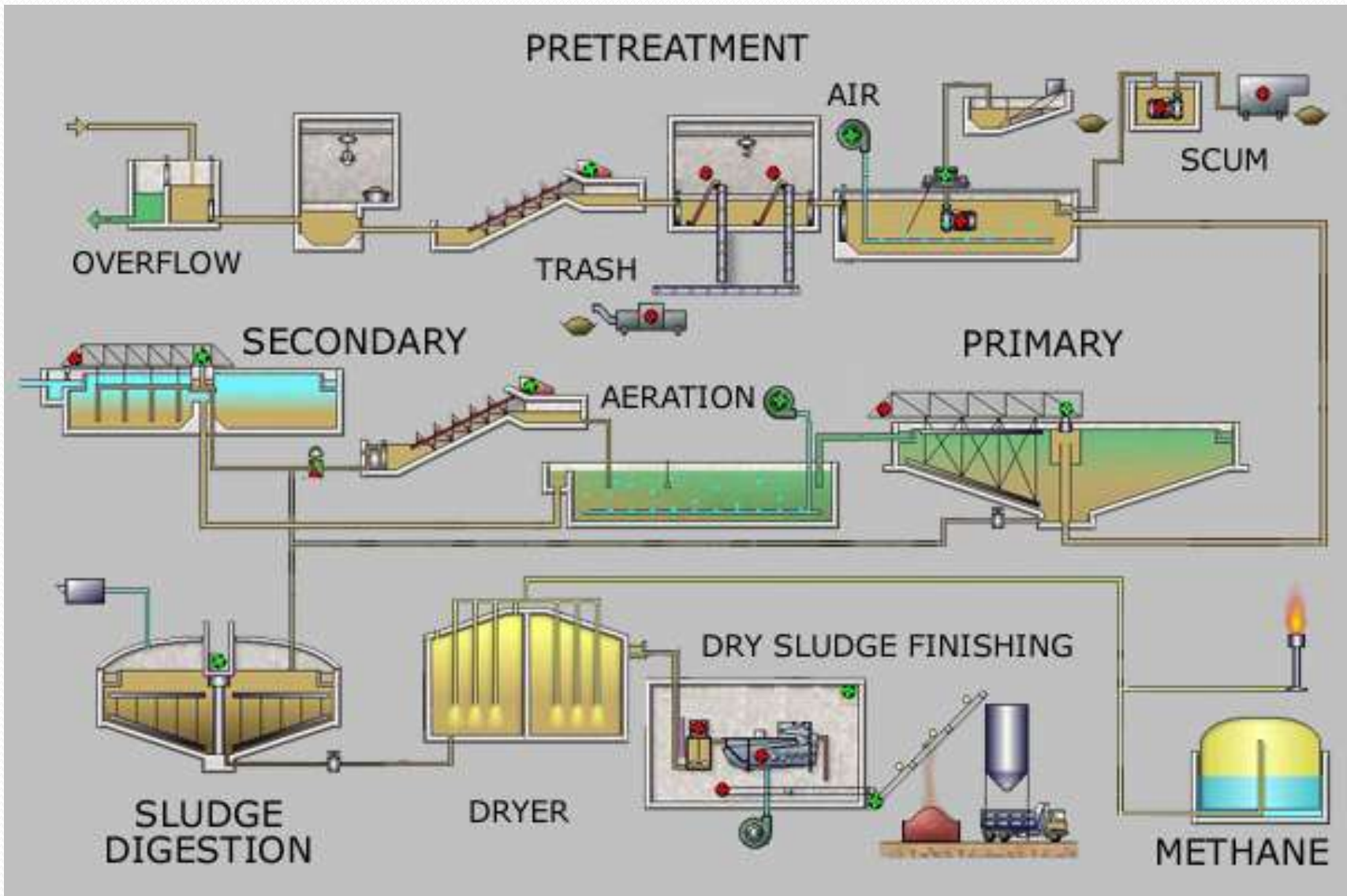
## 2. Sedimentation

- The process by which the suspended particles are removed from the impure water by the action of gravity is called as sedimentation. It can be done in two ways:
- Plain sedimentation
- Sedimentation with coagulation: It is the process in which an insoluble gelatinous flocculent precipitate is formed by adding certain chemicals for absorbing the suspended and colloidal matter and therefore helping in quick sedimentation.

- 3. Filtration:** The process by which water is passed through the thick layers of sand or other granular materials for removing bacteria, colour, taste and thus producing clear sparkling water is called as filtration.
- 4. Disinfection:** The treatment of water with chemicals to kill pathogenic bacteria to make it safe for public use is called as disinfection.
- 5. Aeration:** The process of bringing the water in contact with air so as to absorb Oxygen and remove CO<sub>2</sub> and therefore removing its unpleasant taste.

