12. ENVIRONMENTAL CHEMISTRY

Synopsis :

Environment constitutes air, water, soil, plants and atmosphere around us.

2. The branch which deals with the relationship between living organisms and environment is called environmental chemistry.
3. **EFFECTS OF POLLUTION:**
   a) Due to London Smog nearly 3000-4000 people died.
   b) Many people in japan have suffered from a disease called "Minamata", a disease that spread after eating fish in Minamata Island, as the island waters were contaminated with mercury.
   c) In 1984, thousands of people were killed by the gas, methyl isocyanate (MIC), which leaked from union carbide factory at Bhopal.
   d) Many buildings in Italy and Rome are getting destroyed by the acid rain
   e) The Meditarian sea turned into "dead sea" is unable to support aquatic life.
   f) A special board has been established to purify the holy river Ganges in India.
   g) The dangerous radiations from the radio active fall out of reactors and testing of nuclear weapons creating problems in the air.
   h) The beauty of Taj Mahal is decreasing due to air polution.
   i) In the second world war lakhs of people died in Hiroshima and Nagasaki cities of Japan due to atom bomb.
   j) Nuclear pollution gave more effect to the people at Chernobil in Russia.
   k) The accident in the oil refinery of HPCL near Visakhapatnam.
   l) The accident of ONGC wells which allowed the gas gushing out and burn for months near"Konaseema" in East Godavari District. It is called "blow out".
   m) In 1991, during the Gulf war some millions of litres of oil was thrown into the sea. Due to the formation of a film on the water many birds and animals died.
   n) The accidental fire which burnt the forests in Indonesia caused heavy damage to the near by islands.
4. **DEFINTION OF TERMS:**

a) Pollutant: A substance which is present in the nature and which grows in quantity due to human activity and has adverse effect on environment is called as pollutant.

Ex: CO, SO_2, lead in mercury etc.

b) Contaminant: A substance which is not present in nature, but released due to human activity and has an adverse effect on environment is called as contaminant.

Eg: The killer gas methly isocyanate (MIC) leaked from union carbide factory in Bhopal.

c) Receptor: The medium which is effected by pollution is called receptor.

d) Sink: The medium which reacts with the pollutant and minimises the effect of pollution is called sink.

1) Micro organisms which eat the dead animal or which convert the dry leaves and garbage into fertillizers.
2) Sea water is a big sink for carbondioxide.

Plants are also good sink for CO_2.

Speciation: Categorisation of various pollutants as per the degree of their toxicity is called speciation.

Alkylated mercury is more toxic than mercury. Mercury compounds are more poisonous than lead.

e) Dissolved Oxygen (D.O.)

i) The amount of oxygen present in water in dissolved state is called dissolved oxygen (D.O)

ii) The amount of oxygen required for the healthy growth of plants and animals in water is 4-6 mg/litre.

iii) The D.O. value in water is less than 5 ppm, then the water is said to be polluted.

Higher the DO value, lower is the pollution of water and vice versa.

vi) When temperature increase D.O. value decreases.

vii) D.O. value is used to estimate the extent of pollution.

f) Biochemical Oxygen Demand (B.O.D):

i) The amount of oxygen used by the microorganisms present in water for five days at 20°C is called as B.O.D.

ii) For pure water B.O.D. value is 3 ppm.

iii) Impure water has higher B.O.D.value i.e.>3 ppm

iv) The municipal sewage has BOD value of 100 - 4000 ppm.

v) Higher BOD of water leads to death of plants, fish, aquatic fauna.

vi) Thus higher the BOD, higher is the pollution.

g) Chemical Oxygen Demand (COD):

i) The amount of oxygen required to decompose organic matter present in water is called as chemical oxygen demand (COD).

ii) COD value is an important parameter for determination of quality of water.

iii) The above O_2 is available from 50% acidified potassium dichromate

iv) Higher the COD value, higher is the pollution

v) COD value is also useful to determine the extent of pollution of H_2O.

