Department of biology

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((Environmental Pollution))

Stage (3)

LEC- ((3))

Air pollution

By

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Air pollution

1.The atmosphere

Without our atmosphere, there would be no life on earth. Two gases (nitrogen 78%, and oxygen 21%) make up the bulk of the earth's atmosphere . Argon, carbon dioxide and various trace gases make up the remainder.

The typical composition of unpolluted dry air is given in this table.

Constitutes	Molecular formula	Volume fraction
Nitrogen	N2	78%
Oxygen	O2	21%
Argon	Ar	0.93%
Carbon dioxide	CO2	0.032%
Neon	Ne	18ppm
Helium	He	5.2ppm
Methane	CH4	1.3ppm
Krypton	Kr	1ppm
Hydrogen	H2	0.5ppm
Nitrous oxide	N2O	0.25ppm
Carbon monoxide	CO	0.1ppm
Ozone	O3	0.02ppm
Sulfur dioxide	SO2	0.001ppm
Nitrogen dioxide	NO2	0.001ppm

For purpose of dealing with air pollution, it is necessary to have a rough idea of the temperature distribution with atmospheric layers.

1.1:Troposphere

This is the layer of the atmosphere closest to the Earth's surface, extending up to about 10-15 km above the Earth's surface. It contains 75% of the atmosphere's mass, in which the temperature decrease fairly steadily from the ground temperature to a temperature of -50 °C. The air in the troposphere is well mixed by currents. This layer contains most of

the atmospheric water, clouds and particulate matter. The temperature curve changes slop rather suddenly in a narrow transitional layer known as the *tropopause*.

1.2: Stratosphere

Above the tropopause is the stratosphere, typically 50km high, in which the temperature curve shows a warming trend with increasing height. This warming due to absorption of solar ultraviolet by ozone. The air in the stratosphere is very dry. The *stratopause* at the top of stratosphere.

1.3: Mesosphere

Mesosphere located directly above the stratosphere, extending from 50 to 80 km above the Earth's surface, in which the temperature again decreases with height with a very coldest temperature in the atmosphere, typically about -100 °C. The region of minimum temperature is the *mesopause.*

1.4: Thermosphere

The thermosphere extends from 80 km above the Earth's surface to outer space. This layer is very hot and may be reaching to thousands degrees.

2. Air pollutants

Air pollutants are generally defined as " **substances emitted into the atmosphere by both natural and anthropogenic (human-caused) sources, that are capable of causing harm to the environment in general, and living organisms in particular**".

The major five air pollutants are particulate matter, carbon monoxide, sulfur oxides, hydrocarbons and nitrogen oxides.

1.Particulate matter

They are tiny fragments of solid or liquid nature suspended in the air (aerosols). Particles may be ***primary*** – when emitted directly into the atmosphere by sources, or ***secondary*** – when particles are formed in the atmosphere through the interaction of primary emissions. Solid particles between **1 and 100 µm** in diameter are called *dust* particles, while solid particles **less than 1 µm** in diameter are called *fumes*, or *smoke*.

The major sources

Anthropogenic particles account for around 10% of the total amount of particles in the atmosphere. Fossil fuel combustion is one of the main processes which causes vast amounts of particles to be emitted into the atmosphere.

The major anthropogenic sources of airborne particles are; Road transport, Electrical power generating and other processes. While main natural sources of particles are;

1- Erosion of soil by wind which generates *dust* particles that travel around the globe.

2- Evaporation of droplets of sea water resulting in sea *salt crystals* being suspended in the air.

3- Volcanoes

4- Forest fires

Effects of particulate matter

Particles less than 10 μm in diameter are of biggest concern to human and animal health as they can be easily inhaled and get trapped in the respiratory system. The most harmful particles are the small ones. The smaller particles reach the lung more easily, and a greater proportion of them remain in the lung. Unfortunately, toxic substance are more expected to be found in the smaller particles.

The four chief human illnesses resulting from particulate matter are listed below:

1- Chronic bronchitis. The bronchial tubes are permanently damaged.

2- Bronchial asthma : foreign matter leads to an allergic reaction which cause shortness of breath.

3- Emphysema

4- Lung cancer

2.Sulfur Dioxide (SO2)

Sulfur dioxide is a colorless gas with acrid taste. The most important sulfur emitted by pollution sources is sulfur dioxide(SO2) and this form oxidized to SO3 in the atmosphere by photochemical or catalytic processes, in the presence of humidity the SO3 becomes sulfuric acid or sulfate salt, both of which dangerous to

health. The SO2 in the atmosphere lasts only a few days at most, and this reason that the SO2 mass in the atmosphere is so small compared to annual emissions by humans.

Sources of Sulfur Dioxide Emissions

Sulfur is contained within all fossil fuels, and is released in the form of *sulfur dioxide* (SO2) during fossil fuel combustion. Fossil fuel combustion accounts for almost all anthropogenic (human-caused) sulfur emissions.