# Sewage Treatment

- It is process by which the objectionable substances present in sewage are removed to make the water more safe for various utilities.
- Various stages of Treatment are:
  1. Preliminary Treatment
  2. Primary Treatment
  3. Secondary Treatment
  4. Tertiary Treatment



# Primary Treatment

- The main purpose of Primary Treatment is to reduce organic and inorganic solids that settle on the floor by sedimentation, while oil, grease and lighter solids float on the surface with skimming.
- The precipitated and suspended material is removed and the remaining liquid is discharged or subjected to the next step.



# Secondary Treatment

- This is also known as biological sewage treatment and is accomplished through spraying and activated sludge methods.
- In the sprinkler filter, water is sprayed with bricks in an enclosed space. This brick is covered with a microbial layer that oxidizes all impure substances.
- The activated sludge process involves adding microorganisms to sewage and aeration.

<b>PRETREATMENT</b>	<b>PRIMARY TREATMENT</b>	<b>SECONDARY TREATMENT</b>	<b>TERTIARY TREATMENT</b>
Pretreatment function is to provide protection to waste water treatment plant.	The purpose of this treatment is to remove the settled or floating particles.	The purpose of this treatment is to remove the soluble BOD <sub>5</sub> that escaped from the primary treatment. It also removes suspended solids.	The purpose of this treatment is to provide chemical treatment and filtration.
The processes involve in pretreatment includes: Bar rack, grit chamber, equalization basin.	Primary treatment includes all the processes involved in pretreatment and additionally primary settling tank.	Biological processes are involved which are performed by secondary settling tanks.	Tertiary waste treatment and land treatment systems are involved in this treatment.
Equalization step is less important compared to other steps. Hence, it can be eliminated at times.	This step removes about 60% of suspended solids and 35% of BOD <sub>5</sub> . However, it cannot separate soluble pollutants.	This step removes more than 85% of BOD <sub>5</sub> . However, nitrogen, phosphorous, and some heavy metals cannot be removed.	This step removes 99% of BOD <sub>5</sub> , phosphorous, suspended solids and bacteria. It also removes 95% of nitrogen.

# Standards of Water Quality

Parameter*	BIS Standards		WHO standards
	<i>Desirable</i>	<i>Max. Permissible</i>	
Color	5	25	-
Odor	Unobjectionable	Unobjectionable	-
Taste	Agreeable	Agreeable	-
pH	6.5-8.5	6.5-8.5	6.5-9.2
TH	300	600	300
TA	200	600	
TDS	300	1500	500
Cl <sup>-</sup>	250	1000	250
SO <sub>4</sub> <sup>2-</sup>	250	400	200
NO <sub>3</sub> <sup>-</sup>	45	45	50
F <sup>-</sup>	1.0	1.5	0.5
Ca <sup>2+</sup>	75	200	100
Mg <sup>2+</sup>	30	100	150
K <sup>+</sup>	-	-	200
Na <sup>+</sup>	-	-	200
NH <sub>4</sub> <sup>+</sup>	-		1.5
Phenol	-		0.0
B	-		0.3
Fe	-		0.3

\*Except pH and color (hazen unit) all unit are in mg l<sup>-1</sup>

# Soil Pollution



# Soil Pollution

- Soil pollution is defined as the change in physical, chemical and biological conditions of the soil resulting in degradation in quality.
- It refers to the contamination of soil with anomalous concentrations of toxic substances.
- It is a serious environmental concern since it harbours many health hazards.

# Sources of Soil Pollution

- **Industrial wastes:** Industrial pollutants are discharged from chemical industries, sugar factories, textile mills, Steel, distilleries, oil refineries, petroleum industries and thermal and atomic power plants.
- **Agricultural wastes:** Fertilizers, pesticides, insecticides, weedicides etc. adversely affect the physical, chemical and biological properties of soil.
- **Urban wastes:** It includes both commercial and domestic waste like plastics, glass, metallic cans, papers, leaves etc.
- **Radioactive materials:** Radioactive materials from nuclear devices penetrate into the soil and enter the food chain.
- **Biological agents:** The biological organisms from human and animal excreta are other important soil pollutants.

# Solid Waste

- Solid waste is the solid and semi solid waste arising from human and animal activities. Solid waste has great impact on environment.
- Pathogenic organisms excreted by man: Pathogens present in human excreta are transmitted to the man by the consumption of vegetables for fruits.
- Pathogenic organisms excreted by animals: Pathogenic bacteria and worms excreted by animals carry fungal and bacterial spores, which are transmitted from animals to soil and then to man.

