

Acid Rain-The Major Cause of Pollution: Its Causes, Effects

Subodh Kumar

*Assistant Professor, Chemistry Department
Chandra Kamal Mahavidhyalaya, Vichawa,
Mainpuri, Utter Pradesh, India.*

Abstract

Acidification of rain-water is identified as one of the most serious environmental problems of transboundary nature. Acid rain is mainly a mixture of sulphuric and nitric acids depending upon the relative quantities of oxides of sulphur and nitrogen emissions. Due to the interaction of these acids with other constituents of the atmosphere, protons are released causing increase in the soil acidity. Lowering of soil pH mobilizes and leaches away nutrient cations and increases availability of toxic heavy metals.

Keyword: Acid rain, sulphuric, Deposition, nitrogen, pollutants Causes, Effects, Control PDF of full length paper is available with author .

INTRODUCTION

Since the beginning of civilization, human beings have used various natural resources for their benefit. To make their life easier, they have produced facilities that use many of the Earth's energy resources. . On one side this kind of development makes our lives easier, but on the other hand it results into pollution by release harmful substance into environment. Acid rain is the most serious environmental problems emerged due to air pollution. Acid rain is particularly damaging to lakes, streams and forests, and the plants and animals that live in these ecosystems. Rain is one of the most essential ingredients for human and animal life. The water provided by rain allows all life on

Earth to survive. Although rain is naturally acidic, it is being increasingly acidified by pollution from homes, factories, power stations and cars. The term used to describe this problem is “acid rain”. **Acid rain** hasn’t just occurred in the last twenty to thirty years. This was over 100 years ago. For years ever since most of the world has been industrialized, the effects of pollution have plagued nations alike. Acid rain is one of the largest contributors to this industrialized form of pollution.

New Delhi adds 1,500 poorly regulated new cars to its roads every day, so it's no wonder that the city is choking on auto exhaust. Asian air pollution kills 2 million people every year. Tough emissions laws in the U.S. explain why we're breathing better, despite adding cars, population and miles traveled. Acid rain is also called acid deposition because this term includes other forms of acidic precipitation such as snow. It is two types of deposition:

1. Wet deposition
2. Dry deposition

Wet Deposition

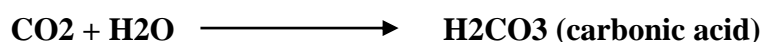
Wet deposition refers to acidic rain, fog, and snow. If the acid chemicals in the air are blown into areas where the weather is wet, the acids can fall to the ground in the form of rain, snow, fog, or mist. As this acidic water flows over and through the ground, it affects a variety of plants and animals.

Dry Deposition

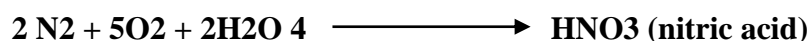
In areas where the weather is dry, the acid chemicals may become incorporated into dust or smoke and fall to the ground through **dry deposition**, sticking to the ground, buildings, homes, cars, and trees. Dry deposited gases and particles can be washed from these surfaces by rainstorms, leading to increased runoff.

Causes of acidification:- Sulphur dioxide (SO₂) and oxides of nitrogen and ozone to some extent are the primary causes of acid rain. These constituents interact with reactants present in the atmosphere and result into acid deposition. The natural sources of sulphur pollutants are oceans and to much smaller extent from volcanic eruptions. The man-made sources of SO₂ emissions are the burning of coal and petroleum and various industrial processes (Cullis and Hirschler, 1980). Other sources include the smelting of iron and other metallic (Zn and Cu) ores, manufacture of sulphuric acids, and the operation of acid concentrators in the petroleum industry. The levels of NO_x are small in comparison to SO₂, but its contribution in the production of acid rain is increasing.

The degree of acidity is measured by pH value, it is shorthand version of potential hydrogen. The pH of normal rainwater is also acidic; the reason is that water reacts to a slight extent with atmospheric carbon dioxide (CO₂) to produce carbonic acid.



