ENVIRONMENTAL POLLUTANTS

Any substance which causes pollution in the environment is known as e**nvironmental pollutant.**

WATER POLLUTION

The quality of drinking water is very important for human welfare. The pollution of water by sewage has been linked with the spreading of diseases such as cholera and typhoid fever.

In addition, industrial wastes also contaminate water.

(i)Heavy Metals : Such as Cd, Pb and Hg may be present.

(ii) Detergent and Fertilizers : The may contain PO_4^{-3} as additives which encourages the formation of algae which reduces the dissolved oxygen concentration of water. This process known as Eutrophication.

(iii) Acid Polluted Water (pH < 3) : This is deadly to most forms of aquatic life.

(iv)Polychlorinated Biphenyls (PCBs) : PCBs are resistant to oxidation and their release into the environment causes skin disorders in humans. They are reported to be carcinogenic.

Determination of quality of waste water : It is done through BOD and COD.

Biological : Oxygen demand (BOD) - is the amount of oxygen required for biological oxidation by microbes in any unit volume of water. This test is done for at least 5 days. BOD values generally approximates the amount of oxidisable organic matter.

Chemical oxygen demand (COD) : BOD measurement takes a few days, so another parameter called COD measurement is required. In COD measurement sample of fixed volume is treated with oxidising agent (usually $K_2Cr_2O_7$ in acidic medium). The reagent oxidises most of the polluting substances including those which are resistant to microbial oxidation. The remaining $K_2Cr_2O_7$ is determined by back titration from the concentration of $K_2Cr_2O_7$ consumed the amount of oxygen used can be calculated.

AIR POLLUTION

Air is very essential for life, particularly oxygen is needed for breathing. But air is never found clean due to the pollution caused by various activities both natural as well as human. Man made pollutants such as gases like CO, NO, NO_2 , SO_2 , H_2SO_4 , hydrocarbons and aerosols etc are being constantly released in the atmosphere leading to air pollution.

Atmospheric Pollution

Tropospheric pollution : Troposphere extends upto height of 10km from sea level. It contains 80 % of total mass of air and almost all of H_2O vapour pollution caused by SO_2, SO_3, NO_2 etc

Stratospheric pollution : Extends (10–50) km above sea level. It contains N_2, O_2 and ozone.

Table : Sources of Air Pollution

Sl. No.	Class	Aerosols	Gases and Vapours
1.	Combustion processes	Dust, fumes, smoke	SO_2, NO_2, CO, Organic vapours
2.	Chemical processes (cement and fertilizers)	Dust, fume, mist	Process dependent (CO_2, SO_2, CO, NH_3, NO_2 organic vapours)
3.	Petroleum operations	Dust, mist	SO_2, H_2S, NH_3, CO, hydrocarbons mercaptans
4.	Metallurgical processes (Al-refineries, steel plant)	Dust, fumes	SO_2, CO, fluorides, organic vapours
5.	Mineral processing	Dust, fumes	Process dependent
6.	Food and feed operation	Dust, mist	Odouroys materials

7.	Agricultural activities crop spraying, field burning	Dust, mist, Organic phosphates, chlorinated smoke flyash hydro sulphur oxide, organic vapours
8.	Nuclear energy programme (i) Fuel fabrication (ii) Ore preparation (iii) Bomb explosion	Dust Fluorides, I-131, Ar-41 radioactive gases (Sr-90, Cs-137, C-14 etc.)

Smog

Combination of 2 words smoke and fog. This is the best known example of air pollution. Smog is of 2 types :

(1) Classical smog : Occurs in cool humid climate and is chemicaly reducing smog and has high concentration of SO_2.

(2) Photochemical smog : Occurs in warm, dry and sunny climate. It is an oxidsing smog. Major component of photo chemical smog is NO.

Formation of photochemical smog : NO is oxidised in air to NO_2 and NO_2 breaks to NO and O.

$NO_2 \xrightarrow{h\nu} NO + O$

This atomic O produces ozone.

$O + O_2 \longrightarrow O_3$

O_3 undergoes many reactions constituting the smog

$O_3 + NO \longrightarrow NO_2 + O_2$

The other products formed are formaldehyde, acrolein and peroxyacetyl nitrate (PAN).

Acid Rain

Rain water normaly has pH of 5.6 due to the formation of H^+ ions from the reaction of rain water with CO_2 present in atmosphere.

$$H_2O(l) + CO_2(g) \longrightarrow 2H^+(aq) + CO_3^{-2}(aq) .$$

When pH of rain water drops below 5.6 it becomes acidic. Acid rain caused by the presence of oxides of sulphur and nitrogen in the atmosphere. Oxides of sulphur are released into the environment largely because of fossil fuel combustion, ore smelting etc. Nitrogen oxides emitted into the atmosphere mainly from automobile exausts and fossil fuel combustion. SO_2 and NO_2 after oxidation and reaction with water are major contributors to acid rain.

$$2SO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 2H_2SO_4(aq)$$

$$4NO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 4HNO_3(aq).$$

Acid rain is toxic to vegetation and aquatic life. It damages building and statues and dissolves heavy metals from soils, rocks etc. The heavy metals such as Cu, Pb, Hg, Al etc leached from soil enter well waters and produce a variety of toxic effect.

