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# Concepts and scopes of Environmental Chemistry

Class-T.Y.B.Sc.

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## **Concepts and scopes of Environmental Chemistry**

### **Definition:-**

Environmental chemistry is a science of chemical phenomena occurring in the environment.

It is a systematic study of chemical species in air, water and soil with reference to their sources, reactions, transport and also their effect and their ultimate fate in the environment.

Environmental chemistry includes all the disciplines such as Chemistry, Physics, Biology, Ecology, Geology and Geography which affect these interactions.

The natural environment has been getting disturbed over ages because of human activities like farming, urbanization, industrial revolution and advancement in technology.

## Terminology:-

- **Pollutant:-** Anything in the environment, living or non-living or any physical agent (such as noise, heat) that is found above certain level such that it is injurious to human, plant or animal life is called pollutant. e.g CO, SO<sub>2</sub>, H<sub>2</sub>, Pb are all natural substances whose level in the environment increases above natural level due to human activities like combustion of fuels causing injuries to human life.
- **Contaminant:-** A material which does not occur in nature, but is introduced by human activity into the environment affecting its composition, is called contaminant. e.g Cl<sub>2</sub> and MIC do not exist naturally in atmosphere.

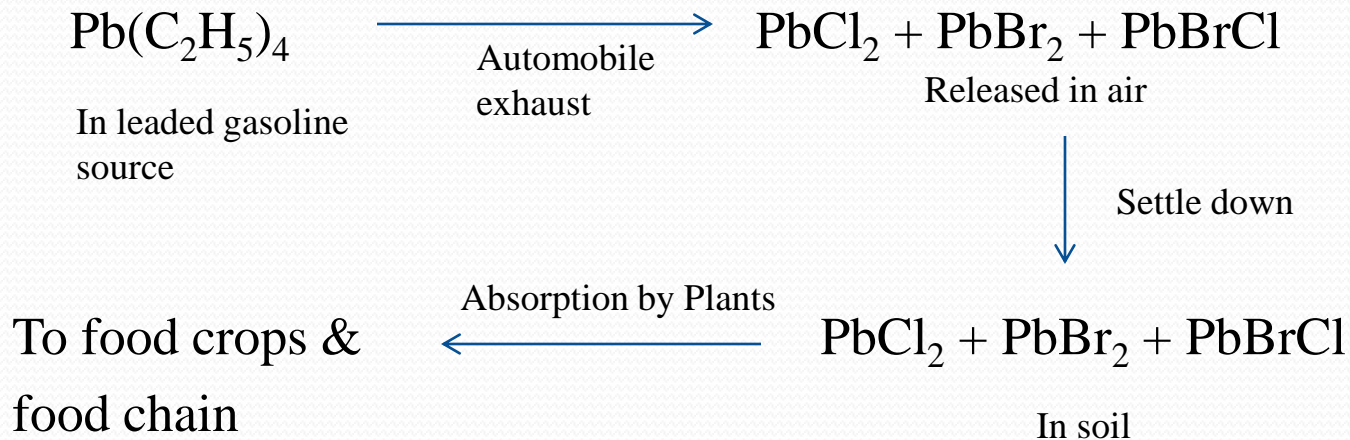
- **Source:-** Source is the place or substance or process from where a pollutant originates. e.g Combustion of leaded gasoline is the source of Pb in atmosphere. Combustion of coal is one of the source of oxides of sulphur in atmosphere.
- **Receptor:-** Receptor is anything that is affected adversely by a pollutant. E.g Man is a receptor for photochemical smog which causes irritation of eyes and respiratory track. Plants are receptors for oxides of sulphur as they die on excess exposure.
- **Sink:-** The medium that retains and interacts with long lived chemical species, often a pollutant is called sink. E.g. Marble structure acts as sink for atmospheric  $\text{H}_2\text{SO}_4$  and get damaged ultimately as a result of the reaction.



Ocean acts as sink for atmospheric CO<sub>2</sub> which is absorbed and retained as dissolved bicarbonate and carbonate.



- **Pathway of Pollutant:-** The mechanism by which a pollutant is distributed from its source into various segments of environment is referred to as pathway of that pollutant, e.g pathway of Pb is as shown below.



- **Speciation:-** The process of identification of chemical form i.e species of pollutant element in the environment is called speciation. E.g Lead pollution, Mercury pollution etc. In some segment of environment pollutant exist not as a free elements but in various chemically combined forms i.e species. Pollutant may be organic, inorganic or organometallic species.
- **D.O (Dissolved Oxygen):-** D.O is the amount of oxygen present in dissolved state in a water sample. D.O level is expressed in mg of O<sub>2</sub>/lit i.e ppm units. E.g D.O level of unpolluted water is 4-6 ppm, D.O level of aerated water is 7 ppm. D.O value is an important parameter of water quality. Dissolved oxygen is essential for healthy aquatic life.
- **C.O.D (Chemical Oxygen Demand):-** C.O.D is amount of chemically available oxygen required for complete oxidation of O.M. in the polluted water sample. C.O.D is determined by carrying out chemical oxidation of water sample using K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in 50% H<sub>2</sub>SO<sub>4</sub>. It is expressed in ppm of O<sub>2</sub>.

