Environmental Pollution

Environment is the surroundings of an organism, consisting of all living and nonliving components. It has the conditions suitable for the existence and growth of plants, animals, and microorganisms. These conditions have been continuously changing since life evolved, which have been beneficial to some organisms, while harmful to others. New species came into existence due to changes beneficial to them, and a number of existing species, which could not adapt to the same changes, became extinct from earth. A typical example is the extinction of dinosaurs due to hostile conditions. One of the causes attributed to their extinction is the appearance of many primitive mammals that fed on dinosaur eggs.

Although the earth's environment has been continuously changing due to natural reasons for millions of years, it has been subject to extreme and harmful changes since human population increased and their activities expanded. Some activities that have degraded the environment are as follows:

a. **Deforestation** has been occurring for thousands of years, which involves cutting of trees in forests for farming or other requirements such as building residential areas.
b. **Hunting of wild animals** for food and game has been responsible for the extinction of many species such as the Tasmanian tiger.
c. **Industrialization** has led to pollution of air, water, and land because of harmful materials and effluents (liquid waste) released from industries.
d. **Manmade environmental disasters** have profoundly affected the environment. Some such incidents include the Great Smog of London; the nuclear bombing of Hiroshima and Nagasaki during World War II; nuclear accidents such as those in Chernobyl (Ukraine); Three Mile Island (USA), Fukushima (Japan) etc.

Pollution

Pollution is an undesirable change in the physical, chemical, or biological characteristics of the environment. It adversely affects the life support system of the biosphere. The agents that pollute the environment are called pollutants. Sometimes, even the normal constituents of the atmosphere become pollutants when their concentration increases to abnormal limits. For example, carbon dioxide (CO_2) is not normally considered as a pollutant, but its increased concentration has been responsible for global warming.

Pollutants are of two type's non-degradable and biodegradable pollutants. Non-degradable pollutants are not decomposed by bacteria, and so they persist for a long time in the environment, get accumulated, and biomagnify to dangerous levels. Examples of non-degradable pollutants include pesticides, heavy metals, rubber, plastic, and nuclear waste. Biodegradable pollutants such as paper, domestic sewage, garden waste, and fertilizers are broken down into simple components by bacterial decomposition.

There are several types of environmental pollution. But in this course we will only study the following types:

1. Air or Atmospheric Pollution
2. Industrial Waste Pollution
3. Water Pollution
4. Noise Pollution

Air or Atmospheric Pollution

Air pollution is an undesirable change in the physical, chemical, or biological characteristics of air that adversely affects its life support system. Pollution is caused by the addition of harmful substances that unfavourably alter the quality of air. Normally, carbon dioxide is not considered as a pollutant. However, its presence in excessive amount leads to global warming, which is responsible for health hazards.

Types of Air Pollutants:

The substances that are responsible for causing air pollution are called air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural (e.g. wildfires) or manmade. Pollutants can be classified as either primary or secondary. Usually, primary pollutants are substances which are 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. Important examples of secondary pollutant are photochemical smog and ground level ozone.

Examples of primary pollutants:

a. Emission of CO, CO_2, SO_2, NO etc. from the car exhaust and smokestacks.
b. Particulate material in the form of dust, pollen, soot, ash from a volcanic eruption etc.
c. Toxic metals such as lead and mercury
d. Volatile organic compounds (VOCs) in the form of methane, propane, CFCs etc.

Examples of secondary pollutants:

Atmospheric acids: Sulfuric acid (H_2SO_4) causes acid rain. Burning of fossil fuels like oil, coal etc. releases the sulfur dioxide. When the sulfur dioxide gas comes into contact with water droplets in the atmosphere, it changes into sulfuric acid. This results in acid rain. Nitric acid (HNO_3) also causes acid rain. When nitrogen oxides from automobile exhausts mix with water vapor in the air, they turn into nitric acid. This nitric acid comes down with rain in the form of acid rain.

Photochemical oxidants (NO_2): when NO_2 is exposed to ultraviolet radiation it undergoes series of reaction with hydrocarbon to form photochemical smog.

Effects of Air Pollutants

There are various harmful effects of the air Pollutants. These are as follow:

a. **Carbon monoxide:** (source: automobile exhaust, photochemical reactions in the atmosphere, biological oxidation by marine organisms, etc.). Affects the respiratory activity, as hemoglobin has more affinity (natural liking) for CO than for oxygen. Thus, CO combines with hemoglobin and thus reduces the oxygen carrying capacity of blood. This results in blurred vision, headache, unconsciousness and death due to asphyxiation (lack of oxygen).
b. **Carbon dioxide:** (source: carbon burning of fossil fuels, depletion of forests (that remove excess carbon dioxide and help in maintaining the oxygen and carbon dioxide ratio). Global warming as it is one of the greenhouse gases.
c. **Sulphur dioxide**: (source: industries, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions). Respiratory problems, severe headache, reduced productivity of plants, damage to leather, and increased rate of corrosion of iron, steel, zinc and aluminum.
d. **Nitrogen Oxides:** (source: automobile exhausts, burning of fossil fuels, forest fires, electric generation plants, smelting plants, industrial boilers, petroleum refineries and volcanic eruptions). Forms photochemical smog, at higher concentrations causes leaf damage or affects the photosynthetic activities of plants and causes respiratory problems in mammals.
e. **Chlorofluoro carbons (CFCs)**: (source: refrigerators, air conditioners, foam shaving cream, spray cans and cleaning solvents). Destroy ozone layer which then permits harmful UV rays to enter the atmosphere. The ozone layer protects the earth from the ultraviolet rays sent down by the sun. If the ozone layer is depleted by human action, the effects on the planet could be catastrophic (causing sudden great damage).
f. **Particulate matter: Lead halides (lead pollution)**: (source: combustion of leaded gasoline products). Toxic effect in man.
g. **Asbestos particles**: (source: mining activities). Asbestosis – a cancerous disease of the lungs.
h. **Mercury**: (source: combustion of fossil fuel and plants). Brain and kidney damage.

