

**COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH**  
**UNIVERSITY GRANTS COMMISSION**

CHEMICAL SCIENCES

CODE:01

**4.5. Environmental chemistry**

4.5.1. **Environmental chemistry:** It is the scientific study of the chemical and biochemical phenomena that occur in natural places. It is an interdisciplinary science that includes atmospheric, aquatic and soil chemistry as well as heavily relying on environmental chemistry and other areas of the science.

4.5.2. **Environmental pollution:** It is described as the contamination of the environment with harmful wastes arising mainly from certain human activities.

**Pollutant:** The substance which causes pollution is known as a pollutant. A substance becomes a pollutant when it is present in concentration harmful to the natural environment.

4.5.3. **Atmospheric pollution:**—Mainly atmospheric pollution is tropospheric and stratospheric pollution. The presence of ozone in the stratosphere prevents about 99.5% harmful ultraviolet radiation and protect human and other animals from its effect.

4.5.4. **Gaseous air pollutants:**

**Oxides of sulphur:** They are produced when sulphur containing fossil fuel is burnt. This is the most widespread and serious air pollutant.

- low concentration of Sulphur dioxide causes respiratory disease such as asthma, bronchitis, emphysema in human beings.
- It causes irritation to the eyes resulting in tears and redness.
- High concentration of Sulphur dioxide leads to stiffness of flower buds which eventually fall off from plants.

**Oxides of Nitrogen:** In an automobile engine when fossil fuel is burnt,  $N_2$  and  $O_2$  combine to yield significant quantities of nitric oxide and Nitrogen dioxide.

- The irritant red haze in the traffic and congested place is due to oxides of Nitrogen.
- Higher concentration of  $NO_2$  damage the leaves of plant and retard the rate of photosynthesis.
- $NO_2$  is a lung irritant that can lead to an acute respiratory disease in children.
- It is toxic to living tissues.
- $NO_2$  is harmful to various textile fibres and metals.

**Oxides of carbon:** CO is one of the most serious air pollutants. It is a colourless and odourless gas and highly poisonous to living beings due to its ability to block the delivery of oxygen to the organs and tissues.

CO is produced as a result of incomplete combustion of carbon, released into air my automobile exhaust, incomplete combustion of coal, firewood, petrol etc.

- CO binds the hemoglobin to form hemoglobin which is much more stable than the oxygen haemoglobin complex. When the concentration of carboxyhemoglobin in blood reaches about 3-4%, the oxygen carrying capacity of blood is greatly reduced. This causes deficiency of oxygen, headache, weak eyesight, nervousness and cardiovascular disorder.
- Carbon dioxide is released into the atmosphere by respiration, burning of fossil fuels, by decomposition of limestone during manufacture of cement. Deforestation and burning of fossil fuels increases the carbon dioxide level and disturb the balance of the atmosphere. The increase amount of carbon dioxide in the air is mainly responsible for global warming.

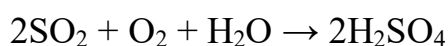
**4.5.5. Global warming:** About 75% of the solar energy reaches the earth is absorbed by the Earth's surface. This increases the temperature of the Earth surface. The rest of the heat radiates back to the atmosphere. Some of the heat is trapped by the gases (CO<sub>2</sub>, CH<sub>4</sub>, O<sub>3</sub>, CFCs, water vapour). Thus, they add to the heating of the atmosphere. This is known as global warming.

**Greenhouse effect:** It is the phenomenon in which Earth atmosphere trapped the heat from the sun and prevents it from escaping into the outer space. This is known as greenhouse effect.

**Greenhouse gas:** The gases which cause greenhouse effect are known as greenhouse gas.

- Greenhouse effect increases the average global temperature. The increase in temperature causes melting of polar ice caps and flooding of low lying areas all over the Earth.
- Global warming increases the incident of infectious disease like dengue, malaria, yellow fever, sleeping sickness etc.

**4.5.6. Acid rain:** When the pH of rainwater is less than 5.6, the rain is called acid rain. Sulphur dioxide and Nitrogen dioxide reacts with water and form sulphuric acid and nitric acid. These are mixed with the rainwater and causes acid rain.



- Acid rain is harmful for agriculture, trees and plants as it dissolves and washes away nutrients needed for their growth.
- Acid rain causes respiratory ailments in human beings and animals.
- When acid rain mixed with rivers and lakes, it affects plants and animal lives in aquatic ecosystem.
- Acid rain corrodes water pipes resulting in the leaching of heavy metals such as iron, Lead and copper into the drinking water.
- It damages buildings and other structures made of stone or metal. The Taj Mahal in India has been affected by acid rain.

