ENVIRONMENTAL POLLUTION
CAUSES, EFFECTS AND CONTROL MEASURES

ENVIRONMENTAL POLLUTION may be defined as any undesirable change in the physical, chemical or biological characteristics environment which can cause undesirable effects on various forms of life or property.

Types of pollutants

Biodegradable pollutants: That degrades or decomposes rapidly by natural processes.

Non-biodegradable pollutants: Do not decompose or decompose very slowly in the environment.

AIR POLLUTION

Air pollution - Air pollution may be defined as an atmospheric condition in which certain substances are present in concentrations which can cause undesirable effects on man and his environment.

Sources of Air pollution

Sources of air pollution are of two types.

Natural sources

Natural sources of pollution are those that are caused due to natural phenomena. Ex: Volcanic eruptions, Forest fires, Biological decay, Pollen grains, Marshes, Radioactive materials.

Artificial sources

Artificial sources are those which are created by man. Ex: Thermal power plants, Vehicular emissions, Fossil fuel burning, agricultural activities etc.

Classification of Air Pollutants

Depending on the form of pollutants present in the environment**,** they are classified as:

1. Primary pollutants and
2. Secondary pollutants

Primary pollutants are those that are directly emitted in the atmosphere in the harmful form Ex: CO, NO, CO_2, SO_2 etc.

Secondary pollutants are those that are formed by reacting with other components or some basic component of the atmosphere to form new pollutants. Ex: Oxides of Nitrogen (NO_2 or NO_3) react with moisture in the atmosphere to give Nitric acid

INDOOR AIR POLLUTION

The air pollution inside buildings, offices, and houses is called indoor air pollution.

Indoor air pollutants are primary air pollutants. The most important indoor air pollutant is **Radon** gas.

Sources of indoor air pollutants are:

Radon gas is emitted from building materials like bricks, concrete, tiles, etc that are derived from soil containing radium

Radon is also found in natural gas and ground water and is emitted while being used.

Burning fuel in the kitchen and cigarette smoke release pollutants like CO, SO_2, HCHO (Formaldehyde) and BAP (Benzo-(A) pyrene).

SOURCES AND COMMON EFFECTS OF COMMON AIR POLLUTANTS

Carbonmonoxide: It is a colourless, odourless gas that is poisonous animals. It is formed by incomplete combustion of carbon containing fuels.

Source of carbonmonoxide is cigarette smoking and incomplete combustion of fossil fuels (more than 77% comes from motor vehicle exhaust)
Health effects include reduced ability of red blood cells to carry oxygen to body cells and tissues. This leads to headache and anemia. At high levels it causes coma, irreversible brain damage and death.

Nitrogen Dioxide: It is a reddish-brown irritating gas that causes photochemical smog. In the atmosphere, it gets converted into nitric acid (HNO3). It is caused by burning fossil fuels in industries and power plants.
Health effects include lung irritation and damage. Environmental effects involve acid deposition leading to damage of trees, lakes, soil and ancient monuments. NO2 can damage fabrics.

Sulphur Dioxide: It is a colourless and irritating gas that is formed by combustion of sulphur containing fossil fuels such as coal and oil. In the atmosphere it is converted into Sulphuric acid which is a major component of acid deposition.
Health effects involve breathing problems for healthy people.
Environmental effects involve reduced visibility and acid deposition on trees, lakes, soils and monuments leading to their deterioration and adverse effect on aquatic life.

Suspended Particulate Matter (SPM): Includes a variety of particles and droplets (aerosols) that can be suspended in atmosphere for short to long periods.
Human sources for SPM include burning coal in power and industrial units, burning diesel and other fuels in vehicles, agriculture, unpaved roads, construction, etc.
Health effects include nose and throat irritation, ling damage, bronchitis, asthama, reproductive problems and cancer.
Environmental Effects include reduced visibility and acid deposition. Acid deposition may lead to damaged trees, soils and aquatic life in lakes.

