

B.Sc. Part II (Hons.), Paper - III B (Inorganic Chemistry)

Group-C, Unit-3 Idea of Major Chemical pollutants in Environment.

(By Dr. Birendra Kumar, Maharaja College)

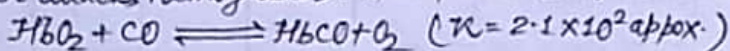
The presence or increase in our environment of chemical substances (organic or inorganic) that not naturally present there or are found in amounts higher than their natural background values is referred as chemical pollution, and the chemical substances are called chemical pollutants.

The major chemical pollutants in environment are: Carbon monoxide (CO), ^{Ozone} (O₃), Carbon dioxide (CO₂), Sulphur dioxide (SO₂), Nitrogen dioxide (NO₂), Lead (Pb), Volatile Organic compounds, Chlorofluorocarbons (CFCs), Unburned hydrocarbons, Particulates, heavy metals (As, Hg, Cd) etc.

1. Carbon monoxide (CO): It is an air pollutant (primary).

Sources: (i) Volcanic action, natural gas emission, electric discharge during storms, marsh gas production etc. (ii) Human activities, e.g. vehicle exhaust, fossil fuel burning and industrial processes.

Effect: (i) It attacks hemoglobin and displaces O₂ to form carboxy hemoglobin.



HbCO is a stronger complex so that the net result is reduction in the blood's capacity for carrying O₂. Thus, less O₂ is available to the body cells. It also reduces the dissociation of HbO₂ into Hb & O₂, so that oxygen starvation. The blocking of oxidation also effect the cell functioning.

(ii) It causes bronchitis, emphysema and lung cancer.

2. Carbon dioxide (CO₂): It is also an air pollutant (primary).

Sources: vehicle exhaust, deforestation, fossil fuel burning, industrial processes etc.

Effect: (i) Breathing becomes more difficult with the rise of CO₂ level in environment.

(ii) It causes headaches (iii) It increases the green house effect / global warming.

(iv) It can produce a variety of health effects, e.g. increased heart rate, elevated blood pressure, coma, asphyxia, dizziness, restlessness, needles feeling etc.

3. Ozone (O₃): It is a secondary air pollutant, formed by chemical reaction in the atmosphere ($O_2 \xrightarrow{hv} O + O$; $O_2 + O \rightarrow O_3$). It present in the upper atmosphere (stratosphere) as ozone blanket.

Effect: (i) It causes irritation of the eyes & respiratory tracts of human beings.

(ii) It brings about non-lethal accumulation of fluid in the lungs and damage to lung capillaries.

(iii) The biochemical effect of O₃ is mostly due to the generation of free radicals

(iv) It oxidizes sulphhydryl groups (-SH) on enzymes.

4. Nitrogen oxides (NO_x): They are air pollutant (primary or secondary).

Sources: (i) vehicle exhaust, fossil fuel burning etc.

(ii) NO & NO₂ are emitted to the atmosphere in significant quantities during combustion. $N_2 + xO_2 \xrightarrow{1100^\circ C} 2NO_x$.

(iii) NO_x are also produced during fading of textile dyes and additive, deterioration of cotton and nylon, and corrosion of metal due to particulate nitrates.

Effect: (i) NO like CO forms bond with hemoglobin and reduces O_2 transport efficiency. However, since NO concentration is much less in polluted air, so less effect produced.

(ii) Inhalation of NO_2 containing gases from burning celluloid and nitrocellulose film lead to death. NO_2 is more toxic than NO. It is more harmful to human health.

(iii) When exposed to NO_2 (50-100ppm) for a period of one hour, it causes inflammation of lung tissue for 6-8 weeks.

(iv) When level of NO_2 is 150-200ppm, it causes Bronchiolitis fibrosa obliterans. When one is exposed to NO_2 for a period of 3-5 weeks, it can cause death.

(v) Probably some cellular enzyme systems are susceptible to disruption of NO_2 including Catalase and lactic dehydrogenase.

5. Sulphur dioxide (SO_2): It is primary air pollutant. It is always accompanied by a little SO_3 . The mixture of SO_2 & SO_3 is usually referred to as SO_x .

Sources: (i) Minerals (Sulphides/pyrites) and fossil fuel burning ($FeS_2 + O_2 \rightarrow FeO + SO_2$)

(ii) Natural processes, e.g. volcanoes provide 67% of the SO_x pollution.

(iii) Man made sources contribute ~33% SO_x pollution (mainly in urban areas). Among man made sources, thermal power stations (75%), industries (22%), transportation (2%) of the total SO_x pollution.