- Sediments or suspended solids: Solids washed into water bodies due to soil erosion and disposal of sewage and industrial effluents are in the form of organic or inorganic particles. These solids affect the quality of water.
- **Classification of solid waste:**
- **Types of waste:**
  1. Biodegradable solid waste
  2. Non Biodegradable solid waste
- **Sources of waste:**
  1. Municipal solid waste
  2. Industrial solid waste
  3. Biomedical solid waste



# Effects of Solid Waste

- Municipal solid wastes heap up on the roads due to improper disposal system, which adversely affect the whole community.
- This produces foul smell and breeds various types of insects and infectious organisms besides spoiling the aesthetics of the site.
- Industrial solid wastes are sources of toxic metals and hazardous wastes, which may spread on land and can cause changes in physicochemical and biological characteristics of soils.
- Toxic substances may percolate to contaminate the ground water.
- Burning of wastes like cans, pesticides, batteries, radioactive materials etc. can produce harmful substances which may cause various types of diseases including cancer.

# E-Waste

- **Electronic waste** or **e-waste** means discarded electrical or electronic devices. E—waste, if not disposed off properly, can lead to adverse human health effects and environmental pollution.



- Telecommunication Waste:

1. Mobile phones
2. Telephones
3. Telephone exchanges Wireless Equipment cables and related scrap material
4. PC and TV

- Electrical Waste:

1. Switches
2. Relays
3. Connectors and related Scrap Material

- Electronic Waste:

1. Electronic – metal waste
2. Printed Circuit Boards
3. E – Equipment and Machinery
4. IC
5. Sockets Connectors

- Cable Waste:

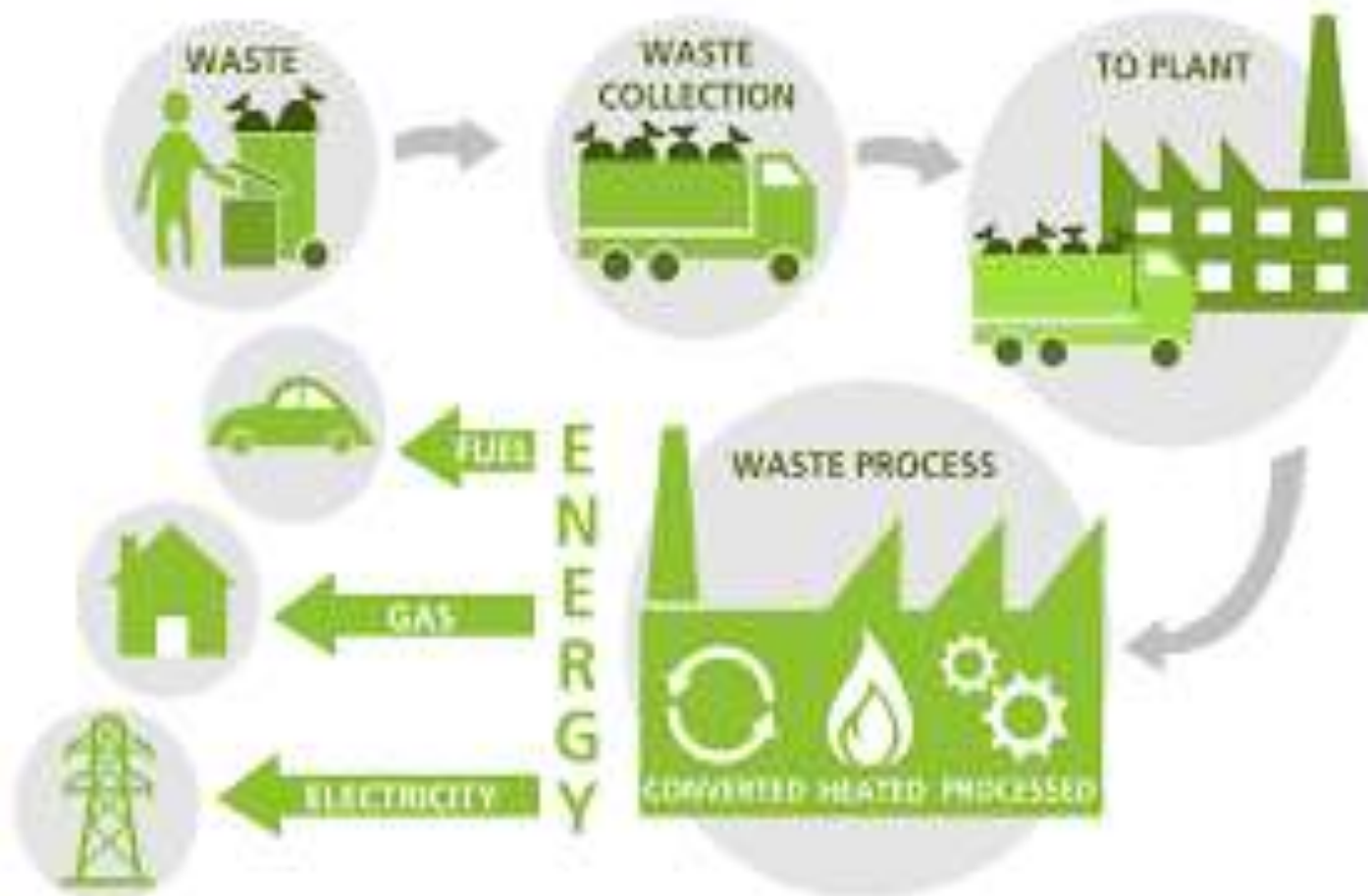
1. PVC
2. Pre Insulated Copper and Aluminum Cable waste