Ozone is a highly reactive gas with an unpleasant odour occurring in the stratosphere where it protects mankind from the harmful ultra-violet rays from the Sun. However on earth, it is a pollutant.
It occurs on earth due to reaction between Volatile Organic Compounds (VOCs) and Nitrogen Oxides. It moderates the climate
Photochemical smog is a browinsh smoke that frequently forms on clear, sunny days over large cities with significant amounts of automobile traffic. It is mainly due to chemical reactions among nitrogen oxides and hydrocarbons in the presence of sunlight.
Health effects include breathing problems, cough, eye, nose and throat irritation, heart diseases, reduced resistance to colds and pneumonia.
Environmental effects involve damage to plants and trees. Additionally, Smog reduces visibility.
Lead is a solid and highly toxic metal. Its compounds are emitted into the atmosphere as particulate matter.
Human Sources: Paint, Smelters (metal refineries), lead manufacture, storage batteries, leaded petrol, etc
Health effects: Lead accumulates in the body and brain leading to nervous system damage and mental retardation (especially in children), digestive and other health problems. Lead containing chemicals are known to cause cancer in test animals.
Environmental Effects: It can harm wildlife.

Hydrocarbons Lower haydrocarbons accumulate due to decay of vegetable matter.
Human effects: They are carcinogenic

Chromium: It is a solid toxic metal emitted into the atmosphere as particulate matter.
Human sources: Paint, Smelters, Chromium manufacture, Chromium plating.
Health Effects: Perforation of nasal septum, chrome holes, etc.

HARMFUL EFFECTS OF AIR POLLUTION

Effects on Human Health

- Sulphur oxides causes irritation of eyes, nose, throat; Damage to lungs, Acute and Chronic Asthma, Bronchitis and Emphysema
- Nitrogen oxides causes chronic obstructive pulmonary diseases, infant and cardiovascular diseases
- Carbon monoxide induces headaches, dizziness, loss of vision, decreased muscular coordination and severe effects on the baby of a pregnant woman
- Photochemical smog causes respiratory problems and irritation to eyes
- VOCs causes tiredness, drowsiness, dizziness, nausea, confusion, bone marrow disease, Skin cancers, leukemia, cardiovascular disease
- Dust particles induces stuffy noses, sinusitis, sore throats, dry cough, burning eyes, chest pain, aggravated asthma and chronic bronchitis
- Lead damages the brain and central nervous system, kidneys and brain
- Mercury brings nervous disorders, insomnia, memory loss, excitability, irritation, tremor and minamata disease

Effects on Plants

- Air pollutants affect plants by entering through stomata and destroy chlorophyll
- Damages the leaf structure and causes necrosis (dead areas of leaf), loss of chlorophyll content causing yellowing of leafs (Chlorosis) or down ward curling of leaf (epinasty) and dropping of leaves (abscission).
- PAN (Peroxyacetyl nitrate) causes silvering of lower surface of leaf, damage to young and more sensitive leaves and suppressed growth
- Ozone causes flecks on leaf surface, premature ageing, necrosis and bleaching

Effects on Materials

- Mixing of air pollutants and moisture in air causes acid rains which in turn damages the buildings, monuments and statues.
- They also affects the aquatic life specifically fishes
- Ozone in the atmosphere can cause cracking of rubber.

CONTROL MEASURES

The atmosphere has several built-in self cleaning processes such as dispersion, gravitational settling, flocculation, absorption, rain-washout, etc to cleanse the atmosphere. However, control of contaminants at their source level is a desirable and effective method through preventive or control technologies.

Source control: Some measures that can be adopted in this direction are:

- Using unleaded petrol
- Using fuels with low sulphur and ash content

- Encouraging people to use public transport, walk or use a cycle as opposed to private vehicles
- Ensure that houses, schools, restaurants and playgrounds are not located on busy streets
- Plant trees along busy streets as they remove particulates, carbon dioxide and absorb noise
- Industries and waste disposal sites should be situated outside the city preferably on the downwind of the city.
- Catalytic converters should be used to help control emissions of carbon monoxide and hydrocarbons

CONTROL MEASURES IN INDUSTRIAL CENTERS

- Emission rates should be restricted to permissible levels by each and every industry
- Incorporation of air pollution control equipment in design of plant layout must be made mandatory
- Continuous monitoring of the atmosphere for pollutants should be carried out to know the emission levels.