Determination of COD or BOD value:

- COD or BOD is expressed in ppm.
- It is the number of parts by weight of O_2 required for 1 million Parts by weight of water. or It is the number of mg of O_2 required per litre of water
- COD or BOD in ppm $= \frac{\text{weight of } O_2}{\text{weight of water}} \times 10^6$

h) Threshold Limit Value (TLV):

i) The minimum level of the toxic substances or pollutants present in the atmosphere, which affect a person adversely when he is exposed to it for 8 hours in a day in the industry is called the threshold limit value (TLV).

ii) TLV indicates the permissible level of the pollutants that can be present in industries or mining areas.

5) ENVIRONMENT SEGMENTS:

Environment is divided into four segments.

a) Atmosphere b) Hydrosphere

c) Lithosphere d) Biosphere

A) ATMOSPHERE:

1. The layer of air present around the earth is called the atmosphere.
2. Atmosphere act as a protective layer to the earth. It absorbs a portion of electromagnetic radiations coming from the sun and transmit near U,V., visible and near infrared radiation.
3. Atmosphere maintains the heat balance on earth.

B) HYDROSPHERE:

1. The portion of water present on the earth is called hydrosphere.
2. Water occupies 4/5th of the earth surface.
3. In the hydrosphere 97% is present in the form of sea water,3% is in the form of ice in polar ice caps and traces of water left for drinking and agriculture purposes.
4. Though sea water is not used for drinking, many of the marine animals and plants survive in sea water.

C) LITHOSPHERE:

1. Except hydrosphere the rest of the earth space is in the form of land. It is called Lithosphere.
2. The lithosphere is occupied by plants, animals human beings,
3. The surface inner layers of the earth contain minerals.
4. The deeper inner layers contain oil and natural gas.

D) BIOSPHERE:

1. All living organisms like plants, animals and human beings constitute the biosphere.
2. Biosphere and other segments of the environment are inter related.
   The relationship between all the living systems and their surroundings is called ecosystem.
3. The level of oxygen and CO_2 depend on the plants animals, and human beings present in the biosphere.
4. Biosphere and other segments of environment are interrelated.
   The main reasons for environmental pollution are
   i) Increase in population ii) Industrialization
   iii) Urbanization iv) Deforestation

Atmosphere is divided into four parts

i) Troposphere (0-11km)
ii) Stratosphere (11-50km)
iii) Mesosphere (50-85km)
iv) Thermosphere (85-500km)

i) **Troposphere (0-11km):**

i) It is up to 11 kilometers from the earth.
ii) It is the main portion of atmosphere and contains air.
iii) The density of air and temperature decreases with the increase in the altitude.
iv) Troposphere is homogeneous due to constant circulation of air.

ii) **Stratosphere: (11-50 km)**

i) This part is present from 11 to 50 km above the earth. Ozone layer is present in it.
ii) Ozone layer absorbs the U.V. radiations coming from sun and prevents it from falling on the earth. So it acts as a protective layer.

iii) **Mesosphere:**

i) It is present in between 50-85km above the earth.
ii) Sound waves cannot propagate in this region.
iii) O_2^+, NO^+ ions are present in this region.
Temperature decreases with increase in the altitude.

iv) **Thermosphere (Ionosphere):**
i) It is present between 85-500km above the earth.
ii) O_2^+.O^+,NO^+ ions are present.
iii) In this region temperature rises as we go up and reaches a maximum of 1473K.
iv) Here atmospheric oxygen undergoes ionization after the absorption of solar radiation.

6) AIR POLLUTION:

1. The major components in air are nitrogen, oxygen and water vapour.
2. The minor components in air are argon, carbon dioxide.
3. The tracer components in air are neon, helium, methane, krypton, nitrous oxide, hydrogen, xenon, sulphur dioxide, ozone, ammonia etc.
4. The density and pressure of the air decreases as we go up from the earth.
5. The important air pollutants are
   a) Oxides of carbon: Carbon monoxide (CO) and Carbon dioxide.
   b) Oxides of Nitrogen: NO, NO_2
   c) Oxides of Sulphur: SO_2
   d) Ozone - O_3
   e) Chlorofluoro carbons - (Freons)
   f) Hydrocarbons-Methane, Butane etc.,
   g) Metals - Hg,Pb etc.,
   h) smog
   i) Organic pollutants
   j) Dust

A. CARBON MONOXIDE (CO):

1. Due to incomplete combustion of petrol and diesel in automobiles under high pressure and temperature waste substances come out in the form of smoke. This smoke mainly contains carbon monoxide.

$$2C + O_2 \rightarrow 2CO$$

2. The organic matter present in fuel dissociates into methane. This methane also undergoes oxidation into carbon monoxide.

