

## Chapter ⇒ 14

# Environmental Chemistry

### ⇒ Environmental Chemistry :-

It is the branch of science which deals with, the chemical changes in the environments. It includes our surroundings air, water, soil, forest etc.

### ⇒ Environmental Pollution :-

It is the effect of undesirable changes in our surrounding that have harmful effects on plants, animals and human beings.

### ⇒ Pollutants :-

A substance, which causes pollution, is known as pollutant. Pollutants can be solid, liquid or gaseous substances. Present in higher concentration, it can be produced due to human activities or natural happenings.

### ⇒ Troposphere :-

The lowest region of atmosphere, in which the human beings along with other organisms live, is called troposphere.

it extends to the height of about 10 km from the sea level. It contains air, water vapours, clouds etc. The pollution in this region is caused by some poisonous gases, smoke fumes, smog etc.

### ⇒ Stratosphere :-

It extends from height of 10 to 50 km above the sea level. Ozone and some other gaseous substances present in this region are responsible for the pollution.

### ⇒ Tropospheric Pollution :-

Pollution in this region is caused by the presence of undesirable gaseous particles like oxides of Sulphur, nitrogen and Carbon, hydrocarbons along with solid particles like dust, mist, fumes, smoke etc.

### ⇒ Oxides of Sulphur :-

These are produced when coal containing sulphur is burnt.



It is also produced during volcanic eruptions.



### ⇒ Harmful effects :-

- (i) It is poisonous to both animals and plants.
- (ii) A very high concentration of  $SO_2$  may cause respiratory diseases e.g., asthma, bronchitis, emphysema in human beings.
- (iii) It causes irritation to the eyes, resulting in tears and redness.
- (iv) Its high concentration leads to the stiffness of flower buds.
- (v) Particulate matter present in the air can catalyse the formation of sulphur trioxide from sulphur dioxide.



$O_3$  and  $H_2O_2$  also promote this reaction.



### ⇒ Oxides of Nitrogen :-

Main Oxides of nitrogen are nitric oxide ( $NO$ ) and nitrogen dioxide ( $NO_2$ ).

Major Sources:

- (i) Lightning discharge results in the combination of  $N_2$  and  $O_2$  to form  $NO$ .

(iii) Combustion of gasoline in automobiles, burning of hydrocarbons and coal etc.

### ⇒ Harmful effects:

Nitric oxide itself is not harmful to human beings, but it is very unstable and changes to nitrogen dioxide which is toxic in nature. These effects are as follows:

- (i) It reacts with ozone ( $O_3$ ) present in the atmosphere and thus decreases the density of ozone.
- (ii) It affects the respiratory system and damages the lungs.
- (iii) Higher concentrations of  $NO_2$  damage the leaves of plants and retard the rate of photosynthesis.
- (iv) It causes cracks in rubber.
- (v) Nitrogen dioxide is also harmful to various textile fibres and metals.

### ⇒ Hydrocarbons :-

Incomplete combustion of fossil fuel in industry in the thermal power plants and the exhaust of a automobile release hydrocarbons into the atmosphere constantly causing pollution. Harmful Effects.

- (i) They cause cancer.
- (ii) Methane is one of the greenhouse gases.



(iii) They harm plants in various ways like breakdown of tissues, shedding of leaves etc.

### → Oxides of Carbons :-

Carbon dioxide.

0.03%  $\text{CO}_2$  is present in air by volume.

### → Major Sources :

- (i) By burning of fossil fuels.
- (ii) By the decomposition of limestone during the manufacture of cement.
- (iii) Emitted during volcanic eruptions.
- (iv)  $\text{CO}_2$  is released into the atmosphere by respiration.

### → Harmful effects :

Deforestation and burning of fossil fuel increases the  $\text{CO}_2$  level which is mainly a responsible for general global warming.

### → Carbon Monoxide :-

Carbon Monoxide is a colourless and odourless gas.

