



CONSEQUENCES OF AN ACID RAIN AND ITS CONTROL MEASURES

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Abstract

Acidic rain is one among the chronic problems for the global climate change and ecological deformation of our surroundings. Acid rain as the name suggests can be given to the precipitation of acid in the form of rain. But this term actually is somewhat misleading because even pure rain water collected in areas remote from civilization is slightly acidic (pH = 5.6) due to dissolved carbon dioxide, which reacts with water to give carbonic acid, a weak acid. It's been reduced by pack up smokestacks and exhaust pipes furthermore as victimization alternatives energy sources for vehicles, fuel station and electricity generation for various purpose so as to measure in an exceedingly safe and appropriate atmosphere without concern of worldwide warming and inexperienced house gases. Herein, the chemical analysis of the acid rain, its consequences and control measures undertaken by the government and should be taken by us are described.

Keywords: Acid rain, environment.

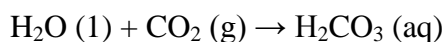


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Introduction

The term 'Acid Rain' was first used by Robert A. Smith in 1872 from his studies of air in Manchester, England. The widespread occurrence of acid rain was recognized only in 1980. Acid rain is a rain or any other form of precipitation that is unusually acidic, i.e., elevated levels of hydrogen ions (low pH). It is downpour containing harmful quantities of nitric and sulfuric acids which released into the atmosphere. When fossil fuels are burned, harmful emissions released into the air.

"Clean" or unpolluted rain has an acidic pH, but usually no lower than 5.7, because carbon dioxide and water in the air react together to form carbonic acid, a weak acid. However, unpolluted rain can also contain other chemicals which affect its pH. A common example is nitric acid produced by electric discharge in the atmosphere such as lightning. Carbonic acid is formed by the reaction.



Unlike the normal rain that we all knew; acid rain has a pH below 5.6 [1]. It could be considered as a result of air pollution. This is due to the presence of acidic oxide emissions in

the atmosphere from industries and vehicles. It has many other names such as acid precipitation or acid deposition. Emissions of sulfur dioxide and nitrogen oxides are causing the acid rain, which they can react with the water molecules to produce acids.

Acid rain could affect negatively on plants, aquatic animals, and infrastructure. Acid forming gases are oxidized over several days by which time they travel several thousand kilometers. In the atmosphere, these gases are ultimately converted into sulphuric and nitric acids. This acidic mixture then falls as rain, sleet, mist or snow or as solid flakes. Hydrogen chloride emission forms hydrochloric acid

Acid rain is the phenomenon of wet and dry acidic deposition. The phase of acid deposition can either be wet or dry. Acid rain, snow, dew, fog, frost and mist represent the wet form of deposition, while dust particles containing sulphates and nitrates, settled on earth, is called dry deposition. However, the wet acid rain is much more common.

Wet deposition of acids occurs when any form of precipitation (rain, snow, and so on) removes acids from the atmosphere and delivers it to the Earth's surface. This can result from the deposition of acids produced in the raindrops (see aqueous phase chemistry above) or by the precipitation removing the acids either in clouds or below clouds. Wet removal of both gases and aerosols are both of importance for wet deposition.

Dry deposition: Acid deposition also occurs via dry deposition in the absence of precipitation. This can be responsible for as much as 20 to 60% of total acid deposition [2]. This occurs when acidic particles and gases stick to the ground, plants or other surfaces. The wind blows these acidic particles and gases towards buildings, cars, homes and trees. Dry deposited gases and particles can also be washed from trees and other surfaces by rainstorms. When that happens, the runoff water adds those acids to the acid rain, making the combination more acidic than the falling rain alone

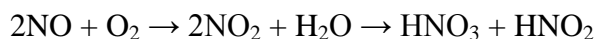
Methodology:

Acid rain is measured using pH meter from 1 to 14 value scales with a pH of 7.0 being neutral, 0 to 7 being acidic, and 7 to 14 basic [3]. When the pH value lowers, the acidity nature of rain increases. Pure water has a pH value of 7. However, normal rain is slightly acidic because different acidic oxide emissions react with rain that lowers the pH value about 5.6.

