

Acid Rain

EPA Website



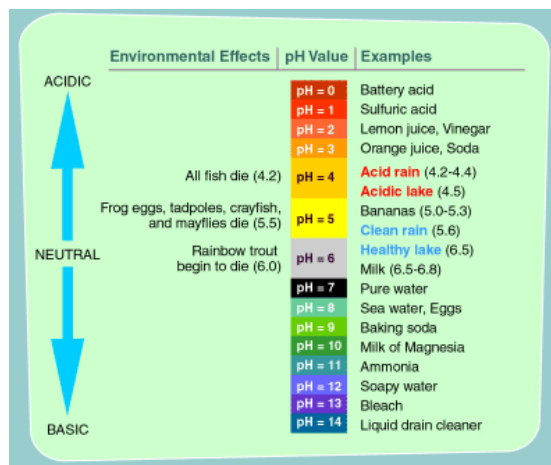
Section 1: What is Acid Rain?

Acid rain is rain that has been made **acidic** by certain pollutants in the air. Acid rain is a type of **acid deposition**, which can appear in many forms. Wet deposition is rain, sleet, snow, or fog that has become more acidic than normal. Dry deposition is another form of acid deposition, and this is when gases and dust particles become acidic. Both wet and dry deposition can be carried by the wind, sometimes for very long distances. Acid deposition in wet and dry forms falls on buildings, cars, and trees and can make lakes acidic. Acid deposition in dry form can be inhaled by people and can cause health problems in some people.

Section 2: Acidity Review

What is acidity?

Acidic and basic are two ways that we describe chemical compounds. Acidity is measured using a pH scale. A pH scale runs from zero (the most acidic) to 14 (the most **basic** or **alkaline**). A substance that is neither basic or acidic is called "neutral", and this has a pH of 7.



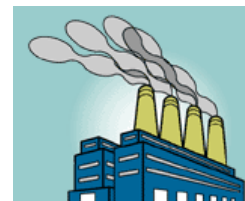
Acid Rain and the pH Scale

The pH scale measures how acidic an object is. Objects that are not very acidic are called basic. The scale has values ranging from zero (the most acidic) to 14 (the most basic). As you can see from the pH scale above, pure water has a pH value of 7. This value is considered neutral—neither acidic or basic. Normal, clean rain has a pH value of between 5.0 and 5.5, which is slightly acidic. However, when rain combines with sulfur dioxide or nitrogen oxides—produced from power plants and automobiles—the rain becomes much more acidic. Typical acid rain has a pH value of 4.0. A decrease in pH values from 5.0 to 4.0 means that the acidity is 10 times greater.

Section 3: What Causes Acid Rain?

Sources of Acid Rain

Acid rain is caused by a chemical reaction that begins when **compounds** like sulfur dioxide and nitrogen oxides are released into the air. These substances can rise very high into the atmosphere, where they mix and react with water, oxygen, and other chemicals to form more **acidic pollutants**, known as acid rain. Sulfur dioxide and nitrogen oxides dissolve very easily in water and can be carried very far by the wind. As a result, the two compounds can travel long distances where they become part of the rain, sleet, snow, and fog that we experience on certain days.



Human activities are the main cause of acid rain. Over the past few decades, humans have released so many different chemicals into the air that they have changed the mix of gases in the atmosphere. Power plants release the majority of sulfur dioxide and much of the nitrogen oxides when they burn **fossil fuels**, such as coal, to produce electricity. In addition, the **exhaust** from cars, trucks, and buses releases nitrogen oxides and sulfur dioxide into the air. These pollutants cause acid rain.

Acid Rain is Caused by Reactions in the Environment

Nature depends on balance, and although some rain is naturally acidic, with a **pH** level of around 5.0, human activities have made it worse. Normal **precipitation**—such as rain, sleet, or snow—reacts with **alkaline chemicals**, or non-acidic materials, that can be found in air, soils, bedrock, lakes, and streams. These reactions usually **neutralize** natural acids. However, if precipitation becomes too acidic, these materials may not be able to neutralize all of the acids. Over time, these neutralizing materials can be washed away by acid rain. Damage to crops, trees, lakes, rivers, and animals can result.

Section 4: Why is Acid Rain Harmful?

Acid Rain Can Cause Health Problems in People

Air pollution like sulfur dioxide and nitrogen oxides can cause respiratory diseases, or can make these diseases worse. Respiratory diseases like **asthma** or chronic **bronchitis** make it hard for people to breathe. The pollution that causes acid rain can also create tiny particles. When these particles get into people's lungs, they can cause health problems, or can make existing health problems worse. Also, nitrogen oxides cause ground-level **ozone**. This ground-level ozone causes respiratory problems, like **pneumonia** and **bronchitis**, and can even cause permanent lung damage. The health effects that people have to worry about are not caused by the acid rain, but are caused when people breathe in these tiny particles or ozone. Swimming in an acidic lake or walking in an acidic puddle is no more harmful to people than swimming or walking in clean water.

Acid Rain Harms Forests

Acid rain can be extremely harmful to forests. Acid rain that seeps into the ground can dissolve nutrients, such as magnesium and calcium, that trees need to be healthy. Acid rain also causes **aluminum** to be released into the soil, which makes it difficult for trees to take up water. Trees that are located in mountainous regions at higher elevations, such as spruce or fir trees, are at greater risk because they are exposed to acidic clouds and fog, which contain greater amounts



of acid than rain or snow. The acidic clouds and fog strip important nutrients from their leaves and needles. This loss of nutrients makes it easier for infections, insects, and cold weather to damage trees and forests.

Acid Rain Damages Lakes and Streams

Without pollution or acid rain, most lakes and streams would have a pH level near 6.5. Acid rain, however, has caused many lakes and streams in the northeast United States and certain other places to have much lower pH levels. In addition, aluminum that is released into the soil eventually ends up in lakes and streams. Unfortunately, this increase in acidity and aluminum levels can be deadly to aquatic wildlife, including **phytoplankton**, mayflies, rainbow trout, small mouth bass, frogs, spotted salamanders, crayfish, and other creatures that are part of the food web. This problem can become much worse during heavy downpours of rain or when the snow begins to melt in the spring. These types of events are known as **episodic acidification**.

Acid Rain Damages Buildings and Objects

Acid rain can also have a damaging effect on many objects, including buildings, statues, monuments, and cars. The chemicals found in acid rain can cause paint to peel and stone statues to begin to appear old and worn down, which reduces their value and beauty.