

UNIT-3: Pollution & its Effects

Public Health Aspects of Environmental Pollution

- Water Pollution
- Air Pollution
- Soil Pollution
- Noise Pollution
- Thermal Pollution
- Solid waste management.

Handout

- Water pollution is when waste, chemicals, or other particles cause a body of water (i.e. rivers, oceans, lakes) to become harmful to the fish and animals that need the water to survive. Water pollution can disrupt and negatively impact nature's water cycle as well.
- Sometimes water pollution can occur through natural causes like volcanoes, algal blooms, animal waste, and silt from storms and floods.
- Anthropogenic causes include sewage, pesticides and fertilizers from farms, waste water and chemicals from factories, silt from construction sites, and trash from people littering.
- Fertilizers from farms can get into the water through runoff. They promote the algal growth resulting in algal blooms and contaminate water bodies like lakes etc. Thus, eutrophication is the gradual increase in the concentration of phosphorous, nitrogen and other plant nutrients in an aquatic ecosystem such as a lake.
- Water pollution can have disastrous effects on the environment. Pollution in the water can reach a point where there isn't enough oxygen in the water for the fish to breathe. The fish can actually suffocate.
- Sometimes pollution affects the entire food chain. Small fishes absorb pollutants, such as chemicals, into their bodies (bioaccumulation). Then bigger fishes eat the smaller fishes and get the pollutants in increased concentration leading to biomagnifications too. Birds or other animals may eat the bigger fishes and be harmed by the pollutants. One example of this was the use of the insecticide (bug killer) DDT. When birds of prey ate fishes that were infected with it, they would lay eggs with thin shells. The population of birds of prey began to drop until DDT was banished in many countries.
- Sewage can also cause major problems in rivers. Bacteria in the water will use oxygen to break down the sewage thus increasing BOD (Biochemical Oxygen Demand) and decreasing DO (Dissolved Oxygen). If there is too much sewage, the bacteria could use up so much oxygen that there won't be enough left for the fish.
- Water pollution from major events like acid rain or oil spills can completely destroy marine habitats.
- Dirty, polluted water can make people sick and is especially tough on young children. Some bacteria and pathogens in water can make people so sick and even can prove fatal.
- Control of water pollution can be done by source corrective measures (minimizing water pollution from various sources) and by treating the sewage water. Treatment of wastewater involves physical, chemical, and biological processes, which remove physical, chemical and biological matter that contaminates the wastewater.
- Save water - Fresh and clean water is a precious resource. Don't waste it!

Water Pollution

Water pollution is the release of substances into bodies of water that makes water unsafe for human use and disrupts aquatic ecosystems. It can be defined as the undesirable change in water leading to effect on its quality aspects and rendering it unfit for various uses. Water pollution is caused when water bodies such as rivers, lakes, oceans, groundwater and aquifers get contaminated with industrial and agricultural effluents.

Sources of Water Pollution

The key causes of water pollution in India are:

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.
- Agricultural run-offs- Use of insecticides and pesticides.

Effects of Water Pollution

The effect of water pollution depends upon the type of pollutants and their concentration. Also, the location of water bodies is an important factor to determine the levels of pollution.

- Water bodies in the vicinity of urban areas are extremely polluted. This is the result of dumping garbage and toxic chemicals by industrial and commercial establishments.
- Water pollution drastically affects aquatic life. It affects their metabolism, and behavior, and causes illness and eventual death. Chemicals travel up the food chain before entering the human body and result in bio-magnification.
- Water contamination leads to water borne and water induced diseases.
- It leads to eutrophication of lakes etc.
- The cause of blue baby syndrome is water contaminated with nitrates results in methemoglobinemia (cyanosis).
- The effect of water pollution can have a huge impact on the food chain. It disrupts the food chain. Cadmium and lead are some toxic substances, these pollutants upon entering the food chain through animals (fish when consumed by animals, humans) can continue to disrupt at higher levels.

- **DO, BOD & COD**

DO: The dissolved oxygen content (DO) of a sample is measured in milligrams per liter, or parts per million. This measurement indicates the actual amount of free oxygen dissolved in water and is an important requirement to support aquatic life in our streams and rivers.

BOD: The standard Biochemical Oxygen Demand (BOD) test determines the amount of oxygen required by the micro-organisms for the decomposition of the bio-degradable matter present in the wastewater sample under 5 days of aerobic condition at a temperature of 20 degree Celsius. It is measured in mg/l.

COD: The amount of oxygen that is required for the chemical oxidation of the organic and inorganic chemicals present in the wastewater by utilizing oxidizing agents like Potassium permanganate, Potassium dichromate etc. is called as chemical oxygen demand (COD).