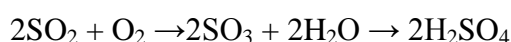
Discussions:

Chemical Reactions Involved in the Acid Rain:

- (i) Oxides of nitrogen like NO reacts with O₂ and H₂O produces nitrous and nitric acid as follows:



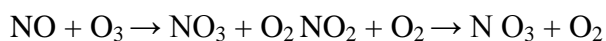
- (ii) Oxides of Sulphur also produce H₂SO₄ as follows:



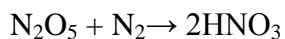
Every source of energy that we use-be it coal, fuel wood or petroleum products, has sulphur and nitrogen. These two elements, when burnt in atmospheric oxygen, are converted into their respective oxides (SO₂ and NO_x) which are highly soluble in water. By anthropogenic and by natural sources, oxides of sulphur and nitrogen enter the atmosphere.



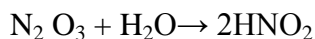
In case of nitrogen, following reactions are involved.



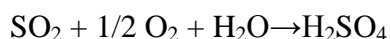
Under the humid conditions of air, N₂O₅ invariably reacts with water vapors to form droplets of HNO₃.



Some HNO₂ is also formed.



HNO₃ and HNO₂ then return to the earth's surface. However, HNO₃ can be removed as a particulate or as particulate nitrates after reaction with bases such as NH₃SO₃ in humid atmosphere forms droplets of H₂SO₄



HNO₃ and H₂SO₄ thus formed combine with HCl (emitted from natural and man-made sources) to generate precipitation which is commonly referred to as acid rain.

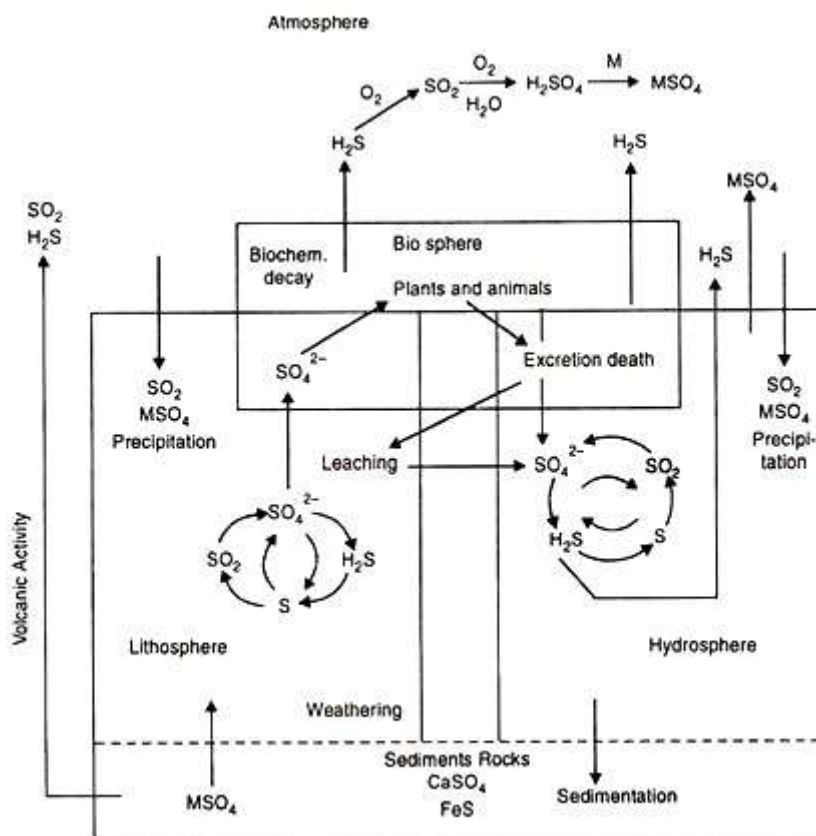


Fig. 1. Formation of sulphuric acid present in acid rain

A recent study conducted by ocean scientists from Florida State University, USA provides evidence of the greater role of atmospheric nitrogen, rather than of ground sources, in controlling the nitrogen levels of rivers.

