Acid Rain

Acid Rain Rain is slightly acidic because it contains dissolved carbon dioxide (CO_2). Sulpher dioxide (SO_2) and Nitrogen oxides (NO_x) which are normally present in the air. Acid rain contains more acidity than the normal value because of presence of acidions due to the dissolution of these gases present in higher concentration. Acid rain, therefore, is the direct consequence of air pollution caused by gaseous emissions from industrial sources, burning of fuels (thermal plants, chimneys of brick-kilns or sugar mills.) and vehicular emissions. It is not necessary that acid rain will occur locally near the sources of air pollution. Due to the movement of air, acid rain may occur for away from the source. For instance, U.K. contributes 26% of the acidic sulpher deposited in the Netherlands, 23% in Norway and 12% in Sweden. Acid emissions arise naturally from volcanoes, forest fires and biological decomposition, especially in the oceans. But their contribution to a acid rain are SO_2, NO_x and to a lesser extent CO_2 and HC1 gas. SO_2 pollutions is mostly contributed by thermal power plants, refineries industry and NO_x form road transport, power stations and industry. The acid gas concentrations in the air will vary according to location, time and weather conditions.

Effects of Acid Rain

The most important effects are: damage to freshwater aquatic life, damage of vegetation and damage to buildings and material. a) Damage to aquatic life: - The main impact of fresh water acidification is a reduction in diversity and populations of fresh water species. The effect on soil and rock will depend upon the in situ capacity called ‘buffering capacity’ to neutralize the acids. The soil organisms are killed in acid rain where soils have limited buffering capacity. The acidic leaf litter in forest areas adds to the nutrient leaching effects of acid rain. This scavenging from cloud increases the amount of pollution deposited. Trees are quite effective in intercepting the air borne pollutants than other types of upland vegetation. In the areas of high acid deposition and poor buffering in the lakes, a PH less than 5 has become common. At PH 5, fish life and frogs begin to disappear. By PH 4, 5, virtually all aquatic life has gone. Acid rain releases metals particularly aluminium-from the soil, which can build up in lake water to levels that are toxic to fish and other organisms. A decline in fish and amphibian population will affect the food chain of birds and mammals that depend on them for food.

b) Damage to Trees and Plants

For some years there has been concern about the apparent deterioration of trees and other vegetation. It is not easy to establish the cause of damage: pollution, drought, frost, pests and forst management methods can all affect tree health. SO_2 has a direct toxic effect on trees and in parts of central Europe for example where SO_2 levels are very high, extensive areas of forest have been damaged or destroyed. Acid deposition may combine with other factors to affect tree health; for instance by making trees more susceptible to attack by pests, or by acidifying soils which may cause loss of essential nutrients such as magnesium, thus impairing tree growth. Nitrogen and sulphur are both plant nutrients and deposition can upset the balance of natural plant communities by encouraging the growth of other plant species. Secondary pollutants like ozone are also known to exacerbate the effects of acid deposition.

c) Damage to Buildings and Materials

All historic buildings suffer damage and decay with time. Natural weathering causes some of this but there is no doubt that air pollution, particularly SO2, also plays an important part. SO2 penetrated porous stones such as limestone and is converted to calcium sulphate, which causes gradual crumbling. Most building damage happens in urban areas where there are many SO2 emitters (domestic chimneys, factories and heating plant). The introduction of the Clean Air Acts and the replacement of coal fires by gas and electricity has greatly reduced sulphur dioxide levels in urban areas. Other materials badly affected by pollutant gases include marble, stained glass, most metals and paint. Poorly set or fractured concrete may also allow sulphates to penetrate and corrode the steel reinforcement inside.

REDUCING ACID POLLUTION

Sulphur Dioxide

The sulphur which is present in nearly all fossil fuels combines with oxygen when the fuel is burnt and is released into the atmosphere as SO2 gas. These emissions can be reduced by measures taken before, during, or after the combustion process.

One approach is to use fuels which naturally have little sulphur in them. The sulphur content of coal can vary considerably. Some fuels may be treated to reduce their sulphur content, but effective treatment is expensive. Demand for low sulphur fuels is increasing as more countries develop programmes to reduce sulphur pollution, so they are becoming more expensive. During combustion it is possible to reduce the eventual emissions of SO2 by the introduction of a sorbent such as limestone. The potential for sulphur reduction by this approach depends on the type of furnace or boiler.

After combustion, sulphur can be removed from flue gases or ‘scrubbed’. This process is known as the flue gas desulphurization (FGD). In most FGD system a mixture of limestone and water is sprayed into the flue gas. The SO2 is converted to gypsum (calcium sulphate), which can be used in the manufacture of plaster products. However, FGD systems of this type are expensive and use considerable amounts of limestone. If all power stations were fitted with FGD, gypsum production would exceed requirements, leading to a waste disposal problem. Although such a programme would increase limestone extraction by about 5%, there would be a useful reduction in gypsum quarrying.

An alternative to limestone FGD systems is the regenerative FGD approach in which SO_2 is captured by a substance which can be recycled. Sulphur or sulphuric acid is obtained as a by-product and can be used in the chemical industry. Again, there are limits to the amount of by-product which industry can use.

Although FGD can reduce sulphur emissions by up to 90%, such systems use extra energy and, therefore, increase emissions of the greenhouse gas CO_2.

Nitrogen Oxides

NO_x is produced partly from the oxidation of nitrogen contained in the fuel and partly as a result of high temperature and pressure combustion, which oxidizes nitrogen in the air. Furnace burners can be changed to reduce outputs of NO_x by up to 40% (low-NO_x burners). NO_x in flue gas can be reduced by adding ammonia and passing it over a catalyst to produce nitrogen and water. This process is called selective catalytic reduction (SCR) and can reduce NO_x from combustion plant by 85%, NO_x produced by cars can also be treated by using catalysts; fitting a catalytic converter to the exhaust system reduces NO_x emissions by up to 90%, although it may increase emissions of CO_2.

Other Options

Since most acid pollution comes from burning fossil fuels, one way of reducing emissions is to reduce the overall demand for energy by encouraging energy conservation and improving the efficiency of electricity generation. Another option is to develop non-fossil fuel energy sources such as nuclear power or renewable energy (solar, wind, tidal power, etc.) However these have their own environmental problems which must be balanced against those of fossil fuels.

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