Control Measures of Water Pollution: Water pollution, to a larger extent, can be controlled by

- A. Source corrective measures: Rather than releasing sewage waste into water bodies, it is better to treat them before discharge. Practicing this can reduce the initial toxicity and the remaining substances can be degraded and rendered harmless by the water body itself. A very special plant, the Water Hyacinth can absorb dissolved toxic chemicals such as cadmium and other such elements. Establishing these in regions prone to such kinds of pollutants will reduce the adverse effects to a large extent.
- B. Waste water treatment : Treatment of wastewater involves physical, chemical, and biological processes, which remove physical, chemical and biological matter that contaminates the wastewater. The sewage treatment plant treats all of the collected sewage water. Before wastewater is discharged into water reservoirs, it goes through the following processes.

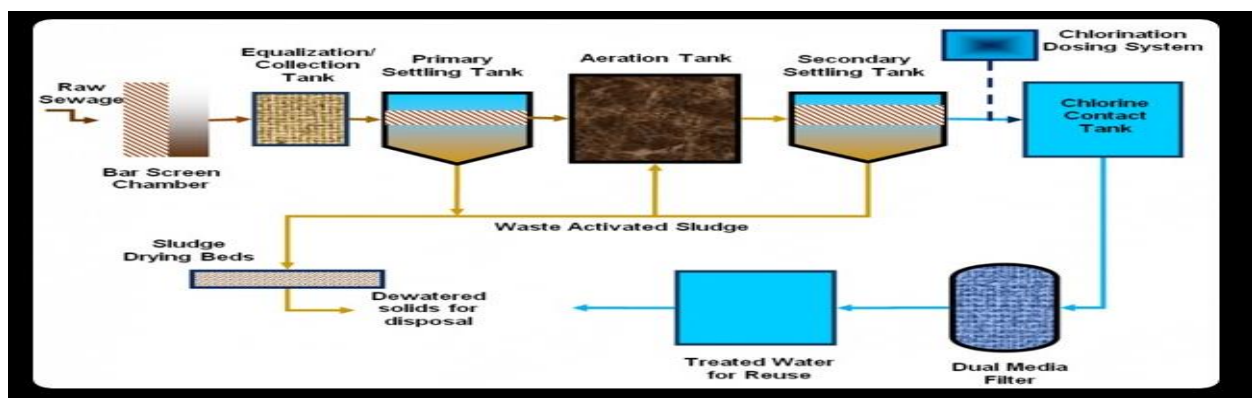


Fig. Wastewater treatment plant

Screening

The wastewater that enters the sewage treatment plant is first filtered through bar screens, a process known as screening. The bar screen separates large trash objects from the wastewater, such as rags, sticks, cans, plastic bags, napkins, sanitary towels, and so on. As a result, screening removes large pieces of trash from the wastewater. These large pieces of rubbish that are caught by the bar screen are removed from time to time.



Grit and Sand Removal

The wastewater (or sewage) that passes through the bar screen is forced to flow slowly through a tank known as the 'grit and sand removal tank.' Because wastewater flows slowly, grit and sand settle to the bottom of the tank. This grit and sand is periodically removed from the tank.



First Sedimentation tank

The wastewater (or sewage) is then pumped into a sedimentation tank and allowed to settle for a while. The majority of the solid organic matter (faeces, for example) settles as sludge on the sloping bottom of the sedimentation tank. As a result, the solid component of sewage is known as sludge. In this manner, the first sedimentation tank separates the solid organic sludge from the rest of the wastewater.

a. The sludge is removed from the bottom of the first sedimentation tank and placed in a large, closed tank known as the digester tank. Many different types of anaerobic bacteria decompose the organic matter in sludge in the digester tank to produce biogas. The biogas produced here can be used directly as a fuel or to generate electricity. The digested sludge that remains after the removal of biogas is collected, dried, and used as manure.

As a result, wastewater treatment (or sewage treatment) yields two useful products: (i) biogas and (ii) sludge. Biogas is used as a fuel, and sludge is used as manure (or fertilizer). The use of dried sludge as manure restores the nutrients to the soil.

b. The wastewater remaining in the first sedimentation tank contains some organic waste in the form of tiny suspended particles as well as soluble organic matter. Some oil and grease may also be floating on the surface of the wastewater in the sedimentation tank. A skimmer

collects these floating materials. As a result, the first sedimentation tank contains mostly watery waste. It is also known as clarified water.



Aeration Tank

The primarily clarified water from the first sedimentation tank is pumped into the aeration tank (The tank in which air is put into water is called aeration tank). Aerobic bacteria already exist in the watery waste. Compressed air is bubbled through the watery waste in the aeration tank to provide oxygen for aerobic bacteria to activate and grow rapidly in this water.

The large numbers of aerobic bacteria produced in this manner digest any remaining human waste, food waste, soaps, and other unwanted and harmful matter in the wastewater, resulting in relatively pure water. Aerobic bacteria clean the clarified watery waste and render it almost harmless in this way.



Second Sedimentation Tank

The treated watery waste from the aeration tank is pumped into the second sedimentation tank and allowed to settle. The microorganisms used in the aeration tank settle at the bottom of the tank, forming a fine sludge known as 'activated sludge.' It is known as activated sludge because it contains active microorganisms such as aerobic bacteria and oxygen.

