



ACID RAIN-CAUSES, EFFECTS AND PREVENTIVE STRATEGIES

Shree Meenakshi. K Senior Research Fellow, Anna University.

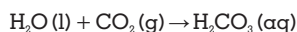
ABSTRACT

Acid rain was discovered in the 19th century by Robert Angus Smith, a pharmacist from Manchester (England), who measured high levels of acidity in rain falling over industrial regions of England and contrasted them to the much lower levels he observed in less polluted areas near the coast. Little attention was paid to his work until the 1950s, when biologists noticed an alarming decline of fish populations in the lakes of southern Norway and traced the problem to acid rain. Similar findings were made in the 1960s in North America (the Adirondacks, Ontario, Quebec). These findings spurred intense research to understand the origin of the acid rain phenomenon. In this research paper we will investigate and take a look at the key factors and the chemical origins of acid rain and the steps undertaken to prevent it.

KEYWORDS : acid rain, corrosion, industrial regions, acidity, pollution.

INTRODUCTION

Acid rain is considered one of the most dangerous factors of local pollutions. This rain possesses higher levels of hydrogen ions (H⁺) because of contamination of sulfuric and nitric acids. It decreases the pH (potential hydrogen) scale of aquatic ecosystems. Northeast America, Central Europe, and China have been identified as the three largest acid rain affected regions in the world. Distilled water has a neutral pH of 7. Liquids with a pH less than 7 are acidic, and those with greater than 7 to 14 are alkaline. If pH value lies in 1-5, the solution is felt like acid. For example, pH value of battery acid is 1, lemon juice is 2, and that of vinegar is 3. Typical pH values of acid rain for anthropogenic emissions may be in the range of 3.5-5. Rainwater mixed with carbon dioxide (CO₂) in the air to form the weak carbonic acid (H₂CO₃) with a pH of 5.6;



Acid rain is a type of acidic rain which is caused by hydrogen, nitrous and sulphuric compounds in the air mixing with ordinary rainwater, snow, fog, hail, and mist.

Certain chemicals in the atmosphere dissolve with water in the atmosphere. Sulphides and nitrates are the key chemicals in question here, as well as hydrogen – indeed, the more hydrogen that is added into the mix, the more acidic that rain will be.

Acid rain falls to the earth like normal rainfall, but instead of nourishing the earth in the way that natural rainfall does, acid rain:

1. has very negative effects on fish, plants, humans, and animals,
2. can poison lakes, wells, and drinking water,
3. erodes buildings, pavements, and statues, and
4. is able to destroy an entire forest or lake.

It is also worth noting that acid rain does not always take the form of rain: it can equally take the form of snow, hail, fog, mist, and sleet as long as it is acidic water (either in frozen or liquid form) falling to earth. All that is required is for sulphur and nitrogen compounds in the air to dissolve with water to form acidic compounds which then somehow fall to earth.

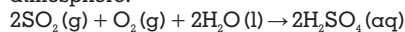
Calcium and magnesium are substances that are able to neutralize the acids in acid rain. Some rocks contain calcium and magnesium deposits naturally and so to some extent they are able to resist the effects of acid rain.

The phenomenon of acid rain was first discovered in 1853 in Canada when a lake was found to be 'dead' – i.e., saturated with acid to such an extent that the fish and aquatic mammals had died or left the lake, plant life could not survive, and the water was not fit for drinking. The cause of this environmental catastrophe was found to be acid rain.

THE CAUSES OF ACID RAIN

The key causes of acid rain are all human derived. Human activity is what is poisoning our planet by means of acid rain. Here are the main causes of acid rain. The two main culprits that are majorly responsible for acid rain – Sulphur Dioxide (SO₂) and Nitrous Oxide (NO_x). Both SO₂ and NO are released into the atmosphere by human activities. These pollutants are transported into the atmosphere by wind and air currents. Here they react with the water in the atmosphere and oxygen in the air to form Sulphuric Acid and Nitric Acid respectively. These acids then lower the pH value of rainwater, making it acidic and harmful.

Let us look at the chemical reactions that occur in the atmosphere.



