Journal of University Studies for inclusive Research
Vol.1, Issue 2 (2020), 38-45
USRIJ Pvt. Ltd.

Neutralizing Acid Rain in Fresh Waters by Using Alkaline

Leas T. Abusel[1], Rowaid S. Karabsheh[1], Yazan Edor[1], Rami A. Shariah[2]

[1]International Pioneers Academy, Amman, Jordan.
[2] Mentor/Chemist
* Author to whom correspondence should be addressed.
E-mail: leasabusel2003@gmail.com

March 2020

Abstract - *The objectives of this study were to (1) find a neutralizing agent for acid rain, and (2) to assure the solution doesn't poison the fresh water and keeps it suitable for aquatic life. We used the tip of an unlit match as our source of sulfur (one of the main components of acid rain) to react with the surrounding oxygen once lit. 20±0.05ml of distilled water was poured on a pad of cotton to absorb the reaction's product in its liquid form. We used calcium carbonate as our neutralizing agent which raised the acidity of our acidic samples up to 5.2-5.9pH (relative to clean rain and freshwater). None of the chemicals used in this experiment were poisonous or flammable.*

***Keywords*:** {acid rain, alkaline, fresh water, pH, neutralizing agent}

1. Introduction

More than 100,000 species of aquatic life thrive in rivers, lakes and other types of freshwater sources. Most of this planet's land life lives by fresh water as we humans do. One change to its acidity can be detrimental. Take the acid rain as a typical scenario. Acidic water, caused by reactions of sulfur dioxide and nitrogen oxides, has a pH scale ranging between 4.0-3.0; whereas clean rain ranges between 5.0-5.5. In addition, clean rivers and lakes have a pH between 6.5-7.5, concluding with the death of a great amount of fish and animals.

Acid rain is an expansive term that portrays a few different ways through which acid rain falls out from the atmosphere. Acid rain incorporates acidic rain, fog (mist), hail and snow. The issue of acid rain is broadly accepted to result from the waste of oxides of sulfur, nitrogen and different constituents present in the atmosphere. The origin of these oxides is coal fired power stations, smelters (delivering SO2) and motor vehicle exhausts (creating NOx). These oxides may respond with different synthetic compounds and produce destructive substances that are cleaned out. Acid rain influences the nature of human life, undermines the ecological strength and the maintainability of nourishment and timber holds, therefore representing a monetary emergency. What's more, this is the specific motivation behind why we must make a more financially reasonable and a safe, non-dangerous answer for this worldwide issue.

2. Literature Review

As D. W. Schindler mentioned, not only does the acidification of acid rain endanger aquatic life, it also threatens the survival of most invertebrates living in an aquatic area [1]. In addition to H. Van Miegroet's claim that nitrogen and sulfur compounds are a critical matter to discuss, we believe that sulfur can harm soil and exceeded amounts of nitrogen compounds may do as well [2]. Karl-Goran Maler's point adds on to H. Van Miegroet's claim. High amounts of sulfur and nitrogen are being transmitted worldwide, ruining soil on its way [3]. Another critical point implied by Roger W. Ferenbaugh, is that acid rain affects plant growth. In his statement, he claims that at pH values under 3, plants exhibit failure to attain normal height. With that said, plants are also threatened by this global disaster [4]. The information Irina C. Irvine's team provided us is important and exclusive to this paper. It adds up the number of life sources that can get affected by acid rain. Two tree species which provide habitats and shelter for animals are sensitive to low acidity levels. In addition, they're common in northeastern USA; with acid rain, many animals would lose their habitats and the trees would lose their lives [5]. According to what Robert A. Goyer and his team said, human beings may also get exposed to acidic materials by water and soil that have been exposed to acid rain. Concluding what the cited authors and their teams have mentioned, acid rain not only affects detrimentally fresh waters, but also invertebrates, soils, plants, trees, and humans. To make matters worse, sulfur and nitrogen (the two main components of acid rain) are transferred to different countries worldwide [6].

3.Chemicals and materials

- Calcium Carbonate (Sigma Aldrich)
- Cotton pad (Cotton Soft)
- Matches (THREE STARS SAFETY MATCHES)
- Distilled water (via Jordanian distilled water sources)
- Beakers (Corning)
- Graduated Cylinders (Corning)
- Mason Jar (Golden Harvest)

- pH Indicator (Jenco Instruments 630 (calibrated))

4. Methods

The method our team used was simple. The used materials in our experiment were cheap and reliable. None of the chemicals are poisonous, dangerous, flammable, etc. We specifically chose our method due to its cheap price, safety, reliability, and accessibility of all materials. One of the common sources of sulfur are matches. The tip contains an amount of sulfur that, when lit, reacts with the oxygen in air and forms sulfur dioxide, the key component of acid rain. So, we used a beaker and taped a certain number of matches (exact number present in **"Results and Discussions"**) on the edge (inside the beaker). We placed a cotton pad at the bottom of the beaker functioning as a sponge for the solution. 20±0.05ml were prepared in a graduated cylinder for each solution before lighting the match and 10±0.05ml after. We chose the alkaline calcium carbonate as our solution due to its abundance, cheap price, non-reactive nature, and high pH reading (9.9).

