

## UNIT-II

### ENVIRONMENTAL POLLUTION

#### 2.1 INTRODUCTION:

Environmental pollution may be defined as, “The unfavorable alteration of our surroundings”. It changes the quality of air, water and land which interferes with the health of humans and other life on earth

#### Classification of pollution

1. Air pollution
2. Water pollution
3. Soil pollution
4. Marine pollution
5. Noise pollution
6. Thermal pollution
7. Nuclear hazards

#### 2.2 AIR POLLUTION

Air pollution is defined as the presence of one (or) more contaminants like dust, smoke, mist and odour in the atmosphere which causes damage to plants, animals and human beings. It is also defined as any visible or invisible particles or gas found in the air that is not a part of the original, normal composition

##### 2.2.1 Chemical composition of Atmospheric Air

During several billion years of chemical and biological evolution the composition of earth's atmosphere has varied. Today about 99% of the volume of air we inhale consists of two gases: Nitrogen and Oxygen.

Constituents	%
Nitrogen	78
Oxygen	21
Argon	<1%
CO <sub>2</sub>	0.0637%,
O <sub>3</sub> , He, NH <sub>3</sub>	Trace amount

### 2.2.2 Indian ambient air quality standards

Air quality standards are legal limits placed on the concentration of air pollutants in a community where people and things are exposed.

Ambient air quality standards are permissible exposure of all living and non-living things for 24 hours per day, 7 days per week. Indian Ambient air quality standards are given in table

**Table Indian Ambient air quality standards**

Category	Area	Concentration in			
		SPM	SO <sub>2</sub>	NO <sub>x</sub>	CO
A	Industrial and mixed use	500	129	120	5,000
B	Residential	200	80	80	2,000
C	Sensitive	100	30	30	1,000

#### SOURCES:

**National Source:** Volcanic eruption, fires, biological decay, radioactive materials.

**Man-made source:** Thermal power plants, Automobile emission, forest fires, fuel burning, agricultural activities, coal.

### 2.2.3 CLASSIFICATION OF AIR POLLUTANTS

Primary pollutions

Secondary pollutions

**Primary Pollutants:** Pollutants emitted directly into the atmospheres in harmful form. **E.g.:** CO, NO, SO<sub>2</sub> etc.

**Indoor Air Pollutants:** These are primary air pollutants. The important indoor air pollutant is radon gas.

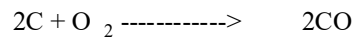
**Sources of I.A. Pollutants:** Radon gas is emitted by the building materials like bricks, concrete, tiles which are derived from soil containing radium.

**Secondary Pollutants:** Some of primary pollutants react with one another (or) with basic components of air to form new pollutants.

#### Common Air pollutants sources and their effects

##### 1. Carbon monoxide(CO)

CO – it is formed during the incomplete combustion of carbon containing fuels.

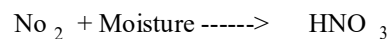


Human Sources – Cigarette smoking, burning of fossil fuels. 77% CO comes from motor vehicle exhaust.

Health Effect- Reacts with hemoglobin in red cells and reduces the ability of blood to carry O<sub>2</sub> to body cells and tissues, which causes headaches, impaired vision and anemia.

##### 2. Nitrogen di oxide

In atmosphere it reacts with moisture to form HNO<sub>3</sub>. it is a reddish brown gas



Human sources: Fossil fuel burning in motor vehicles and power industrial plants.

Health effect: Lung irritation and damage, wheezing

Environment effect:  $\text{HNO}_3$  corrode metals and stone on buildings, statues,  $\text{NO}_2$  damages fabrics.

### 3. Sulphur di oxide

It is a colorless and irritating gas. It is formed mostly by the combustion of sulphur containing fossil fuels like coal and oil. It is converted to  $\text{H}_2\text{SO}_4$  in the atmosphere. It is major component of acid deposition.

Human Source: Coal burning in power plants (88%) and industrial process.

Health effects: Breathing problems.

Environmental effects – Reduce visibility,  $\text{H}_2\text{SO}_4$  damages trees, soil and aquatic life.

### 4. Suspended particulate Matter (SPM)

It includes varieties of particles and droplets.

Human Sources: Burning diesel and other fuels in vehicle, agriculture, unpaved roads construction etc.

Health Effect: Nose and throat irritation, lung damage, asthma, reproductive problems and cancer.

### 5. Ozone

Highly reactive irritating gas in the troposphere. It is major component of photo chemical smog.

Human Source: Chemical reactions with volatile organic compounds and nitrogen oxides.

Environment effect: Moderates the climate.

### 6. Photochemical smog:

Any chemical reaction activated by light is called photochemical reaction. Photochemical smog is a mixture of more than 100 primary and secondary pollutants formed under the influence of sunlight. Its formation begins inside automobile engines and the boilers in coal burning power and industrial plants.

Health Effect: Breathing problems, cough, heart diseases etc.,

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Environment effect: Smog can reduce visibility.

**7. Lead:** Solid toxic metal and its components emitted into the atmosphere as a particulate matters.

Human Source: Paint, lead manufacture, storage batteries, leaded petrol.

Health Effect: Mental retardation (in children) digestive and other health problems.

Environment effect: affect the wild life.

**8. Chromium (Cr)**

It is a solid toxic metal, emitted into the atmosphere as particulate matter

Human resources: Paint, chromium plating

Health effect: central nervous system disease, chrome holes

**2.2.4 Control measures:**

Controlling at the sources:

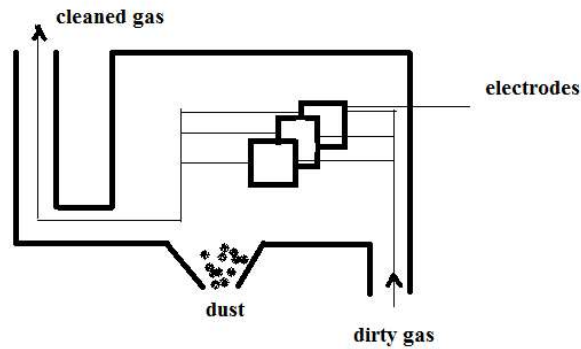
1. Use only unleaded petrol
2. Use fuels that have low sulphur and ash containing.
3. Plant trees along busy streets because they remove particulates and CO and absorb noise
4. Industries and waste disposal should be located outside the city area.
5. Use catalytic converters to control the emission of CO and hydrocarbon.

**2.2.5 Control Measures in industries:**

1. Emission rates should be restricted to permissible levels in all industries.
2. Air pollution control equipment should be incorporated in plant layout
3. Monitoring of the atmosphere for the pollutants should be carried out continuously to know the emission levels.
4. Scrubber, cyclone separator, bag house filter and electrostatic precipitators must be used in manufacturing process to retain harmful materials that must be disposed of safely.
5. Chemical treatment to deal with factory fumes

6. The disposal of the collected air pollutants is equally important for controlling air pollution.

**Equipment used to control air pollution**



**Fig: electro static precipitators**

**Procedure:**

- It is a particle control device that uses electrical forces to move the following particles out of the flowing gas stream and onto collector plates
- The particles are removed from the plates by rapping and collected in a hopper located below the unit. The removal efficiency is about 99%
- It is suitable for cement, pulp and paper industry

**Chemical and photo chemical reactions in the atmosphere :**

**3.1 Formation of smog**

Smog is a mixture of smoke and fog in suspended droplet form. The brownish sooty like appearance that frequently forms on clear, sunny days over large cities with significant amounts of automobile traffic.

