2. Air pollution

Air pollution Air pollution can be defined as the presence of toxic chemicals or compounds (including those of biological origin) in the air, at levels that pose a health risk. air pollution means the presence of chemicals or compounds in the air which are usually not present and which lower the quality of the air or cause detrimental changes to the quality of life (such as the damaging of the ozone layer or causing global warming).

2. Sources of Air Pollution: These sources can be classified into two major categories which are: Anthropogenic sources (human activity) : mostly related to burning different kinds of fuel:

i. "Stationary Sources" include smoke stacks of power plants, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices.

ii. "Mobile Sources" include motor vehicles, marine vessels, aircraft and the effect of sound etc.

iii. Chemicals, dust and controlled burn practices in agriculture and forestry management.

iv. Fumes from paint, hair spray, varnish, aerosol sprays and other solvents.

v. Waste deposition in landfills, which generate methane. Methane is not toxic; however, it is highly flammable and may form explosive mixtures with air.

Natural sources:

i). Dust from natural sources, usually large areas of land with little or no vegetation.

ii).. Methane, emitted by the digestion of food by animals, for example cattle.

iii. Radon gas from radioactive decay within the Earth's crust. Radon is a colourless, odourless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard

iv. Smoke and carbon monoxide from wildfires.

v. Volcanic activity, which produce sulphur, chlorine, and ash particulate

3.. Types of Air Pollutants: An air pollutant is known as a substance in the air that can cause harm to humans and the environment. Pollutants can be classified as either primary or secondary. Usually, primary pollutants are substances directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact.

Major primary pollutants produced by human activity include:

i). Sulphur oxides (SO2): SO2 is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulphur compounds, their combustion generates sulphur dioxide. Further oxidation of SO2, usually in the presence of a catalyst such as NO2, forms H2SO4, and thus acid rain.

ii).. Nitrogen oxides (NO2): Especially nitrogen dioxide are emitted from high temperature combustion. Nitrogen dioxide is the chemical compound with the formula N02. It is responsible for photochemical smog, acid rain etc.

iii. Carbon monoxide: It is a colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.

iv. Carbon dioxide (CO2): A greenhouse gas emitted from combustion but is also a gas vital to living organisms. It is a natural gas in the atmosphere

Volatile organic compounds:

VOCs are an important outdoor air pollutant. In this field they are often divided into the separate categories of methane (CH4) and non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming.

i). Toxic metals – such as lead, cadmium and copper.

ii). Chlorofluorocarbons (CFCs) – harmful to the ozone layer emitted from products currently banned from use.

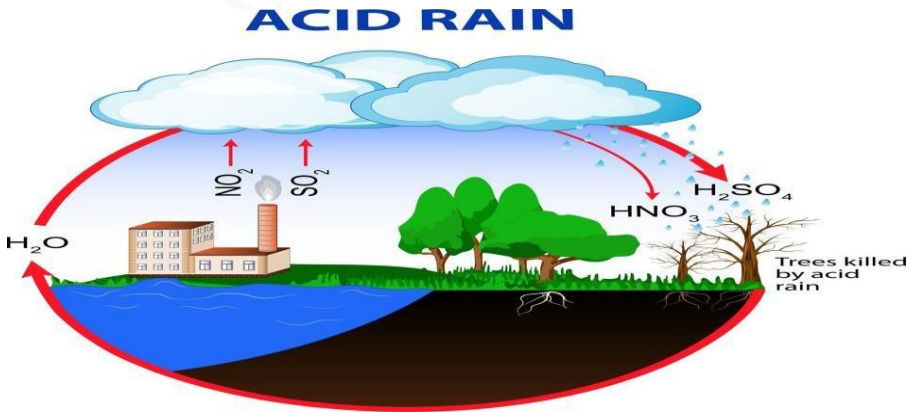
iii). Ammonia (NH3) – emitted from agricultural processes. Ammonia is a compound with the formula NH3. It is normally encountered as a gas with a characteristic pungent odor. Although in wide use, ammonia is both caustic and hazardous.

iv). . Radioactive pollutants – produced by nuclear explosions, war explosives, and natural processes such as the radioactive decay of radon.