### → Major Sources :

- (i) Released by the automobile exhaust.

- (ii) Incomplete combustion of coal, fire, wood, petrol etc.
- (iii) By the dissociation of  $\text{CO}_2$  at high temperature.

### ➔ Harmful effects :

(i) It binds to haemoglobin which is more stable than oxygen-haemoglobin complex. Its concentration in blood when reaches to 3-4%, the oxygen carrying capacity of blood is greatly reduced.

The oxygen deficiency, results into headache, weak eyesight, nervousness etc.

(ii) It has harmful effects on plants when its concentration is (100 ppm or more).

### ➔ Global warming and Greenhouse Effect

#### Greenhouse Effects :-

Some gases like carbon dioxide, methane, ozone, water, vapours, CFCs have the capacity to trap some of the heat radiations that are released from the earth or from sun. These gases are known as greenhouse gases and the effect is called greenhouse effect. This leads to global warming.



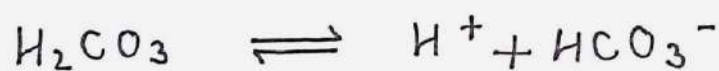
### ⇒ Consequences of global warming:

- (i) It leads to melting of polar ice caps and flooding of low lying areas all over the earth.
- (ii) Global rise in temperature increases the incidence of infectious diseases like dengue, malaria, yellow fever, sleeping sickness etc.

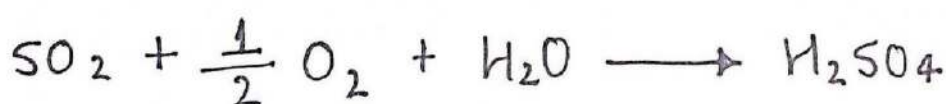
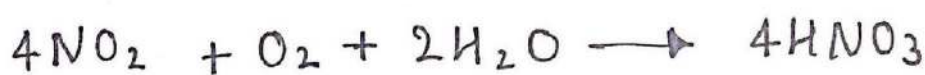
### ⇒ Acid Rain :-

When the pH of the rain water drops below 5.6, it is known as acid rain.

Normal rain is slightly acidic due to dissolution of atmospheric carbon dioxide in water.

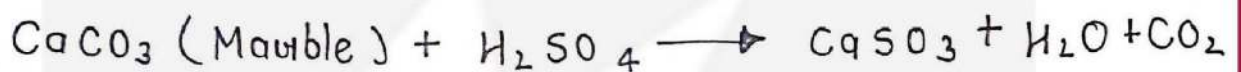


Oxides of Nitrogen and Sulphur released as a result of Combustion of fossil fuels dissolve in water to form nitric acid and Sulphuric acid.



### ⇒ Harmful Effect of Acid Rain :

- (i) It has harmful effects on trees and plants as it dissolves and washes away nutrients needed for their growth.
- (ii) It has very bad effect on aquatic ecosystem.
- (iii) Acid rain damages building structures made of stone or metal. Taj mahal in India has been affected by acid rain.



### ⇒ Particulate Pollutants :-

#### ⇒ Viable Particulates :

They are minute living organisms that are dispersed in the atmosphere. e.g., bacteria, fungi moulds, algae etc.

#### ⇒ Non Viable Particulates :

##### (i) Smoke :

It is the mixture of solid and liquid particles formed during combustion of organic matter,

Example : Cigarette smoke, smoke from



burning of fossil fuel.

(ii) Dust :

Composed of fine solid particles (over 2 $\mu$ m in diameter).

It is produced during crushing, grinding and attrition of solid particles.

(iii) Mist :

These are produced due to the spray of liquids like herbicides and pesticides over the plants. They travel through air and form mist.

(iv) Fumes :

They are generally released to the atmosphere by the metallurgical operations, and also by several chemical reactions.

⇒ Harmful Effects of Particulate Pollutants :

(i) Fine particles less than 5 microns penetrate into the lungs. Inhalation of such particles can lead to serious lung diseases including lung cancer.