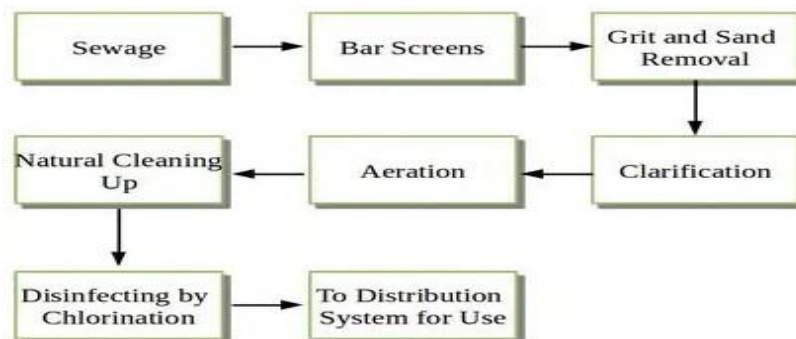
Some of the activated sludge is returned to the aeration tank to boost the population of aerobic bacteria and accelerate the cleaning of watery waste. The digester tank receives the remaining activated sludge. The water in the second sedimentation tank contains very little organic material and suspended matter.

Because there aren't many harmful substances in this water, it's perfectly safe. This water is then either discharged into a river (or sea) or allowed to percolate into the ground. Natural processes clean the water even more. Please keep in mind that the water in a river is naturally cleaned through processes similar to those used in a wastewater treatment plant.



Disinfecting

Before releasing treated water into the distribution system, it may be necessary to disinfect it with chemicals such as chlorine or ozone. The goal of disinfection in wastewater treatment is to completely remove any harmful microorganisms from the water before it is discharged back into the environment. The treated wastewater can also be filtered through sand layers. The majority of the remaining suspended matter in the treated wastewater is removed by sand filtration.



Wastewater Treatment: Flow Chart

Handout- Air pollution

Air pollution is when unwanted chemicals, gasses, and particles enter the air and the atmosphere causing harm to animals and damaging the natural cycles of the Earth.

- Some sources of air pollution come from nature. These include eruptions of volcanoes, dust storms, and forest fires
- Human activity is a major cause of air pollution, especially in large cities. Air pollution is caused by things such as factories, power plants, cars, airplanes, chemicals, fumes from spray cans, and methane gas from landfills.
- Air pollution and the release of gasses into the atmosphere can have many negative effects on the environment. It affects plants by causing chlorosis, necrosis, abscission etc. One type of air pollution is the addition of carbon dioxide gas into the air. Some scientists believe that releasing too much carbon dioxide into the atmosphere is one of the causes of global warming. .
Acid Rain can effect forests, aquatic habitats, textiles, buildings etc. Air pollution can also make people sick. It can make it difficult to breathe and cause diseases such as lung cancer, respiratory diseases, and heart disease.
- Control can be done by source corrective measures and by use of emission cleaning devices

AIR POLLUTION

Air pollution is the introduction into the atmosphere of chemicals, particulates, or biological materials that cause discomfort, disease, or death to humans, damage other living organisms such as food crops, or damage the natural environment or built environment. A substance in the air that can be adverse to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made.

Primary and secondary air Pollutants:

Primary pollutants are directly produced from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories.

Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An example of a secondary pollutant is ground level ozone, smog.

Major primary pollutants produced by human activity include:

- **Sulphur oxides (SO_x)** - especially sulphur dioxide, a chemical compound with the formula SO₂. SO₂ is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulphur compounds, their combustion generates sulfur dioxide.
- **Nitrogen oxides (NO_x)** - especially nitrogen dioxide are expelled from high temperature combustion, and are also produced naturally during thunderstorms by electric discharge.
- **Carbon monoxide (CO)** - is a colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.
- **Volatile organic compounds** - VOCs are an important outdoor air pollutant e.g., benzene, toluene and xylene are suspected carcinogens and may lead to leukemia through prolonged exposure.
- **Particulate matter (PM):** These are fine tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to particles and the gas together. Sources of particulates can be manmade (burning of fossil fuels in vehicles, power plants etc.) or natural (from volcanoes, dust storms etc). Persistent free radicals connected to airborne fine particles could cause cardiopulmonary disease.
- **Toxic metals**, such as lead and mercury, especially their compounds.
- **Chlorofluorocarbons (CFCs)** - harmful to the ozone layer emitted from products currently banned from use.
- **Ammonia (NH₃)** - emitted from agricultural processes.
- **Radioactive pollutants** – produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon.

Factors Responsible for Air Pollution: Air pollution can result from both anthropogenic (human) and natural actions.

Natural sources that pollute the air include forest fires, volcanic eruptions, wind erosion, pollen dispersal, evaporation of organic compounds and natural radioactivity.

Anthropogenic sources: Man-made sources are mostly related to burning different kinds of fuel. "Stationary Sources" include smoke stacks of power plants, manufacturing facilities

(factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices.

"**Mobile Sources**" include motor vehicles, marine vessels, aircraft and the effect of sound etc.

