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7. A Study on Effect of Acid Rain

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ABSTRACT

Since the 19th century, acid rain has been a severe menace to the environment. Acid rain is a severe environmental concern that has a negative influence on aquatic and terrestrial ecosystems because of the wet and dry deposition of acidic compounds from the sky. An acid rain storm is formed when the combustion of fossil fuels releases sulphur and nitrates into the air, which react with moisture in the air to form acid rain. Soil moisture and water bodies like ponds and lakes are affected by acid rain. Many plant and animal species are harmed by an increase in acidity. As a result of exposure to acid rain, people can suffer from a wide range of lung and eye irritation, asthma attacks, bronchitis, and other respiratory and cardiovascular diseases. Acid rain is primarily caused by rainwater containing excessive amounts of sulfur and nitrogen. As a result of human activity, such as the combustion of fossil fuels in thermal power plants and burnable wastes, automobiles, and planes, emissions of these gases have increased in the atmosphere.

KEYWORDS

Acid Rain, pH Value, Pollution, Corrosion.

Introductions:

Humans have been using the earth's resources since the dawn of time. A number of the Earth's energy resources are being used in order to make their lives easier. Aside from making our lives more convenient, this type of development also contributes to pollution by releasing harmful substances into our environment. Air pollution has caused the most catastrophic environmental issues, including acid rain.

Acid rain has a particularly negative impact on aquatic ecosystems, such as lakes, streams, and forests, as well as the animals and plants that rely on them for their life. [1] For both humans and animals, rain is a crucial element. Rainfall is essential to the survival of all species on Earth. Rain is inherently acidic, but pollution from homes, factories, power stations, and cars is making it even more acidic. It's called "acid rain" when it comes to this particular issue.

The term "acid deposition," which encompasses a wide range of processes through which acidity can be transported from the Earth's atmosphere to the planet's surface, is more often known as "acid rain." Besides rain, acid deposition includes other forms of acidic wet deposition, such as snow, hail, and fog (or cloud water). When it's dry, acidic particles and gases might be deposited on the ground, affecting the landscape. As a result, acid deposition can have a negative impact on landscapes and living organisms even when there is no precipitation. [2]

Causes Of Acidification:

SULFUR DIOXIDE (SO2), CARBON DIOXIDE (CO2), and NITROGEN OXIDES (NOX) are some of the air pollutants that cause acid rain. Sulfur dioxide and carbon dioxide are already present in the environment, but burning fossil fuels increases their concentration. This acid rain is formed when these pollutants are discharged into the atmosphere and react with water and other chemicals. [3]

The burning of coal and petroleum, as well as numerous industrial operations, are the main sources of SO2 emissions (Cullis and Hischler, 1980). These include iron and other metallic (Zn and Cu) ores, production of sulphuric acids, and operation of acid concentrators in the petroleum industry, among other things. NOx levels are relatively low compared to SO2, but their role in acid rain formation is growing. [4] Potential hydrogen (PH) is a measure of acidity, and the pH value is a shorthand for this. Water reacts with atmospheric carbon dioxide (CO2) in a little amount to form carbonic acid, which results in the pH of rainwater being acidic.

$$CO2 + H2O \longrightarrow H2CO3 \text{ (carbonic acid)}$$

The oxidation of nitrogen in the presence of water during lightning storms produces small amounts of nitric acid, which is also responsible for the acidity of typical rainwater. [5]

$$2\,N2 + 5O2 + 2H2O\ 4 \longrightarrow HNO3 \text{ (nitric acid)}$$

Acid rain has a pH value of less than 5.6 and a concentration of H+ ions more than 2.5 µeq-1.

Effects of Acid Rain:

In addition to damaging the environment, acid rain has a negative impact on human health. Acid rain produces eye, nose, and throat irritations, as well as lung problems, such as dry coughs, asthma, headaches, and bronchitis, as a result of sulphur dioxide and nitrogen oxide emissions (EPA, 2004). A buildup of ammonia in the atmosphere through the usage of urea and animal dung can lead to acid deposition. An invisible epidemic of the industrial era, acid rain has wide-ranging economic, social, and medical consequences. [6]

AQUATIC environments including streams, lakes and marshes are the most affected by acid rain. It is the rain that falls on woods and fields that eventually reaches lakes and marshes because of its acidic content. Acid rain is also a direct threat to aquatic life because of its acidic nature. Acidic rain is normally neutralised by soil's ability to buffer it. As a result, most lakes and streams have a pH of 6 and 8. When precipitation is so acidic that the surrounding soil is unable to neutralise it, lakes and streams become acidic (pH values decrease). [7] As a result, certain lakes in places where the soil lacks buffering capacity are naturally acidic even when there is no acid rain. Acidic water can be tolerated by some plants and animals. Those who are sensitive to acidity will either leave or die if the pH falls below a certain level. Acidic lakes have no fish since most fish eggs cannot hatch at a pH of 5 or lower. There's a risk of death for adult fish at lower pH values. [8]