OZONE AND REACTIONS CAUSING OZONE LAYER DEPLETION

Ozone (O_3) a light bluish gas found in the stratosphere, absorbs ultraviolet (UV) radiation of the sun which is harmful to the living things. O_3 therefore act as one of the earth's most important life support system.

In recent years however there have been reports of the depletion of this protective ozone layer. The major cause of ozone layer depletion is believed to be the release of chlorofluoro carbon compounds (CFCS), also known as freons into the atmosphere. These compounds enter its upper layers where they get broken down by the powerful UV radiation emitted by the sun. The life time of CF_2Cl_2 (CFC-12) is 139 years while that of $CFCl_3$ (CFC-11) is about 77 years. The decomposition product destroy ozone as is clear from the following reactions.

$$CF_2Cl_2(g) + h\nu \longrightarrow Cl^{\bullet}(g) + {}^{\bullet}CF_2Cl(g)$$

Highly reactive chlorine free radical (Cl) reacts with ozone to form chlorine monoxide.

$$\dot{C}l(g) + O_3(g) \longrightarrow ClO^{\bullet}(g) + O_2(g)$$

$$ClO^{\bullet}(g) + O(g) \longrightarrow Cl^{\bullet}(g) + O_2(g)$$

It has been shown that over one thousand ozone molecules, can be destroyed by one $Cl^{\bullet}(g)$.

Effect of the Depletion of Ozone Layer

Following are the main effect of ozone layer depletion in stratosphere

1. Increased human cataracts
2. Skin cancer
3. Reduction of planktons in ocean waters
4. Depletion of plants and crops etc.

SOIL POLLUTION

It is caused by pesticides and other chemicals which are added to the soil to grow better crops. Solid wastes are another cause of land pollution.

Pesticides are used to kill unwanted organisms. Synthetic pesticides are concern to us. Pesticides affects human being through eating of food, drinking water. These pesticides can be classified in three ways.

Classification

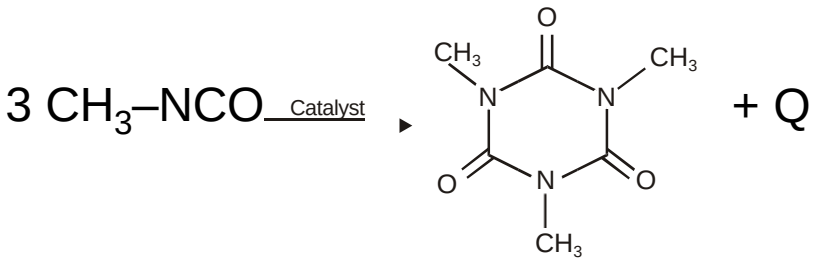
1. **Insecticides :** Control of insects by insecticides help to curb disease for *e.g*, (malaria and yellow fever) and protects crops. e*.g.,* organo- chlorine like DDT. **Bhopal gas tragedy** Occured in 2^{nd} Dec., 1984 in Bhopal (United Carbide Ltd.) point.

   Methyl iso-cyanate was used to manufacture the insecticide called Carbaryl or Sevin (commercial name). There were three tanks in the plants that stored MIC. Due to increase of pressure in one of the tanks so its valve released so MIC escaped into atmosphere. This MIC was

   (a) Hydrolysed due to presence of water in surrounding ponds.

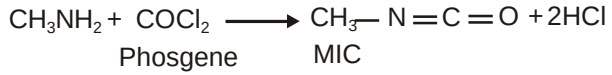
$$CH_3 — N= C = O + H_2O \longrightarrow CH_3NH_2 + CO_2\uparrow + \Delta H$$

(b)Impurities present in water of metals which caused polymerisation reaction

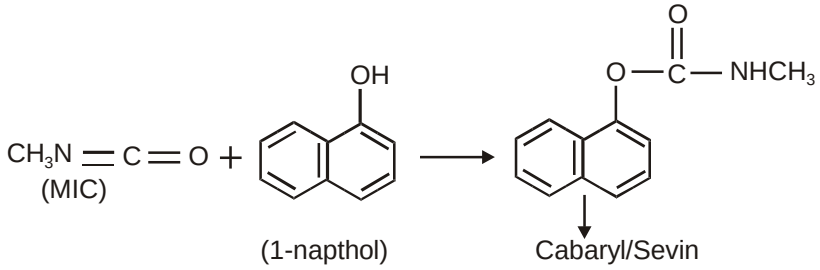


Both above reactions are exothermic in nature. So escaping tendency of MIC increased and caused immense loss of life and injury to people and life stock.