Effects of Air Pollution

Health Effects Air pollution is a significant risk factor for multiple health conditions including respiratory infections, heart disease, and lung cancer, according to the WHO. The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing, asthma and aggravation of existing respiratory and cardiac conditions.

Environmental Effects : Poisonous air pollutants (toxic chemicals in the air) can form acid rain. It can also form dangerous ground level ozone. These destroy trees, crops, farms, animals and continue to make water bodies harmful to humans and animals that live and depend on water.

Economical Effects : Air pollution reduces agricultural crop and commercial forest yields by billions of money each year. This in addition to people staying off work for health reasons can costs the economy greatly.

Effect on Plants: Air pollutants such as nitrogen oxides and sulfur dioxide when deposited on soil surfaces can result in acidification processes, altering the soil's pH and nutrient balance. NO₂ results in necrosis (dead areas on a leaf), chlorosis (reduction of chlorophyll), epinasty (downward curvature of leaf) and abscission (dropping of leaves). SO₂ causes bleached spots, chlorosis and affects photosynthesis along with ozone and PAN.

Effect on Materials: NO₂ fades away dyes in clothes like cotton, rayon, causes cracks in rubber and produces photochemical smog with O₃ and Peroxyacetyl nitrate (PAN). CO₂ damages fabric, leather, paint, paper and historic monuments. H₂SO₄ attacks marble causing stone leprosy. The CaSO₄, so formed on the surface of masonry is twice as bulky as CaCO₃ which looks leprous. Hydrocarbons induce chemical alterations in textile, paper, rubber and polymers making them more brittle and fragile.

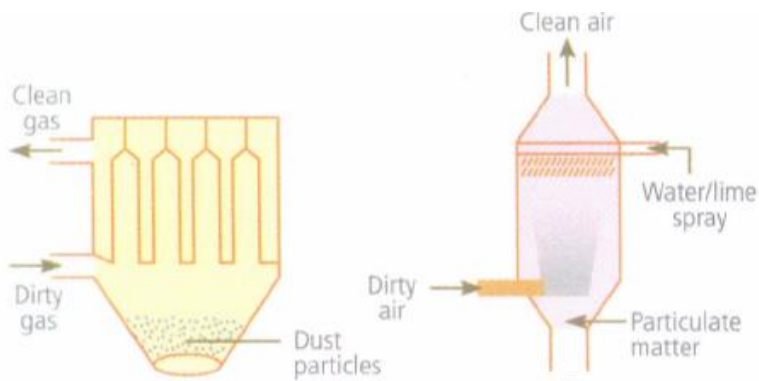
Control Measures of Air Pollution

Prevention interventions are always a better way of controlling air pollution. It includes harnessing wind energy and solar energy, as well as other renewable energy, to minimize burning of fossil fuels, which cause heavy air pollution.

Use of public transport like bus, train or bike when commuting. If we all do this, there will be fewer cars on road and less fumes.

Control devices: These can either destroy contaminants or remove them from an exhaust stream before it is emitted into the atmosphere.

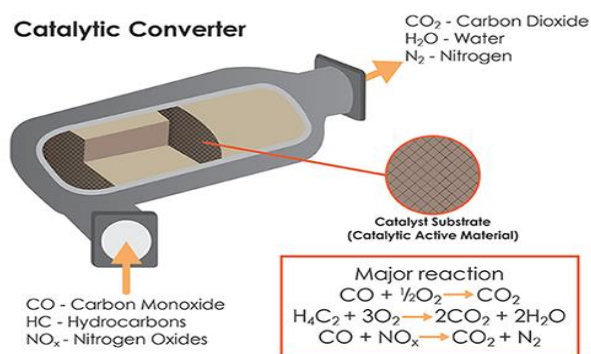
- a. **Cyclonic separators** : They use centrifugal force to separate dust particles from gas streams
- b. **Electrostatic precipitators:** An electrostatic precipitator (ESP), or electrostatic air cleaner is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge.
- c. **Bag house filters or Fabric Filters:** They trap dust particles on the surface of filter bags or cartridges.
- d. **Particulate scrubbers:** In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, by forcing it through a pool of liquid, or by some other contact method, so as to remove the pollutants.
- e. **Catalytic Converter:** A catalytic converter is an exhaust emission control device which converts toxic gases and pollutants in exhaust gas from an internal combustion engine into less-toxic pollutants.



Fabric Filter and Wet Scrubber



Catalytic Converter



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CASE STUDIES

1. Bhopal gas tragedy / disaster occurred as a chemical leak in 1984 in the city of Bhopal, Madhya Pradesh. On December 3, 1984, about 45 tons of the dangerous gas methyl isocyanate

escaped from an insecticide plant that was owned by the Indian subsidiary of the American firm Union Carbide Corporation.

- The gas drifted over the densely populated neighborhoods around the plant, killing thousands of people immediately and creating a panic as tens of thousands of others attempted to flee Bhopal. The final death toll was estimated to be between 15,000 and 20,000.