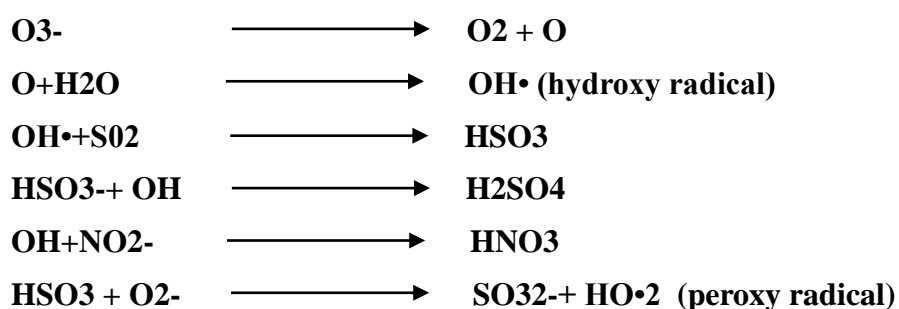
Small amount of nitric acid is also responsible for the acidity of normal rainwater, which is produced by the oxidation of nitrogen in presence of water during lightning storms.



Rain that presents a concentration of H⁺ ion greater than 2.5 μeq-1 and pH value is less than 5.6 is considered acid (Evans, 1984). Galloway et al. (1982) proposed a pH of 5.0 as a limit of natural contribution.

Chemical reactions during acid rain formation: The chemical reaction that results in the formation of acid rain involves the interaction of SO₂, NO_x and O₃. When the pollutants are vented into the atmosphere by tall smoke stacks, molecules of SO₂ and NO_x are caught up in the prevailing winds, where they interact in the presence of sunlight with vapours to form sulphuric acid and nitric acid mists. These acids remain in vapour state under the prevalent high temperature conditions. When the temperature falls, condensation takes the form of aerosol droplets, which owing to the presence of unburnt carbon particles will be black, acidic and carbonaceous in nature.

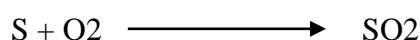
Acid reactions involving O₃:-



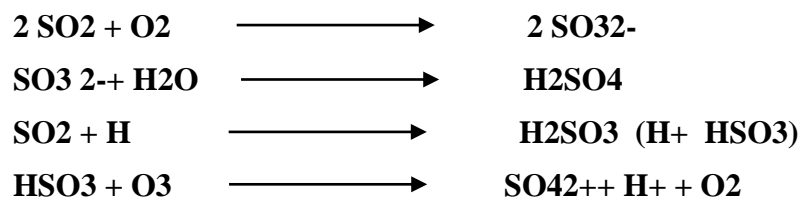
Peroxy radicals react with formaldehyde, acetaldehyde and form formic and acetic acids and some other organic acids, contributing to 5-20% acidity in total acid rain load.

Acid reactions involving sulphur:

Coal is especially rich in sulphur. As coal is burned, its component get oxidized



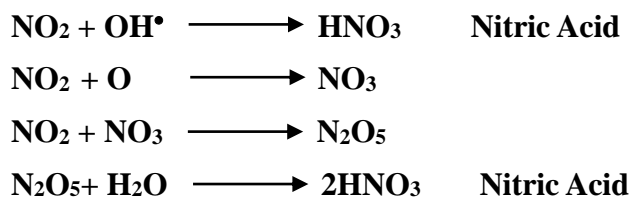
The oxidation of sulphur to SO₂ occurs directly in the flame; therefore SO₂ is discharged to the atmosphere from the smoke stacks. As SO₂ is swept along by the prevailing wind, it is slowly oxidized at ordinary temperature to SO₃-



Oxidant property of atmosphere plays an important role in conversion of SO_3^{2-} to SO_4 . Sulphur dioxide oxidation is most common in clouds and especially in heavily polluted air where compounds such as ammonia and O_3 are in abundance. These catalysts help to convert more SO_2 into sulphuric acid.



Acid reactions involving nitrogen:-



Effects of Acid Rain

After studying the Hubbard Brook Forest and other areas today, there are several important impacts of acid deposition on both natural and man-made environments. Aquatic settings are the most clearly impacted by acid deposition though because acidic precipitation falls directly into them. Both dry and wet deposition also runs off of forests, fields, and roads and flows into lakes, rivers, and streams.