The major causes of acid rain that release these pollutants (SO₂ and NO) into the air The biggest cause is electricity production by burning coal. This thermal electricity plants are responsible for about 70% of Sulphur Dioxide release in the world. They also release huge quantities of NO about 20% in total.

Any type of fossil fuels that we burn release both these pollutants. So, the burning of petrol and diesel to run automobiles, crafts and aeroplanes is one of the major causes of this pollution. Also, every production and manufacturing plant that uses pollutants is also at fault. Especially if they do not have an effective pollution control system in place. Therefore, the main reasons of acid rain can be classified as:

1. Burning fossil fuels in general: Levels of acid rain were negligible and basically non-existent until the industrial revolution really took off in the early nineteenth century. At this point, humans began burning large amounts of fossil fuels. Burning of fossil fuels releases huge amounts of hydrogen, sulphides, and nitrates into the atmosphere which fall back down to earth as acid rain. One key culprit here is the manufacturing industry, as many factories burn fossil fuels to power their machinery and also release harmful gases as a result of the synthetic materials that they use in the production process (the plastics industry is a big problem here).

2. Electricity generation: This is one of the biggest contributors to acid rain. Conventional methods for generating electricity involve gas and other fossil fuels and produce plenty of harmful waste gases. Burning of coal for electric generation in Thermal power plants is considered the greatest source for the release of green-houses that further cause Acid rain. By contrast, generating electricity using solar panels or other green alternatives such as wind farms does not cause such huge problems for the environment.

3. The shipping industry: The biggest ships in the container shipping industry generate most harmful gases. Nevertheless, it is definitely worth noting that travelling by car or bike also contributes to acid rain as the fumes from your vehicle's exhaust mingle with the clouds.

4. Agriculture: Using pesticides, intensive farming, and nitrate-based fertilizers can all release nitrates and other gases into the air. This, again, contributes to acid rain which poisons the very land that farmers are trying to cultivate.

5. Aviation: Jet fuel is a huge polluter of the air and the aviation industry is responsible for the production of a large proportion of our acid rain.

6. Natural causes: Chemicals are also released into the atmosphere as a result of natural phenomena. For example, when a volcano is erupted, it emits various gases such as hydrogen chloride, hydrogen sulphide, sulphur dioxide and carbon dioxide causing the atmosphere to become acidic. Some old glaciers are also very acidic.

EFFECTS OF ACID RAIN

Below are some of the highly negative effects that acid rain has on our planet and its environment.

1. Dissolving buildings: priceless buildings and statues are being destroyed by acid rain. Drop a pipette of sulphuric acid onto a piece of rock and you will most probably start to see the rock bubble and dissolve. This is precisely what acid rain does when it falls on both natural rock formations and on stone buildings. One very sad example of this happening is the Taj Mahal. This mid seventeenth century palace is of immense historical value, but acid rain has not only discoloured the stone of this edifice – it has also begun to smoothe away and dissolve some of the intricate patterns on the brickwork.

2. Poisoning water: over 88% of the beautiful Great Lakes in Michigan, US are affected by acid rain. Marine and freshwater organisms can be very sensitive to changes in the acidity of their watery environment. Acid rain poisons water and eventually creates what are known as 'dead zones' – i.e., areas of water where absolutely nothing is able to live or grow. In fact, acid rain was first discovered around a century and a half ago as a result of the appearance of a dead zone in a lake that was once teeming with life. Acid rain is also one of the causes for ocean acidification. When ocean water becomes acidic, the water ecosystem is disrupted. The water habitats face difficulties in acidic water.

3. Poisoning the soil: Acid rain can fall onto soil and, once it has soaked in to the soil, change its pH. Soil has a very specific pH, and plants need certain pH levels in order to grow and flourish. The pH of soil has developed over many years – sometimes even centuries – in order to create the perfect habitat for particular species of plants to grow in. When soil gets more acidic, fewer plants – including crops for humans to eat – can grow there. Farmers may attempt to solve the problem by pouring more fertiliser into the ground but, ultimately, this will just result in worsening the problem of acid rain.

4. Damaging human health: the poisonous acids in acid rain can also cause health problems in humans. Everything from respiratory diseases to eye allergies can result from living in an environment that is blighted by acid rain. They increase the risk of certain cancers, as well as making it more probable than humans will develop asthma and heart disease. Breathing in acid rain or acidic fog or mist can really irritate the respiratory tract of both humans and animals.