Classical Smog vs Photochemical Smog

| London smog or Classical smog | Los Angeles smog or Photochemical smog |
|---|---|
| This type of smog is first observed in 1952 in London. | This type of smog was first observed in 1943 in Los Angeles. |
| It involves smoke and fog (smog) | The word smog is misnomer here as it does not involve any smoke or fog. |
| It is formed due to presence of SO ₂ and humidity in the air which combine to form H ₂ SO ₄ (Sulphuric acid) fog which deposits on the particulates. Therefore London smog is also known as Sulfurous smog | It is formed due to photochemical reaction (presence of sunlight) taking place when air contains NO ₂ and hydrocarbons forming toxic chemicals like peroxyacylnitrates (PAN), Ozone etc.. Los Angeles smog is also known as Photochemical smog. |
| It is reducing* in character. Chemically it is reducing mixture and hence is called reducing smog. | It is oxidizing* in character. It has high concentration of oxidizing agents hence it is known as oxidizing smog. |
| It causes bronchitis irritation, <i>i.e.</i> , problem in the lungs. | It causes irritation in the eyes. |
| It is formed in the months of winter particularly in the morning hours when temperature is low. | It is formed in the months of summer during afternoon when there is bright sunlight so that photochemical reactions can take place. |

Handout- Noise Pollution

The unwanted or unpleasant sound that affects human health, wildlife, and the environment is called noise pollution

- The major sources of Noise Pollution are: Natural sources and Anthropogenic sources.
- The natural sources of noise pollution are volcanic eruptions, the wild sea waves, a rush of rivers, thunder, roaring of animals, etc., They occur occasionally, but sometimes they are very damaging.
- Anthropogenic sources include: Industrialization, increased number of automobiles, Weddings and public gatherings etc. result in the production of unwanted noise.
- The sources can also be categorized as indoor and outdoor sources.
- Effects of noise pollution: It can be divided into Auditory and Non-auditory impacts
- Non-auditory impacts: It includes causing aggressive behavior and irritability, Lack of Concentration, high blood pressure etc.
- Auditory impacts include temporary and permanent hearing loss.
- Noise control techniques: There are 4 fundamental ways in which noise can be controlled.
 - Reduce noise at the source
 - Block the path of noise
 - Increase the path length
 - Protect the recipient.

NOISE POLLUTION

Noise is undesirable and unwanted sound that unreasonably intrudes into our daily activities. Sound is measured in a unit called the decibel (dB). Human hearing is generally thought to be harmed by sound levels of more than 85 decibels (dB). The permitted noise level is 125 decibels as per the Environment Protection Rules 1999.

Sources: are classified into two classes such as indoor and outdoor.

1) Outdoor - Industries/factories, vehicular movements such as car, motor, truck, train, tempo, motor cycle, aircrafts, trains, Construction work, defence equipments, explosions, playing of loudspeakers etc. The higher the speed of an aircraft, greater the noise pollution. The invention of supersonic aircrafts has added more noise for the persons who live near aerodromes. Satellites are projected into space with the help of high explosive rockets, contributes to noise pollution.

2) Indoor - Loudly played radio or music systems, other electronic gadgets etc.

Effects of noise pollution: It can be divided into Auditory and Non-auditory impacts

Non-auditory effects: It includes

- Emotional or psychological effects like irritability, anxiety and stress.
- Noise effects the circulatory system by raising blood pressure and altering pulse rates.
- Lack of concentration and mental fatigue are health effects of noise.
- The performance of school children is poor when schools are in busy areas of a city.
- Lowers workers efficiency and productivity

Auditory effects: It includes

- Physical damage to the ear and the temporary hearing loss often called a temporary threshold shift (TTS). People suffering from this condition will be unable to detect weak sounds. However, hearing ability is usually recovered within a month of exposure.
- Permanent loss, usually called Noise Induced Permanent Threshold Shift (NIPTS) represents a loss of hearing ability from which there is no recovery.
- Below a sound level of 80 dB hearing loss does not occur at all. However temporary effects are noticed at sound levels between 80 and 130 dB. A sound level of 150 dB or more can physically rupture the human eardrum.

Noise control: There are 4 fundamental ways in which noise can be controlled.

- 1) Reduce noise at the source 2) Block the path of noise
- 3) Increase the path length and 4) Protect the recipient.

Reduce noise at the source

1. Make sure that all openings are acoustically sealed. In industries, different types of absorptive material can be used to control interior noise.
3. Regular and thorough maintenance of operating machinery. We must improve lubrications.
4. A smooth flow of traffic causes less noise.

Block the path of noise: Planting of trees around houses can also act as effective noise barriers. Highly absorptive interior finish material for walls, ceilings and floors can decrease indoor noise levels significantly.

Increasing the path length: Increasing distance from the noise source, offers a passive means of control. Municipal land-use ordinances pertaining to the location of airports make use of the attenuating effect of distance on sound levels.