## → Smog :-

This is the common form of air pollution which is combination of smoke and fog. Smog exists in two types:

### (i) Classical Smog:

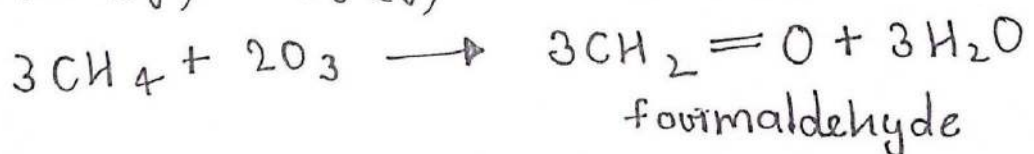
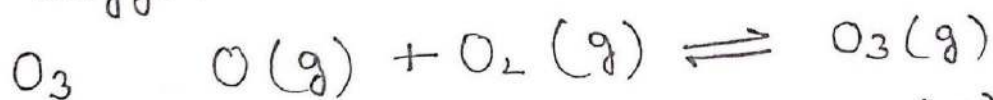
Occurs in cool humid climate. It contains smoke, fog and sulphur dioxide. It is also called as reducing smog.

### (ii) Photochemical Smog:

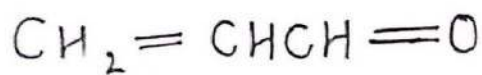
This type of smog results from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides released by the vehicles and industries. It has high concentration of oxidising agents and is therefore, called as oxidising smog. formation of Photochemical Smog.



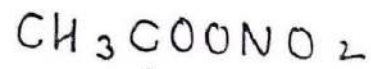
Oxygen atoms combine with air ( $\text{O}_2$ ) and form







Acrolein



Peroxyacetyl

Nitrate (PAN)

⇒ Harmful effects of Photochemical Smog:

(i) It can cause cough, bronchitis, irritation of respiratory system etc.

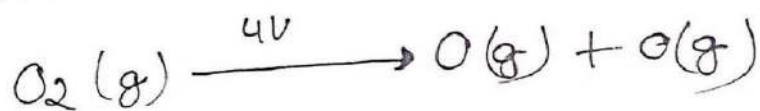
- To control this type of pollution the engines of the automobiles are fitted with catalytic converters to check the release of both oxides of nitrogen and hydrocarbons in the atmosphere.

- Some plants like vitis, Pinus, Juniperus Quercus, Papyrus can metabolise nitrogen oxide and therefore, their plantation can be done.

⇒ Stratospheric pollution.

Formation of Ozone:

Ozone in the stratosphere is produced by UV radiation. When UV-radiation act on dioxygen ( $\text{O}_2$ ) molecules, Ozone is produced.



Ozone is thermodynamically unstable and decomposes to molecular oxygen.

### ⇒ Depletion of Ozone layer:

Ozone blanket in the upper atmosphere prevents the harmful UV radiation from reaching earth. But in recent years, there have been reports of depletion of the layer due to the presence of certain chemicals in the stratosphere.



Chlorofluorocarbons dissociate in the presence of light to form chlorine free radicals, which catalyze the conversion of ozone into oxygen.

### ⇒ Effects of the depletion of ozone layer.

- (i) This leads to many diseases like skin cancer, sunburn, ageing of skin, cataract etc.
- (ii) UV radiation can kill many phytoplanktons, damage the fish productivity.
- (iii) It can decrease the moisture content of the soil by increasing the evaporation of surface water.



## → Water Pollution :-

Presence of undesirable materials in water which is harmful for the human being and plants is known as water pollution.