**Types of smog**

There are two types of smog

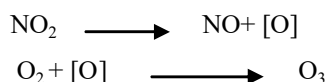
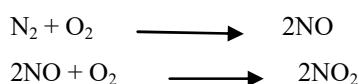
1. London smog
2. Los Angeles smog (or) Photochemical smog

1. London Smog

It is a coal smoke plus fog. Fog mainly consists of mixture of  $\text{SO}_2 + \text{SO}_3 +$  humidity. It is bad in morning hours and becomes worse after sun rise. This is due to sunlight induced oxidation of  $\text{SO}_2 + \text{SO}_3$ , followed by reaction with humidity giving sulphuric acid and aerosol.

## 2. Los Angeles (or) Photochemical smog

It is not related to smoke (or) fog. It is formed by the combination of  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{CO}$ ,  $\text{SO}_2$  and unburnt hydrocarbon particles. The important reaction is dissociation of  $\text{NO}_2$  in sunlight.



Hydrocarbon +  $\text{O}_2$ ,  $\text{O}$ ,  $\text{O}_3$ ,  $\text{NO}_2$ ,  $\text{NO}$   $\longrightarrow$  Oxidized hydrocarbons, of humidity causes photochemical smog.

### Health effects of smog

1. It causes irradiation to eyes and lungs.
2. It damages plants.
3. It irritates nose, throat, etc.,
4. It also causes bronchial irritation.

### Environmental effects of smog

1. It produces acid rain.
2. It damages plants and trees.
3. Smog can reduce visibility.

### Remedial measures of smog

1. By decreasing nitrogen oxides and hydrocarbon levels in the air.
2. By using unleaded petrol in automobiles.

### PAN (peroxy acetyl nitrates) (Lachrymatory substance)

#### Description

Peroxy acetyl nitrates is a secondary pollutant present in photochemical smog. It is a lachrymatory substance. It is thermally unstable and decomposes into peroxy ethanoyl radicals and nitrogen dioxide gas. It is an oxidant and more stable than ozone.

**Health effect**

At lower concentrations

It is a powerful respiratory and eye irritants, toxic in nature.

At higher concentrations

Cause extensive damage to vegetation, causing skin cancer.

**Production of PAN**

They are formed by the photochemical reaction between hydrocarbons, nitrogen oxides and light. It occurs in two steps

**Step 1**

Unburnt hydrocarbons undergo oxidation to give aldehydes, ketones and dicarbonyl compounds, which creates peroxyacyl radicals.

**Step II**

Peroxyacyl radicals combine with nitrogen dioxide to form peroxyacyl nitrates.



Sources

1. It comes from the degradation of isoprene hydrocarbon, acylation.
2. Blended gasoline with ethanol

**Environmental effects**

1. Damages plants and art.
2. React explosively.
3. Plays a very large role in photochemical smog

**Acid Rain (or) Acid Precipitation**

Normal rain water is always acidic because of the fact that CO<sub>2</sub> present in the atmosphere gets dissolved in it. Because of the presence of SO<sub>2</sub> and NO<sub>2</sub> gases as pollutants in the atmosphere, the Ph of the rain water is further lowered. This type of precipitations of water is called acid rain (or) acid deposition.

**Formation (or) causes of acid rain**

Acid rain means the presence of excessive acids in rain water. The thermal power plants, industries and vehicles release nitrous oxide and sulphur dioxide into atmosphere due to burning of coal and oil. When these gases react with water vapour in the atmosphere, they form acids and descend on to earth's 'acid rain' through rain water.



Due to the drifting of these gases in the atmosphere by the wind, their presence are felt as far as 2,000 kilometers. The air pollution of one nation could cause acid rain for another nation.

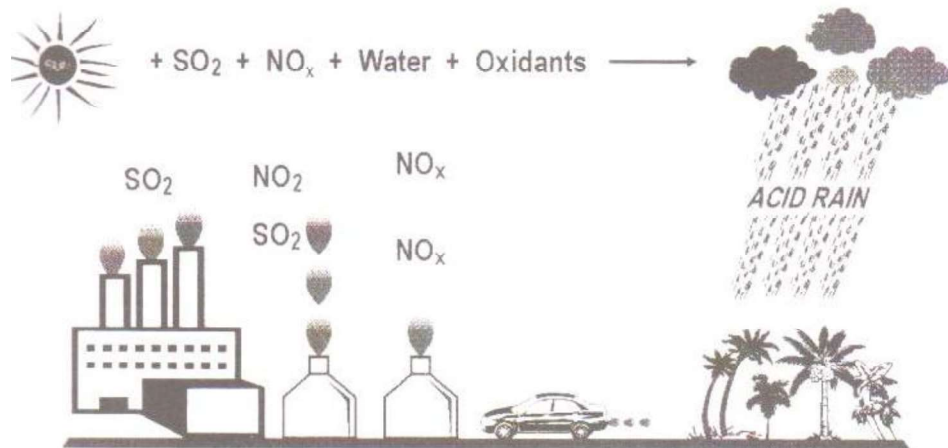


Fig : Formation (or) causes of acid rain

### Effects (impacts) of Acid rain

Acid rain causes a number of harmful effects. Some of the adverse are as follows.

#### I. Effects of acid rain on human beings

1. Acidic rain has been found to be very dangerous to the living organisms as it can destroy life. Human nervous system, respiratory system and digestive system are affected by acid rain.

2. It also causes the premature death from heart and lung disorders such as asthma and bronchitis.

#### II. Effects of acid rain on buildings

1. The Taj Mahal in Agra suffering at present due to  $\text{SO}_2$  and  $\text{H}_2\text{SO}_4$  acid fumes released from Mathura refinery. Crystals of  $\text{CuSO}_4$  &  $\text{MgSO}_4$  are formed as a result of corrosion caused by acid rain.

2. Acid rain corrodes houses, monuments, statues, bridges and fences. British parliament building also suffered damage due to  $\text{H}_2\text{SO}_4$  rains.

3. Acid rain and dry deposition of acidic particles contribute to the corrosion of metals, and the deterioration of paint and stone. These effects seriously reduce the value of buildings, bridge and cultural objects.

4. Dry deposition of acidic compounds can also dirty building and other structures, leading to increased maintenance costs.

### **III. Effects of acid rain on terrestrial and lake ecosystem**

1. The effect of acid precipitation on terrestrial vegetation reduces rate of photosynthesis and growth and increased sensitivity to drought and disease.