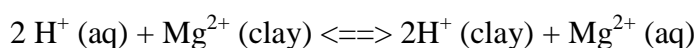
It was believed that ground sources such as fertilizer runoff from farmland and municipal waste streams contributed to the variation of nitrogen levels in rivers, But scientists from Florida analysed the data from two sources the acid rain measurements of National Atmospheric Deposition Programme and the River Chemistry Studies of US Geological Survey to conclude that the atmospheric deposition of nitrogen plays a major role in quality of water and acid rain is the most important sources of nitrogen.

The oxides of sulphur and nitrogen are swept up into the atmosphere and can travel thousands of kilometres. The longer they stay in the air, the more likely they are to be oxidised into acids.

For example, a given molecule of SO₂ may remain in the atmosphere up-to 40 hours, while a sulphate particle may remain for three weeks. They have enough long-life period and so these molecules may be wind transported several kilometres from their point of release.

During the last few decades acid rain occurred within the downwind of areas of major industrial areas in Europe and America. The chemicals in acid rain can cause paint to peel, corrosion of steel structures such as bridges, and erosion of stone statues. Both the lower pH and higher aluminium concentrations in surface water that occur as a result of acid rain can cause damage to fish and other aquatic animals. At pH lower than 5 most fish eggs will not hatch and lower pHs can kill adult fish. As lakes and rivers become more acidic biodiversity is reduced. Acid rain has eliminated insect life and some fish species, including the brook trout in some lakes, streams, and creeks in geographically sensitive areas, such as the Adirondack Mountains of the United States.

Soil biology and chemistry can be seriously damaged by acid rain. Some microbes are unable to tolerate changes to low pH and are killed. The enzymes of these microbes are denatured (changed in shape so they no longer function) by the acid. The hydronium ions of acid rain also mobilize toxins such as aluminum, and leach away essential nutrients and minerals such as magnesium.



Soil chemistry can be dramatically changed when base cations, such as calcium and magnesium, are leached by acid rain thereby affecting sensitive species, such as sugar maple (*Acer saccharum*). Parts of India such as North East, Coastal regions of Kerala, Orissa, Bihar, and West Bengal have reported decline in fertility of soil due to reduced pH of soil (increased in acidity).

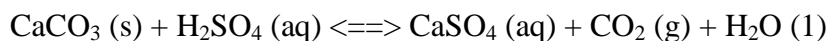
Acid rain not only damages soil but can also affect the trees directly. Pollutants can block or damage the little pores on the leaves through which the plant takes in the air it needs to survive. High altitude forests are especially vulnerable as they are often surrounded by clouds and fog which are more acidic than rain.

Other plants can also be damaged by acid rain, but the effect on food crops is minimized by the application of lime and fertilizers to replace lost nutrients. In cultivated areas, limestone may also be added to increase the ability of the soil to keep the pH stable, but this tactic is largely unusable in the case of wilderness lands. When calcium is leached from the needles of red spruce, these trees become less cold tolerant and exhibit winter injury and even death.

Acid rain does not directly affect human health. The acid in the rainwater is too dilute to have direct adverse effects. However, the particulates responsible for acid rain (sulphur dioxide and nitrogen oxides) do have an adverse effect. Increased amounts of fine particulate matter in the air do contribute to heart and lung problems including asthma and bronchitis.

Acid rain can also damage buildings and historic monuments and statues, especially those made of rocks, such as limestone and marble that contain large amounts of calcium carbonate.

When sulphur pollutants fall on to buildings made from limestone and sandstone they react with minerals in the stone to form a powdery substance that can be washed away by rain. Acids in the rain react with the calcium compounds in the stones to create gypsum, which then flakes off.



The effects of this are commonly seen on old gravestones, where acid rain can cause the inscriptions to become completely illegible. Acid rain also increases the corrosion rate of metals, in particular iron, steel, copper and bronze. Famous buildings like the Statue of Liberty in New York, the Taj Mahal in India and St. Paul's Cathedral in London have all been damaged by this sort of air pollution.

Control of Acid Rain: Governments have made efforts since the 1970s to reduce the release of sulphur dioxide into the atmosphere with positive results.