## → Maximum prescribed Concentration of some Metal in Drinking water:-

Metal	Maximum concentration (ppm or mg dm <sup>-3</sup> )
Fe	0.2
Mn	0.05
Al	0.2
Cu	3.0
Zn	5.0
Cd	0.005

### Major water Pollutants

Pollutant	Source
micro-organisms organic wastes  Plant nutrients Toxic heavy metals Sediments Pesticides Radioactive substance Heat	Domestic sewage Domestic sewage, animal excreta and waste, decaying animals and plants, discharge from food Processing factories. Chemical fertilizers. Industries and Chemical factories. Erosion of soil by agriculture and strip mean Chemical used for killing insects, fungi and weeds mining of uranium containing minerals. Water used for cooling in industries.

## • Causes of water Pollution:-

### (i) Pathogens:

Pathogens are the bacteria and the other organisms that enter water from domestic sewage and animal excreta.

Human excreta contain bacteria such as *Escherichia coli* and *Streptococcus faecalis*.

### (ii) Organic wastes:-

Organic matter such as leaves, grass, trash etc. can pollute water.

— Excessive growth of phytoplankton within water also pollute water.

— Large number of bacteria in water can consume oxygen dissolved in water by decomposing organic matter present in water.

### ⇒ BOD (Biochemical Oxygen Demand) :-

It is defined as the amount of oxygen required by bacteria for the breakdown of the organic matter present in a certain volume of a sample of water.



## ► Chemical pollutants :-

### (i) Industrial wastes :-

Chemical reactions carried in the industrial units also pollute water to a great extent. For example, lead, mercury, nickel, cobalt etc. These chemicals give very bad effect to the groundwater and water bodies are pollute due to the chemical reactions known as leaching.

### (ii) Pesticides :-

These are mostly chlorinated hydrocarbons, organophosphates and metallic salts etc. They dissolve in water to small extent and pollute it.

### (iii) Polychlorinated biphenyls (PCBS) :-

These are the chemical compounds used as fluids in transformers and capacitors. These are released in atmosphere as vapours.

### (iv) Eutrophication :-

The process in which algae like organisms reduce dissolved oxygen in water is called as eutrophication. It is harmful for aquatic life.

### → International Standards for Drinking water fluoride :-

Concentration of fluoride up to 1 ppm or  $1 \text{ mg dm}^{-3}$ , is not harmful for human being if it is used as drinking water.

The  $F^-$  ions make the enamel on teeth much harder by converting hydroxyapatite  $[3Ca_3(PO_4)_2 \cdot 3Ca_3(OH)_2]$ .

### • Lead :-

Upper limit concentration of lead in drinking water is about 50 ppm. Lead can damage kidney, liver, reproductive system etc.

### • Sulphate :-

At moderate level it is harmless but excess is harmful.

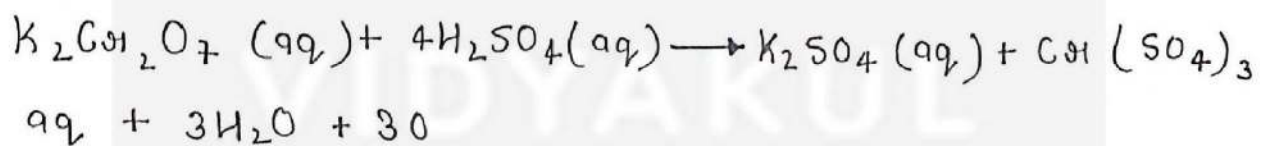


### → Nitrate :

The maximum limit of nitrate should be 50 ppm. Excess nitrate in drinking water can cause disease such as

methemoglobinemia (blue baby syndrome). **Chemical Oxygen Demand (COD):** water is treated with  $K_2Cr_2O_7$  in acidic medium to oxidise polluting substance which cannot be oxidised by microbial oxidation. The remaining is determined by back titration with suitable reducing agent.

From the concentration of  $K_2Cr_2O_7$  consumed, the amount of  $O_2$  used in the oxidation is calculated.



### → Soil Pollution - Sources of Soil Pollution

Pesticides : It can be classified as :

#### (i) Insecticide :

The most common insecticides are chlorinated hydrocarbons like DDT, BHC etc.

