International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-2, Issue-1, January 2016
ISSN: 2395-3470
www.ijseas.com

ACID RAIN A MENACE TO CONSTRUCTION INDUSTRY

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Abstract
Acid rain is a complex environment problem which affects many countries around the world including Nigeria. Its forms when oxide of Nitrogen; sulphur dioxide and carbon monoxide reacts in the atmosphere to form various acid compounds. Acid rain is mainly caused by the indiscriminate emission of acid gases like NO_x and SO_2 by industries, burning of fossil fuel, power plant, cars, trucks and natural gas used to produce the electricity needed to do all kinds of things. It damages man made materials such as buildings, paints, monuments, pipes, cables, metals and vehicles. These damages are problems to the construction industry. This problem caused by acid rain can be prevented by reducing emission, finding alternative source of energy and conserving the resources.

Keyword: *Acid Rain,Man made materials.*

1. INTRODUCTION

Air pollution these days has reached to its peak and it brings along various other conundrums with it. It is perilous to the environment as well as to all living creatures that dwell on this planet (Swaroop, 2014). Humans makes use of many things found in nature such things are called natural resources. Some examples of natural resources are plants, mineral and water. All of these things are important to humans because they provide us with the materials needed for daily use (Parks, 2006). Burning of fuels, wood or papers causes emission of not only smog, but also various harmful gases. The smoke contains various invisible gases such as sulphur dioxide and nitrogen dioxide that are harmful to man made materials and the environment (Paterinos 1985, Swaroop, 2014).

'Acid Rain' or more precisely acid precipitation is the word used to describe rainfall that has a pH level of less than 5.6. Acid rain forms when clean rain comes in contact with pollutants in air like

sulphur dioxide (SO_2) released from cars and industries mix and react with the oxygen, water and other pollutants and precipitate in the form of acid rain ('O'Connor 2003,USEPA 2005).

Acid rain is both wet and dry precipitate and occurs in the form of rain, sleet, snow and fog. Dry precipitate is dangerous because it can eventually wash pollutants into the streams, lakes and rivers (Petheran 2002, WHO 2005).

Chemical compound have two basic properties, acidic and basic. Acidic property is the amount of H^+ ions present in the compound. It is measured with the help of a pH scale the scale run from zero (the most acidic) to 14 (the most basic), and 7 being the neutral. Acid rain is not strong enough to burn human skin unlike other acids that instantly harm the skin or can even erode metals. Unpolluted precipitate will have a pH value ranging from 5-6 where an acid rain have a pH level of 4-5.6 (Michael, 2003, Swaroop 2014).

1.1 Caused of acid rain

Humans are solely to be blamed for causing the phenomenon of acid rain. Over the past few decades, human have misused their privilege and have caused unfathomable harm to the environment. Untreated emission gases by power plants into the air release sulphur and nitrogen dioxides, which contribute in forming acid rain. In addition, exhausts from car, trucks and buses too lead to the release of these gases (Parks, 2006). Other substances that causes acid rain are Hazardous air pollutants (HAPS), particulate matter (PM), Lead and chlorofluorocarbons (CFCS) (UNEP, 1999).

1.1.1 Sulfurdioxides: Sulfurdioxide is a colourless prudent gas released as a by-product of combusted fossil fuels containing sulfur. A variety of industrial-processes such as the production of iron and steel, utility factories and crude oil processing produce this gas. In sulfate are produces pure metal. This causes the release of sulfur dioxide. Metals commonly obtained emitted into the atmosphere by natural disasters or means. This ten percent of all sulfur dioxide emission comes from, volcanoes sea spray plankton and rotting vegetation. Over all 69.4 percent of sulfur dioxide is produced by industrial combustion. Only 3.7 percent is caused by transportation (Goklany *et al,* 1984,WHO 2005).

1.1.2 Nitrogen Oxide: The other chemical that is also chiefly responsible for the make-up of acid rain is nitrogen oxide. Oxides of nitrogen is a term used to describe any compound of nitrogen monoxide and nitrogen dioxide are all oxides of nitrogen. These gases are by products of firing processes of extreme high temperature (automobiles, utility plants) and in chemical industries (fertilizer production). Natural processes such as bacterial action in soil, forest fires, volcanic action, and lightning makeup five percent of nitrogen oxide emission (Paerl, 1985, WHO 2005).

Not only does the acidity of acid precipitation depend on emission levels but also on the chemical mixtures in which sulfur dioxide and nitrogen oxides interact in the atmosphere sulfur dioxide and nitrogen oxides go through several complex steps of chemical reactions before they become the acids found in acid rain. The steps are broken down into two phases, gas phase and aqueous phase. There are various potential reactions that can contribute to the oxidation of sulfur dioxide in the

atmosphere each having varying degrees of success. One possibility is photooxidation of sulfuric dioxide by means of ultraviolet light.

