Environmental Impact on the Corrosion of Steel Nipples

Scienteer Project # E8028

Problem / Question

How do environmental materials affect the corrosion of steel nipples?

Hypothesis

If the environmental materials have more oxygen, then the steel nipples will have more corrosion. Since the environmental materials have different properties, they should affect how much the steel nipples corrodes.

Variables

Independent variable

The Environmental Material that is in the bin
- Snow Salt
- Potting Soil
- All-Purpose Sand
- Beach Sand

Dependent variable

The weight of the steel nipple after it corrodes (in grams)

Background Research

Steel is used in car parts that are exposed to environmental materials like the ones used in this project which are: snow salt, potting soil, all-purpose sand, and beach sand. They are exposed to these outside every year. This project is important to science because car parts are researched, but not always on how specific materials affect them. So, by doing this project, the data should show which environmental materials affect steel nipples the most, which will show which materials affect car parts the most. This is important because it could prevent car problems and then having to pay to fix the problems. This project will also show how time affects the corrosion of steel nipples with environmental materials.

For corrosion to form, both water (or moisture) and oxygen need to be present. According to BYJU'S, the chemical formula for iron, which is in steel, to rust is $Fe_2O_3.nH_2O$. Steel can corrode easier than other metals and depending on how much moisture and oxygen it is exposed to how much the steel corrodes can change. The more moisture, or water, and oxygen the steel is exposed to the more it will corrode.

While the steel nipples are in the bins they will be exposed to 20 ounces of water and oxygen. When snow salt comes into contact with water, it dissolves by combining with the water, whereas the potting soil repels water. All purpose sand is mostly used in the home, while beach sand comes in contact with water often and the water makes the sand wet and moist. All of these materials will react differently to the water, so they also will affect the corrosion on the steel nipples differently.

Materials

Materials List

1. Notebook with pencil or phone to record data
2. Weight Scale
3. Camera (IPhone 12)
4. Four, 45 ounce bins with lids
5. 8 steel nipples
6. 80 ounces of water
7. 5 cups of asphalt
8. 300 grams of snow salt
9. 200 grams of potting soil
10. 300 grams of all-purpose sand
11. 300 grams of beach sand
12. 1 or 2 paper towels, paper plate, or napkin
13. Measuring tools, ½ cup and 1 cup

Procedure

1. Measure the weight of all the nipples and calculate the average of the nipples and record it in your notebook.
2. Set up all four bins by removing the lid, separating them, labeling them 1, 2, 3, and 4, and setting them out on a table.
3. Label all of the nipples 1, 2, 3, etc., until the last one which should be labeled 8.
4. Pour 1 kilogram of asphalt into each bin.
5. Compress the asphalt in each bin by pushing down on it with your hand all around; the asphalt should be slightly packed.
6. Pour 0.3 kilograms of snow salt into bin #1.
7. Fill the bin with 16 ounces of water.
8. Repeat step 6, but with the all-purpose sand (bin #3) and beach sand (bin #4), and put 0.2 kilograms of potting soil into bin #2.
9. Repeat step 7 for bins 2, 3, and 4.
10. Ask for help with dropping two nipples into each bin, then record the starting time that you dropped the nipples into each bin.
11. To keep findings organized, use a paper towel and write the numbers 1, 2, 3, and 4 for the bins. Make sure that the number markings are spaced apart sufficiently.
12. For each trial, after approximately 1 week for each, ask for help and take all of the nipples out of the bins at the same time and place them on the paper towel with identifying number markers, and let the nipples dry for an hour.
13. After an hour, thoroughly dry-off each of the nipples and remove any environmental materials on them; you may need to remove materials from the center or inside of the nipples.
14. Measure the weight of each nipple and record it in a notebook, indicating which nipples came from which bin with the labels 1 to 8 for each of the nipples.
15. Subtract the original weight of each nipple from the new weight of the nipples to identify the change in weight.
16. To collect more data for additional trials, put the nipples back in the bins and repeat steps 10-15.

Data / Observations

Trial 1, Day 0 of experiment
- 1(Snow Salt) - 45 grams
- 2(Snow Salt) - 44.8 grams
- 3(All-Purpose Sand) - 45.9 grams
- 4(All-Purpose Sand) - 45.8 grams
- 5(Beach Sand) - 46.2 grams
- 6(Beach Sand) - 46 grams
- 7(Potting Soil) - 44.8 grams
- 8(Potting Soil) - 45.2 grams
- Total Average - 45.4625 grams

Soon after the water was poured in, the snow salt started to melt and the potting soil absorbed most of the water.