Effects of acid rain on Health:-

Acid rain looks, feels, and tastes just like clean rain. The harm to people from acid rain is not direct. Walking in acid rain, or even swimming in an acid lake, is no more dangerous than walking or swimming in clean water. However, the pollutants that cause acid rain sulfur dioxide (SO_2) and nitrogen oxides (NO_x) do damage human health. These gases interact in the atmosphere to form fine sulfate and nitrate particles that can be transported long distances by winds and inhaled deep into people's lungs. Fine particles can also penetrate indoors. Many scientific studies have identified a relationship between elevated levels of fine particles and increased illness and premature death from heart and lung disorders, such as asthma and bronchitis.

Acid rain harms other plants

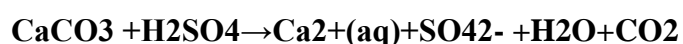
Acid rain can harm other plants in the same way it harms trees. Although damaged by other air pollutants such as ground level ozone, food crops are not usually seriously affected because farmers frequently add fertilizers to the soil .

Effects in the forest

Over the years, scientists, foresters, and others have noted a slowed growth of some forests. Leaves and needles turn brown and fall off when they should be green and healthy. In extreme cases, individual trees or entire areas of the forest simply die off without an obvious reason.

Effects on Stone Buildings and Monuments in Acid Rain

Marble and limestone have long been preferred materials for constructing durable buildings and monuments. . Marble and limestone both consist of calcium carbonate (CaCO₃), and differ only in their crystalline structure. Limestone consists of smaller crystals and is more porous than marble; it is used more extensively in buildings. Marble, with its larger crystals and smaller pores, can attain a high polish and is thus preferred for monuments and statues. Although these are recognized as highly durable materials, buildings and outdoor monuments made of marble and limestone are now being gradually eroded away by acid rain calcium carbonate and sulfuric acid (the primary acid component of acid rain) results in the dissolution of CaCO₃ to give aqueous ions, which in turn are washed away in the water flow.



This process occurs at the surface of the buildings or monuments; thus acid rain can easily destroy the details on relief work (*e.g.*, the faces on a statue), but generally does not affect the structural integrity of the building.

What's Being Done?

Because of these problems and the adverse effects air pollution has on human health, a number of steps are being taken to reduce sulfur and nitrogen emissions. Most notably, many governments are now requiring energy producers to clean smoke stacks by using scrubbers which trap pollutants before they are released into the atmosphere and catalytic converters in cars to reduce their emissions.

Control of acid rain:-

This can be achieved by following ways:

Liming:- The damage to lakes and other water bodies can be eliminated by adding lime. Many chemicals such as caustic soda, sodium carbonate, slacked lime and limestone are most popular for raising pH of acidified water (Khemani et al., 1985).

Liming eliminates some of the symptoms of acidification; it is expensive and not real cure.

Policy Intervention:- In 1970s and 1980s the effects of acid rain on natural resources and ecosystems became an issue of considerable public concern in both northwestern Europe and northeastern United States. Several northeastern States and the Province of Ontario, Canada, sued the US Environment Protection Agency in 1980 to take action to control acid precursor emissions emanating from states in the government. U.S congress formed the national acid precipitation assessment programme (NAPAP) and mandated NAPAP to conduct a 10-year scientific, technological and economic study of the acid rain issue under the acid precipitation act of 1980. The purpose of the study was to inform public policy by providing information on:

1. Specific regions and resources affected by acidic deposition.
2. How and where acid precursor emissions are transformed and distributed?
3. Whether the effects are extensive and require mitigation?
4. What emission control technologies and mitigation options are

REFERENCES

- [1] Brown, Lemay, and Buser. *Chemistry: the Central Science*, 7th ed. Upper Saddle River, NJ: Prentice Hall, 1997. p. 673-5.
- [2] Charola, A. "Acid Rain Effects on Stone Monuments," *J. Chem. d.* **64** (1987), p. 436-7.
- [3] Firor, J. (1992) *The Changing Atmosphere*, New Haven, CT: Yale University Press.