Protect the recipient: Use of earplugs and earmuffs. Specially designed earmuffs can reduce the sound level reaching the eardrum by as much as 40 dB.

Making legislation, educating and bringing awareness in the people is common for control of any pollution e.g., Ban on loud speakers from 10 pm to 6 am.

Handout-Solid waste Management

Any garbage, refuse, sludge from a wastewater treatment plant or an air pollution control facility, and other discarded materials, including solid, liquid, semi-solid, or contained gaseous material, resulting from industrial, commercial, mining, and agricultural operations, as well as community activities, are considered solid waste.

- **Sources:** Residential, commercial, institutional, and industrial activity are all sources of solid waste
- The term "solid waste management" refers to the entire collection, treatment, and disposal procedure for solid waste. Wastes are gathered from various sources and disposed of during the waste management process.
- Disposal methods are as: Sanitary landfills: In these landfills/pits the layers of plastic and sand are used to line these landfills with an impervious liner to prevent any percolation and contamination of groundwater.
- Incineration: It is the burning of solid wastes at a very high temperature until the waste turns to ashes
- Recycling: Recycling is the conversion of discarded solid waste into new products. Recycling reduces solid waste and helps in recovering the material to make new products for reuse.
- Composting: The decomposition of degradable waste in the presence of microorganisms like fungi & bacteria which turns this degradable waste into the organic matter known as compost and can be used as manure.
- Vermicomposting: It is actively decomposition of organic waste by the action of earthworms into nutrient-rich compounds (manure).
- Pyrolysis is a chemical decomposition process whereby solid wastes are subjected to heat up to 430 degrees Celsius at a specific pressure and in absence of oxygen
- **Leachate**, which is a black liquid oozing out from the waste contaminates soil and groundwater.
- Foul odours from the waste rotting in heaps are other consequences of dumping waste in the open. Decomposing solid waste attracts animals, mosquitoes, and flies.
- Poor management of the collection and disposal of solid waste may lead to Water , air, soil Pollution etc.
- Principles of solid waste management include R's-Refuse, reduce, reuse, recycle etc.

Solid Waste Management

The term 'solid waste' refers to any unwanted solid material that can no longer be used. Solid waste is not only limited to solid materials. Some solid wastes also contain some gaseous matter in them and also include semi-solid matter.

Sources: The sources are as:

- 1. Residential:** The waste is of food, old electronics, cardboard, clothes, etc.
- 2. Industrial:** The waste is like packaging material, food, ash, etc.
- 3. Commercial:** The waste consists of paper, plastics, cardboard, etc.
- 4. Construction sites:** The waste is like wood, concrete, steel, dirt, etc.
- 6. Agriculture:** The waste is generated from vineyards, orchards, dairies, and farms.

Integrated Solid Waste Management (ISWM): ISWM represents a contemporary and systematic approach to solid waste management. The term "solid waste management" refers to the entire generation of wastes, its collection, its transportation, its segregation and disposal procedure. Wastes are gathered from various sources and disposed off during the waste management process.

Disposal methods are as:

- 1. Open Dumping:** The *open dumps* of garbage leads to emissions of methane and contributes to global warming. *Leachate*, a black liquid oozing out from the waste contaminates soil and groundwater. Foul odour is generated in the open dumps.
- 2. Landfills:** It is simple burial of waste in pits. The Leachate seep into the ground causing groundwater and land pollution.
- 3. Sanitary landfills:** In these landfills/pits the layers of plastic and sand are used to line these landfills with an impervious liner to prevent any percolation and contamination of groundwater. These are referred as Engineered Pits.
- 4. Incineration:** It is the burning of solid wastes at a very high temperature until the waste turns to ashes. It has high cost and releases particulate emission in environment.
- 5. Pyrolysis** is a chemical decomposition process whereby solid wastes are subjected to heat up to 430 degrees Celsius at a specific pressure and in absence of oxygen e.g., we can generate ethanol from bagasse (sugarcane waste).
- 6. Composting:** The decomposition of degradable waste in the presence of microorganisms like fungi & bacteria which turns this degradable waste into the organic matter known as compost and can be used as manure.
- 7. Vermicomposting:** It is active decomposition of organic waste by the action of earthworms into nutrient-rich compounds (manure).
- 8. Follow R's principle:** Refuse, reduce, Recycle, Repair etc. can be followed to reduce the generation of solid.

Solid Waste Management Rules 2016: These rules replace *the Municipal Solid Wastes (Management and Handling) Rules, 2000* are now applicable in India.