2. Acid rain severely retards the growth of crops such as beans, raddish, potato, spinach and carrots etc.,

3. Acid rain causes a number of complications in ponds, rivers and lakes where it accumulates as acid snow. It causes a significant reduction in fish population.

4. Block flies, mosquitoes, deer files and the aquatic worms occur abundantly where fishes are eliminated due to acid deposition.

5. The activity of the bacteria and other microscopic animals is reduced in acidic water. So the dead materials and other accumulated substances lying on the bottom of lakes are not rapidly decomposed. Thus essential nutrients such as nitrogen and phosphrous stay locked up in dead wastages. Biomass production is reduced and fish population declines.

#### **Other names of acid rain**

Acid fog, acid snow and acid precipitation

#### **Control measures of acid rain**

1. Improvement in technologies and switching to clean combustion technologies are highly essential in order to monitor the air pollution.

2. Emission of SO<sub>2</sub> and NO<sub>2</sub> from industries and power plants should be reduced by using pollution control equipments.

3. Coal with lower sulphur content is desirable to use in thermal plants, Replacement of coal by natural gas would also reduce the problem.

4. Liming of lakes and soils should be done to correct the adverse effects of acid rain.

5. The real solution is to cut back on the use of fossil fuels by reducing our dependency on motor vehicles and unnecessary utility of motor articles.

## OXYGEN AND OZONE CHEMISTRY

### a. Oxygen chemistry

The word oxygen comes from Greek words “oxy” and “genes” which together means acid forming. Our atmosphere currently contains about 21% of free oxygen. It plays an important role in sustaining life without oxygen. animal would be unable to breath and consequently die.

Production of oxygen

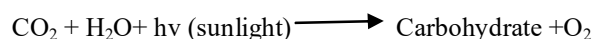
Oxygen is produced in various ways.

#### 1. Photochemical dissociation

Photochemical dissociation of water molecules by UV rays produce about 1 – 2% of our oxygen.

#### 2. Photosynthesis

Photosynthesis is performed by plants, which involves the following general reaction



#### 3. Industrial production

Oxygen is industrially produced by fractional distillation of liquefied air.

Structure of O<sub>2</sub>

It is a colourless, odourless gas. Electronic configuration of oxygen is 1s<sup>2</sup>, 2s<sup>2</sup>, 2p<sup>4</sup> and its valency is 2. It is paramagnetic. Hence its structure is



### b. Ozone chemistry

O<sub>2</sub> molecule is not elemental form of oxygen. Another form of (allotrope) oxygen is ozone (O<sub>3</sub>).

Production of ozone

Formation of ozone involves the following two steps

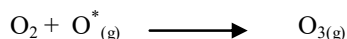
Step I

In the presence of lightning or spark of light, O<sub>2</sub> molecule dissociate to form oxygen atoms.



StepII

These oxygen atoms react with O<sub>2</sub> molecule to form ozone (O<sub>3</sub>)



Structure of ozone

Ozone is an unstable compound with a sharp, pungent odour. Its structure is shown below.

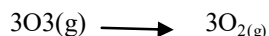
Oxygen (O<sub>2</sub>) and Ozone (O<sub>3</sub>) are example of allotropes having different chemical and physical properties.

**Table Properties of allotropes of oxygen**

Properties	Oxygen(O <sub>2</sub> )	Ozone (O <sub>3</sub> )
Melting point	-218.75°C	-192.5°C
Boiling point	-182.96°C	-110.5°C
Density (at 20°C)	1.331 g/lit	1.998 g/lit
O-O bond order	2	1.5
O-O bond length	0.1207 nm	0.1278 nm

**Properties of ozone**

Ozone under goes slow decomposition to give oxygen



**At low concentration**

At lower concentration ozone is relatively pleasant

**At higher concentration**

At higher concentration ozone leads to coughing, rapid beating of the heart, chest pain and general body pain.

**Ozone Layer Depletion (ozone hole)**

Ozone is a gas (O<sub>3</sub>) found throughout the atmosphere, but most concentrated in the stratosphere between 10 and 50 km above sea level, where it is known as the ‘ozone layer’.

**Importance of ozone layer**

Without the ozone layer, life on the earth’s surface would not be possible. It protects us from the damaging ultraviolet radiation of the sun. In particular it filters out UV -B radiation.

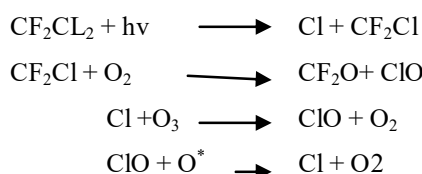
Recently evidence has shown that certain parts of the ozone layer are becoming thinner and ozone ‘holes’ have developed. The consequence of any thinning of the ozone layer is that more UV-B radiation reaches the earth’s surface. UV-B radiation affects DNA molecules,

causing damage to the outer surface of plants and animals. In humans it causes skin cancer, and eye disease.

### **Mechanism of Ozone layer depletion (or) Formation (or) Causes of ozone hole**

In 1970, it was found that the ozone layer was attacked by chlorofluoro carbons (CFCs) which are released into atmosphere by refrigeration units, air conditioning systems, aerosol sprays and cleaning solvents. Chlorofluoro carbons release chlorine which breaks ozone into oxygen.

The following reactions will then occur



Each chlorine atom is capable of attacking several ozone molecules. So that a long chain process is involved. A 1% loss of ozone results in a 2% increase in UV rays reaching the earth's surface.

### **Ozone Depleting Substances**

The ozone depleting substances essentially consists of chlorine or bromine atoms which are extremely reactive while they are in the free state. The following gases are accumulated in the atmosphere and are found to be instruments in ozone depletion.

#### **1. Chloro Fluoro Carbon (CFC)**

Sources

Refrigerants (Freon) in refrigerators, propellant in aerosol spray cans, blowing agent, foam plastic blowing agent.

#### **2. Hydro Chloro Fluoro Carbon (HCFC)**

Sources

Refrigerants, blowing agents.

#### **3. Bromo Fluoro Carbons (BFC)**

Sources

Fire extinguishers

#### **4. Other Chemicals**

1. Certain halogen compounds are potential ozone destroyers upto ten times more powerful than the CFCs.

2. Sometimes the atmospheric sulphur dioxide is converted into sulphuric acid which greatly increases the rate of ozone depletion.

**Effects (or) Environmental impact (or) consequences of Ozone Layer Depletion**

As the ozone layer gets deteriorated the harmful UV rays will reach the ground and cause various effects.

**1. Effect on human health**

- (i) The UV-rays damage genetic material in the skin cells which cause skin cancer.
- (ii) For the fair skinned people life long exposure to the high level radiation of UV rays increases the risk of non melanine skin cancer.
- (iii) Prolonged human exposure to UV-rays may lead to slow blindness called actinic keratitis. Enhanced level of UV –ray could lead to more people suffering from cataracts.
- (iv) Human exposure to UV-rays can suppress the immune responses in humans and animals. It also reduces human resistivity leading to a number of diseases such as cancer, allergies and some other infectious diseases.