As they are not much soluble in water, they

stay in the soil for long time. They are absorbed by the soil and contaminate root crops like radish, carrot etc

(ii) Herbicides: These are the compounds used to control weeds, namely, sodium chlorate ( $\text{NaClO}_3$ ) and sodium arsenite ( $\text{Na}_3\text{AsO}_3$ ) are commonly used herbicides but arsenic compounds, being toxic are no longer preferred.

→ Fungicides: Organo-mercury compounds are the most common fungicides. Its dissociation in soil produces mercury which is highly toxic and harmful for the crops.

i Industrial waste: It has been seen that most of the industrial waste are thrown into water or dumped into the soil. These industrial waste contain huge amounts of toxic chemicals which are mostly non-biodegradable. For example, metal processing industries.

→ Strategies to control environmental pollution:

- (i) The improper disposal of wastes is one of the major causes of environmental degradation. The management of wastes is very important.
- (ii) All domestic wastes should be properly collected and disposed.

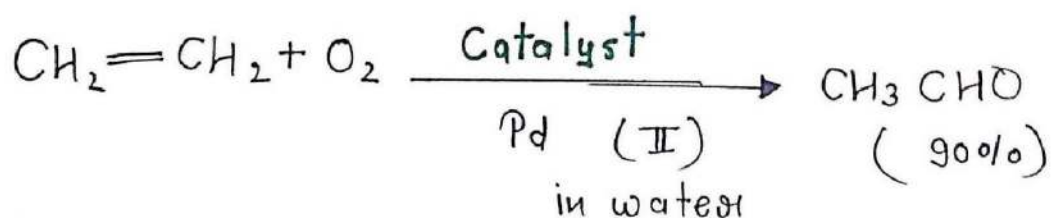


## ⇒ Green Chemistry :-

Green Chemistry is a way of thinking and is about utilising the knowledge and principles of Chemistry that would control the increasing environmental pollution.

### ⇒ Green Chemistry in day-to-day life :

- (i) Dry-Cleaning of clothes and laundry :  
Replacement of halogenated solvent like  $\text{CCl}_4$  by liquid  $\text{CO}_2$  which is less harmful to ground water.
- Hydrogen Peroxide ( $\text{H}_2\text{O}_2$ ) is used for the purpose of bleaching clothes.
- (ii) Bleaching of Paper : In place of Chlorine  $\text{H}_2\text{O}_2$  is used for the bleaching paper,
- (iii) Synthesis of Chemicals: Ethanal ( $\text{CH}_3\text{CHO}$ ) is prepared by step oxidation of ethene. Such as,



## ⇒ Environmental pollution :-

It is the effect of have undesirable changes in the surroundings that have harmful effects on plants, animals and human beings.

## ⇒ Troposphere :

The lowest region of atmosphere which extends up to the height of 10 km from sea level in which man and other living organism exists.

## ⇒ Stratosphere :

It is above troposphere between 10 to 50 km above the sea level.

## ⇒ Acid rain :

It is caused by the presence of oxides of Sulphur and nitrogen and  $\text{CO}_2$  in the atmosphere. The pH of the rain drops below 5.6, and it becomes acidic.

## ⇒ Greenhouse gases :

Some gases like carbon dioxide, methane, ozone water vapours, CFCs have the capacity to trap some of the heat radiations from the earth or from the sun. This leads to global warming.



⇒ Eutrophication: When phosphate ion increases in water it increases the growth of algae which consume the dissolved oxygen in water consequently aquatic life is adversely affected. This results in loss of biodiversity and the phenomenon is known as Eutrophication.

⇒ COD (Chemical Oxygen Demand):

It is calculated as the amount of oxygen required to oxidise the polluting substances. It is measured by treating the given sample of water with an oxidising agent, generally  $K_2Cr_2O_7$  in the presence of dil.  $H_2SO_4$ .