EQUIPMENT USED TO CONTROL AIR POLLUTION

- Air pollution can be reduced by adopting the following approaches.
- Ensuring sufficient supply of oxygen to the combustion chamber and adequate temperature so that the combustion is complete thereby eliminating much of the smoke consisting of partly burnt ashes and dust.
- To use mechanical devices such as wet scrubbers, cyclones, bag house filters and electro-static precipitators in manufacturing processes. The equipment used to remove particulates from the exhaust gases of electric power and industrial plants are shown below. All methods retain hazardous materials that must be disposed safely. Wet scrubber can additionally reduce sulphur dioxide emissions.
- The air pollutants collected must be carefully disposed. The factory fumes are dealt with chemical treatment.

NOISE POLLUTION

Noise is defined as, "the unwanted, unpleasant or disagreeable sound that causes discomfort to all living beings". Statistically, ever since the industrial revolution, noise in the environment has been doubling every ten years.

Sound intensity is measured in decibels (dB) that is the tenth part of the longest unit Bel. One dB is the faintest sound that a human ear can hear.

Types of Noise: Environmental noise has been doubling every ten years. Noise is classified as:

1. Industrial Noise
2. Transport Noise and
3. Neighbourhood noise

Industrial Noise: It is sound with a high intensity caused by industry machines. Such noise pollution is caused by machines from various factories, industries and mills. Noise from mechanical saws and pneumatic drills is unbearable and a nuisance to the public. The Indian Institute of Oto-Rino Laryngology, Chennai reported that increasing industrial pollution damages the hearing ability by at least 20%.

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

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

Noise levels in most residential areas in metropolitan cities are hovering around the border line due to increased vehicular noise pollution. This high level of noise pollution leads to deafening in the elderly.

Neighborhood noise: This type of noise includes disturbance from household gadgets and community. Common sources being musical instruments, TV, VCR, Radios, Transistors, Telephones, and loudspeakers etc.

Effects of Noise pollution

1. Noise pollution affects both human and animal health. It leads to:
   - Contraction of blood vessels
   - Making skin pale
   - Excessive adrenalin in the blood stream which is responsible for high blood pressure.
   - Blaring sounds are known to cause mental distress
   - Heart attacks, neurological problems, birth defects and abortion
2. Muscle contraction leading to nervous breakdown, tension, etc
3. The adverse reactions are coupled with a change in hormone content of blood, which in-turn increases heart beat, constriction of blood vessels, digestive spams and dilation of the pupil of the eye.
4. Adverse affects health, work efficiency and behaviour. Noise pollution may cause damage to the heart, brain, kidneys, liver and may produce emotional disturbance.
5. The most immediate and acute effect of noise is impairment of hearing that diminishes some part of the auditory system. Prolonged exposure to noise of certain frequency pattern leads to chronic damage to the inner ear.
6. Impulsive noise may cause psychological and pathological disorders
7. Ultrasonic sound can affect the digestive, respiratory, cardiovascular system and semicircular canals of the internal ear.
8. The brain is adversely affected by loud and sudden noise by jets and airplanes. People are subjected to psychiatric illness.
9. Recent reports suggest that blood is thickened by excessive noise.
10. The optical system of human beings is also affected by noise pollution. Severe noise pollution causes: Pupullary dilation, Impairment of night vision and Decrease in rate of colour perception

Control measures:

SOURCE CONTROL: This includes source modification such as acoustic treatment to machine surface, design changes, limiting operational timings, etc

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

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

OILING: Proper oiling will reduce noise from the machine.

Preventive measures:

1. Prescribing noise limits for vehicular traffic
2. Ban on honking (usage of horns) in certain areas
3. Creation of silence zones near schools and hospitals
4. Redesigning buildings to make them noise proof
5. Reduction of traffic density in residential areas
6. Giving preference to mass public transport system.

SOIL POLLUTION

Soil pollution is defined as, "contamination of soil by human and natural activities which may cause harmful effect on living organisms". Composition of soil is listed below:

COMPONENT %

Organic mineral matter 45
Organic matter 05
Soil water 25
Soil air 25

TYPES, EFFECTS AND SOURCES OF SOIL POLLUTION

Soil pollution mainly occurs due to the following:

1. Industrial wastes
2. Urban wastes
3. Agricultural practices
4. Radioactive pollutants
5. Biological agents

Industrial wastes – Disposal of Industrial wastes is the major problem for soil pollution

Sources: Industrial pollutants are mainly discharged from various origins such as pulp and paper mills, chemical fertilizers, oil refineries, sugar factories, tanneries, textiles, steel, distilleries, fertilizers, pesticides, coal and mineral mining industries, drugs, glass, cement, petroleum and engineering industries etc.