5. Effect on trees: Acid rain harms plant life by destroying its

food supply by shrivelling up green leaves. When acid rain falls on plants' leaves, these leaves can die very quickly. However, leaves provide an important source of food for plants by using their chlorophyll to absorb photons from the sun's rays and turn this into food for the plant by the process of photosynthesis. In addition, when the trees die, the whole ecosystem of the forest or wood will often collapse because animals who rely on the trees for shelter, shade, or vital nutrients will suddenly find their habitat drastically altered.

PREVENTATION AND CONTROL OF ACID RAIN

When acid rain falls to earth, acid rain can be devastating: it can dissolve buildings and statues, kill organisms, poison water, and harm human health. As a result, it is so important for us to take all of the steps that we can to prevent and control acid rain.

1. Stop burning fossil fuels: Oil, coal, and gas release nitrous and sulphuric compounds into the atmosphere and this results in acid rain. Prevent acid rain by switching to greener, cleaner energy sources such as solar energy and wind energy. Switching to these cleaner energy sources will also help to prevent other harmful environmental effects such as climate change and the greenhouse effect.

2. Take public transport: your car's exhaust pumps polluting chemicals into the air which will dissolve into the rain. Take the train or bus instead – or, for shorter distances, try cycling or walking as these are better for your help as well.

3. Buy local: cut down on your carbon footprint by purchasing locally produced goods instead of items that were produced abroad and that require the aviation industry to ship them to your country. In so doing, you will help your local economy as well. You could also try producing your own versions of products with a high carbon footprint that you previously bought in shops. Make your own sauces and chutneys (perhaps even from your own veg) and learn to brew and blend your own drinks. When you do purchase something that has been imported, opt for environmentally friendly brands which have a commitment to reducing and offsetting their carbon footprint.

4. Get involved with political action: often, the changes that we need to make in order to stop acid rain ought to happen at a systemic level. Though every individual can take concrete action right now to significantly offset their carbon footprint, we often need to get governments and big companies involved so that they can change their policies at a national or international level. Go on a march, start and sign petitions, write to your government or other local authority, and use the platforms available to you (including social media) to spread the word about the harmful effects of acid rain and which companies and policies are the biggest culprits in terms of perpetuating the problem.

5. Consume fewer manufactured goods: the fumes from factories are one of the biggest causes of acid rain worldwide. Cut down on your spending and your bank balance will get a lot healthier at the same time as the planet! Repair and reuse items instead of simply throwing them into landfill and buying something new. Purchase second hand clothes, vintage jewellery, furniture, and books so that you are not stimulating factories to pollute the atmosphere. Give your old items to a charity shop so that other people can buy them instead of newly manufactured goods. And, again: if you do need to purchase something new, always purchase from eco-friendly brands. If you can't find an eco-friendly option for something that you wish to buy, get in touch with your preferred brand via the phone, letter, or social media to ask them to create one for you – often companies will be very responsive to consumer suggestions.

6. Be more electricity efficient: the generation of electricity is one of the key contributors to acid rain. Electrical power plants are big polluters. Do your bit by switching off lights and appliances when they are not in use, and using a timer to turn off your electric heaters when you are not at home. If you run a company, stop keeping the lights of unused rooms and other spaces burning 24 hours a day and commit to a more efficient form of energy use instead. Swap out conventionally generated electricity for solar panels, and if you can make a big change such as exchanging your conventional electric heating system for something like a natural thermal or solar based heating system instead.

CONCLUSIONS

We should take steps in halting the tide of acid rain today. Acid rain is falling somewhere in the world right now. This pernicious effect of human consumption and lack of care for our planet has been blighting the environment since the industrial revolution began in the 19th century. It is destroying the beautiful Taj Mahal, it is creating 'dead zones' in precious and once highly biodiverse lakes, and it is causing cancers and respiratory problems in human beings to name but a few of the adverse effects of acid rain. If we all work together and make a commitment to halting acid rain, we can start to reverse the catastrophic impact that it is having on our environment. It is time to act to stop acid rain before it is too late.

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