**2. Effect on Aquatic Systems**

- (i) UV rays directly affect the aquatic forms such as phytoplankton, fish larval crabs.
- (ii) The phytoplankton consumes large amount of CO<sub>2</sub>  
Decrease in population of phytoplankton could have more amount of CO<sub>2</sub> in the atmosphere which contributes to the global warming.

**3. Effect on Materials**

Degradation of paints, plastics and other polymeric material will result in economic loss due to effects of UV radiation.

**4. Effect on Climate**

The ozone depleting chemicals can contribute to the global warming i.e., increasing the average temperature of the earth's surface.

**Measurement of Ozone**

The amount of atmospheric ozone is measured by 'Dobson spectrometer' and is expressed in Dobson units (DU). 1 DU is equivalent to a 0.01 mm thickness of pure ozone at the density it posses if it is brought to the ground level (1atm) pressure.

In temperate latitude its concentration is 350 DU

In tropics its concentration is 250 DU

In subpolar region its concentration is 450 DU

**Control Measures**

1. Replacing CFCs by other material which are less damaging
2. Use of gases such as methyl bromide which is a crop fumigant also to be controlled.
3. Manufacturing and using of ozone depleting chemicals should be stopped.

**2.3 WATER POLLUTION**

It is defined as, the alternation in physical, chemical & biological characteristics of water which may cause harmful effects on humans and aquatic life. The major pollutants are sewage, effluents, and bacteria.

It is also defined as, " water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds

**2.3.1 Types, effects and sources of water pollution**

**1. Infectious Agents**

E.g. Bacteria, viruses, protozoa, parasitic worms

Human Source- Human and animal waste

Health Effect – Variety of diseases.

**2. Oxygen demanding wastes:**

Organic wastes, such as animal manure & Plant debris that are decomposed by aerobic bacteria.

Human Source- Sewage, animal feedlots, paper mills, food processing facilities.

Health Effect – Depletion of dissolved O<sub>2</sub> in water. This causes death of aquatic life.

**3. Inorganic Chemical**

E.g. water soluble chemicals like acids. Compound of toxic metals like Lead, arsenic selenium. Salts like NaCl in sea water and fluorides found in some soils

Human Source: Industrial effluents, household waste.

Health Effect:

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- can make fresh water into unusable water
- Causes skin cancer & neck damage.
- Damage nervous system, liver & Kidney.
- harm fish and other aquatic life

**4. Organic Chemicals**

Plastics, pesticides, detergents

Human Source: Industrial effluents, household waste.

Health Effect: Damages nervous system, causes some cancers

**5. Plant Nutrients:**

Water soluble compounds containing Nitrates, ( $\text{NO}_4$ ) phosphates

Human Source: Sewage, manure, runoff of agriculture, urban fertilizer.

Health Effect: Drinking water with high levels of nitrate lowers the  $\text{O}_2$  carrying capacity of Blood and kills urban children and infants

**6. Sediment** :Example: Soil, silt

Human Source: Land Erosion

Health Effect: Clouds water and reduces photosynthesis. Disturbs aquatic food web

**7. Radioactive materials**

Radio isotopes of Iodine, radon, uranium and thorium

Human Source: Nuclear power plants, mining and processing of thorium.

Health Effect: Genetic mutation, birth defects and certain cancers.

**Point and non-point resources**

Point resources: it refers to the contaminant that enter a waterway from a single, identifiable source, such as pipe, ditch. Point sources are discharged pollutant at specific locations through pipes, ditches or sewers into bodies of surface water.

Example: underground mines and oil tankers



Non-point resources: it refers to diffuse contaminants that does not originate from a single discrete source

Example: runoff of chemicals into surface water from crop land

**Chemical and other contaminants:**

Detergents, Food

**2.3.2 Control measures of water pollution**

- All domestic and municipal effluents be rained in water bodies only after treatment
- Water pollution control should be given to the hand of state or central government
- The national goal should be 'plant more trees'.
- Use of pesticides in agriculture should be limited and only standard quality pesticides should be used
- Chemical such as potassium permanganate should be spread regularly in order to protect water from micro organism
- The harmful compound like phosphorous, mercury, sodium, ammonium etc, may be removed by adsorption ion exchanges, electrolysis etc,
- Highly qualified and experienced person should be consulted from time to time for effective control of water pollution
- The possible recycle of treatment sewage effluents and industrial wastes should be emphasized and encouraged
- Sewage is treated by biochemical oxidation. The chemicals retard the growth of plants and retard reproduction process.
- Acids and bases are removed by neutralization

**2.3.3 Treatment of waste water:**

Primary treatment: it is a mechanical process used to screen or filter out coarse, solids, silts from the waste water

Secondary treatment: it is biological process used to remove biodegradable organic wastes by aerobic bacteria

Tertiary treatment: it removes all the remaining pollutants and other pollutants of important such as phosphates and other dissolved inorganic compounds. Some other methods,

Ion exchange method

Reverse osmosis

## 2.4 SOIL POLLUTION

It is defined as the Contaminations of the soil by human and natural activities which may cause harmful effects on living beings. Soil pollution is caused by xenobiotic (human made) chemicals or other alteration in the natural soil environment

### Composition of soil:

Components	%
Mineral matter	45
Organic matter	5
Soil water	25
Soil air	25

### 2.4.1 Types, effects and sources of soil pollution:

**(i) Industrial wastes:** Industries are the major causes for soil pollution Textiles, steel, paper, Cement, oil, dyeing and other industries are responsible for soil pollution. Toxic organic compounds and phenol destroy the fertility of the soil.

Effect: These pollutants affect and alter the chemical and biological properties of soil

**(ii) Biological agents:** Fungi, protozoa, bacteria are important Biological agents for soil pollution. The human and animal wastes, garbage, waste water generates heavy soil pollution.

**(iii) Radioactive pollutants:** Atomic reactor, nuclear radioactive devices releases radioactive Pollutants. These pollutants enter the land and accumulate there by causing soil pollution.

**(iv) Pesticides:** Pesticides pollute the soil. There are of two types

(i) chlorinated hydrocarbons Insecticide, (ii) Organic phosphorous pesticides.

Common chlorinated hydrocarbon insecticides are DDT, BHC.

Organic phosphorous insecticides are synthetic chemicals like Malathion and parathion.

DDT reduces the activity of sex hormones of male and female. The land with fungicides insecticides causes diseases to human beings.

**(v) Fertilizers:** These discharge N, Na, K, S, Nitrates etc., into the soil. The nitrate causes cancer.

**(vi) Polymer, Plastics & other water:** These materials appear as garbage. Solid wastes and their quantities increase day by day. They pollute the atmospheres, land and also water badly.

**(vii) Agricultural practices:** Modern agriculture practices pollute the soil to a large extent. Today huge quantities of fertilizers, pesticides, and weedicides are added to increase the crop field. Apart from these farm wastes, manure debris, soil erosion containing inorganic chemicals are causing soil pollution.