4. Acid rain

Acid rain is one of the consequences of air pollution. It occurs when emissions from factories, cars or heating boilers contact with the water in the atmosphere. These emissions contain nitrogen oxides, sulphur dioxide and sulphur trioxide, which when mixed with water become sulphurous acid, nitric acid and sulfuric acid..

Acid rain effects The resulting acids are precipitated to earth as rain or snow with very negative consequences: the damage to nature in the form of acidification of soils, lakes and seas .On the other hand, acid rain also causes corrosion of metallic elements -buildings, bridges, towers and other structures- and the historic structures, statues, sculptures...



Acid rain gases that cause this rain (nitrogen oxides, sulphur dioxide and sulphur trioxide), are harmful. These gases contain particles of sulphate and nitrate and are carried by the wind and inhaled by people causing respiratory diseases.

Renewable energy sources and reducing the use of fossil fuels in the industrial and automotive sector and in the daily life of every citizen.

5. Photochemical smog Photochemical smog is formed when sunlight interacts with certain chemicals in the atmosphere. Ozone is the main component in this type of air pollution. Ozone in the stratosphere protects us against harmful ultraviolet radiation. Ground-level ozone forms when motor vehicle emissions containing nitrogen oxide and volatile organic compounds

Health Effects Photochemical smog is capable of inflicting irreversible damage on the lungs and heart. It causes painful irritation of the respiratory system, reduced lung function and difficulty breathing; this is more evident while exercising or working outdoors..

Effects on Environment The collection of chemicals found in photochemical smog causes problems for plants and animal life. Some plants such as tobacco, tomato and spinach are highly responsive to ozone, so photochemical smog can decimate these sensitive crops, trees and other vegetation.

Precautions Generally, photochemical smog is less concentrated in the early morning or evening; therefore, exercising and planning outdoor activities during this part of the day.. Reduce your daily pollutant emissions by driving less, making use of carpools, and maintaining the car in good condition. tightly sealing the lids of chemical products like garden chemicals, solvents evaporation of the chemicals and helps reduce smog

6. Greenhouse effect The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and reradiated by greenhouse gases.

Greenhouse gases include water vapor 36–70%, carbon dioxide 9–26%, methane 4–9%, ozone 3–7% and some artificial chemicals such as chlorofluorocarbons (CFCs).

The absorbed energy warms the atmosphere and the surface of the Earth. This process maintains the Earth's temperature at around 33 degrees Celsius warmer than it would otherwise be, allowing life on Earth to exist.

Enhanced greenhouse effect The problem we now face is that human activities – particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing – are increasing the concentrations of greenhouse gases. This is the enhanced greenhouse effect, which is contributing to warming of the Earth. Greenhouse effect

Step 1: Solar radiation reaches the Earth's atmosphere - some of this is reflected back into space.

Step 2: The rest of the sun's energy is absorbed by the land and the oceans, heating the Earth. Step 3: Heat radiates from Earth towards space.

Step 4: Some of this heat is trapped by greenhouse gases in the atmosphere, keeping the Earth warm enough to sustain life.

Step 5: Human activities such as burning fossil fuels, agriculture and land clearing are increasing the amount of greenhouse gases released into the atmosphere.

Step 6: This is trapping extra heat, and causing the Earth's temperature to rise

7. Ozone Layer French Physicist Charles Fabry and Henri Buisson discovered ozone in the year 1913. Ozone layer/ shield is a region present in the stratosphere of the earth's atmosphere and this region absorbs

majority sun's UV radiation. Mainly found in the lower region of stratosphere almost 20 to 30 kilometres above Earth.

Importance of Ozone Shield The stratosphere of the earth's atmosphere contains a significant amount of O3. Thus, this gaseous compound protects living organisms including humans from the harmful UV radiations ($\lambda = 255$ nm). Excessive exposure to the UV radiation for a longer period of time can cause melanoma or skin cancer in humans..