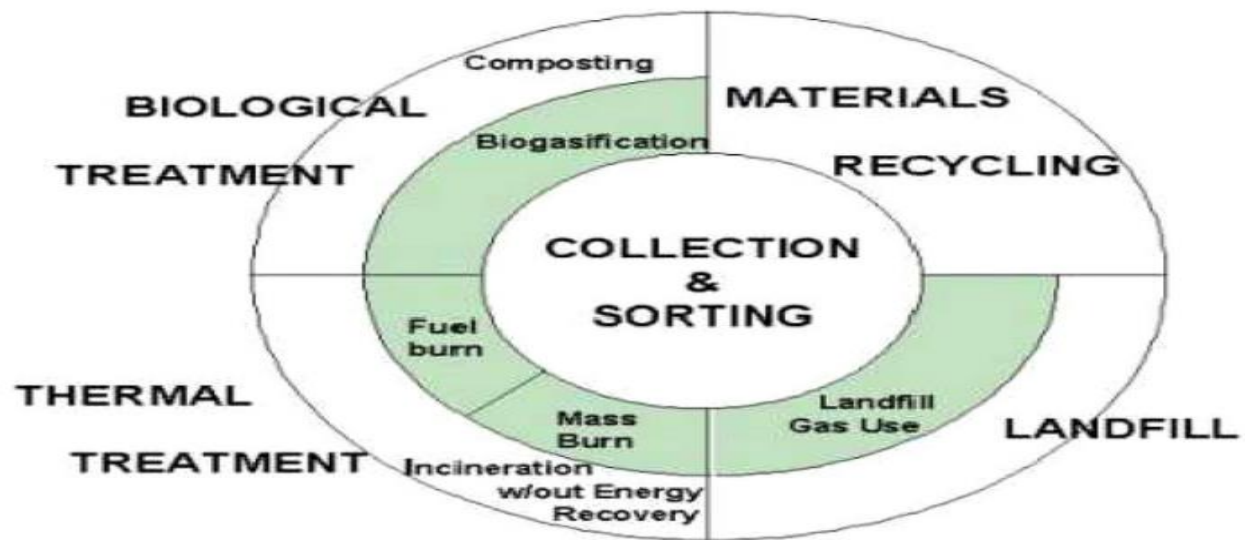


Fig. Integrated solid waste management

Hazardous Wastes

Hazardous wastes are those that can cause harm to human and the environment.

Characteristics of hazardous wastes: Wastes are classified as hazardous if they exhibit any of four primary characteristics based on physical or chemical properties of toxicity, reactivity, ignitability and corrosiveness.

Toxic wastes: Toxic wastes are those that are poisonous in small or trace amounts. Some may have acute or immediate effect on human or animals e.g., pesticides, heavy metals.

Reactive wastes: reactive wastes are those that have a tendency to react vigorously with air or water are unstable to shock or heat, generate toxic gases or explode during routine management e.g., Gun powder, nitroglycerine.

Ignitable waste: are those that burn at relatively low temperatures ($<60^{\circ}\text{C}$) and are capable of spontaneous combustion during storage transport or disposal e.g., Gasoline, paint thinners and alcohol.

Corrosive wastes: are those that destroy materials and living tissues by chemical reactions e.g., acids and base

Infectious wastes: included human tissue from surgery, used bandages and needles, hospital wastes etc.

Handout-Soil pollution

- Soil pollution is defined as the presence of hazardous chemicals (pollutants or contaminants) in high enough quantities in the soil to endanger human health and the environment. Soil pollution is defined as a change in the natural soil.
- Soil pollution can be divided into two broad categories: Natural and Anthropogenic
- Soil contamination is a natural occurrence. Some contaminants naturally accumulate in soils via exceedingly unusual processes. The buildup of compounds containing the perchlorate anion (ClO_4^-) in some dry, arid habitats is an example of natural soil pollution.
- Soil contamination caused by humans (caused by human activity). Almost all incidents of soil pollution are caused by humans. Soil contamination can be caused by a variety of anthropogenic activities like improper disposal of highly toxic industrial/chemical waste, Spillage of gasoline and diesel during transportation, Chemical pesticides, Sewage from metropolitan areas, Nuclear waste, e-waste, and coal ash etc.
- Soil contamination has a wide range of negative consequences that affect plants, animals, humans, and the entire ecosystem. Contaminants in the soil might be present in all three periods (solid, liquid, and gaseous). As a result, these contaminants can enter the human body through a variety of routes, including direct skin contact or inhalation of contaminated soil dust.
- Soil contamination is frequently accompanied by a reduction in nutrient availability, plant life ceases to grow in such soils. Furthermore, this form of pollution raises the salinity of the soil, making it unsuitable for plant growth. Plants cultivated in polluted soil can acquire significant levels of soil contaminants through a process called bioaccumulation
- Several microorganisms that improve soil texture and aid in the breakdown of organic materials are unable to thrive in acidic soils. As a result, soil pollution has a negative impact on soil quality and texture.
- To deal with soil cleanup, several technologies have been created. The following are some of the most important ways for decontaminating polluted soil.
 - Pollutant extraction using thermal remediation – the temperature is raised to drive the contaminants into the vapour phase, where they can then be recovered via vapour extraction
 - The use of microorganisms and plants for soil purification is known as bioremediation or phyto remediation
 - The employment of fungi for heavy metal contamination accumulation is known as myco remediation
 - Solid waste treatment: Proper methods should be adopted for management of solid waste disposal.

