

ENVIRONMENTAL CHEMISTRY

- Environmental chemistry is the branch of chemistry which deals with the chemical changes in the environment. It includes our surroundings such as air, water, soil, forests, sunlight etc. Environment consists of four segments.
 1. Atmosphere
 2. Hydrosphere
 3. Lithosphere
 4. Biosphere

1. Atmosphere :-

- Atmosphere is a cover of gases that extends to a height of about 1600 km above the surface of earth and protect the life on the earth from the harmful radiations (cosmic rays) coming from the sun or the outer space. Regions of the atmosphere are given in the following table.

	Region	Altitude from earth's surface	Temperature range	Gases/species present
i	Troposphere	0-10 km	Decreases from 15 to 56 ⁰ C	N ₂ , O ₂ , CO ₂ , H ₂ O vapour
ii	Stratosphere or (ozonosphere)	10-50 km	Increases from -56 ⁰ to - 2 ⁰ C	N ₂ , O ₂ , O ₃ , O-atoms
iii	Mesosphere	50-85 km	Decreases from - 2 to - 92 ⁰ C	N ₂ , O ₂ , O ₂ ⁺ , NO ⁺
iv	Thermosphere	85-500 km	Increases from - 92 ⁰ C to 1200 ⁰ C	O ₂ ⁺ , O ⁺ , NO ⁺ , e ⁻

2. Hydrosphere :-

- It contains all types of water resources like oceans, seas, rivers, reservoirs, lakes polar ice caps, ground water etc. About 75% of earth surface is covered by hydrosphere. 75% of water is present in oceans and sea.

3. Lithosphere:-

- It is the solid component of the earth consisting of soil, rocks, mountains etc. The solid thick upper most part of the earth is called crust. Its inner layers contain minerals, and the deep inner layers contain natural gas and oil.

4. Biosphere:-

- It is that part of the lithosphere, hydrosphere and atmosphere where living organisms interact with these parts and thus live together. Biosphere and environment are influenced considerably by each other e.g. the levels of O₂ and CO₂ depend on plants.
- Environmental pollution is caused by the addition of any undesirable substance to air, water or soil naturally or by human activity to such an extent that adverse effects are observed on human beings, animals, plants etc.
- Pollutant is that substance whose undesirable excess concentration causes pollution i.e. adversely effects the environment e.g. Hg, Pb, CO, SO₂ etc.

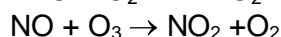
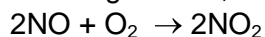
Types of Pollution –

a. Air pollution -

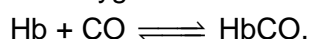
Air pollution is defined as the addition of undesirable materials into the atmosphere either due to natural phenomena or due to human activity on the

earth which adversely affect the quality of the air and hence affects the life on the earth.

- **Oxides of sulphur** are probably the most harmful of the common gaseous pollutants. The combustion of any sulphur containing material results in the formation of sulphur dioxide (SO₂) and sulphur trioxide (SO₃). SO₂ can cause acute irritation to the membranes of the eyes resulting in tears and redness.
- **Oxides of nitrogen** like N₂O, NO and NO₂ are liberated into air during the combustion of fossil fuels. N₂ and O₂ do not react with each other at sea level but at temp. >1210°C or lightning during thunderstorm they combine to yield significant quantities of nitric oxide (NO). It is oxidized by ozone to NO₂ which is extremely toxic to living tissues, textiles and is also responsible for acid rain.

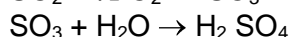
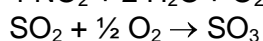
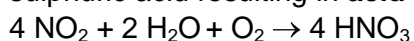


- Out of the two **oxides of carbon** i.e. CO and CO₂ carbon monoxide (CO) is the most serious air pollutant. Microorganisms present in the soil act as a sink for CO. Carbon monoxide combines with haemoglobin about 200 times more strongly than does oxygen to form carboxyhaemoglobin reversibly as –



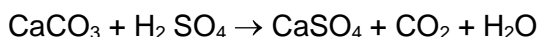
Note: CO can cause mental impairment, muscular weakness, dizziness and even death.