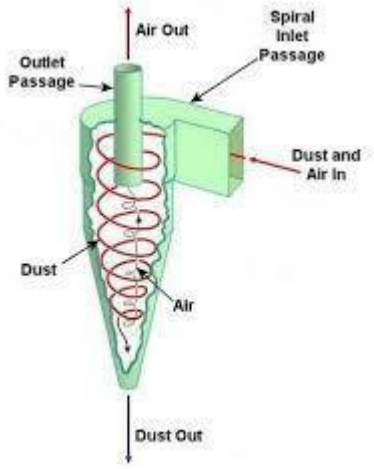
Control of Air Pollution:

The following devices are commonly used to control the air pollution. They can either destroy contaminants or remove them from an exhaust stream before it is emitted into the atmosphere.

a. Cyclonic Dust Separator

Cyclonic Dust Separator is used to remove the dust particulates from an air, gas or water stream, without the use of filters, through vortex separation. Rotational and gravity effects are used to separate mixtures of solids and fluids.

A high speed rotating flow of air, known as a cyclone is established within a conical shape container. This container is wide from the top and narrow in the bottom. Air flows in the form of spiral pattern is started from the top and ended in the bottom. During the spiral flow of the air, clean air come out from the center of the cyclone in upward direction.



The denser dust particles in the rotating air stream will have more inertia than the air molecules. So dust particles will not able to follow the spiral curve of the air flow. Instead they will strike with the wall and will fall down in the bottom of the conical shape container. In a conical system, as the rotating flow moves towards the narrow end of the cyclone the rotational radius of the stream is reduced which helps in separating smaller and smaller particles.

b. Electrostatic Precipitators:

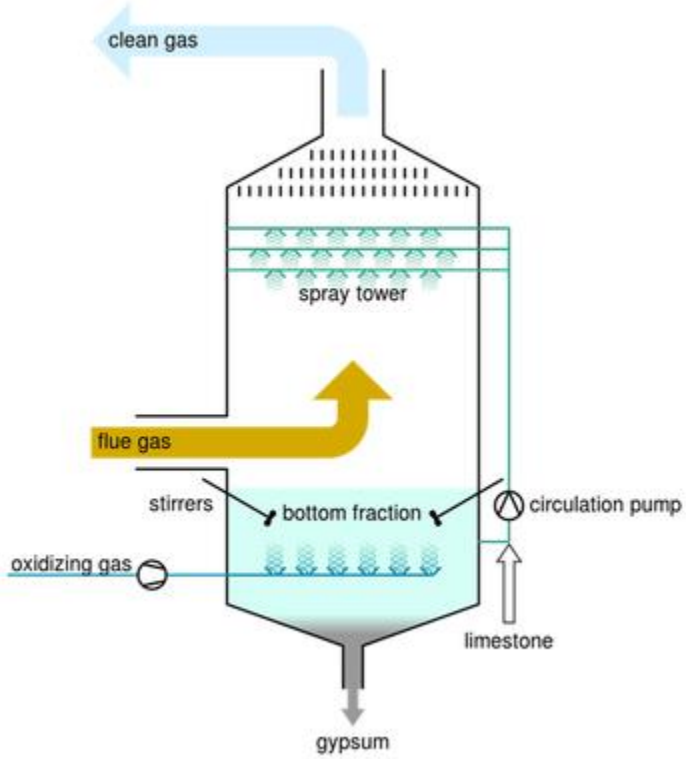
An electrostatic precipitator or electrostatic air cleaner is a particulate collection device that removes particles from a flowing gas (such as air) using the force of an induced electrostatic charge. Electrostatic precipitators are highly efficient filtration devices that minimally impede the flow of gases through the device, and can easily remove fine particulate matter such as dust and smoke from the air stream.

c. Particulate Scrubbers:

The term wet scrubber describes a variety of devices that remove pollutants from a furnace flue gas or from other gas streams. In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid, by spraying it with the liquid, or by forcing it through a pool of liquid, or by some other contact method, so as to remove the pollutants.

The design of wet scrubbers or any air pollution control device depends on the industrial process conditions and the nature of the air pollutants involved. Scrubbers can be designed to collect particulate matter and/or gaseous pollutants. Wet scrubbers remove dust particles by capturing them in liquid droplets. Wet scrubbers remove pollutant gases by dissolving or absorbing them into the liquid. For example: the flue gases from the furnace of steam generator contain enough amount of SO_2, which cannot exhaust directly into the atmosphere because later it will cause the acid rain. Before exhausting into

the atmosphere, the flue gases are sprayed with mixer of water and limestone to denaturalizing the toxic effects of SO_2. In this way SO_2 can be chemically locked and in the mixture of water and limestone which results in formation of gypsum. This settles down in the bottom of the wet scrubber.



d. Vehicular pollution can be checked by regular tune-up of engines; replacement of more polluting old vehicles; installing catalytic converters; by engine modification to have fuel efficient (lean) mixtures to reduce CO and hydrocarbon emissions; and slow and cooler burning of fuels to reduce NOx emission.

e. Using low sulphur coal in industries.

f. Minimize/modify activities which cause pollution e.g. transportation and energy production.