Pollutant	Occurrence	Pollutant	Occurrence
Arsenic	Semiconductors, diodes, microwaves, LEDs (Light-emitting diodes), solar cells		(polyvinyl chloride) stabilizers, lasers, LEDs, thermoelectric elements, circuit boards
Barium	Electron tubes, filler for plastic and rubber, lubricant additives	Liquid crystal	Displays
Brominated flame-proofing agent	Casing, circuit boards (plastic), cables and PVC cables	Lithium	Mobile telephones, photographic equipment, video equipment (batteries)
Cadmium	Batteries, pigments, solder, alloys, circuit boards, computer batteries, monitor cathode ray tubes (CRTs)	Mercury	Components in copper machines and steam irons; batteries in clocks and pocket calculators, switches, LCDs
Chrome	Dyes/pigments, switches, solar	Nickel	Alloys, batteries, relays, semiconductors, pigments
Cobalt	Insulators	PCBs (polychlorinated biphenyls)	Transformers, capacitors, softening agents for paint, glue, plastic
Copper	Conducted in cables, copper ribbons, coils, circuitry, pigments	Selenium	Photoelectric cells, pigments, photocopiers, fax machines
Lead	Lead rechargeable batteries, solar, transistors, lithium batteries, PVC	Silver	Capacitors, switches (contacts), batteries, resistors
		Zinc	Steel, brass, alloys, disposable and rechargeable batteries, luminous substances

# Control of Solid Waste

- Main objective of solid waste control is to minimize the adverse effects of solid waste on the environment. The various steps are
  1. **Collection of solid waste:** Collecting the waste, transporting it to the centralized location and moving to the site of disposal.
  2. **Disposal of solid waste:** Proper solid waste disposal method is selected keeping in view the health hazards, cost and adverse environmental effects.
  3. **Utilization of solid waste:** Conservation of natural resources, economic development, employment opportunities and control of air pollution.

# Methods of Solid Waste Disposal



# 1. Landfilling

- A **landfill** site, also known as a **garbage dump** or **dumping ground**, is a site for the disposal of waste materials. Landfilling is the oldest and most common form of waste disposal.
- Simple and economical
- Segregation of waste not required
- Natural resources returned to soil
- Large area required, transportation costs extra.
- Proper landfill management is needed

## 2. Incineration

- **Incineration** is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration of waste materials converts the waste into ash, flue gas and heat.
- Residue is only 20-25 %, requires little space.
- Hygienic and used as a power source.
- Overall cost high, needs skilled person
- Formation of smoke, dust can cause air pollution.



## 3. Composting

- This process recycles various organic waste materials and produces a soil conditioner .
- Good quality manure produced.
- Recycling can be done, manure can be sold.
- Keeps organic matter out of landfills, ecofriendly process.
- Amount of effort involved.
- Only for organic matter, smell can be an issue.

## 4. Pulverization

- Pulverization (comminution, crushing, grinding) is the process of applying an external force to a solid waste material of a certain size to reduce it into pieces that are smaller than the original size.
- Can be disposed off by landfilling.
- Odorless and unattractive to insects.
- Quite costly and not famous therefore.

## 5. Pyrolysis

- It is the thermal decomposition of materials at elevated temperatures in an inert atmosphere. It involves a change of chemical composition.
- It is an endothermic process and differs from conventional incineration.
- Thermal decomposition leads to the formation of new molecules. This allows to receive products with a different, often more superior character than original residue.

## 6. Dumping into the Sea

- This method had been used in the past to dispose off refuse by throwing it away in to sea, after carrying it at reasonable distance from the coast.
- The sea depth from the disposal point should not be less then 30m or so, and the direction of the current should be as not to bring it back towards the shore.
- Simple and cheap
- Light waste components may return to shore.
- Method not suitable during stormy weather.

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