Effect: These pollutants affect and alter the chemical and biological properties of soil. As a result, hazardous chemicals can enter into human food chain from the soil or water, disturb the biochemical process and finally lead to serious effects on living organisms.

Urban wastes – Urban wastes comprise of both commercial and domestic wastes consisting of dried sludge and sewage. All the urban solid wastes are commonly referred to as refuse.

Constituents of urban refuse: This refuse consists of garbage and rubbish materials like plastics, glasses, metallic cans, fibres, paper, rubbers, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products. Urban domestic wastes though disposed off separately from industrial wastes, can still be dangerous. This happens because they are not easily degraded.

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

Radioactive pollutants/ - Radioactive substances resulting from explosions of nuclear testing laboratories and industries giving rise to nuclear dust radioactive wastes, penetrate the soil and accumulate giving rise to land/soil pollution.

Ex:

- Radio nuclides of Radium, Thorium, Uranium, isotopes of Potassium (K-40) and Carbon (C-14) are commonly found in soil, rock, water and air.
- Explosion of hydrogen weapons and cosmic radiations include neutron, proton reactions by which Nitrogen (N-15) produces C-14. This C-14 participates in Carbon metabolism of plants which is then into animals and human beings.
- Radioactive waste contains several radio nuclides such as Strontium90, Iodine-129, Cesium-137 and isotopes of Iron which are most injurious. Strontium get deposited in bones and tissues instead of calcium.
- Nuclear reactors produce waste containing Ruthenium-106, Iodine-131, Barium-140, Cesium-144 and Lanthanum-140 along with primary nuclides Sr-90 with a half life 28 years and Cs-137 with a half life 30 years. Rain water carries Sr-90 and Cs-137 to be deposited on the soil where they are held firmly with the soil particles by electrostatic forces. All the radio nuclides deposited on the soil emit gamma radiations.

Biological agents – Soil gets a large amount of human, animal and bird excreta which constitute a major source of land pollution by biological agents.

Ex: Heavy application of manures and digested sludge can cause serious damage to plants within a few years

Control measures of soil pollution:

Soil erosion can be controlled by a variety of forestry and farm practices. Ex: Planting trees on barren slopes

Contour cultivation and strip cropping may be practiced instead of shifting cultivation

Terracing and building diversion channels may be undertaken.

Reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.

Proper dumping of unwanted materials: Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.

Production of natural fertilizers: Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Ex: Organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

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

Ex: Lavatories should be equipped with quick and effective disposal methods.

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

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

Recycling and Reuse of wastes: To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc should be recycled and reused.Ex: Industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

Ban on Toxic chemicals: Ban should be imposed on chemicals and pesticides like DDT, BHC, etc which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

WATER POLLUTION

Water pollution may be defined as "the alteration in physical, chemical and biological characteristics of water which may cause harmful effects on humans and aquatic life."
Pollutants include:

1. Sewage
2. Industrial effluents and chemicals
3. Oil and other wastes

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

TYPES, EFFECTS AND SOURCES OF WATER POLLUTION Water pollution is any chemical, biological or physical change in water quality that has a harmful effect on living organisms or makes water unsuitable for desired uses.
Infectious agents
Ex: Bacteria, Viruses, Protozoa, and parasitic worms.
Human sources
Human and animal wastes
Effects: Variety of diseases.

