Environmental Chemistry

I. Environmental Pollution and Environmental Segments:

Pollution: - The addition of any foreign material like organic, inorganic, biological, radiological etc., or any change in nature which may harm or affect badly the living organism directly or indirectly, immediately or slowly.

Pollutant: - A substance released into the environment due to natural or human activity which affects adversely the environment is called pollutant.

Pollutants are classified as primary and secondary on the basis of their form.

Contaminant: - A substance which is not present in nature, but released during human activity into environment is called as contaminant.

Eg: Industrial effluents, Pesticides.

Receptor: - The medium which is affected by pollutant is called receptor.

Eg: Our eyes and lungs are receptors to smoke of automobiles.

Sink: - The medium which reacts with pollutants is called sink

Eg: Sea water is sinking for CO_2. Microorganisms are sinking for dead plants, animals.

Speciation: - The chemical form of pollutants is known as speciation. Toxicity of pollutants depends on the form.

Eg: Alkylated mercury is more toxic than mercury.

Dissolved oxygen (DO): - The amount of oxygen present in water is called dissolved oxygen. 4 to 6mg/litre is required for healthy growth of plants and animals. Lesser DO Value indicates greater pollution.

Chemical oxygen demand (COD): The amount of oxygen required to oxidize organic substances present in polluted water is called COD. It is determined by using acidified (50% H_2SO_4) + Potassium dichromate. Greater COD value indicates greater pollution.

Biochemical oxygen demand (BOD): The amount of oxygen used by suitable microorganisms present in water during 5days at 20^0C is called BOD. Greater BOD value indicates greater pollution. For pure water BOD is 1ppm, fairly pure water 3ppm, doubtful purity 5ppm, municipal sewage has 100 to 4000ppm. Fish become rare if BOD level is 4 to 5ppm. BOD greater than 17ppm is harmful and highly polluted.

BOD → Number of mg of O_2 required / number of litres of water sample

BOD O_2 Parts of oxygen / million parts of water sample

Thershold limit value (TLV): The minimum level of toxic pollutants present in atmosphere which affect a person adversely when he is exposed to 7 to 8 hours in a day is called TLV.

ENVIRONMENTAL SEGMENTS:

Environment can be divided in to four segments

1) Atmosphere 2) Lithosphere 3) Hydrosphere 4) Biosphere

WATER POLLUTION:

Water pollutants are

i) Inorganic pollutants ii) Organic pollutants iii) Sediments

iv) Oils v) Domestic waste vi) Industrial waste

vii) Agricultural waste viii) Fluorides xi) Pathogens

EUTROPHICATION: - Enrichment of water bodies with phosphates like nutrients is called Eutrophication

It is supports the abnormal growth of algae and the lakes and ponds become marshy

The lakes & ponds get filled with sediment and dry up

The DO value in water decreases

It produces unpleasant odour, clogging of pipes and also interferes with fishing & navigation

BIOAMPLIFICATION: - The process of increase of concentration of the pollutants as they pass in the form of food chains from lower animals to higher animals and human beings is called as "Bioamplification"

Due to bioamplification human beings gets high blood pressure & increase in irritation levels.

FLOURIDE WATER:

Fluoride deficiency in drinking water is harmful and causes tooth decay. When fluorides concentration in water is greater than 3ppm it makes the enamel on teeth harder by converting hydroxyl apatite $\left[3Ca_3\left(PO_4\right)_2 Ca\left(OH\right)_2\right]$, the enamel in the surface of teeth to fluorapatite, $\left[3Ca_3\left(PO_4\right)_2 CaF_2\right]$

In fluorosis, the fluoride in water reacts with calcium present in the body to form calcium fluoride.

$Ca^{2+} + 2F^- \rightarrow CaF_2$

Fluoride ions can be detected by Zirconium- Alzarin-S dye. The colour of the dye becomes weak with increase in the amount of fluoride ion.