A second and more common process is where sulfur dioxide reacts with moisture found in the atmosphere. When this happens, sulfate dioxide immediately oxidizes to form a sulfite ion.

$$SO_{2(g)} + O_{2(g)} \longrightarrow SO_{3(g)}$$

Afterwards, it becomes sulfuric acid when it joins with hydrogen atoms in the air.

$$SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$$

This reaction occurs quickly, therefore the formation of sulfur dioxide in the atmosphere is assumed to lead this type of oxidation of become sulfuric acid (USEPA 2005).

Another common reaction for sulfur dioxide to become sulfuric acid is by oxidation by ozone. This reaction occurs at a preferable rate and is sometimes the main contributor to the oxidation of sulfuric acid. All the reactions mentioned so far are gas phase reactions. In the aqueous phase sulfur dioxide exists as three species.

$$S(iv) \longrightarrow SO^{2}(aq) + HSO_3^{2-} + SO_3^{2-}$$

Thus dissociation occurs in a two part process.

$$SO_{2(aq)} \longrightarrow H^+ + HSO_3^-$$

$$HSO_3^-{}_{(aq)} \longrightarrow H^+ SO_3^{2-}$$

The oxidation process of aqueous sulfur dioxide by molecular oxygen relies on metal catalyst such as iron and manganese. This reaction is unlike other oxidation process which occurs by hydrogen peroxide. It requires an additional formation of an intermediate (A-), for example peroxymono sulfucous acid ion. This formation is shown below:

$$HSO_3H_2O_2 \longrightarrow A- + H_2O$$

$$A^- + H \longrightarrow H_2SO_4$$

Sulfure dioxide oxidation is most common in clouds and especially in heavily polluted air where compounds such as ammonia and ozone are in abundance. These catalyst help covert more sulfuric acid.

Like sulfur dioxide, nitrogen oxides rise into the atmosphere and are oxidize in clouds to form nitric or nitrous acid. These reactions are catalyzed in heavily polluted clouds where traces of iron, manganese, ammonia, and hydrogen peroxide are present. Nitrogen oxides rise into the atmosphere mainly from automobile exhaust in the atmosphere it reacts with water to form nitric or nitrous acid (Goklany *et al,* 1984,WHO 2005)

$NO_{2(g)} + H_2O \longrightarrow H_2NO_3(aq) + HNO_2(aq)$ (gas phase).

In the aqueous phase there are three equillibria to keep in mind for the oxidation of nitrogen oxide.

(1) $2NO_{2(g)} + H_2O_{(l)} \longrightarrow 2H^+ + NO_3^- + NO_2^-$

(2) $NO_{(g)} + NO_2\ (g) + H_2O_{(l)} \longrightarrow 2H^+ + 2NO_2^-$

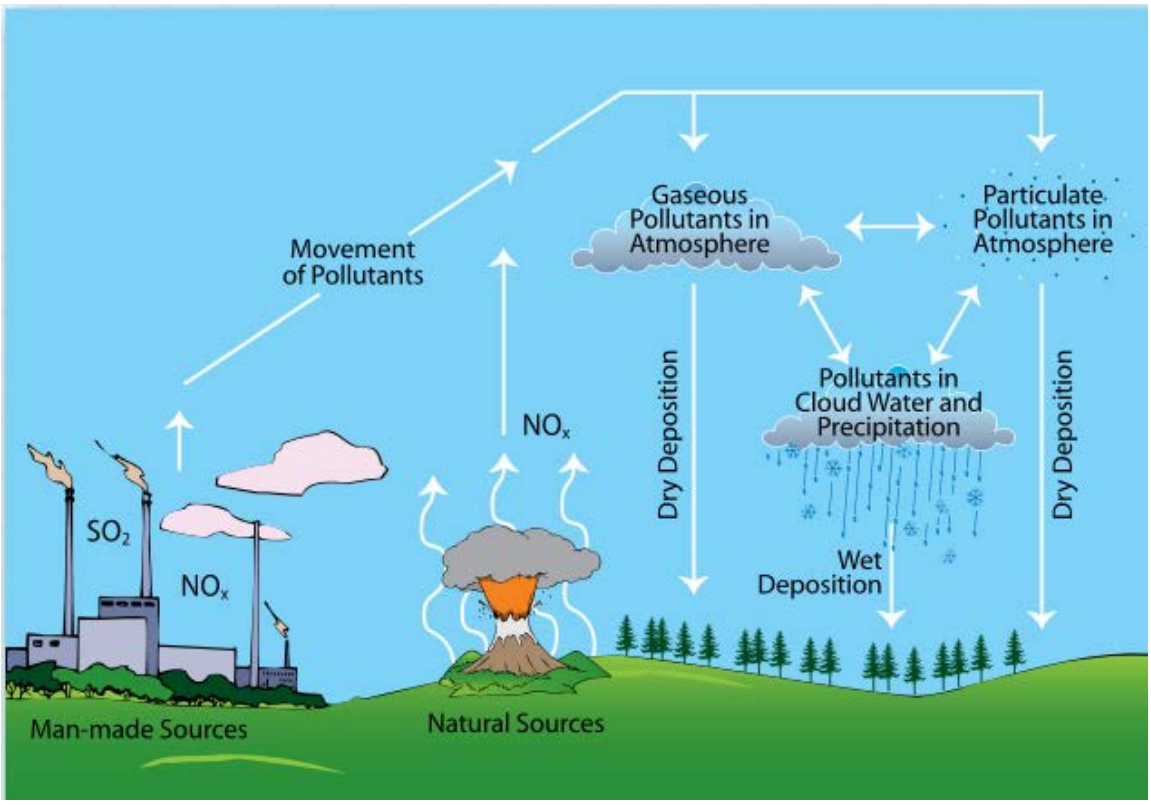
(3) $3NO_{2(g)} + H_2O_{(l)} \longrightarrow 2H^+ + 2NO_3^- + NO_{(g)}$