Oxygen demanding wastes (Dissolved oxygen): This degradation consumes dissolved oxygen in water. Dissolved Oxygen (DO) is the amount of oxygen dissolved in a given quantity of water at a particular pressure and temperature.
The saturated point of DO varies from 8 to 15 mg/L Ex: Organic wastes such as animal manure and plant debris that can be decomposed by aerobic (oxygen-requiring) bacteria.
Human sources: Sewage, Animal feedlots, paper mills and food processing facilities.
Effects: Large populations of bacteria decomposing these wastes can degrade water quality by depleting water of dissolved oxygen. This causes fish and other forms of oxygen-consuming aquatic life to die.
Inorganic chemicals
Ex: Water soluble inorganic chemicals:

1. Acids
2. Compounds of toxic metals such as lead (Pb), arsenic (As) and selenium (Se)
3. Salts such as NaCl in oceans and fluoride (F^-) found in some soils

Human sources: Surface runoff, industrial effluents and household cleansers
Effects: Inorganic chemicals can:

1. Make freshwater unusable for drinking and irrigation
2. Cause skin cancer and neck damage
3. Damage nervous system, liver and kidneys

4. Harm fish and other aquatic life
5. Lower crop yields
6. Accelerate corrosion of metals exposed to such water

Organic chemicals
Ex: Oil, Gasoline, Plastics, Pesticides, Cleaning solvents and Detergents.
Human Sources: Industrial effluents, household cleansers and surface runoff from farms.
Effects:

- Can threaten human health by causing nervous system damage and some cancers.
- Harm fish and wildlife.

Plant nutrients
Ex: Water soluble compounds containing nitrate, Phosphate and Ammonium ions.
Human sources: Sewage, manure and runoff of agricultural and urban fertilizers.

Effects:

- Can cause excessive growth of algae and other aquatic plants, which die, decay, deplete dissolved oxygen in water thereby killing fish
- Drinking water with excessive levels of nitrates lower the oxygen carrying capacity of the blood and can kill urban children and infants.

Sediment
Ex: Soil, silt, etc.
Human Sources: Land erosion
Effects:

- Causes cloudy water thereby reducing photosynthetic activity
- Disruption of aquatic food chain
- Carries pesticides, bacteria and other harmful substances
- Settles and destroys feeding and spawning grounds of fish
- Clogs and fills lakes, artificial reservoirs, stream channels and harbours.

Radioactive materials:
Ex: Radioactive isotopes of:

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

Human sources: Nuclear power plants, mining and processing of uranium and other ores, nuclear weapon production and natural sources.
Effects: Genetic mutations, birth defects and certain cancers.

Heat (Thermal pollution)
Ex: Excessive heat
Human sources: Water cooling of electric power plants and some types of industrial plants. Almost half of whole water withdrawn in United States each year is for cooling electric power

plants.

Effects

- Low dissolved oxygen levels thereby making aquatic organisms more vulnerable to disease, parasites and toxic chemicals.
- When a power plant starts or shuts down for repair, fish and other organisms adapted to a particular temperature range, can be killed by an abrupt *temperature change*known as *thermal shock.*

Point and non-point sources of water pollution:

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

Ex: Factories, sewage treatment plants, abandoned underground mines and oil tankers.

Non point sources These pollutants cannot be traced to a single point of discharge. They are large land areas or air-sheds that pollute water by runoff, subsurface flow or deposition from the atmosphere.

Ex: Acid deposition, runoff of chemicals into surface water from croplands, livestock feedlots, logged forests, urban streets, lawns, golf courses and parking lots.

Control measures of water pollution

- Administration of water pollution control should be in the hands of state or central government
- Scientific techniques should be adopted for environmental control of catchment areas of rivers, ponds or streams
- Industrial plants should be based on recycling operations as it helps prevent disposal of wastes into natural waters but also extraction of products from waste.
- Plants, trees and forests control pollution as they act as natural air conditioners.
- Trees are capable of reducing sulphur dioxide and nitric oxide pollutants and hence more trees should be planted.
- No type of waste (treated, partially treated or untreated) should be discharged into any natural water body. Industries should develop closed loop water supply schemes and domestic sewage must be used for irrigation.
- Qualified and experienced people must be consulted from time to time for effective control of water pollution.
- Public awareness must be initiated regarding adverse effects of water pollution using the media.
- Laws, standards and practices should be established to prevent water pollution and these laws should be modified from time to time based on current requirements and technological advancements.
- Basic and applied research in public health engineering should be encouraged.

GLOBAL WARMING - DEFINITION, EFFECTS AND CONTROL MEASURES

Global warming is defined as the increase in temperature of Earth, that causes change in climate The last few centuries have seen an increase in industrial, agricultural and other human activity resulting in release of more *green house gases* in the atmosphere. These gases cause the

atmosphere to trap increasing amounts of heat energy in the Earth's surface making the planet warmer than usual.