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

3. Nearly 80% of carbon monoxide is released from vehicles.
4. In urban area, at peak times the level of the CO gas increases upto 50-100 ppm where as the acceptable level of CO in the air is 9ppm.

CO combines with heamoglobin of blood and converts in to carboxyl hemoglobin, which can not act as oxygen carrier.

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

The poisonous effect is mainly due to it's strong tendency to form dative bond with iron of haemoglobin.

The concentration of carbon monoxide is high at 9. a.m. and at 5 a.m. in the day.

Table showing the effect of carbon monoxide.

Level of Coinppm in atmosphere	*% of CO Hb formed from O_2–Hb*	*Effect on the health of human beings*
10	2	Loss of vision
100	15	headache, fatigue
250	32	unconsciousness
750	60	death after few hours
1000	66	Immediate Death

B. NITROGEN OXIDES

1. The important oxides of Nitrogen which cause air pollution are NO, N_2O and NO_2.
2. The nitrogen oxides are produced during combustion of fossil fuels and fuels from automobiles.
3. The permissible level of nitrogen oxides is 10ppm Beyond 10 ppm, plants can not perform photosynthesis.
4. The nitric oxide combine with ozone resulting in the decomposition of $O_3$to O_2.

$$NO + O_3 \rightarrow NO_2 + O_2$$

$$NO_2 + O_3 \rightarrow NO + 2O_2$$

C. SULPHUR OXIDES - SO_2:

1. SO_2 is released in to the atmosphere by burning of Sulphur, sulphide ores, ores and fuels containing sulphur.

$$S + O_2 \rightarrow SO_2$$

$$2H_2S + 3O_2 \rightarrow 2H_2O + 2SO_2$$

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

2. SO_2 causes respiratory diseases in human beings damaging the mucous membrane of the nose and the respiratory tract.
3. SO_2 bleaches the green colour of the leaves in plants to yellow colour. This prevents photosynthesis in plants.
4. If SO_2 is ≥ 500 ppm in air, it leads to death.
5. Oxides of nitrogen and sulphur combine with rain water and form acids resulting in acid rains.

D. CHLOROFLUOROCARBONS(CFC's)- FREONS:

1. Chlorofluorocarbon's are synthetic compounds of chlorine, fluorine and carbon and are often referred to by the trade name 'freon'.
2. The important chlorofluoro carbon is trichlorofluoromethane ($CFCl_3$).
3. CFC are commonly used as a refrigerant propellants, solvents and also as foaming agents.
4. CFC's are colourless and odourless gases. They are very cheap to prepare and highly stable.
5. In stratosphere, CFC's absorb U.V. radiation and decompose into radicals.

$$CFCl_3 \xrightarrow{uv} CFCl_2 + Cl^* \qquad Cl^* + O_3 \rightarrow ClO^* + O_2 \qquad ClO^* + O \rightarrow Cl^* + O_2$$

6. To restore the depleted ozone layer to the original level nearly 50 - 100 years are required though the production of CFC's has been banned.

E. HYDROCARBONS:

1. Among the hydrocarbons, methane is present in large quantity around the world.
2. Methane is produced by the degradation of organic matter.
3. The smoke from automobiles contain a mixture of hydrocarbons methane, ethane, acetylene, propane, butane etc.,
4. Benzopyrene, which causes cancer to human beings is from the diesel engines.
5. Peroxy acetyl nitrate (PAN) ia another harmful substance which damages the plants.
6. Small amounts of PAN (0.02 to 0.05 ppm) is sufficient to cause considerable damage.
7. Peroxy benzoyl nitrate (PBN) causes irritation to eyes when present in the atmosphere.