1.1.3 Others sources of acid rain are **chlorofluorocarbons**: CFCS are the chemicals that are used in industry, refrigeration, air conditioning systems and consumer products. Whenever CFCS are released into the air, they reduce the stratosphere ozone layer. The stratospheric ozone layer protects earth's surface from the harmful rays of the sun (Pearce, 1982).

1.1.4 Particulate Matter (PM): PM, little particles of pollution is released by cars, trucks and buses that are burning diesel fuel, fertilizers, pesticides, road construction, steel making mining, and turning on fire places and wood stoves (UNEP,1999).

1.1.5 Lead: lead is released by house and car paint as well as the manufacturing of local batteries, fishing lures, certain parts of bullet, some ceramic ware, water pipes and fixtures.

Formation of Acid Rain:



Source:www.epa.gov/region/teacher

1.1.6 Hazardous air pollutants (HAPS): HAPS are released into the air by sources such as chemical plants, dry cleaners, printing plants, and motor vehicles (cars, trucks, buses and planes).Goklany *et al* 1984).

There are a lot of similarities in all of these pollutants. Most of the pollutants are from automobiles. Automobiles release harmful smoke into the air, which causes acid rain. Coal, oil and gasoline are also some of the most common causes of all the pollutants (USEPA, 2005).

2. Acid Rain Effects to Construction Industries

Acid rain can be carried great distances in the atmosphere, not just between countries but also take the form of snow, mists and dry dusts. The rain some time falls many miles from the sources of pollution but whenever it falls it can have a serious effect on soil, trees, buildings, water and other materials (Michael 2003;USEPA, 2005).

Acid rain damage man-made materials and structures. Marble, limestone, and sandstone can easily be dissolved by acid rain. Metals, paints textiles, and ceramic can effortless be corroded. Acid rain can down grade leather and rubber. Man-made materials slowly deteriorate even when exposed to unpolluted rain helps speed up the process. Acid rain causes carving and monuments in stone to lose their features (Johnson *et al* 1984; UNEP 1999; USEPA 2005).

3.Ways of Preventing Acid-Rain

All environmental problems including acid rain are caused or impacted by the combined actions of individuals or group of people. This is why individual or group can play a big part in solving these problems (Paterinos 1985; Johnson 2004).

3.1 Reduce Emission: in most of the developing countries of the world, burning fossils fuels is still one of the cheapest and reliable ways to produce electricity. So lowering emission of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) the pollutant that causes acid rain by power plants are remedy. Scientists should research new ways to burn fuel which don't produce so much pollution(Pearl 1985; WHO 2005).

3.2. Monitoring Site: Government, (federal and states) university and other agencies need to spend more money on pollution control by setting quality and disposition monitoring stations across the country as is done in most of the developed countries (USEPA, 2005). These monitoring stations should contain equipment that constantly collects air quality data and samples. These devices measure many things including the amount of rainfall, air, the pH of rain, and the surrounding temperature.

3.3.Alternative ways of producing energy: There are other ways of energy besides fossil fuels. These include hydroelectric power, wind power, nuclear power, solar power and fuel cells. Two sources that are currently use in most developing countries are hydroelectric and solar power. These are clear as far as acid goes but what other impact do they have on our environment? Wind mills work the same way like hydroelectric but instead use wind to turn the turbines. Fuel cells are similar to batteries, except that fuel cells run on oxygen and hydrogen. They use chemical reactions to generate electricity and produce water as waste.

Nuclear power could be a good alternatively for fossil fuels but it has it on disadvantages of generating dangerous waste that are harmful to human health (WHO2005;Park 2005).

4. Conserving Resource: Greater subsidies of public transportation by government to encourage people to use public transport rather than always traveling by car or people could drive the most fuel efficient car. Conserve electricity by turning off light appliances and computers when no one is using (Paterinos 1985; UNEP 1999).

Conclusion

Acid rain damages man made materials such as building and status (monuments) vehicles, pipes, paints, cables. People can help stop acid rain by not polluting the air. When the chemicals in the air turn into a gas and evaporate, they mix with the water vapour, and causes acid rain. Every one can help prevent this pollution by turning off light appliances, and computers when no one is using them, using transportation that is friendly to the environment and setting up air quality and disposition monitoring stations across the country.

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