The global temperature is now 1C higher than in 1900. Predictions of future climate indicate that by the middle of the next century, the Earth's global temperature may be 1C to 3C higher than what it is today.

Researchers have checked through indirect evidence (tree rings, coral growth, ice cores) and confirmed that the warmest decade in the past 1000 years was from 1990 to 1999. The warmest year of the millenium was 1998.

The International Red Cross and Red Crescent have analyzed the past 33 years of natural disasters and 90% of them were weather related. Moreover, the occurrence of these disasters has increased in the past three decades.

Effects of Global Warming

Following are the effects of global warming:

1. More heat waves
2. Expansion of desert area
3. Natural fires in forest lands
4. More evaporation of water from oceans and water bodies
5. Melting of Ice caps in Arctic and Antarctic regions
6. More cloud formation in the atmosphere
7. Shorter and warmer winters coupled with longer and hotter summers
8. Changes in rainfall pattern
9. Rise in sea level
10. Flooding and submergence of low lying coastal areas
11. Disruption in farming
12. More drought
13. Impact on plants, animals and humans

Control and remedial measures:

Some of the remedial and control measures of global warming are listed below:

1. Reduction in consumption of fossil fuels such as coal and petroleum
2. Use of bio-gas plants
3. Use of nuclear power plants
4. Increasing forest cover
5. Use of unleaded petrol in automobiles
6. Installation of pollution controlling devices in automobiles (catalytic converter) and industries (Electro Static Precipitators, Bag filters, Wet scrubbers etc)

OZONE LAYER DEPLETION

Ozone is a colourless, odorless gas composed of three atoms of oxygen (O3). Ozone has the same chemical structure regardless of where it occurs and can be useful or harmful depending on where it occurs in the atmosphere. Ozone is formed naturally in the *upper stratosphere* when wavelengths less than 240nm are absorbed by normal oxygen molecules which dissociate to give

O atoms. The O atoms in combination with other oxygen molecules produce ozone. In the stratosphere, about 19 to 30 km above the Earth's surface, ozone is constantly being produced and destroyed naturally. This production and destruction makes stratosphere with ozone layer that filters the Ultra-Violet radiation from the Sun and protects life on Earth. Normally there is a fine balance between production and destruction of ozone thereby safeguarding life on Earth.

Man-made chemicals called *Chloro Fluoro Carbons*(**CFC**s) are used as aerosol sprays, refrigerants and coolants etc destroy ozone molecules in the stratosphere. The CFCs themselves do not destroy ozone molecules but they decay ozone molecules at low temperatures. A small amount of chlorine atom and chlorine mono-oxide function as catalyst in the process of destruction of ozone. The equations involved are:

$Cl + O_3 = ClO + O_2$

$ClO + O = Cl + O_2$

Hence, net effect:

$O_3 + O = 2O_2$

Chlorine atom in the above reaction functions as a catalyst and is not consumed in the reaction. Chlorine atom used in the reaction remains as chlorine atom even at the end of the reaction. Once chlorine has broken one ozone molecule, it is free to repeat the process until it is removed by another reaction in the atmosphere. Chloro-Fluoro-Carbons are very stable molecules and can live upto 100 years.

Harmful effects of ozone layer depletion

Ozone layer protects all life forms on Earth from the Sun's harmful UV radiation. Any significant decrease in the amount of ozone in the stratosphere results in the amount of UV radiation reaching the Earth's surface leading to harmful effects on all living organisms.

Effects on human health

1. Reddening of skin in sun shine (Sun burn)
2. Skin cancer
3. Reduction in body's immunity to disease
4. Eye disorders like cataracts and blindness

Other living organisms

- UV rays are particularly harmful to small plants and animals living in the sea called *'plankton'*. Plankton forms the base of ocean food chain
- UV rays damage certain crops like rice which is the staple food for many people in the world
- UV radiation can damage polymers used in paint, clothing and other materials

ACID RAIN - FORMATION, EFFECTS AND CONTROL MEASURES

Normally rain water is slightly acidic due to the fact that CO2 present in the atmosphere gets dissolved in it. Because of the presence of Oxides of Nitrogen and Sulphur (NOx and SOx) as pollutants in the atmosphere, the pH of rain water is lowered further. This type of precipitation of water is called acid rain or acid deposition.