1. Clean up smokestacks and exhaust pipes: Emission of SO₂ and NO₂ from industries and power plants should be reduced by using pollution control equipment's such as scrubbers in the smokestacks of factories. These spray a mixture of water and limestone into the polluting gases, recapturing the sulphur. Almost all of the electricity that powers modern life comes from burning fossil fuels like coal, natural gas, and oil. However, exhaust emission of these fuels are the main causes of acid deposition that released into the atmosphere. Coal fuel accounts for most US SO₂ and a large portion of NO_x emissions. Sulphur is present in coal as an impurity, and it reacts with air when the coal is burned to form SO₂. In contrast, NO_x is formed when any fossil fuel is burned. There are several options for reducing SO₂ emissions, including using coal containing less sulphur, washing the coal, and using devices called scrubbers to chemically remove the SO₂ from the gases leaving the smokestack and recycling to use as a raw material. Power plants can also switch fuels; for example, burning natural gas creates much less SO₂ than burning coal. Certain approaches will also have additional benefits of reducing other pollutants such as mercury and carbon dioxide. Understanding these "co-benefits" has become important in seeking cost-effective air pollution reduction strategies. Finally, power plants can use technologies that don't burn fossil fuels. Each of these options has its own costs and benefits, however; there is no single universal solution. Similar to scrubbers on power plants, catalytic converters reduce NO_x emissions from cars. These devices have been required for over twenty years in the US, and it is important to keep

them working properly and tailpipe restrictions have been tightened recently. EPA has also made, and continues to make, changes to gasoline that allows it to burn cleaner dioxide of sulphur (SO₂) and NO_x

2. Liming of lakes and soils should be done to correct the adverse effects of acid rain. Powdered limestone added to water and soil to neutralize acid. It is commonly used in Norway and Sweden. However, it is more expensive and short-term remedy. Acid deposition penetrates deeply into the fabric of an ecosystem, changing the chemistry of the soil as well as the chemistry of the streams and narrowing, sometimes to nothing, the space where certain plants and animals can survive. Because there are so many changes, it takes many years for ecosystems to recover from acid deposition, even after emissions are reduced and the rain becomes normal again. For example, while the visibility might improve within days, and small or episodic chemical changes in streams improve within months, chronically acidified lakes, streams, forests, and soils can take years to decades or even centuries (in the case of soils) to heal. However, there are some things that people do to bring back lakes and streams more quickly. Limestone or lime (a naturally-occurring basic compound) can be added to acidic lakes to "cancel out" the acidity. This process, called liming. Liming tends to be expensive, has to be done repeatedly to keep the water from returning to its acidic condition, and is considered a short-term remedy in only specific areas rather than an effort to reduce or prevent pollution. Furthermore, it does not solve the broader problems of changes in soil chemistry and forest health in the watershed, and does nothing to address visibility reductions, materials damage, and risk to human health. However, liming does often permit fish to remain in a lake, so it allows the native population to survive in place until emissions reductions reduce the amount of acid deposition in the area

3. A coating of protective layer of inert polymer should be given in the interior of water pipes for drinking water.

4. In catalytic converters, the gases are passed over metal coated beads that convert harmful chemicals into less harmful ones.

5. Use alternative energy sources: There are other sources of electricity besides fossil fuels such as nuclear power, hydropower, wind energy, geothermal energy, and solar energy. Of these, nuclear and hydropower are used most widely; wind, solar, and geothermal energy have not yet been harnessed on a large scale. There are also alternative energies available to power automobiles, including natural gas-powered vehicles, battery-powered cars, fuel cells, biofuels and biodiesel and combinations of alternative and gasoline powered vehicles. All sources of energy have environmental costs as well as benefits. Some types of energy are

more expensive to produce than others. Nuclear power, hydropower, and coal are the cheapest forms today, but changes in technologies and environmental regulations may shift that in the future. All of these factors must be weighed when deciding which energy source to use today and which to invest for tomorrow

Conclusions:

Mostly, rainfall that has a pH value less than 5.6 is considered as acid rain. It is formed when sulphur dioxides and nitrogen oxides reacted with water during rain and as gases or fine. Acid rain is defined in terms of wet and dry depositions. The wet deposition refers to acidic rain, fog and snow whereas dry deposition refers to acidic gases and particles. This acid rain affects a variety of plants and animals in our environment. Hence, its reduction is potentially important for our future generations. we can reduce it by Clean up smokestacks and exhaust pipes as well as using alternative energy sources for vehicles and electricity generation for different purpose with the purpose of live in a safe and suitable environment.

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