- **Green house effect** is the phenomenon in which earth's atmosphere traps the heat from the sun and prevents it from escaping into the outer space. The green house effect received its name because the earth's atmosphere acts much like the glass or plastics roof and walls of a green house. This green house effect results in infectious diseases such as malaria, sleeping sickness, dengue and yellow fever. Some green house gases are CO₂, CFCs, CH₄, O₃, NO, water vapour etc.
- The oxides of nitrogen and sulphur dissolve in rain water forming nitric acid and sulphuric acid resulting in **acid rain**.



The pH of the acid rains may be about 4-5.

Due to acid rains the pH of the soil changes which affects the fertility of the soil. Life of building may be considerably reduced by acid rain. The glassy nature of Taj Mahal is effected due to the reaction between acid rain and marble.



- **Smog** which describe the smoke-fog like conditions are the best known examples of air pollution. There are two types of smogs.
 1. **Classical smogs** occur in cool humid climate as a result of build up of SO₂ and particulate matter from fuel combustion.
 2. **Photochemical smog** occur in warm, dry and sunny climate as a result of the action of sunlight on the nitrogen oxides and hydrocarbon produced by automobiles and factories. The three main components of photochemical smog are nitrogen oxides, ozone and organic derivatives such as PAN.

Water pollution:-

- Water pollution is defined as the contamination of water by foreign substances which make it harmful for health of animals or plants or aquatic life and make it unfit for domestic, industrial and agricultural use.

Ground water pollution → pesticide, fertilizers.

Surface water pollution → industrial, agriculture, wastes
 Lake water pollution → organic wastes, industrial wastes
 River water pollution → industrial wastes, domestic sewage.
 Sea water pollution → oily wastes, radioactive wastes.

- Cyanides H_2S , NO_2 , CO_2 and sulphites change the pH of water and make it toxic to aquatic animals. Heavy metals like Hg and Pb also make water toxic.
- Detergents and fertilizers contain phosphates or additives. This encourage the formation of algae which reduces the dissolved oxygen known as **eutrophication**. Acid polluted water ($pH < 3$) is deadly to most forms of aquatic life.
- Polychlorinated biphenyls (PCBs) are resistant to oxidation and their release into the environment causes skin disorders in human.
- **Bioamplification** is a process of increasing the concentration of pollutants like pesticides in higher animals and human beings through lower animals.
- **Dissolved oxygen** (D.O.) is the amount of oxygen present in water. The optimum value for good quality water is 4-6 mg/lit. Lower D.O. value indicates water pollution and on the basis of D.O. value the extent of water pollution is estimated. D.O is consumed by oxidation of organic matter in presence of microorganism in water sample

$$CH_2O + O_2 \xrightarrow[\text{organicmatter}]{\text{Microorganisms}} CO_2 + H_2O$$
- **Biochemical oxygen demand (BOD)** is a measure of the dissolve oxygen that would be needed by the microorganisms to oxidize these compounds. BOD, therefore is a measure of the contamination caused by the totality of those compounds which can be oxidized in the presence of microorganism.
- In **chemical oxygen demand (COD)** the water sample is treated with a known quantity of an oxidizing agent $K_2Cr_2O_7$ in acidic medium. This reagent oxidises most of the polluting substances including those which are resistant to microbial oxidation. The amount of oxygen that consumed by the pollutants is expressed in ppm and is called COD of the given sample of water.

Soil Pollution

Most of the land pollution is caused by pesticides and other chemical which are added to the soil to grow better crops. Some of these poisons pass through food chains and eventually reach harmful proportions. Solid wastes are another cause of land pollution.

- **Insecticides** which are used to kill the insects that destroy the crop. They also help to control malaria and yellow fever. The most common insecticides in use since 1950 are DDT, BHC, aldrin etc. They stay in the soil for long time and are absorbed by the soil thus contaminating root crops like raddish, carrot etc.
- **Herbicides** are used to kill weeds. $NaClO_3$ and sodium arsenite Na_3ASO_3 are commonly used weed killers but inorganic arsenic compounds are toxic to mammals.
- **Fungicides** are used to check the growth of fungi. Organic compounds of mercury have been used as fungicides, are dissociate in the soil producing mercury which is highly toxic and proves fatal.
- The environmental pollution can be controlled by -
 - a- Recycling of the household and industrial wastes
 - b- Sewage treatment

- c- Incineration converts organic materials to CO_2 and H_2O . It may serve to destroy household waste, chemical waste and biological waste at high temperature in the presence of plenty of oxygen.
- d- Growth of population must be controlled.