Effect: (i) SO_2 causes irritation on the respiratory tract and so constriction of respiratory tract with corresponding increase in resistance to air flow during breathing.

(ii) Prolonged exposure of SO_2 (1500ppm) by aged peoples suffer from diseases of respiratory and Cardiovascular.

(iii) SO_2 is injurious to plants. It causes destruction of leaf tissue, damage the edges of leaves and the areas between leaf veins. Chronic exposure to SO_2 leads to Chlorosis, e.g. bleaching or yellowing of the green portion of leaves.

(iv) It causes acid rains which also damage plants besides aquatic lives in rivers and lakes.

6. Lead (Pb): It is both air & water pollutants.

Sources: (i) ^{By} Combustion of leaded petrol/gasoline max^m release of lead into the air.

(ii) Environmental contamination of lead due to its use in batteries, cables, paints, glazing of ceramics, PVC, plastics, pesticides, TEL (tetraethyl lead) & tetramethyl lead.

(iii) ^{In} Aquatic environment, lead contaminations are due to industrial discharges from smelters, sewage effluents and runoff from contaminated land areas.

Effect: (i) Lead (Pb) inhibits several enzymes involved in the process of heme synthesis resulting the accumulation of metabolic intermediate delta-aminolevulinic acid.

(ALA). It also inhibits the conversion of ALA-dehydrase enzyme from porphobilinogen, an important phase of heme synthesis. $HOOC-CH_2-CH_2-C(=O)-CH_2-OH$ (ALA). Thus, the synthesis of hemoglobin is disrupted by Pb and other related respiratory molecules such as cytochromes which require heme. Ultimately Pb does not permit utilisation of O_2 & glucose for life sustaining energy production.

(ii) Pb is accumulated in the bones of the body due to chemical analogy of Pb^{2+} with Ca^{2+} . The accumulated Pb reacts with phosphates of bones which extra toxic effect when transported to soft tissues.

(3)

7. Arsenic (As): It is both air and water pollutants.

- Sources: (i) Insecticides, fungicides and herbicides are sources of arsenic pollution
(ii) It enters into atmosphere (air) from fossil fuel burning and minerals burning.
(iii) Liquid effluent of fertilizer plants is another source of arsenic pollution in water.

Effect: (i) As(III) compounds are the most toxic due to following reaction:



- The enzymes which generate cellular energy in the Citric acid cycle are adversely affected.
- (ii) As(III) compounds at higher concentration coagulate proteins possibly by attacking the sulphur bonds maintaining the secondary & tertiary structures of proteins.
- (iii) The three major biochemical actions of As are coagulation of proteins, complication with coenzymes and uncoupling of phosphorylation.
- (iv) Long term exposure of arsenic from drinking water and food can cause cancer and skin lesions. It also produces cardiovascular disease and diabetes.
- (v) Chronic exposure of arsenic is related to Vit-A deficiency, which is related to heart disease and night blindness.

8. Chlorofluorocarbons (CFCs): They are non-toxic, nonflammable chemicals & ^{an} air pollutant.

Sources: It is released into the atmosphere from various human applications, e.g. air conditioning, refrigeration, blowing agents in foams, insulation and packing materials, propellants in aerosol cans, and as solvents.

Effect: (i) CFC influence the greenhouse effect which result global warming and make winters shorter & summer longer.

(ii) Depletion of the ozone layer from CFCs dangerous environmental effects and increases exposure to dangerous UV-rays which can cause cataracts, weakened immune system and skin cancer.

9. Particulates: They include all solid and liquid particles suspended in air many of which are hazardous. They may be viable or non-viable. viable particulate matter are the minute living organisms dispersed in air, e.g. bacteria, fungi, moulds, virus etc. Non-viable particulate matter in air are mist (by spray liquids & by condensation of vapour in air), smoke (by burning & combustion of organic matter, oil, tobacco, carbon), fumes (chemical & metallurgical processes), dust (by natural disintegration of rock and soil or by mechanical process of grinding, crushing etc.)

Sources: Most of particulates form in the atmosphere as a result of complex reactions of chemicals such as SO₂, NO_x which are pollutants emitted from power plants, industries and automobiles. Some are emitted directly from a source (construction sites, fields, roads, smoke stacks or fires).

Effect: (i) Exposure of such particles can affect both your lungs and hearts.

(ii) A variety of problems including premature death in people with heart & lung disease, non-fatal heart attacks, diabetes, cancer, cardiovascular etc.

(iii) It contributes to acid rain and climate change (drought, global warming, winters short summer long) and cause the ocean to acidify.