4.5.7. **Particulate pollutants:** Particulate pollutants are the minute solid particles for liquid droplet in air. These are present in vehicle emissions, smoke particles from fire, dust particles and ash from industries. Particulars are two types: viable and non viable.

**Viable particulates:** bacteria, fungi, moulds, algie etc.

**Non viable particulates:** smoke, dust, mists, fumes.

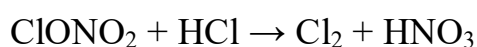
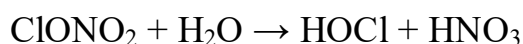
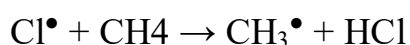
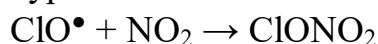
4.5.8. **Lead:** It is used to be a major pollutant emitted by vehicles. Leaded petrol used to be the primary source of airborne lead emission in Indian cities. This problem is removed by using unleaded petrol in most of the cities in India. Lead interferes with the development and maturation of red blood cells.

4.5.9. **Smog:** Smog is the mixture of smoke and fog. There are two type of smog:

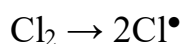
**Classical smog** occurs in cool humid climate, which is the mixture of smoke, fog and Sulphur dioxide. It is also called as reducing smog.

**Photochemical smog** occurs in warm, dry and sunny climate. The main components of the photochemical smog result from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides produced by automobile and factories. It is also called as oxidizing smog. The common components of photochemical smog are ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN).

4.5.10. **Ozone depletion:** Depletion of ozone layer commonly known as ozone hole. In summer season, Nitrogen dioxide and methane react with chlorine monoxide and chlorine atoms forming chlorine sinks, preventing much more depletion. In winter season special type of clouds polar stratospheric clouds are formed over Antarctica. This clouds provide surface on which chlorine nitrate formed gate hydrolysed to form hypochlorous acid. It also reacts with HCl to give molecular chlorine.



When sunlight returns to the Antarctica in the spring, the sun's warmth breaks up the clouds and HOCl and Cl<sub>2</sub> are photolysed by sunlight.



**Effects:**

- UV radiations lead to ageing of skin, cataract, sunburn, skin cancer, killing of many photo planktons, damage to fish productivity etc.
- Plant proteins are easily affected by UV radiation which leads to the harmful mutation of cells.
- IIT in physics evaporation of surface water through the stomata of the leaves and decreases the moisture content of the soil.
- Increase in UV radiation damage plants and fibres causing them to fade faster.

4.5.11. **Water pollutants:** Microorganisms, organic waste, plant nutrients, toxic heavy metals, sediments, pesticides, radioactive substances, heat.

4.5.12. **Pathogens:** The most serious water pollutants are the disease causing agents called pathogens. Pathogens include bacteria and other organisms that enter water from domestic sewage and animal excreta. Human excreta contain bacteria such as *Escherichia coli* and *streptococcusfaecalils* which cause gastrointestinal disease.

4.5.13. **Eutrophication:** The process in which nutrient enriched water bodies support a dense plant population, which kills animal life by depriving it of oxygen and result in subsequent loss of biodiversity is known as eutrophication.

4.5.14. **Biochemical oxygen demand (BOD):** The amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water is called biochemical oxygen demand. Clean water would have BOD value less than 5ppm where is highly polluted water could have a BOD value if 17 ppm or more.

4.5.15. **Maximum prescribed concentration of some metals in drinking water;**

Fe  $\rightarrow$  0.2 ppm

Mn  $\rightarrow$  0.05 ppm

Al  $\rightarrow$  0.2 ppm

Cu  $\rightarrow$  3.0 ppm

Zn  $\rightarrow$  5.0 ppm

Cd  $\rightarrow$  0.005 ppm

4.5.16. **Pesticides:** these are basically synthetic toxic chemicals with ecological repercussions. They include insecticides, herbicides, fungicides.

**Insecticides:** These help to control the insects and help to curb disease and protect crops. DDT is used in agriculture to control the damages caused by insects, rodents etc. Organochlorine are also used as insecticides.

**Herbicides:** These are used to kill weeds. Sodium chloride and sodium arsinite are used as weed killers. Organic herbicides such as trizines are presently widely used to kill weeds in cornfields.

**Fungicides:** These are used to check the growth of fungi. Organic compounds of Mercury have been used as fungicides.