Formation of Acid Rain

Acid rain means the presence of excessive acids in rain water. Thermal power plants, industries and vehicles release nitrous oxide and sulphur dioxide into the atmosphere by burning of coal and oil. When these gases react with water vapour in the atmosphere, they form acids and descend on Earth as "acid rain" through rain water.

$SOx + H_2O = H_2SO_4$

$NOx + H_2O = HNO_3$

Due to the drifting of these gases in the atmosphere by wind, their presence is felt as far as 2000 km away. Air pollution in one nation can cause acid rain in another nation.

Effects of Acid Rain

Effect of acid rain on human beings:

1. Acid rain has been found to be very dangerous to living organisms as it can destroy life. Human nervous system, respiratory system and digestive system are affected by acid rain.
2. It can also cause premature death from heart and lung disorders such as asthma and bronchitis

Effect of acid rain on buildings

1. The '**Taj Mahal**' in Agra is affected from the acid fumes being emitted from 'Mathura Refinery'. Crystals of CuSO4 and MgSO4 are formed as a result of corrosion due to acid rain.
2. Acid rain corrodes houses, monuments, statues, bridges and fences.

Solid waste management - sources, effects and methods of disposal

Solid waste management

Rapid population growth and urbanization in developing countries has led to people generating enormous quantities of solid waste and consequent environmental degradation. The waste is normally disposed in open dumps creating nuisance and environmental degradation. Solid wastes cause a major risk to public health and the environment. Management of solid wastes is important in order to minimize the adverse effects posed by their indiscriminate disposal.

Types of solid wastes: Depending on the nature of origin, solid wastes are classified into

1. URBAN OR MUNICIPAL WASTES
2. INDUSTRIAL WASTES and
3. HAZARDOUS WASTES

SOURCES OF URBAN WASTES

Urban wastes include the following wastes:

Domestic wastes containing a variety of materials thrown out from homes

Ex: Food waste, Cloth, Waste paper, Glass bottles, Polythene bags, Waste metals, etc.

Commercial wastes: It includes wastes coming out from shops, markets, hotels, offices,

institutions, etc. Ex: Waste paper, packaging material, cans, bottle, polythene bags, etc.
Construction wastes: It includes wastes of construction materials. Ex: Wood, Concrete, Debris, etc.
Biomedical wastes: It includes mostly waste organic materials Ex: Anatomical wastes, Infectious wastes, etc.

Classification of urban wastes

Urban wastes are classified into:
Bio-degradable wastes - Those wastes that can be degraded by micro organisms are called bio-degradable wastes
Ex: Food, vegetables, tea leaves, dry leaves, etc.
Non-biodegradable wastes: Urban solid waste materials that cannot be degraded by micro organisms are called non-biodegradable wastes.
Ex: Polythene bags, scrap materials, glass bottles, etc.

SOURCES OF INDUSTRIAL WASTES

The main source of industrial wastes are chemical industries, metal and mineral processing industries.
Ex: Nuclear plants: It generated radioactive wastes
Thermal power plants: It produces fly ash in large quantities
Chemical Industries: It produces large quantities of hazardous and toxic materials.
Other industries: Other industries produce packing materials, rubbish, organic wastes, acid, alkali, scrap metals, rubber, plastic, paper, glass, wood, oils, paints, dyes, etc.

EFFECT OF IMPROPER SOLID WASTE MANAGEMENT

1. Due to improper disposal of municipal solid waste on the roads and immediate surroundings, biodegradable materials undergo decomposition producing foul smell and become a breeding ground for disease vectors.
2. Industrial solid wastes are the source for toxic metals and hazardous wastes that affect soil characteristics and productivity of soils when they are dumped on the soil
3. Toxic substances may percolate into the ground and contaminate the groundwater.
4. Burning of industrial or domestic wastes (cans, pesticides, plastics, radioactive materials and batteries) produce furans, dioxins and polychlorinated biphenyls that are harmful to human beings.