5. Results and Discussions

Using our method, we hypothesized the number of matches that would lower the acidity of distilled water relative to acid rain; 3.0-4.0. Trial (1) included 25 matches taped to a beaker. We placed a piece of cotton to absorb the acid rain after the experiment. Then, we poured 20±0.05mL of distilled water into the beaker and lit the matches (automatically covering the beaker afterwards). After half a minute we poured 10mL of distilled water into a hole of the covering causing acid rain to develop (after the water was poured, we covered the solution once more for another half a minute). We removed the covering and placed a pH indicator in the solution after squeezing the cotton into a cup. The indicator read 3.8, an exemplary sample of acid rain. We labeled it and saved it in a container for testing.

As a result, our hypothesis was accurate. So, we attempted the experiment with 5 more matches; hoping its acidity would decrease relative to 3.0. Trial (2) included 35 matches resulting with a pH of 2.8.

After saving the two samples, we had to determine an exemplary alkaline to raise the acidity of the acid relative to a neutral solution (fresh water). Calcium carbonate was our first and only testing agent since its pH is 9.9.

We performed 3 tests for each trial with different measures of the agent. Test (1): 4ml of sample (1) were placed in a beaker filled with 0.50±0.05ml of calcium carbonate. This test assured the agents basic nature with a resultant pH of 9.5. Too basic for fresh water (also poisonous). It was evident that we should decrease the amount of the agent to reach an acidity of rain or fresh water. Test (2): 4±0.05ml of sample (1) were mixed with 0.20±0.05ml of calcium carbonate in an uncontaminated beaker. The decrease of pH was successful, but it exceeded the limit. The indicator read 4.6; no living aquatic animal can survive such acidity. We concluded that we should slightly increase the volume of the neutralizing agent to reach a successful acidity ranging from the acidity of rainfall (5.0-5.5) or fresh water itself (6.5-7.5). Test (3): 2±0.05ml of sample (1) were mixed with 0.25±0.05ml of calcium carbonate. The results were successful. The solution had an acidity of 5.1, relative to rainwater. Results from Sample (1) are shown in Table (1)

After finding a solution to the more acidic sample (1), we determined that we should reduce the amount of the base to assure it remains in the range of rainwater of freshwater acidity.

Test (4): 4±0.05ml of sample (2) were mixed with 0.05±0.01ml of calcium carbonate. Exemplary results were shown. The pH of the solution read 5.3, also within the range of clean rainfall. Since Test (4) was successful, we decided to assure its reliability. Test (5) and (6) had the same procedure. Test (5), (6): 4±0.05ml sample (2) were mixed with 0.05±0.01ml of calcium carbonate. Results were relative to the initial test (test (4)). Test (5): 5.9 pH. Test (6): 5.2 pH.

With these results, our team deduced that this solution and method is applicable and reliable.

Table 1. Sample (1) Test Results

Test	Acid Rain	Calcium Carbonate	pH readings	Result
1	4ml	0.50ml	9.5pH	Too basic
2	4ml	0.20ml	4.6pH	Too acidic
3	2ml	0.25ml	5.1pH	Relative to rain

Table 2. Sample (2) Test Results

Test	Acid Rain	Calcium Carbonate	pH readings	Result
1	4ml	0.05ml	5.3pH	Rain (5.0-5.5) range
2	4ml	0.05ml	5.9pH	Between Rain and freshwater acidity
3	4ml	0.05ml	5.2pH	Relative to rain

7. Conclusion

Using the results, our team developed two samples of neutralized acid rain: one with a pH of 5.1 and the other of a pH of 5.9. These two samples are in the range of clean rain (5.0-5.5) which does not affect aquatic life and freshwater. To neutralize it, we used an alkaline substance (calcium carbonate) which helped raise the pH of acidic rain and make it safer for marine ecosystems. The significance of this project was to provide a solution for the global catastrophe of acid rain. In conclusion calcium carbonate serves as an exemplary solution to the threat of acid rain.

8. References

[1] *Schindler, David W. "Effects of acid rain on freshwater ecosystems." Science 239.4836 (1988): 149-157.*

[2] *Van Miegroet, Helga. The relative importance of sulfur and nitrogen compounds in the acidification of freshwater. No. CONF-9209156-1. Oak Ridge National Lab., TN (United States), 1992.*

[3] *Mäler, Karl-Göran, and Aart De Zeeuw. "The acid rain differential game." Environmental and Resource Economics 12.2 (1998): 167-184.*

[4] *Bin Yan, Bing Wu, Yuhong Gao, Jianmin Wu, Junyi Niu, Yaping Xie, Zhengjun Cui and Zhongkai Zhang, Effects of nitrogen and phosphorus on the regulation of nonstructural carbohydrate accumulation, translocation and the yield formation of oilseed flax, Field Crops Research, 10.1016/j.fcr.2018.01.032, 219, (229-241), (2018)*

[5] *George Van Houtven, Jennifer Phelan, Christopher Clark, Robert D. Sabo, John Buckley, R. Quinn Thomas, Kevin Horn and Stephen D. LeDuc, Nitrogen deposition and climate change effects on tree species composition and ecosystem services for a forest cohort, Ecological Monographs, 89, 2, (2019)*

[6] Ma*, Chang-Jin, and Gong-Unn Kang. "Particle Scavenging Properties of Rain Clarified by a Complementary Study with Bulk and Semi-bulk Samples." 34.1 (2018): 177-186.*

Acknowledgements

**many thanks to Mr. Rami A. Shariah (Mentor/Chemist), Ms. Enas Abbas (Head of Department of Science), and Ms. Safaa (Lab Instructor) for contributing to this work and giving our team access to the International Pioneers Academy lab.*