#### 2.4.2 Effect of soil pollution

1. Organic wastes enter the soil pores and decompose. Pathogenic bacteria spread infection.
2. Compounds containing As, Hg, Cr, Ni, Zn and Fe are toxic to life.
3. Fluorides affect plant development
4. Water logging and salinity increase the dissolved salt content in the soil. Some plants are very sensitive to soil PH and salinity. Thus land becomes unfit for irrigation.

#### 2.4.3 Control of soil pollution

1. Treat the sewage before land disposal
2. Rotate the crop pattern to allow the soil replenish the nutrients.
3. Preserve and protect top fertile soil, control soil erosion by tree plantation.

4. Fertilizers may be applied only after estimating the soil and crop measures.
5. Production of natural fertilizers Excessive use of chemical fertilizers and insecticides should be avoided. Bio pesticides should be used instead of toxic chemical pesticides.
6. Proper hygienic condition- People should be trained regarding the sanitary habits.
7. Recycling and reuse of waster – The wastes such as paper, plastic, metals, glasses should be recycled and used.

#### **2.4.4 Methods to control soil pollution:**

Control of soil erosion:It can be controlled by a variety of forestry and farm practices

Example:

Trees may be planted non barren slopes

Terracing and building diversion channels may be undertaken

#### **Public awareness:**

Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental pollution

#### **Ban on toxic chemicals:**

Ban should be imposed on chemicals and pesticides like DDT, BHC etc, which are fatal to plants and animals

#### **Bio remediation:**

One of the techniques for treating polluted soil is known as bioremediation. It is a treatment process that uses micro organisms like yeast, fungi to break down or degrade, hazardous substances into less toxic or non-toxic substances

#### **2.4.5 SOLID WASTE MANAGEMENT**

Solid waste is defined as “any garbage refuse, sludge from a waste treatment plant, water supply treatment plant or air pollution control facility and other discarded material”. The

disposal of such wastes is known as solid waste management. Management of solid waste is very important to minimize adverse effect of solid waste.

#### **Types of solid waste**

- Urban waste
- Industrial waste.
- Hazardous waste

#### **Sources of urban wastes**

**Domestic waste:** domestic waste like food waste, waste paper, glass bottles, polythene bags etc

**Commercial waste:** it includes the wastes coming out from the shops, markets, and hotels etc  
example: packing materials cans, bottles, polythene bags etc

**Construction wastes:** like concrete, wood, debris etc.

**Biomedical waste:** like Anatomical waste, infectious waste etc

#### **Classification of urban waste:**

**1. Biodegradable wastes** – urban solid waste materials that can be degraded by micro organisms are called biodegradable waste. E.g. food, vegetables, Tea leaves, dried leaves etc.

**2. Non biodegradable waste.** Urban solid wastes that cannot be degraded by microorganisms are called non biodegradable wastes.

#### **Sources of industrial wastes:**

The main source of industrial waste is chemical industries, metal and mineral processing industries.

**Nuclear power plants** :generate radioactive wastes

**thermal power plants** :produce fly ash in large quantities

**Chemical industries:** pr:oduce toxic and hazardous materials.

**other industries:** produce packing materials acid, alkalis, scrap metals, rubber, plastic, glass ,wood etc

### **Hazardous waste**

Hazardous waste are the waste that pose a substantial danger immediately or over a period of time to human ,plant or animal life.

#### **Sources of Hazardous wastes**

Chemical manufacturing companies ,paper mills, Radio active substances, Biological waste and oter industries.

#### **Types and characteristics of Hazardous waste**

**1.Toxic waste:** These are poisonous even in very small or traces amount.

**(a)Acute Toxicity:**These waste have immediate effect on humans or animals causing death.

**(b)Cronic Toxicity:**These waste have long term effect slowly causing irreparable harm to the exposed person.

**2.Reactive waste:** These waste react vigorously with air, water, heat and generate toxic gases.

**3.Corrosive Waste:**These waste destroy materials and living tissues by chemical reaction.

**4.Radio active waste:**These are from nuclear power plants and persist in the environment for thousand of years.

**5.Infectious waste:**It causes infection to others.\

**6.Heavy metals:**Lead, Mercury

#### **2.4.6 EFFECT OF SOLID WASTES:**

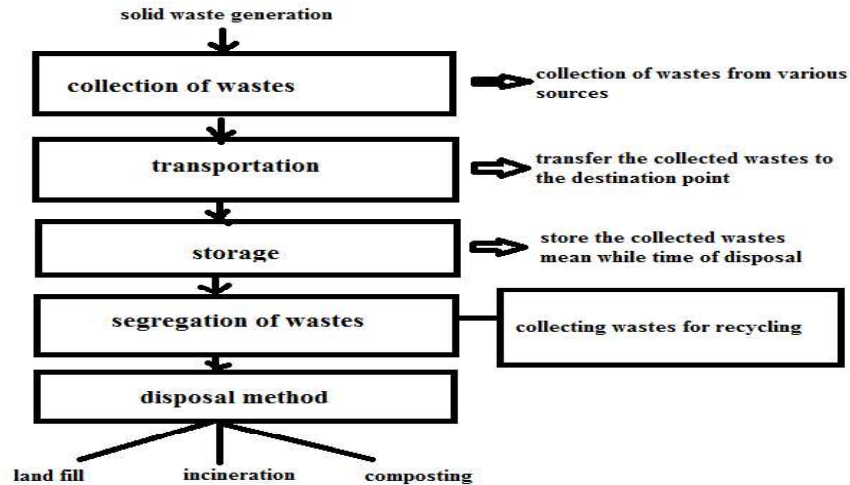
1. Biodegradable materials in the disposed municipal waste undergo decomposition. This produces foul smell and breeds various types of insects which spoil land well.

2. Industrial waste containing toxic metals and hazardous waste affect soil characteristics.

3. Toxic substances name percolate into the ground and contaminates the ground water.

4. Burning of some industrial waste or domestic waste produces furan, dioxins and poly chlorinated biphenyls which are harmful to human beings.

#### 2.4.7 STEPS INVOLVED IN SOLID WASTE MANAGEMENT



Reduce: if the usage of raw materials is reduced the generation of waste also gets reduced.

Reuse of waste materials: discarded refillable containers can be reused. Waste generation during manufacture of rubber bands is reduced by making rubber bands from discarded cycle tubes.

Recycling of materials: Recycling is the reprocessing of discarded materials into new useful products.

Ex. Old aluminium cans glass bottles are melted and recast into new cans and bottles.

Preparation of fuel pellets from kitchen wastes.

#### 2.4.8 METHODS OF DISPOSAL OF MUNICIPAL SOLID WASTES

**Land Fill:** Solid wastes are placed in sanitary land fill system in alternate layers of 80cm thick refuse covered with selected earth fill of 20cm thickness. After 2 or 3 years solid waste volume shrinks by 25-30% and the land is used for parks, roads and small buildings.

Waste disposal is dumping in sanitary land fill which is employed in Indian cities. This method involves spreading the solid waste on the ground. Compacting it and then covering it with soil at suitable intervals.