Review of Literature:

One of the most serious effects of local pollution is acid rain. In this rain, sulfuric and nitric acids have tainted it with large levels of hydrogen ions (H+). The pH (potential hydrogen) scale of aquatic ecosystems is lowered by this substance (Singh & Shishodia, 2007). [9]

The pH of distilled water is 7. Acidic liquids have a pH of less than 7, and alkaline liquids have a pH of 7 to 14. Solution that has a pH value of 1–5 is considered acidic. Battery acid has a pH of 1, lemon juice has a pH of 2, and vinegar has a pH of 3. An acid rain pH range of 3.5–5 may be typical for anthropogenic emissions (Kim et al., 2007) [10].

Ecological implications of acid rain have been discussed by Aadit Gandhi and Parth Patel, and Girish Bagale. Acid rain also destroys man-made materials and structures, according to the researchers. They've discovered that acid rain is primarily caused by human activities including the burning of combustible waste, fossil fuels in thermal power plants, and automobiles (Gandhi et al., 2017). [11]

Objectives:

- As a way to draw attention to the history of acid rain,
- To find out what causes acid rain and how to prevent it
- An indicator of the places that are more prone to acid rain

Research Methodology:

To gather information, the researchers employed an exploratory research method based on earlier published articles from a variety of academic journals, annual reports, newspapers, and magazines. The study's goals dictate the research design, which is a descriptive one. The study relied heavily on secondary data.

Result and Discussion:

When pollution is released into the air at high altitudes, it remains in the air long. The longer pollution lingers in the air, the more likely it is that pollutants will produce acid rain. It is also possible for pollutants to be transported for long distances by the wind before they are

combined with water droplets and result in acid rain. Because of this, acid rain, or wet deposition, can be a concern even in places that are not near pollution sources. Pollutant deposition tends to be higher in urban and industrial regions because of the release of the pollutants. [12]

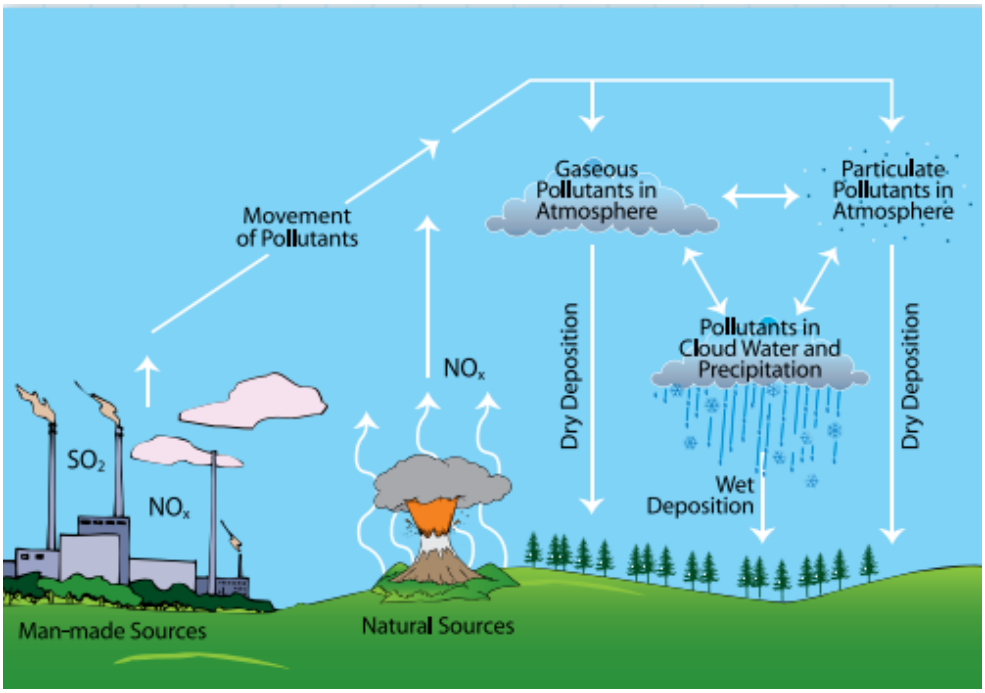


Fig. 1 Formation of Acid Rain

The pH scale is used to quantify acidity and alkalinity, and 7.0 is considered neutral. Chemically speaking, the more acidic or alkaline a substance is, the lower its pH (less than 7). Normal rain has a pH of about 5.6; it is slightly acidic because carbon dioxide (CO2) dissolves into it forming weak carbonic acid. The pH of acid rain is typically in the range of 4.2 and 4.4. [13]