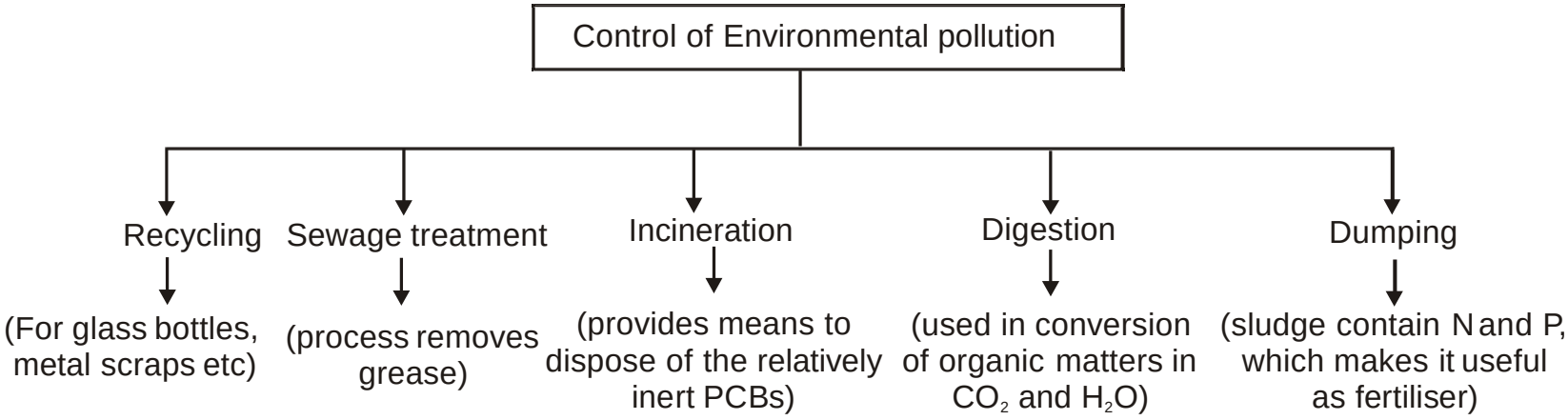
Note : *Some other reactions related to gas tragedy are*



MIC when reacts with 1-napthol it gives Sevin.



Strategy to control environmental pollution : Household wastes, toxic industrial wastes from manufacturing processes requires treatment and safe disposal.



2. **Herbicides** used to kill weeds. *e.g.,* $NaClO_3$ and Na_3AsO_3 etc. Organic herbicides as triazines are presently widely used to kill weeds in cornfields.
3. **Fungicides** are used to kill fungi. Since fungi are plants without chlorophyll. Organic compounds of Mercury $(CH_3)_2Hg$ have been used as fungicides. Methyl mecury as a fungicide was used in bread resulted human deaths in Iraq.

Thus, 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 (BOD)**. The amount of BOD in the water is a measure of the amount of organic material in the water, in terms of how much oxygen will be required to break it down biologically. Clean water would have BOD value of less than 5 ppm whereas highly polluted water could have a BOD value of 17 ppm or more.

Fluoride: For drinking purposes, water should be tested for fluoride ion concentration. Its deficiency in drinking water is harmful to man and causes diseases such as tooth decay etc. Soluble fluoride is often added to drinking water to bring its concentration upto 1 ppm or 1 mg dm^{-3}. The F^- ions make the enamel on teeth much harder by converting hydroxyapatite, $[3(Ca_3(PO_4)_2.Ca(OH)_2]$, the enamel on the surface of the teeth, into much harder fluorapatite, $[3(Ca_3(PO_4)_2.CaF_2]$.

However, F^- ion concentration above 2 ppm causes brown mottling of teeth. At the same time, excess fluoride (over 10 ppm) causes harmful effect to bones and teeth, as reported from some parts of Rajasthan.

Lead: Drinking water gets contaminated with lead when lead pipes are used for transportation of water. The prescribed upper limit concentration of lead in drinking water is about 50 ppb. Lead can damage kidney, liver, reproductive system etc.

Sulphate: Excessive sulphate (>500 ppm) in drinking water causes laxative effect, otherwise at moderate levels it is harmless.

Nitrate: The maximum limit of nitrate in drinking water is 50 ppm. Excess nitrate in drinking water can cause disease such as methemoglobinemia ('blue baby' syndrome).

Other metals: The maximum concentration of some common metals recommended in drinking water are given in Table 14.2.

Metal	Maximum concentration (ppm or mg dm^{-3})
Fe	0.2
Mn	0.05
Al	0.2
Cu	3.0
Zn	5.0
Cd	0.005