Formation of Ozone The reaction of UV radiation with O2 or di oxygen molecules results in the formation of O3. The UV radiation splits the oxygen molecule into the free oxygen or O atoms. These O atoms combine with molecular form of oxygen to form ozone (O3). It is thermodynamically an unstable compound and has a tendency to decompose into molecular oxygen.

$$O2(g) \rightarrow O(g) + O(g) \text{ (in presence of UV Radiation)}$$

$$O(g) + O2(g) \leftrightarrow O3(g) \text{ (in presence of UV Radiation)}$$

Depletion of Ozone Layer The depletion of the protective O3 layer is because of the presence of particular chemicals in the stratosphere of earth's atmosphere. The constant release of compounds like carbon tetrachloride, carbon tetrafluoride, CFCs (chlorofluorocarbon) or freons and other chlorine or bromine containing halogens in the atmosphere is the main reason for the depletion.

However, these chemicals mix with normal atmospheric gases and finally reach the stratosphere. Thus, these compounds break down into free chlorine radicals in the presence of powerful UV radiation in the stratosphere

$$CF_2Cl_2\ (g) \rightarrow Cl(g) + CF_2Cl(g) \text{ (in presence of powerful UV Radiation)}$$

The chlorine radicals combine with the stratospheric O3 thereby forming molecular oxygen and chlorine monoxide radicals.

$$Cl(g) + O_3(g) \rightarrow ClO(g) + O_2(g)$$

Chlorine monoxide radicals will further react with atomic oxygen to form more chlorine radicals.

$$ClO(g) + O(g) \rightarrow Cl(g) + O_2(g)$$

This process will continue and constantly regenerate chlorine radicals. This, in turn, will lead to the breakdown of ozone. Hence, CFCs are transporting agents that are responsible for damaging the ozone layer.

8. Bhopal Gas Tragedy: Bhopal Gas Tragedy on the night of December 2/3, 1984 is a sad example of human negligence which caused deadliest air pollution claiming 5,000 human lives and rendering many thousands sick and handicapped. It is due to the sudden leakage of the poisonous gas methyl iso cyanate (MIC) from the Union Carbide Factory at Bhopal which was stored to manufacture pesticides.

The leakage continued for 40 minutes and the poisonous gas was quickly spread in the air of nearby localities of old Bhopal under the impact of morning breeze killing thousands of human beings and animals.

The gas also polluted drinking water, soils and adversely affected fetus of pregnant women, newly born babies, children and old people. About 200 women delivered dead babies and about 400 babies died within

a few hours of their birth. About 47 percent of the pregnant women suffered from instantaneous abortion and many preferred voluntary abortion.

According to the official figures about 10,000 people have been made permanently disabled and about 30,000 partially handicapped. About 1.5 lakh people are the victims of minor disability. Newly born babies, who could survive, have developed blue spots on their livers and are suffering from cough, asthma and eye trou¬ble.

9. Prevention And Control of Air Pollution Different techniques are used for controlling air pollution caused by 'gaseous pollutants' and that caused by 'particulate pollutants'.

- Methods of controlling gaseous pollutants-The air pollution caused by gaseous pollutants like hydrocarbons, sulphur dioxide, ammonia, carbon monoxide, etc can be controlled by using three different methods-Combustion, Absorption and Adsorption.

1. Combustion-This technique is applied when the pollutants are organic gases or vapours. The organic air pollutants are subjected to 'flame combustion or catalytic combustion' when they are converted to less harmful product carbon dioxide and a harmless product water.

2. Absorption-In this method, the polluted air containing gaseous pollutants is passed through a scrubber containing a suitable liquid absorbent. The liquid absorbs the harmful gaseous pollutants present in air.

3. Adsorption-In this method, the polluted air is passed through porous solid adsorbents kept in suitable containers. The gaseous pollutants are adsorbed at the surface of the porous solid and clean air passes through.

- Methods of controlling particulate emissions-The air pollution caused by particulate matter like dust, soot, ash, etc can be controlled by using fabric filters, wet scrubbers, electrostatic precipitators and certain mechanical devices.