IB Environmental Systems and Societies SL II

November 21, 2011

Acid Deposition Lab

**Aim:** What is the effect of different pH (ranging from 2.0 to 5.0) of nitric and sulfuric acid on steel nails? Does the acid type differ?

**Hypothesis:** Steel nails in more acid solutions will corrode the most, that is change the most in weight and become the most rusty. Sulfuric acid will have the more evident effect than nitric acid because it has stronger corrosive and oxidizing properties.

**Background Information:**

Nitric acid, HNO3, is a very corrosive chemical. It has high oxidizing qualities, for which it is often used as an oxidizing agent. This acid will react with most metals, including steel. Sulfuric acid, H2SO4, has a strong corrosive, dehydrating and oxidizing properties. Sulfuric acid reacts with iron and other metals[[1]](#footnote-1).

**Variables:**

*Independent:* pH levels. These will range from pH 2.0, 3.0, 4.0, 5.0 and water sample at pH 7.0. There will be a control group using water (pH 7.0). Also, the acid used. These will be nitric and sulfuric acid.

*Dependent:* Percent change in mass of the steel nails.

*Controlled:*

* The amount of nails for each pH level. This will be maintained at five. This will be done in order to get a more detailed account of how the different pH affects the steel nails.
* The amount of liquid in which the nails will be placed, which will be 50±1mL.
* All beakers with solutions and nails will be exposed to the same temperatures since they will all be in the same room.
* Each solution will be in the same type of container, in this case glass beakers.
* The nails used will all be of the same metal and same brand. This will be done to only test the acids effects on a specific type of metal (in this case steel).

Method:

*Materials:*

* (9) Glass beakers of 100mL.
* (45) Steel nails of the same length (yet to be determined).
* 50mL of each pH level (2, 3, 4, and 5) of sulfuric and nitric acid.
* 50mL of water.
* pH testing paper for water.
* Electronic balance

*Protocol:*

1. In a beaker, place 100mL of sulfuric acid of pH 2.0. Do the same for every other pH level of sulfuric acid. In another beaker, place 100mL of nitric acid of pH 2.0. Do the same for every other pH level of nitric acid. In the last beaker, place 100mL of water. This will be your controlled variable.
2. Before placing 5 nails into each beaker, weigh them. Record data.
3. Measure the nails every two days (or whenever you meet up with your class) for 12 days. Be sure to dry the nails before weighing them. Record the data and observations.



**Data Collection:**



**Data Processing:**





**Discussion**

The purpose of this study was to see if different pH levels of nitric acid (HNO3) and sulfuric acid (H2SO4) had different effects on steel nails. The hypothesis stated for this was that sulfuric acid of a more acid pH (in this case pH 2.0) would have a greater effect on the nails. This hypothesis is not supported by the data.

According to the data, nitric acid had the greater percent change in mass of the submerged nails. This allows me to conclude that acid rain with traces of nitric acid is more harmful to steel than acid rain with traces of sulfuric acid.

At pH 3 and pH 5, the final measurement was 0.98% lighter than the original mass of those nails. At pH 4, the nails submerged in sulfuric acid were also 0.98% lighter than their original mass, but at pH 3, the nails weighed 1.75% more than they did originally. Interestingly, the pH that was thought to have the most effect, that is pH 2, had the least effect on the nails. For both nitric acid and sulfuric acid there was a 0% change in mass. At pH 5, the nails submerged in sulfuric acid had no percent change either. This data suggests that rain with traces of nitric acid of pH 3 and 5 are the most corrosive for steel nails and rain with traces of sulfuric acid of pH 4 is the most corrosive for steel nails.

This data, however seems to be erroneous because one would think that all masses of nails would decrease while submerged in these acids. Seeing as to how the mass of the nails in sulfuric acid of pH 3 increased, this could bring doubts as to the reliability of this data. For this reason it would be advisable to do further studies of the effect of nitric and sulfuric acid on steel nails.

**Evaluation**

This lab has many weaknesses and limitations that need to be addressed. One of these limitations is that it does not really mimic acid deposition. This is because the nails were kept submerged in 50mL of acid. This is not accurate because in nature the nails would probably be exposed to lower quantities at a time or with water that hits the nails and then runs off. A possible way to improve this limitation is to set a sprinkler system, by means of a hose with wholes, and have the nails on the top of a water collecting object so that the water runs off and does not drown the nails.

Another limitation of this study is that it was not run for long enough. After only 12 days, the effect of the acid will probably be minimal because it takes a longer exposure to the acids for there to be a significant effect. This could be improved by doing a longer trial, for example, look at the effect of the acid over a month.

This study also has some human errors. Looking at the data, there seems to be discrepancies in the weights. This could be due to faulty equipment or faulty use of the equipment. This could also be due to different systems of drying the nails before measurement. This could be avoided by using the same electronic balance for every day of measurement as well as measuring the nails more than once. In terms of the drying, it would probably be better to dry them with paper as well as let them sit for 5 minutes before weighing them.

1. Wikipedia: Nitric Acid, Sulfuric Acid [↑](#footnote-ref-1)