- **B.O.D (Biochemical Oxygen Demand):-**

B.O.D value is the amount of oxygen consumed in biodegradation of O.M. in water during a period of 5 days. The polluted water is aerated and its biodegradation is carried out by added culture of microorganisms. The B.O.D value is expressed as ppm of O<sub>2</sub>. Higher the B.O.D value more polluted the water. E.g B.O.D value of domestic sewage is 165 ppm while that of treated domestic sewage is 25 ppm.

- **T.L.V (Threshold Limit Value):-** T.L.V indicates the permissible level of toxic pollutant in atmosphere to which a healthy industrial worker is exposed during an eight hour day without any adverse effect. E.g T.L.V for Be: 0.002mg/m<sup>3</sup>, for Zn: 1.000mg/m<sup>3</sup>, for NO<sub>2</sub>: 5 ppm.

- **Residence time:-** The time for which a chemical species stays in a region of environment without undergoing any change in its chemical form is called residence time of that species. E.g Residence time of N<sub>2</sub>O in troposphere is 10 years while that of NO<sub>2</sub> is 3 days. CFCl<sub>3</sub> and CF<sub>2</sub>Cl<sub>2</sub> have their tropospheric residence times as > 10 years and > 30 years respectively.

## • Units of Concentrations:-

Pollutants are toxic even at very low concentrations of the order of ppm (parts per million), ppb (parts per billion), ppt (parts per trillion). In case of high concentration of pollutant it is expressed as percent (parts per hundred).

$$1 \text{ ppm} = 0.0001\% = 100 \text{ ppb} = 1000 \text{ ppt} = 1000000 \text{ ppt}$$

In case of liquid and solid samples the fractional units refer to parts by weight. E.g. 4 ppm of D.O. level of water sample refers to 4 parts of dissolved  $O_2$  in  $10^6$  parts of water by weight.

Litre to gram conversion of water

$$1 \text{ L water} = 10^3 \text{ mL water} = 10^3 \text{ gm of water} = 10^6 \text{ mg water}$$

$$4 \text{ ppm D.O.} = 4 \text{ mg D.O. per } 10^6 \text{ mg water}$$

$$= 4 \text{ mg D.O. per 1 L water}$$



In case of gaseous sample fraction refers to volume. Thus 1 ppm of NO<sub>2</sub> in air means 1 volume of NO<sub>2</sub> per 10<sup>6</sup> volumes of air.

- **Segments of Environment:-**

The environment is made up of four segments.

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

## 1. Atmosphere:-

Atmosphere is the protective blanket of gases surrounding the earth. It sustains life on earth and saves it from the hostilities of outer space. It absorbs most of the cosmic rays from the outer space and high energy portion of electromagnetic radiation from the sun. It transmits mainly the following radiations to the earth.

and

Near U.V, visible, near I.R

$\lambda = 300$  to  $2500$  nm

(i.e  $3 \times 10^{-7}$  to  $2.5 \times 10^{-6}$  m)

Radiowaves

$\lambda = 0.1$  to  $40$   $\mu$

(i.e  $1 \times 10^{-5}$  to  $4 \times 10^{-4}$  m)

The tissue damaging far U.V. radiation ( $\lambda < 300$  nm) is observed by the atmosphere. Atmosphere maintains the heat balance on earth through absorption of I.R. light radiated from the earth surface. Atmosphere is the source of gases essential for life.

It supplies  $O_2$  that is essential for aerobic life,  $CO_2$  that is essential for plant photosynthesis and  $N_2$  that on conversion by nitrogen fixing bacteria and atmospheric reactions into chemically bound 'N' becomes available to organisms. Atmosphere is vital carrier of water from oceans to land as a part of hydrologic cycle.

## 2. Hydrosphere:-

Hydrosphere includes all types of water resources oceans, seas, rivers, lakes, streams, reservoirs, glaciers, polar ice caps and ground water. About 97% of earth's total water supply is in oceans as highly salty water, about 2% is in polar ice caps and glaciers and only about 1% is available as fresh water for use to man. Major use of fresh water are for irrigation (~30%) thermal power plant (~50%) industrial consumption (~12%) and domestic (~7%).

Surface water gets contaminated by pesticides and fertilizers in agricultural run-off water, human and animal wastes in sewage and industrial wastes, posing serious problems to aquatic life and mankind.

### **3. Lithosphere:-**

Lithosphere is the outer mantle (i.e. cover) of solid earth. It consists of minerals occurring in earth's crust and the soil. Complex mixture of minerals, organic matter, air and water together constitute the soil which forms the most important part of lithosphere. Industrial mining, agricultural and household activities produce large quantities of solid wastes which pollute the lithosphere. Disposal of solid wastes has become a severe environmental problems.

### **4. Biosphere:-**

Biosphere denotes living organisms and their interactions with the other three segments of environment. Various species of life exist in the zone 600 m above and 10,000 m below sea level, forming the biosphere. Biosphere is made up of smaller units called ecosystems. Biosphere and the other three segments of environment are mutually influenced. Survival of biosphere depends upon the availability of various essential elements in the other three segment of environment.

Composition of the other three segments of environments is consequence of various life processes occurring in biosphere. E.g O<sub>2</sub> level and CO<sub>2</sub> level in the atmosphere is influenced by the most important processes in biosphere, viz respiration and photosynthesis. Natural cycles occurring in the environment provide a mechanism for continuous circulation of various elements like C, H, O, N, S, P, essential for life, within the four segments of environment.

Thank you!