Advantages: 1 Simple and economical. Segregation is not required. Natural resources are returned to soil and recycled. Converts low lying, marshy waste land into useful areas.

**Disadvantages:**

Large area needed. Bad odour.

High transportation cost. Sources of mosquito, flies.

Insecticides and pesticides are to be applied at regular intervals.

Causes fire hazard due to methane formation in wet weather

**Incineration**

In this method the municipal solid wastes are burnt in a furnace called incinerator. The combustible substances such as rubbish, garbage, and dead organisms and non combustible matter such as glass, metals are separated before feeding into incinerator. The non combustible can be left out for recycling and reuse. The left out ashes and clinkers from the incinerator may be about 10-20 % which is disposed by land fill or some other methods.

The heat produced in the incinerator during burning is used as steam power for generation of electricity through turbines. The wet solid waste is dried in pre heaters and then taken into large incinerating furnaces called destructors which incinerate 100- 150tons per hour. The temperature maintained is about 700 ° C and increase to 1000° C when electricity is to be generated.

Advantages:

1. Requires little space
2. Hygienic point of it is safest.
3. Incinerated plants of 300 tons per day capacity generate 3 MW of power.

Disadvantages:

1. Capital and operational cost is high.
2. Needs skilled persons.
3. Formations of smoke, dust and ash causes air pollution.



**Composting:**

In this method bulk organic waste is converted into manure by biological action. Compostable waste is dumped in underground trenches in a layer of 1.5 meters and is finally covered about 20 cms and left for decomposition. Microorganism like actinomycetes is added for active decomposition. Within two to three days biological action starts. The organic matter decomposed by actinomycetes and a lot of heat is liberated. The temperature of the compost increases by 75°C and finally the refuse is converted to a brown coloured powder known as humus and is used in agricultural fields. The compost contains N, P and other minerals.

**Advantages:**

Recycling occurs.

Number of industrial solid wastes can also be treated by this method.

**2.5 NOISE POLLUTION**

It may be defined as unwanted sound which gets dumped into the atmosphere without regarding to its adverse effects. It also be defined as the unwanted, unpleasant or disagreeable sound that causes discomfort for all living beings

**2.5.1 Causes:**

**Industrial noise:** Most affording noise sources are compressors, generators power looms, grinding mills, furnaces. These are used in many industrial processes and installed partially in closed and open sheds. Industrial noise particularly from mechanical saws and pneumatic drill is unbearable and is a nuisance to public

For example: in the steel industry, the workers near the heavy industrial blowers are exposed to 112dB for eight hours and suffer from the occupational pollution

**Domestic noise:** Transistors radio, TV, other musical instruments, Air conditioners, washing machines. They affect users as well as the neighbors.

**Transport noise: Continuous** movement of vehicles causes traffic noise. It affects not only those who are moving but also those who live near the roads, railway links, and airports .a

survey conducted in metropolitan cities has shown that noise level in Delhi ,Bombay and Calcutta is as high as 90 dB

### 2.5.2 Effects of noise pollution

#### 1. Physiological effects

Head ache increase in the rate of heart beat, pain in heart, emotional disturbances, hearing loss.

#### 2. Annoyance

A noise is said be annoying if the exposed individual or groups of individuals reduce the noise avoid or leave the noisy area if possible. Both loudness and annoyance increase with increasing sound levels.

3. Recently it has been reported that the blood also thickened by excessive noise

4. Impulsive noise also causes psychological and pathological disorders.

5. Ultrasonic sound can affect digestive respiratory cardiovascular system and semi circular canals of internal ear.

6. It causes muscle to contract leading to nervous breakdown, tension etc.

7. These adverse reaction are coupled with a change in hormone content of blood

### 2.5.3 Control measures:

#### Source Control

1. Modification of source such as acoustic treatment to machine surface designed changes limiting the operational timings.

2. Oiling: Proper oiling will reduce the noise from the machine.

3. Transmission path intervention: Containing the source inside a sound insulating enclosure, construction of noise barrier or provision of sound absorbing material along the path.

4. Planting of trees: Planting of trees like neem, tamarind, coconut etc near schools hospitals reduce the noise to the extent of 8 to 10 db.

5. Selection of machinery: Careful selection of machine tools and equipments to be used may help to lower the noise levels in machine shop.

## 2.6 MARINE POLLUTION

The discharge of waste substances in to the sea resulting in harmful to the living resources, hazards to the human health, hindrances to the fishery and impairment of quality use of sea water.

### 2.6.1 Sources:

#### 1. Dumping the wastes:

Dumping of untreated wastes and sewages in the oceans by coastal towns, cities and industries. Rivers on the way to sea carry huge amount of sewage garbage agricultural discharge pesticide heavy metals.

#### 2. Huge quantity of plastic dumped in to the sea.

3. Oil: This is discharged in to the sea as crude oil and as separate fraction. Oil and its fractions are used in houses automobiles and industries. This causes devastation of marine environment.

Effects: Oil spills inhibit photosynthesis and the growth of planktons. All aquatic animals depend either directly or indirectly on planktons the basis of tropic chain

#### 4. Radioactive materials enter the ocean from nuclear weapon testing.

5. Toxics: Toxic waste is the most harmful form of marine pollution. Once toxic wastes affects an organism it quickly passes along the food chain and as sea food which cause various problems.

### Uses of marine

The coastal zone contains rich heritage, coral reefs, wetlands and sea grass beds

### Benefits of coral reefs:

Reefs support more than one million species

They provide feeding, breeding and nursery areas to fish and shell fish

They offer medicines

They act as a buffer to ocean waves and protect coastal lines from storms and so on

**Factors affecting coral reefs:**

The coral reefs are threatened by,

The sediment from deforestation carried by runoffs

The agricultural and industrial chemicals reaching through river discharges

The boat anchors and the careless drivers

Rising ocean temperatures

**2.6.2 Effects of marine pollution:**

1. Heavy metals and organic pollutants damages birds by thinning of egg shells and tissue damage of egg.
2. Oil pollution causes damage to marine animals and plants including algae bird, fish etc.
3. Oil spilling in the sea causes abnormal low body temperature in birds resulting in hypothermia.

Example: During Exxon Valdez accident 150 rare species of bald eagles are affected by ingested oil.

4. Oil films are able to retard the rate of oxygen uptake by water.

5. Hydrocarbon and benzpyrene accumulate in food chain and consumption of fish by man may cause cancer.

**2.6.3 Control of marine pollution:**

Nature and world conservation union suggest the principles

1. The industrial unit on the coastal lines should be equipped with pollution control instrument.
2. Urban growth near the coast should be regulated.

Methods of removal of oil

**Physical method:**

- a) Skimming the oil off the surface with suction device

- b) Floating oil can be absorbed using absorbing materials like poly urethane foam. Chopped straw and saw dust also used to absorb oil from the sea water.
- c) Chemical methods like dispersion, emulsification and using chemical additives are used to coagulate the oil

**Protective method:**

1. Municipal and industrial waste should be treated before disposing in to sea
2. Coastal waste are periodically analyzed for detecting pollution level
3. Soil erosion in the coastal land should be arrested by suitable techniques
4. Recreation beaches should be maintained to meet hygienic and aesthetic standard.

