ESS II

Acid Deposition Lab Report

Data Planning:

1. Research Question

*What is the effect of different levels of pH of Sulfuric acid on marble building blocks?*

1. Hypothesis

*If the pH of the Sulfuric acid solution is 2.0 – the most acidic pH of acid rain recorded, then the change of mass produced in the marble blocks will be the greatest.*

1. Variables
   1. Independent Variable:
      1. The pH level of the Sulfuric acid
         1. pH 2.0
         2. pH 3.0
         3. pH 4.0
         4. pH 5.0
         5. pH 5.6
   2. Dependent Variable:
      1. The change in mass of marble blocks
   3. Controlled Variables:
      1. Maintain same temperature by keeping the different containers with the blocks of marble in the same room.
      2. Maintain same amount of solution materials are exposed to by spray each with the solution the same amount of times
      3. Maintain same time period marble will be exposed to solution by performing the experiment for equal number of days with all the marble pieces.
      4. Maintain same method of distributing the solution by being constant with the spraying technique each time.
      5. Maintain same sunlight exposure by keeping all the containers in the relative same spot.
2. Method
   1. Select 20 similar blocks of marble from a sheet used for decoration. Weigh each marble block and record the initial weight.
   2. Label each bottle with the appropriate pH marking.
   3. Fill each bottle with the corresponding pH Sulfuric acid (H2SO4) solution and then cover the bottle with the spray attachment.
   4. Using pH testing strips to confirm the pH levels of the solutions.
   5. Place four 3x3cm marble squares in each of five glass containers and line them up to have them all under the same conditions as the others.
   6. Spray each marble piece with its given spray bottle solution 10 times every other day.
   7. After 2 weeks, let the marble pieces dry in foil containers and weigh their mass two days after being exposed to any direct moisture.
   8. Record observations and calculations.
3. Materials
   1. 20 3x3cm marble squares
   2. Sulfuric acid solution
   3. pH testing strips
   4. Water bottles with spray nozzle attachment
   5. Electric balance
   6. Glass containers
   7. Foil containers
   8. Paper, marker, tape

Data Collection:

**Initial Mass and Second Mass of marble squares following the first two-week period of testing (from Novermber 29, 2011 until December 12, 2011)**

|  |  |  |  |
| --- | --- | --- | --- |
| Container # | Sulfuric Acid Solutions with different pH levels | Initial Mass of marble (+ 0.01 g) | Second Mass of marble (+ 0.01 g) |
| 1 | 2 | 60.59 | 60.52 |
| 2 | 3 | 57.52 | 57.43 |
| 3 | 4 | 60.65 | 60.54 |
| 4 | 5 | 59.46 | 59.23 |
| 5 | 5.6 | 58.10 | 58.01 |

Observations:

* Some squares till had the mesh on the back, which may have affected the weight, while in others the cardboard and mesh came off leaving only glue residue.
* The spray nozzles were all different so the amounts sprayed to each variation was also different
* When sprayed, the bottle containing the pH of 2 was soapy (residue from previous solution may have been left in the spray attachment)

\*\*After only performing the experiment for 2 weeks, it was decided by my instructor and myself that the experiment could yield better results if I continued to do it over the summer for a longer period of time and so I re-started the experiment on January 18, 2012 and performed it following the same guidelines until February 18, 2012.

**Final Mass of marble squares after monthly period of testing (from January 18, 2012 until February 18, 2012)**

|  |  |  |
| --- | --- | --- |
| Container # | Sulfuric Acid Solutions with different pH levels | Final Mass of marble (+ 0.01 g) |
| 1 | 2 | 60.09 |
| 2 | 3 | 57.09 |
| 3 | 4 | 60.14 |
| 4 | 5 | 58.85 |
| 5 | 5.6 | 57.62 |

Observations:

* All the mesh of the marble squares came off.
* The other observations regarding the materials utilized, such as the spray nozzle remained the same.

|  |  |  |  |
| --- | --- | --- | --- |
| **Sulfuric Acid Solutions (pH)** | **% Decrease between Initial and Second mass (+ 0.01 %)** | **% Decrease between Second and Final Mass (+ 0.01 %)** | **% Decrease between Initial and Final mass (+ 0.01 %)** |
| 2.0 | 0.12 | **0.71** | 0.83 |
| 3.0 | 0.15 | 0.59 | 0.75 |
| 4.0 | 0.18 | 0.66 | 0.84 |
| 5.0 | **0.39** | 0.64 | **1.03** |
| 5.6 | 0.15 | 0.67 | 0.83 |

* The rest of the experiment was completed the same way as the first one, following the same criteria of independent, dependent, and controlled variables.