Defluoridation techniques are

a) Ion exchange method b) Nalgonda technique c) Activated carbon method

Activated charcoal can adsorb organic substances like DDT & Endrin. Ion exchange resins remove certain dyes & chlorinated pesticides. Deactivated charcoal can be activated again by treating with 4% NaOH followed by 1% H_3PO_4

AIR POLLUTION:

The important air pollutants are

Oxides of carbon $\left(CO, CO_2\right)$

Oxides sulphur $\left(SO, \& SO_3\right)$

Oxides of nitrogen

Chlorofluoro carbons (CFC)

Hydrocarbons Like CH_4

Photochemical and industrial smog

Dust & other particulate matter from industries & automobiles

CARBON MONOXIDE (CO):

Incomplete combustion of fossil fules liberates CO into air. 80% of CO is released form automobiles.

Permissible level of CO in air is 9ppm. It reduces O_2 supply in human by forming stable carboxy haemoglobin.

$2C + O_2 \rightarrow 2CO$

$2CH_4 + 3O_2 \rightarrow 2CO + 4H_2O$

CO interacts with oxyhaemoglobin $(O_2 - Hb)$ and forms carboxyhaemoglobin $(CO - Hb)$ as:

$O_2 - Hb + CO \rightarrow CO - Hb + O_2$

CO has high affinity for haemoglobin than that of oxygen.

Carbon Dioxide: (CO_2)

It is obtained from in completed burning of fossil and from plants during light. CO_2 causes global warming by the green house effect.

Oxides of Nitrogen: These are produced by the combustion of fossil and fuels from automobiles.

If the concentration of NO in air is greater than 10ppm, it retards photosynthesis in plants and arrests their growth.

NO_2 and N_2O_3 form acid rain.

NO_2 is highly poisonous & causes breathing troubles.

OXIDES OF SULPHUR:

SO_2 enters into air by burning S.

$S + O_2 \rightarrow SO_2$ and by roasting of sulphide ores

$Cu_2S + 2O_2 \rightarrow 2CuO + SO_2$

SO_2 bleaches the green colour of the leaf apexes in plants to yellow color this is called "Chlorosis". This prevents photosynthesis in plants.

Trade name of CFC's freons. Freon is dichlorodifluoromethane (CCl_2F_2)

CFC's absorb u.v. radiation in stratosphere and liberate chlorine atoms which in turn destroy ozone layer

$$CFCl_3 \xrightarrow[uv]{hv} CFCl_2^* + Cl^*$$

$$Cl^* + O_3 \rightarrow ClO^* + O_2$$

$$ClO^* + (O) \rightarrow Cl^* + O_2 \text{ etc}$$

To restore the depleted ozone layer to the original level nearly of 50-100 years will take place.

A molecule of CFC can dissociate one lakh (1, 00,000) ozone molecules

HYDROCARBONS:

Certain free radicals present in air are peroxy acetyl nitrate (PAN) and peroxybenzoyl nitrate (PBN). They mix with Ozone and form photochemical smog.

Smog formed during summer is oxidizing and that formed during winter is reducing type. The exhaust fumes released by motor vehicles include a mixture of hydrocarbons like methane, ethane, acetylene, propane, butane.

0.02-0.05ppm of PAN is Sufficient to destroy plants.

$$NO_2(g) + energy\ from\ sun\ light \rightarrow NO_{(g)} + O_{(g)}$$

$$O_{2(g)} + O_{(g)} \rightarrow O_{3(g)}$$

$$NO_{(g)} + O_{3(g)} \rightarrow NO_{2(g)} + O_{2(g)}$$

$$3CH_4 + 2O_3 \rightarrow 3HCO + 3H_2O$$

$$\underset{Acrolein}{CH_2 = CH - CHO} \xrightarrow{O_3, NO_2} \underset{Peroxy\ acetynitrate(PAN)}{CH_3 - \overset{\overset{O}{\|}}{C} - OONO_2}$$