1.1 ENVIRONMENTAL CONSEQUENCES OF FOSSIL FUEL USE

The conversion of energy from one form to another generally affects the environment. Hence, without considering the impact of energy on the environment, the study of energy is not complete. Fossil fuels have been used since 1700s which has helped the industrial growth and the amenities of modern life. During the combustion of fossil fuels the emitted pollutants are strongly responsible for smog, acid rain, global warming and climate change.

1.2.1 Major air pollutants and their sources are listed below:

Carbon monoxide (CO):

This is a colorless, odorless gas that is produced by the incomplete burning of carbon-based fuels including petrol, diesel and wood. It is also produced from the combustion of natural and synthetic products such as cigarettes. It lowers the amount of oxygen that enters our blood. It can slow our reflexes and make us confused and sleepy

Carbon dioxide (CO_2):

This is the principle greenhouse gas emitted as a result of human activities such as the burning of coal, oil, and natural gases.

Chlorofluorocarbons (CFC):

These are gases that are released mainly from air conditioning systems and refrigeration. When released into the air, CFCs rise to the stratosphere, where they come in contact with other gases, which lead to a reduction of the ozone layer that protects the Earth from the harmful ultraviolet rays of the Sun.

Lead:

This is present in petrol, diesel, lead batteries, paints, hair dye products, etc. Lead affects children in particular. It can cause nervous system damage and digestive problems and, in some cases, cause cancer.

Ozone (O_3):

This occurs naturally in the upper layers of the atmosphere. This important gas shields the Earth from the harmful ultraviolet rays of the Sun. However, at the ground level, it is a pollutant with highly toxic effects. Vehicles and industries are the major source of ground level ozone emissions. Ozone makes our eyes itch, burn, and water. It lowers our resistance to colds and pneumonia.

Nitrogen oxide (NOx):

This causes smog and acid rain. It is produced from burning fuels including petrol, diesel, and coal. Nitrogen oxides can make children susceptible to respiratory diseases in winters.

Suspended particulate matter (SPM):

This consists of solids in the air in the form of smoke, dust, and vapour that can remain suspended for extended periods and is also the main source of haze, which reduces visibility. The finer of these particles, when breathed in can lodge in our lungs and cause lung damage and respiratory problems.

Sulfur dioxide (SO_2):

This is a gas produced from burning coal, mainly in thermal power plants. Some industrial processes, such as production of paper and smelting of metals, produce sulfur dioxide. It is a major contributor to smog and acid rain. Sulfur dioxide can lead to lung diseases

The major areas of environmental problems may be classified as follows water pollution, ambient air quality, hazardous air pollutants, maritime pollution, solid waste disposal, land use and sitting impact, acid rain, stratospheric ozone depletion, global climate change(Green House Effect)

1.2.2 Vital Problems Because of Environmental Issues:

Acid Rain:

Acid rain is a widespread term used to describe all forms of acid precipitation (rain, snow, hail, fog, etc.) Atmospheric pollutants, particularly oxides of sulfur and nitrogen, can cause precipitation to become more acidic when converted to sulfuric and nitric acids, hence the term acid rain. Motor vehicles also contribute to SO2 emissions since petrol and diesel fuel also contains small amounts of sulfur.

The sulfur oxides (SO_2) and nitric oxides (NO) react with water vapors (H_2O) and other chemicals in the atmosphere in the presence of sunlight to form sulfuric acid (H_2SO_4) and nitric acid (HNO_3).

These are below in above Figure 1.2. The acids formed usually dissolve in the suspended water droplets in clouds or fogs. These acid-laden droplets are washed from the air to the soil by rain or snow onto the Earth. This is known as acid rain

The soil is capable of neutralizing a certain amount of acid. However, the power plant, which uses high-sulfur coal, pollutes many lakes and rivers in industrial areas that have become

too acidic for fish to grow. Forests in different regions of the Earth also experience a slow death due to absorption of acids from acid rain through the leaves, needles and roots of the trees.

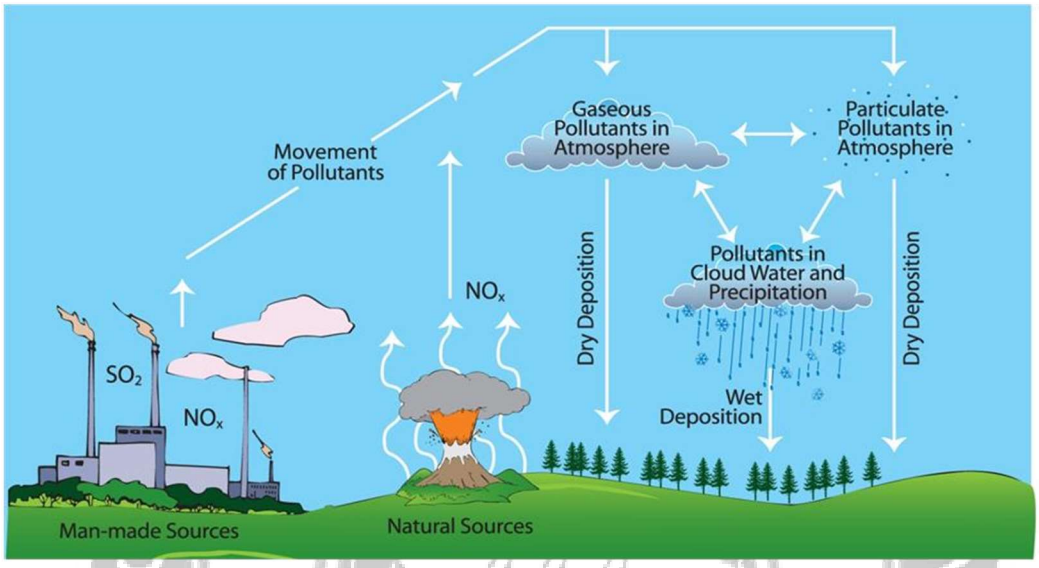

Figure 1.1.1

[Source: "Renewable Energy Sources and Emerging Technologies" by D.P.Kothari,K.C Singal, RakeshRanjan, Page: 225]