Solid waste management involves waste generation, mode of collection, transportation, segregation of wastes and disposal techniques.

STEPS INVOLVED IN SOLID WASTE MANAGEMENT:

Two important steps involved in solid waste management are:
Reduce, Reuse and Recycle of Raw Materials
Discarding wastes
Reduce - If usage of raw materials is reduced, the generation of waste also gets reduced
Reuse - Refillable containers that are discarded after use can be reused
Recycle- Recycling is the reprocessing of discarded materials into new useful products
Ex: Old aluminium cans and glass bottles are melted and recast into new cans and bottles

Preparation of cellulose insulation from paper

Preparation of automobile body and construction material from steel cans

This method **3R's** help save money, energy, raw materials and reduces pollution.

DISCARDING WASTES:

The following methods are adopted for discarding wastes:

1. Landfill
2. Incineration and
3. Composting

LANDFILL: Solid wastes are placed in a sanitary landfill in which alternate layers of 80 cm thick refuse is covered with selected earth-fill of 20 cm thickness. After 2-3 years solid waste volume shrinks by 25-30% and land is used for parks, roads and small buildings. This is the most common and cheapest cheapest method of waste disposal and is mostly employed in Indian cities.

Advantages:

It is simple and economical

Segregation of wastes is not required

Landfilled areas can be reclaimed and used for other purposes

Converts low-lying, marshy waste-land into useful areas.

Natural resources are returned to soil and recycled.

Disadvantages:

Large area is required

Land availability is away from the town, tansportation costs are high

Leads to bad odour if landfill is not properly managed.

Land filled areas will be sources of mosquitoes and flies requiring application of insecticides and pesticides at regular intervals.

Causes fire hazard due to formation of methane in wet weather.

INCINERATION:

It is a hygenic way of disposing solid waste. It is suitable if waste contains more hazardous material and organic content. It is a thermal process and very effective for detoxification of all combustible pathogens. It is expensive when compared to composting or land-filling.
In this method municipal solid wastes are burnt in a furnace called incinerator. Combustibe substances such as rubbish, garbage, dead organisms and non-combustibe matter such as glass, porcelain and metals are separated before feeding to incinerators. The non-combustible materials can be left out for recycling and reuse. The leftover ashes and clinkers may account for about 10 to 20% which need further disposal by sanitary landfill or some other means.
The heat produced in the incinerator during burning of refuse is used in the form of steam power for generation of electricity through turbines. Municipal solid waste is generally wet and has a high calorific value. Therefore, it has to be dried first before burning. Waste is dried in a preheater from where it is taken to a large incinerating furnace called "destructor" which can incinerate about 100 to 150 tonnes per hour. Temperature normally maintained in a combustion

chamber is about 700 C which may be increased to 1000 C when electricity is to be generated.

ADVANTAGES

Residue is only 20-25% of the original and can be used as clinker after treatment
Requires very little space
Cost of transportation is not high if the incinerator is located within city limits
Safest from hygenic point of view
An incinerator plant of 3000 tonnes per day capacity can generate 3MW of power.

DISADVANTAGES

Its capital and operating cost is high
Operation needs skilled personnel
Formation of smoke, dust and ashes needs further disposal and that may cause air pollution.

COMPOSTING

It is another popular method practiced in many cities in our country. In this method, bulk organic waste is converted into fertilizer by biological action.

Separated compostible waste is dumped in underground trenches in layers of 1.5m and finally covered with earth of 20cm and left for decomposition. Sometimes, actinomycetes are introduced for active decomposition. Within 2 to 3 days biological action starts. Organic matter is destroyed by actinomycetes and lot of heat is liberated increasing the temperature of compost by 75C and the refuse is finally converted into powdery brown coloured odourless mass called humus that has a fertilizing value and can be used in agriculture. Humus contains lot of Nitrogen essential for plant growth apart from phosphates and other minerals.

ADVANTAGES

Manure added to soil increases water retention and ion-exchange capacity of soil.
This method can be used to treat several industrial solid wastes.
Manure can be sold thereby reducing cost of disposing wastes
Recycling can be done

DISADVANTAGES

Non-consumables have to be disposed separately
The technology has not caught-up with the farmers and hence does not have an assured market.