F. METALS :

1. Lead particles are present in the fumes coming out from automobiles.
2. The gases coming out from industries contain carbon particles in the form of "aerosol".
3. Metal particles are produced into the air from metal industries.
4. If the gasoline, contains tetraethyl lead, ethylene chloride, ethylene bromide used in motor fuel the lead particles come into air by burning of that fuel.
5. By burning of sulphide ores, metaloxide particles come into the air.

G. PHOTOCHEMICAL SMOG:

1. Smoke and fog is called smog.
2. Photochemical smog was first identified in LosAngles.
3. The smog which contains oxidising agents is called oxidising smog formed in summer
4. The smog which contains reducing agents like SO_2 and carbon is called reducing smog formed in winter.
5. Peroxy benzoylnitrate (PBN) undergoes Photo chemical oxidation, mixes with ozone, oxides of nitrogen and forms photo chemical smog which is oxidising in nature.

H. CARBON POLLUTANTS:

1. Benzopyrene, pesticides and biocides weedicides organic air pollutants.
2. The harmful pesticides, biocides led out into the air by the factories when they are being manufactured, pollute the air and cause minor to major health hazards.

I. DUST:

1. 22 metals are present in the air in the form of dust.
2. The metals like zinc, copper, magnesium and manganese are less in the air but calcium, silicon, aluminium and Iron are more in the atmosphere.
3. Dust produced by the heavy trraffic and various industries pollutes air.

7) EFFECTS OF AIR POLLUTION:

Due to air pollution, the possible hazards will occur

a) acid rains b) depletion in ozone layer

c) green house effect or global warming.

a) ACID RAIN: The oxides of nitrogen and the oxides of sulphur will produce nitric acid & sulphuric acid, which cause acid rains.

i) $NO + O_3 \rightarrow NO_2 + O_2$

$2NO_2 + 2O_2 \rightarrow 2NO_3 + O_2$

$NO_2 + NO_3 \rightarrow N_2O_5$

$N_2O_5 + H_2O \rightarrow 2HNO_3$

ii) $SO_2 \xrightarrow{\frac{1}{2}O_2} SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

1. The rain water which contains nitric acid and sulphuric acid is called acid rain.
2. Acid rain is more in industrial area.
3. In 1918 the pH of acid rain is nearly equal to 5, but in 1962 it was decreased to 4.2.
4. Due to acid rain, the life of buildings will be considerably reduced.
5. The beauty of Taj Mahal is affected due to the action of acid rain on marbles stones.
6. Due to acid rain, the pH of the soil changes affecting the fertility.

b) DEPLETION IN THE OZONELAYER (OR) HOLES IN THE OZONELAYER:

Holes in the O_3 layer are found at north and south poles of earth, due to CFC's.

1. The decrease in ozone layer increase the U.V. radiation falling on the earth by 3%.
2. U.V. rays affect the photosynthesis reaction in the plants.

c) GREEN HOUSE EFFECT OR GLOBAL WARMING:

1. Carbon dioxide and water vapour absorb infrared radiation coming to the earth and partly reflect it back to the earth's surface. Due to this, the surface of the earth gets heated up. This phenomenon of heating up of the surface of the earth is called green house effect.
2. Due to deforestation, the quantity of CO_2 in the atmosphere is increasing.
3. A 50% increase in carbon dioxide level increases the surface temperature of the earth by 3°C.
4. If there is 1° increase in the temperature, the following bad effects are predicted.
   a. The ice caps of the polar region melt there by increasing the level of the sea water by 90 cm.
   b. Due to global warming, the rate of evoporation of water from the sea, rivers, ponds will increase. This leads to untimely rains, cyclones and hurricanes.
   c. Agricultural sector will be badly affected due to fast evoporation of surface water.
5. The carbon dioxide content present in the earth atmosphere is 0.03%
6. The gases which cause green house effect are
   a) CO_2(50%) b) CH_4 (19%)
   c) CFC (4%) d) O_3 (8%)
   e) NO (4%) f) Water Vapour (2%)
7. Ozone in the stratosphere is a protective layer, but harmful in the troposphere.
8. To prevent the global warming, one must increase the number of sinks, by growing trees, forests.