Depletion of Ozone Layer:

It is well known that the natural build up of oxygen in the atmosphere gradually led to the formation of the ozone layer. This layer is found between 19 and 30 kilometers (km) above the ground. The ozone layer filters out incoming radiation from the Sun that is harmful to life on Earth. The development of the ozone layer allowed more advanced life forms to evolve. Most ozone is produced naturally in the stratosphere, a layer of atmosphere between 10 and 50 km above the Earth"s surface, but it can be found throughout the whole of the atmosphere. The ozone layer plays a natural and equilibrium maintaining role for the Earth through the absorption of ultraviolet (UV) radiation (240–320 nm) and absorption of infrared radiation

A global environmental problem is the distortion and regional depletion of the stratospheric ozone layer. This effect due to the emissions of NOx and CFCs, etc. Ozone depletion in the stratosphere can lead to increased levels of damaging ultraviolet radiation reaching the ground. This increases rates of skin cancer, eye damage and other harm to many biological species. Chlorofluorocarbons (CFCs) and NOx emissions are produced by fossil fuel and biomass combustion processes and play the most significant role in ozone depletion. Hence, the major pollutant, NOx emissions, needs to be minimized to prevent stratospheric ozone depletion

Global Warming and Climate Change (Greenhouse Effect):

The greenhouse effect is a process by which radiative energy leaving a planetary surface is absorbed by some atmospheric gases, called greenhouse gases. They transfer this energy to other components of the atmosphere, and it is reradiated in all directions, including back down towards the surface. This transfers energy to the surface and lower atmosphere, so the temperature there is higher than it would be if direct heating by solar radiation were the only warming mechanism

The greenhouse effect is also experienced on a larger scale on Earth. This warms up as a result of the absorption of solar energy (shortwave length) during the day, cools down at night by radiating part of its energy into deep space as infrared radiation (long wavelength). Carbon dioxide (CO2), water vapour and trace amounts of some other gases such as methane (CH4) and nitrogen oxides act like a blanket and keep the Earth warm at night by blocking the heat radiation from the Earth, as shown in the Figure 1.2 Therefore, they are called "greenhouse effect"" gases. In this case, the CO_2 is the primary component.

The greenhouse effect makes human life on the planet Earth feasible by keeping the Earth warm at about 30°C. However, excessive amounts of greenhouse gases emitted by human being disturb the delicate balance by trapping too much energy. This causes the average temperature of the Earth to rise and the climate generally changes at some localities. These undesirable features of the greenhouse effect are generally referred to as global warming or climate change

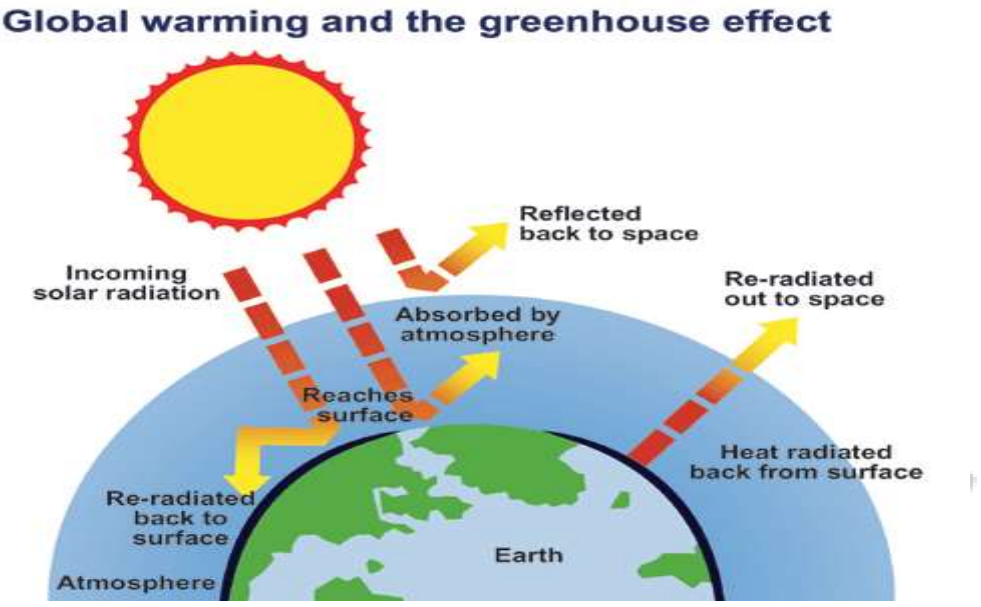

Figure 1.1.2

[Source: "Renewable Energy Sources and Emerging Technologies" by D.P.Kothari,K.C Singal, RakeshRanjan, Page: 226]

The excessive use of fossil fuels such as coal, petroleum products and natural gas, petroleum products and natural gas in electric power generation, transportation and manufacturing processes is responsible for global climate change. The present concentration of CO2 in the atmosphere is about 416.39 ppm . This is 20 percent higher than the level a century ago.Under normal conditions, vegetables consume CO_2 and release CO_2 during the photosynthesis process, thus keeping the CO_2 concentration in the atmosphere in check. A mature growing tree consumes about 12 kg of CO_2 a year and exhales enough oxygen to support a family of four. However, deforestation and the huge increase in CO_2 production due to the fast growing industrialization in recent decades have disturbed this balance.