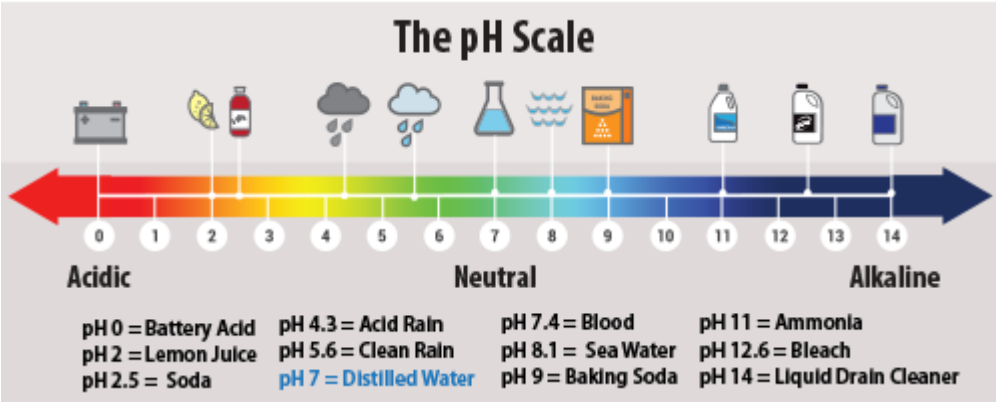
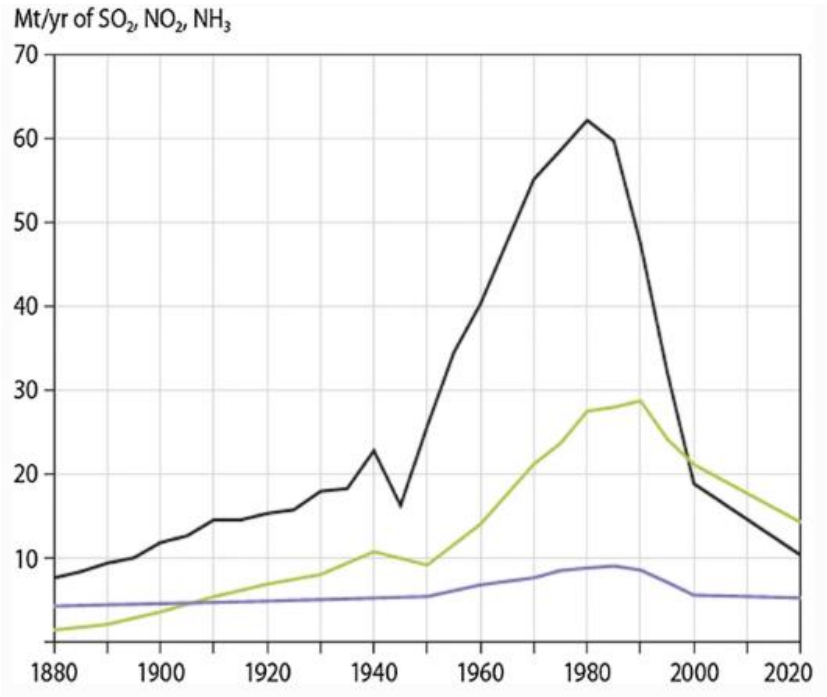


Fig. 2 Measuring Acid Rain

Sulphur dioxide emissions, the most important acidifying chemical, have declined by at least 80% in Europe since their maxima around 1980–1990, as have emissions of all other major air pollutants. [14]



Sulphur dioxide (SO2—black), nitrogen oxides (NOx, calculated as NO2—green) and ammonia (NH3—blue) emissions in Europe from 1880 to 2020 are depicted in the graph shown in Figure 3.

Aspects of the monitoring Wet and dry collectors are utilised by the National Acid Deposition Program (NADP) as shown in Figure 1: the container on the left collects rain water, while the container on the right measures dry deposition (see fig 4). Despite the fact that this is the traditional approach, electrical resistance sensors are now widely employed around the world. [15]

Fig. 4 Wet and Dry deposition collector (Source: NADP, n.d.).

Conclusion:

Since the 19th century, acid rain has been a major environmental issue. Also, car emissions and fossil fuel-based power generation release NOx. Coal burning is the primary source of SO2 production. In addition to suplhuric and nitric acid, both SO2 and NOx create precipitation as wet deposition (rain, snow, sleet and fog) and dry deposition (hazardous particles of PM 2.5), respectively, by reacting with atmospheric water vapour. Leaf yellowing and leaf fall can be caused by acid rain; acidified rivers and lakes can kill fish; calcareous shell-forming species (mollusks) can be lost; soil microorganisms can be affected, causing increased nitrification, which causes eutrophication and changes in the biodiversity. But despite the fact that property damage appears to be more important than ecological damage, as well as greater than lake and river acidification, little recent research has focused on quantifying property loss. Certainly, the costs of decreasing automotive emissions are significant, the health advantages are small, and the ecological benefits are in question. But reducing NOx emissions from stationary sources through improved burner designs and chemical additives may be less expensive.

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