**2.7 THERMAL POLLUTION**

It is defined as the addition of excess of undesirable heat to water that makes it harmful to man, animal or aquatic life or otherwise cause's significant departure from the normal activities of aquatic communities in water. Pollution due to heat which changes the physical and chemical properties of the water that affects man, animals and the aquatic system.

**2.7.1 Sources of thermal pollution**

**1. Industrial waste water**

Industries generating electricity like coal powered and nuclear power plants need huge amount of cooling water for removing heat. Industries like textile, paper and pulp release heat in water to lesser extent. The discharged water will have higher temperature of 6 to 9° C. than the receiving water.

**2. Nuclear power plant**

Nuclear explosion, nuclear experiments discharged large amount of heat with toxic radio nuclides in to receiving water sources. A leakage of radiation from nuclear power plant raises the temperature water bodies.

### 3. Domestic sewages

The domestic sewage contains high BOD, COD and low dissolved oxygen when discharged in to rivers and others water without treatment raises the temperature of water bodies.

### 4. Hydro electric power

An electric power industry with cooling arrangements also causes thermal pollution in receiving water bodies.

### 5. Coal fired power plants

These constitute the major sources of thermal pollution. Their condenser coil are cooled with water free near by lake from river are discharged hot water back in to the stream. This increases the temperature by 15°C. This decreases the dissolved oxygen and killing the aquatic life.

#### 2.7.2 Effects of thermal pollution

**Reduction in dissolved oxygen:** concentration of dissolved oxygen decreases with increase in temperature of water

**Increase in toxicity** Increase in temperature increases the toxicity of the poison present in water

Ex; a rise of 10° C doubles the toxic effect of KCN. A rise of 80° C triples toxic effects of orthoxylene causing massive death of fish.

#### Change in water properties

Rise in temperature changes physical and chemical properties of water

#### Food shortage for fishes

Change in temperature alters the seasonal variation in type and abundance of lower organisms. Thus fish may lack right food at right time.

#### Interference with reproduction:

In fishes the activities like nest building, hatching, migration and reproduction depend upon optimum temperature. Change in temperature affects the above process.

**Direct mortality:**

The increase in the temperature exhausts the micro organisms and shortens their life span. Above a particular temperature a fish dye due to the failure in respiratory and nervous system.

**Thermal shock:** the sudden change in temperature due to hot waste water can be of harm to fish and other aquatic animals that have been used to a particular level of water temperature. This invariably cause fish migrate to a more suitable environment

**Thermal enrichment:** this is when heated water from power plants may be used for irrigation purposes to extend plant growing seasons, speed up the growth of fish and other aquatic animals.

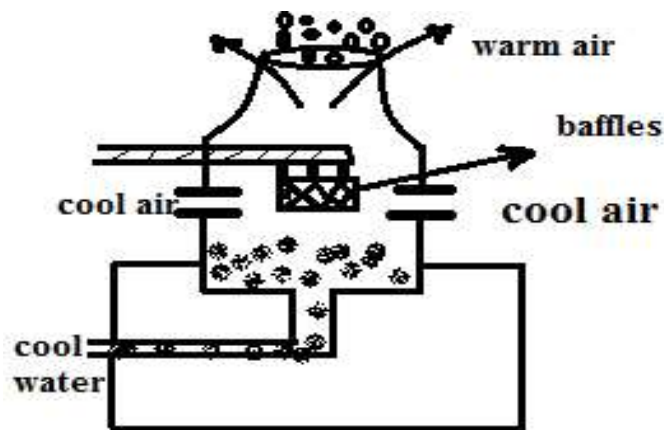
**2.7.3 Control of Thermal pollution:**

**Cooling towers:** Cooling towers transfers some of the heat from hot water to the surrounding atmosphere by the process of evaporation. Cooling towers are used to spread the recovered waste heat to eliminate the problems of thermal pollution.

**Types of cooling towers:**

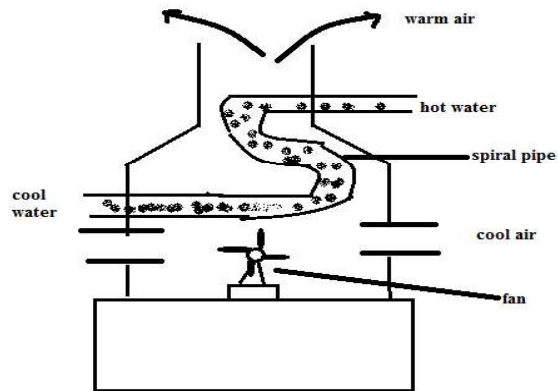
**Wet cooling Towers:**

Hot water coming from the reactor is allowed to spray over baffles .Cool air with high velocity is passed from the sides which takes away the heat and cools water.



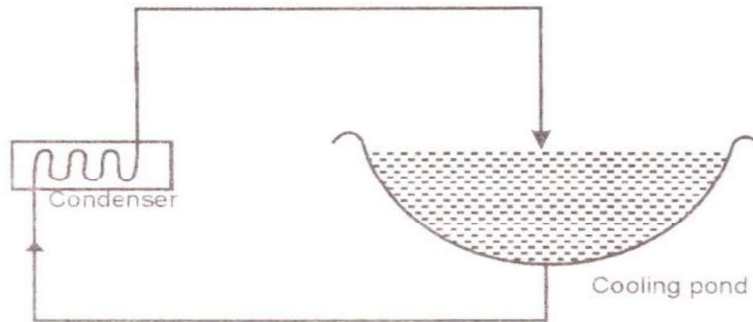
**Dry cooling tower:**

Hot water is allowed to flow in long spiral pipes. With the help of fan cool air is possible over these hot pipes thereby cooling water.



**Cooling Points:**

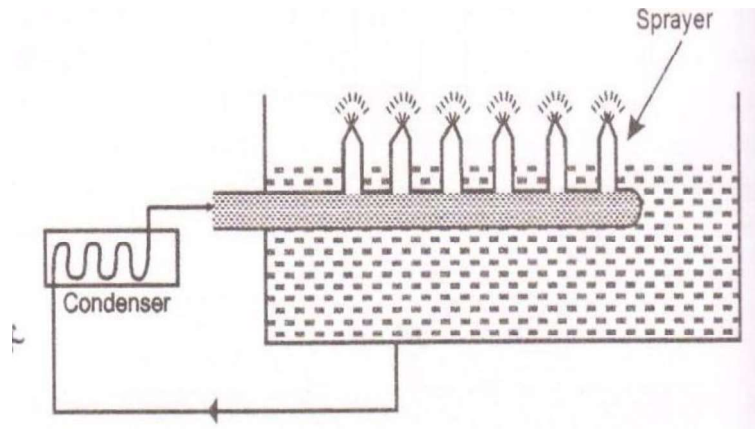
Heated effluents on the surface of water in cooling points maximize dissipation of heat to the Atmosphere and minimize water area and volume. Thus warm water wedge acts like cooling points.