Sulfur contents in fossil fuels range between 0.1% and 4% in oil, and up to 40% in natural gas . Also it is produced by volcanoes and in various industrial processes.

Effects of Sulfur Dioxide

Sulfur dioxide found in the air produces following effects ;

1- **Irritates eyes, nose, throat**

2- **Damages lungs when inhaled**

3- **As part of acid rain:**

- acidifies lakes and streams
- destroys plant and fish life in lakes and streams
- may cause reduction of forest and agricultural yields
- corrodes metals
- damages surfaces of buildings.

3. Carbon monoxide (CO)

Carbon monoxide is a colorless, odorless and tasteless gas which is highly toxic to humans. The combustion of carbon-based fuels produces carbon dioxide (CO2). But not all such combustion is complete, and this leads to the production of carbon monoxide (CO).

The sources

Motor vehicles and industry are among the largest anthropogenic sources of carbon monoxide emissions.

Effects of Carbon Monoxide Emissions

Carbon monoxide is the most common type of fatal poisoning in many countries around the world.

The toxic effects of CO on human beings and animals arise from its reversible combination with hemoglobin (Hb) in the blood.

$$HbO_2 + CO \; HbCO + O_2$$

Hemoglobin has a much greater affinity for CO than it does for O_2 . The combination of hemoglobin with CO lessens the oxygen-carrying capacity of the blood so that less O_2 is available to the body cells. It also reduces the dissociation of oxyhemoglobin (HbO_2) in to hemoglobin and oxygen so that anoxia (Oxygen starvation) may result , although the blood is carrying several times as much O_2 as the body requires.

4.Nitrogen Oxides

Although many different oxides of nitrogen are known, only nitric oxide and nitrogen dioxide are emitted to the atmosphere in significant quantities by humans activities. Nitric oxide (NO) is a colorless gas. While nitrogen dioxide (NO_2) is a gas of reddish-brown color with a distinct sharp odor. Combustion of fuels always produces both NO_2 and NO.

Anthropogenic Sources of Nitrogen Oxides Emissions

Road transport (motor vehicles) is by far the largest contributor of nitrogen emissions. Other sources are energy production and industrial activities.

Effects of Nitrogen Dioxide (NO_2) Emissions

When inhaled, nitrogen dioxide becomes a serious air pollutant which may:

1- Cause pulmonary edema (accumulation of excessive fluid in the lungs).

2- Be part of acid rain (destroying fish and plant life in lakes, damaging surfaces of buildings etc).

3- Contribute to photochemical smog.

5.Hydrocarbons

Hydrocarbons are chemical compounds containing only carbon and hydrogen. Open chain hydrocarbons contain noncyclic chains of carbon atoms to which hydrogen atoms are bounded; they may be saturated (paraffinic) such are methane and propane , or unsaturated (olefinic) such as ethylene. Cyclic hydrocarbons contain rings of carbon atoms; they may be saturated or an saturated .

The light hydrocarbons are gaseous at ordinary temperature , examples, methane, propane and ethylene. Heavier hydrocarbons , such as those which occur naturally as petroleum are liquids. Very heavy hydrocarbons may be solids at ordinary temperature. The gaseous of hydrocarbons are the ones of particular concern as air pollutants . Hydrocarbons with more than 12 carbon atoms are not present in the atmosphere in concentrations high enough to be of concern.

The sources

Natural sources of hydrocarbons are largely biological. Hydrocarbons emissions attributable to humans reaching to 90 million metric tons annually.

The effects

The only pure hydrocarbon known to be capable of harming plants at concentrations that occur in or near urban regions is ethylene, whose role in inhibiting plant growth. Open Chan hydrocarbons appear to have no effects on human beings at level below 500ppm. Hydrocarbons are of particular concern because they are involved in the production of photochemical oxidants, which cause eye irritation and other effects.

Classical and photochemical Smog

Air pollution in urban regions is often referred to as smog. During foggy weather, when little wind was present the smoke produced by the coal would mix with the fog and form smog.

Smoke + Fog = Smog

The smog made it difficult for people to see and breathe. In 1952 the great London smog occurred, killing 4000 or more people.

Today , the London type smog is often referred to as classical smog, whereas the Los Angeles type smog, which is quit different, is referred to photochemical smog, because it is formed through chemical reactions involving sunlight.

Table below lists some of the characteristics of the two types of smog

Characteristics	Classical smog	Photochemical smog
1.First occurrence noted	London	Los Angeles
2.Major pollutants	Sulfur oxides and particulate matter	Ozone, nitrogen oxides, hydrocarbons, carbon monoxide and free

		radicals
3.Principal sources	Industrial and fuel combustion	Motor vehicle fuel combustion
4.Effects on humans	Lung and throat irritation	Eye irritation
5.Effects on compounds	Reducing	Oxidizing
6. Time of occurrence of worst episodes	Winter months (especially in early morning)	Around midday of summer months