SOIL POLLUTION

Soil pollution is defined as the presence of hazardous chemicals (pollutants or contaminants) in high enough quantities in the soil to endanger human health and the environment. Soil pollution can be also defined as a change in the natural soil.

Causes/Sources: Soil pollution can be divided into two broad categories: **Natural and Anthropogenic.**

Natural Soil Contamination: Some contaminants naturally accumulate in soils via exceedingly unusual processes. The buildup of compounds containing the perchlorate anion (ClO_4^-) in some dry, arid habitats is an example of natural soil pollution.

Anthropogenic Soil Contamination: Soil contamination can be caused by a variety of anthropogenic activities like improper disposal of highly toxic industrial/chemical waste, Spillage of gasoline and diesel during transportation, Chemical pesticides, Sewage from metropolitan areas, Nuclear waste, e-waste, and coal ash etc.

Effects of Soil pollution: Soil contamination has a wide range of negative consequences that affect plants, animals, humans, and the entire ecosystem. Contaminants in the soil might be present in all three phases (solid, liquid, and gaseous).

Effect on humans: Soil contaminants can enter the human body through a variety of routes, including direct skin contact or inhalation of contaminated soil dust.

Effect on plants: Soil contamination is frequently accompanied by a reduction in nutrient availability, plant ceases to grow in such soils. Furthermore, this form of pollution raises the salinity of the soil, making it unsuitable for plant growth. Plants cultivated in polluted soil can acquire significant levels of soil contaminants through a process called bioaccumulation

Effect on micro-organisms: Several microorganisms that improve soil texture and aid in the breakdown of organic materials are unable to thrive in acidic soils. As a result, soil pollution has a negative impact on soil quality and texture.

Control of Soil Pollution: To deal with soil cleanup, several technologies have been created.

The following are some of the most important ways for decontaminating polluted soil.

1. Pollutant extraction using thermal remediation – the temperature is raised to drive the contaminants into the vapor phase, where they can then be recovered via vapor extraction
2. The use of microorganisms and plants for soil purification is known as bioremediation or phytoremediation .
3. The employment of fungi for heavy metal contamination accumulation is known as mycoremediation
4. Solid waste treatment: Proper methods should be adopted for management of solid waste disposal.

THERMAL POLLUTION

Thermal pollution is a rapid change in temperature in a natural body of water. This pollution is most often caused by heated discharge from an industrial facility or another human activity.

CAUSES:

Thermoelectric power plants fueled by coal, natural gas, nuclear, or biomass and other waste products constitute significant causes of thermal pollution. Human activities such as the discharge of warm or hot water from energy and manufacturing plants, rain runoff from urban areas, deforestation, and the release of water from reservoirs mainly cause thermal pollution. Streamside erosion can also contribute to thermal pollution.

EFFECTS:

- Thermal pollution can result in disruptions in natural systems and stress, disease, or even death for affected organisms.
- Thermal pollution is harmful because it causes *thermal shock* to aquatic organisms.
- It disrupts the natural functioning of aquatic ecosystems and changes the amount of oxygen available.
- It can disrupt breeding habits, growth, development, migratory behavior and cause problems in the food chain.

CONTROL:

- Installation of human-made structures like cooling ponds and cooling towers.
- The cogeneration process can also be useful in controlling thermal pollution. This process deals with the recycling of heated water for domestic purposes and industrial heating.
- We can implement the concept of the artificial lake as a solution to thermal pollution. These are human-made water bodies where heated substances can be discharged from one end, and water for cooling purposes can be used from the other end.
- Afforestation is an economical method to treat thermal pollution. Tree plantation along the shoreline will prevent soil erosion, raising the chances of stability in the ecosystem.

UNIT 3

Short Answer Questions (2Marks/3Marks)

1. What are pollutants? How can they be classified?
2. Explain the term pollutant. Give examples.
3. What are primary and secondary pollutants? Give example.
4. Define BOD and COD.
5. What is blue baby syndrome?
6. What is thermal pollution?
7. List the impacts of thermal pollution.
8. Define eutrophication.
9. Define bioaccumulation & bio-magnification.
10. What is solid waste management?
11. List the impact of air pollution on plants & materials.
12. What are air borne diseases? Does it come under the diseases caused by air pollution?

Long Answer Questions (5//7/9/10 Marks)

1. What are the main causes and effects of water pollution? How can water pollution be controlled?
2. Explain different sources of water pollution. How water pollution affect the marine life?
3. Describe the methods for controlling the water pollution.
4. What do you mean by solid waste? Describe various methods of solid waste disposal.
5. What is noise pollution? Explain the different sources and effects of noise pollution.
6. What are different effects of air pollution on human, plants and materials?
7. What is the need of education for controlling the pollution?
8. What are different roles of individual for controlling different types of pollution?
9. Explain the causes, effects and control measures of soil pollution.
10. Explain the source correction measures and role of pollution control devices in air pollution.
11. Describe the sources, effects and control of noise pollution.
12. Explain the process of wastewater treatment with the help of suitable diagram.