**Spray Points:**

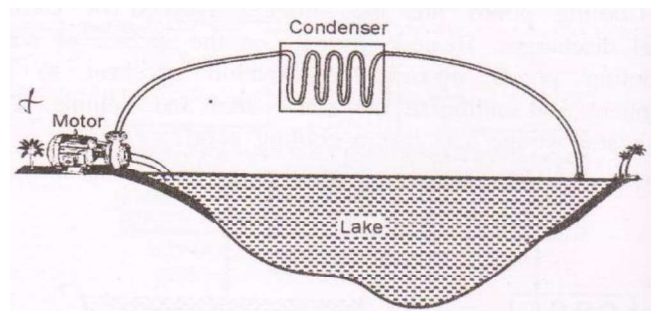
The water from the condenser is allowed to pass in to the ponds through sprayers. Water is sprayed through nozzles as fine droplets. heat from the fine droplets gets dissipated to the atmosphere.





**Artificial lakes:**

The heated effluents from the thermal power industries are discharged in to the artificial lakes at one end while cool water is transferred back from the other end. Heat is evaporated through dissipation in this method.



**2.8 NUCLEAR HAZARDS**

The radiation hazard in the environment comes from ultra violet, visible, cosmic rays and micro wave radiation which produce genetic mutation in human beings

**Sources:**

**Natural source:**

The important natural source is space which emits cosmic rays. Soil, rocks, air, water, radioactive Radon-222 also contains one or more radioactive substances.

**Man made resources:**

Nuclear power plants X-rays, nuclear accidents, nuclear bombs. Mining and refining of plutonium, thorium and preparation of radioactive isotopes are also important reasons

**2.8.1 Effects:**

1. Damages to enzymes, DNA, RNA through ionization, cross linking within and between two affected molecules.
2. it Damages the cell membranes, chromosomes etc.
3. Disruption of central nervous system, loss of sight, inactivation of bone marrow activity resulting in blood cancer, malignance and ulcer in intestinal tract.
4. Death or shortening of life span due to radiation changes in characteristics due to mutation.
5. Internal bleeding and blood vessel damage may show up as red spots on the skin.
6. Urban children are vulnerable to brain damage or mental retardation if radiation occurs in early pregnancy.

**2.8.2 Control Measures:**

- 1 Nuclear devices should never be exploded in air. If necessary they may be explode under ground.
2. Leakage of radioactive elements from reactors and labs processing or using them should be totally checked.
3. In nuclear and chemical industries the use of radio isotopes may be carried under a jet of soil or water instead of powder or gaseous form.
4. In nuclear mines wet drilling may be employed along with underground drainage.
5. Nuclear medicines and radiation therapy should be applied when absolutely necessary with minimum dose.
6. Minimum number of nuclear installations should be commissioned.
7. In nuclear reactors closed cycled coolant system with gaseous coolants may be used to prevent extraneous activation of products.

8. Use of high chimneys and ventilations at working place where radioactive contamination is high.

**2.9 ROLE OF AN INDIVIDUAL IN THE PREVENTION OF POLLUTION:**

A small effort made by each individual at his own place will have pronounced effect at the global level. It is aptly said —Think globally Act locally. Each individual change his life style in such a way has to reduce environment pollution.

**Individual participation:**

Planting more trees.

Use water energy and other resources efficiently.

Purchase recyclable, recycled and environmentally safe products.

Use CFC free refrigerators.

Reduce deforestation.

Increase use of renewable resources.

Remove carbon di oxide from motor vehicular exhausts.

Use of eco friendly products.

Slow down the population growth

**The following activity helps consumers prevent pollution into the daily life**

**Reduce driving time:** cars are big contributors to air pollution problems

**In bath rooms:**

check your toilet for silent leaks

Turn off water while brushing and shaving

**In kitchen:** compost your food scraps rather than using a garbage disposal

## 2.10 CASE STUDIES RELATED TO POLLUTION:

### **Bhopal gas tragedy**

In Bhopal M.P on 3 December 1984 world's worst industrial accident occurred. It occurred at Union Carbide India Ltd this manufactures carbonate pesticides using methyl isocyanate (MIC).

Effects of MIC: Lower concentration of MIC affects lungs, Eyes and causes irritation in the skin.

High concentration of MIC removes Oxygen from the lungs and causes death.

Effects in Bhopal: MIC spread over 40square Km in area. 5000 people are killed and 65000 people suffered from disorders in eye, respiratory, gastrointestinal. 1000 became blind.

### **Taj – Trapezium Case study**

Tajmahal is the king emperor among world wonders. The chemical and hazardous industries and the refinery at Mathura are major sources of damage to Tajmahal. The SO<sub>2</sub> from Mathura refineries combine with Oxygen along with moisture in the atmosphere forms H<sub>2</sub>SO<sub>4</sub> called Acid Rain. This corrodes clean white marble.

### **Gulf War (Marine Pollution)**

The Gulf war between USA and Iraq took place from Jan16th to Feb26th 1991. During the war nearly 700 oil wells of Kuwait fired and the oil spills into the sea. The floating oil covered nearly 80 Km long and 25 Km wide area. The burning the oil produced pollutants like CO<sub>2</sub> and SO<sub>2</sub> in the Atmosphere. Effects: 1 million birds were killed due to oils slick. The oil slick in the sea made the desalination plants ineffective.

### **Soft drink bottling unit:**

The coca-cola bottling unit located at plachimada, palakkad district, Kerala, discharged large amount of sludges is used as fertilizers by the nearby farmers. But, analysis of the sludges showed that it contains toxic metal like cadmium and lead. The scientist warned that the level of these toxic elements would pollute the land, local water supplies and food chain

Chernobyl nuclear disaster:

In April 26, 1986, the melt down of the Chernobyl nuclear reactor, in Russia has leaked out the radioactive rays and radioactive materials

Effects:

Nearly 2000 persons have been killed by the accident

People suffered due to the illness such as degeneration of cells, severe bleeding, anemia, skin cancer

Animals ,plants also affected by nuclear radiation

## **TWO MARKS**

### **1. Define pollution.**

Environmental pollution may be defined as the unfavorable alteration of our surroundings its change the quality of the air, water and land which interferes with the health of humans and other life on earth.

### **2. Types of pollutants.**

- i) Biodegradable pollutants
- ii) Non-biodegradable pollutants

### **3. Define air pollution.**

Air pollution is defined as the presence of one or more contaminates like dust, smoke, mist and odor in the atmosphere which are injurious to human beings, plants and animals.

### **4. What are the different sources of air pollution?**

The two main sources of air pollution are

a. Natural Sources.

Natural sources include dust storms, volcanoes, lightening sea salt, smoke, and forest fires.

b. Man made or anthropogenic sources.

The man made sources are agricultural activities, industrial growth, domestic wastes, automobile exhausts, etc,