8) WATER POLLUTION:

If quality of water in the hydrosphere is decreased it is called as water pollution

1. Water pollutants are classifed into
   a) Inorganic pollutants
   b) Organic pollutants
   c) Domestic waste
   d) Agricultural and industrial waste
   e) Sediments and oils
   f) Fluorides

In organic pollutants are salts, some elements like Cu, Zn, As, complex compounds, cyanides, H_2S, CO_2, NO_2, phosphates, heavy metals like Pb and Hg.

Organic pollutants include industrial waste and agricultural waste.

Various organic pollutants are plastics fibres, detergents, paints, peroxides, insecticides weedicides, dyes, plasma cenlicals etc.

Industrial waste coming from sugar, paper, leather, pulp industries.

Common examples: Malathion, DDT, chlorophenoxy compounds, phenylmercuric acetate.

- **Food chain:** The carriers of pollutants from one to another is called food chain. It Includes plants - Fish - birds - animals, human beings.
- **Bio - amplification**: Increase in the concentration of pollutants as we go from lower animals to higher animals is called bio - amplification.
- **Eutrophication:** Pollutants like CO_2, H_2S, H_2, O_2 nitrates, phosphates, sulfate, boron, chlorine, copper, iron, Mn, V, Zn, etc. Will act as nutrients for the subsequent drying up occurs are called eutrophic or over nutritious.

C. FLUORIDES:

1. The concentration of fluorides up to 3 ppm in drinking water is harmless.
2. The lower and higher limits of fluoride concentration should be in between 1 ppm and 3 ppm.
3. Fluorine concentration can be known with Zirconium Alizarin-S dye.
4. Fluorine gives a colourless substance ZrF_6^{-2} with Zirconium-Alizarin-S.
5. When fluorine concentration increases the colour of the dye decreases.
6. When fluorine is present in the drinking water, it reacts with calcium present in bones and teeth. By this reaction, the colour of the teeth turns yellow, for the same reasons, the bones become weak and the disease is called "fluorosis"
7. In our state drinking water of Nalgonda, Prakasam and Guntur districts contains excess of fluorine

C. DEFLUORIDATION TECHNIQUES FOR DRINKING WATER:

1. The methods for removing fluoride ion from water is called defluoridation technique.
2. Bleaching powder, lime and alum are added to water and stored. The floride ions of the water get precipitated as complex calcium aluminium fluoride. This is filtered and pure water is obtained. This method is introduced by NEERI (National Environmental Engineering Research Institute) of Nagpur in Nalgonda district first. So it is called Nalgonda technique.

OUR RESPONSIBILITY TOWARDS ENVIRONMENT:

1. Micro organisms and enzymes can be used for the degradation of many waste substances like plastics.
2. Bye products formed in any reaction are pollutants. So methods should be developed without any by products i.e. environmental friend reaction.
3. Instead of using conventional fuels and energy systems, non conventional fuels and non conventional energy systems must be used
4. Clean and green technologies should be developed and practiced.
5. The growth of population must be controlled.
6. Forests should be grown.

Activated carbon method:

- Filters made of activated carbon are used
- F ions are adsorbed by carbon.

- Filters get deactivated after some time of usage
- 4% NaOH and 1% H_3PO_4 are used to reactivate the filters.
- By this method, $\bar{F}$ ion concentration can be reduced from 5 -12 ppm to 1 ppm.
  This method is common because the substance used in is cheap and harmless.
- Polluted water has lower DO value, higher BOD value and higher COD value.
  Polluted water can be identified by
  i) Change in the color and increase in saliency
  ii) bad odour
  iii) over growth of weeds
  iv) Decrease in the growth of fish.
- Polluted water leads to contaminated diseases like cholera, typhoid, jaundice, diarrheic
- Polluted water affects tourism and aquatic.
- The main reasons for water pollution are
  i) Industrial revolution
  ii) Green revolution
  iii) Blue revolution
  iv) Increase in population