Data Processing:

In order to see what pH caused the greatest difference I am going to test the percentage change, in this case decrease in mass with the following formula:

% change = original – new (x100)

original

Sample Calculation: Percentage change between the initial and second mass of the marble squares sprayed with pH 2.

% change = 60.59 – 60.52 = .07 x100 = 0.12%

60.59 60.59

Data Presentation:

**Percentage Decrease in mass of marble squares**

**% Decrease between Initial mass and Second mass Graph**

**% Decrease between Initial mass and Second mass Graph**

**% Decrease between Initial mass and Second mass Graph**

Discussion and Review:

Seeing the data tables and the graphs above, it can be seen that there were no significant pattern to be identified in the data. In the first trial of the experiment, where the marble squares where sprayed every other day for two weeks, the squares with the greatest percentage decrease in mass where the ones treated with the solution with a pH of 5.0. In the second trial, where the squares were sprayed every day for a month, the squares with the greatest percentage decrease in mass were actually the ones exposed to the solution with the pH of 2.0, somewhat giving support for my hypothesis that the more acidic the solution, the greater the percentage decrease in mass. However, even in this trial, the other squares had some variability in the order, which may have been due to other factors and limitations in the experiment. In the final calculation, where the percentage decrease in mass from the initial mass to the final mass was calculated, the marble squares with the greatest percent decrease in mass where again the ones exposed to the solution of pH of 5 with a 1.03% decrease, followed by the ones exposed to pH of 4 with a 0.84% decrease, next both the ones exposed to pH of 2 and 5.6 having the same percentage decrease of 0.83%, and lastly the ones exposed to a pH of 3 with a 0.75% decrease in mass. As it can be seen in the graphs, most of the results are very similar and somewhat comparable with no significant patterns possible to identify. Furthermore, as seen in the data, the percentage decreases in mass were minimal ranging from the smallest percent decrease of 0.12% decrease to 1.03% decrease. These minimal changes show that the experiment did not yield successful or useful results.

Evaluation:

While performing this experiment, several limitations occurred leaving a lot of room for improvement in order to produce a more successful outcome. The main limitation for this experiment would have to the uncertainty of whether the material purchased was marble or not. Even though I applied a drop of concentrated acid and saw the liquid sizzle when exposed to the squares, a confirmation it was marble, I believe that instead of pure and natural marble it was a form of synthetic marble (a comment not disclosed to me by the store) and that may be one of the reasons why the marble did not deteriorate as much as was predicted. In order to fix this limitation I would recommend using either limestone or confirm that what you are using truly is marble. The second important limitation was the system of exposing the marble to the solutions with different pH’s. My original intent of using the spray bottles was to imitate real life and the effects of drops of rain falling over the building materials. However, the spray nozzles were all different and thus each sprayed and distributed different amounts of the pH solution, which may have hindered the successfulness of the experiment. I believe that in order to improve this portion of the experiment that the marble blocks should have been to submerge in the solutions are opposed to spraying them. The third limitation for this experiment was time. Even though after performing it for only two weeks I decided to continue the experiment for another lab over the summer, the extended time did not prove to be long enough. In order to have achieved better results the experiment should have ran for about two months in the least, or one month but with the material being submerged instead of sprayed. Making these improvements, the experiment might have turn out more successful or with more accurate results.

Conclusion:

In conclusion, the data did not successfully support the hypothesis. There were no significant patterns that could be identified in the data collections and calculations. Also the percent decreases in mass for the marble squares were minimal ranging from 0.12% to 1.03% decreases in mass, not significant enough to prove my hypothesis that the more acid the solution, the greater the percent decreases in mass. The results from my experiment could potentially mean that the pH of rain is not what causes the deterioration of building materials but the prolonged contact with acid rain over long periods of time such as decades is what causes the detriment.