Trial 2, 8 days after the start of the experiment
- 1(Snow Salt) - 45.1 grams
- 2(Snow Salt) - 44.9 grams
- 3(All-Purpose Sand) - 46 grams
- 4(All-Purpose Sand) - 46 grams
- 5(Beach Sand) - 46.3 grams
- 6(Beach Sand) - 46.4 grams
- 7(Potting Soil) - 45.6 grams
- 8(Potting Soil) - 47.4 grams
- Total Average - 45.9625 grams

Some material was still on the inside of the nipples, causing an increase in the weight for 3-8. All of them seem to have rust except for 7 and 8 and they all had a lot of water on them even after drying them.

Trial 3, 19 days after the start of the experiment
- 1(Snow Salt) - 45.1 grams
- 2(Snow Salt) - 44.8 grams
- 3(All-Purpose Sand) - 46.1 grams
- 4(All-Purpose Sand) - 45.9 grams
- 5(Beach Sand) - 46.2 grams
- 6(Beach Sand) - 46.4 grams
- 7(Potting Soil) - 45.7 grams
- 8(Potting Soil) - 46.5grams
- Total Average - 45.8375 grams

Even after cleaning them there was still a lot of rust especially from beach sand and all-purpose sand and there was a lot of excess material in the middle of the nipples from the beach sand, all-purpose sand, and potting soil. Color of the rust started to become dull.

Trial 4, 27 days after start of the experiment
- 1(Snow Salt) - 45 grams
- 2(Snow Salt) - 44.9 grams
- 3(All-Purpose Sand) - 46.1 grams
- 4(All-Purpose Sand) - 45.8 grams
- 5(Beach Sand) - 46.3 grams
- 6(Beach Sand) - 46.2 grams
- 7(Potting Soil) - 45.4 grams
- 8(Potting Soil) - 46.5 grams
- Total Average - 45.775 grams

There was not as much material inside of the nipples as there was in previous trials. 5 and 6 had a sparkle to them. The color of the rust continued to get more dull.

Photos

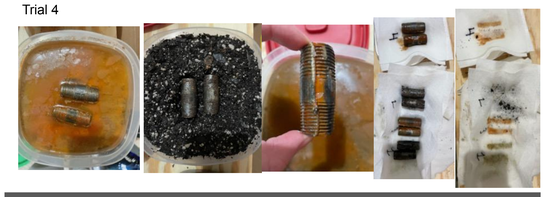
Experiment Set-up/ Trial 1

Set-up during testing

Trial 2

Trial 3

Trial 4

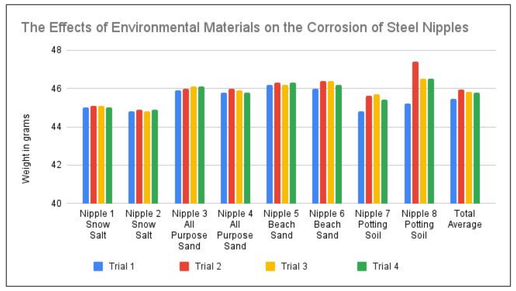


Chart

The Effects of Environmental Materials on the Corrosion of Steel Nipples

Steel Nipple and Environmental Material	Weight in Grams			
	Trial 1 Days: 0	Trial 2 Days: 8	Trial 3 Days: 19	Trial 4 Days:
Nipple 1 Snow Salt	45	45.1	45.1	45
Nipple 2 Snow Salt	44.8	44.9	44.8	44.9
Nipple 3 All Purpose Sand	45.9	46	46.1	46.1
Nipple 4 All Purpose Sand	45.8	46	45.9	45.8
Nipple 5 Beach Sand	46.2	46.3	46.2	46.3
Nipple 6 Beach Sand	46	46.4	46.4	46.2
Nipple 7 Potting Soil	44.8	45.6	45.7	45.4
Nipple 8 Potting Soil	45.2	47.4	46.5	46.5
Total Average	45.4625	45.9625	45.8375	45.775

Graphs



Results

As the time that the nipples were in the bins increased, for most of the nipples their weight also increased. This means that the oxygen molecules in the nipples increased, making the weight of the nipples also increase. While most of the nipple's weight increased, there were two that had the same starting and ending weight, but changed throughout the trials. Overall, each of the nipples stayed in generally the same numbers range with 0-0.2 difference. For example the 4th nipple, which was in all-purpose sand, started at 45.8 and ended at 45.8, but during the second trial increased to 46 and 45.9 during the third trial. The nipple that increased the most was the 7th nipple which was in potting soil. The weight at the first trial started at 44.8 and ended with 45.4; and during the second trial increased to 45.6 and 45.7 during the third trial. Using the averages, the weight of the nipples did increase by 0.3125 grams.

Conclusion

If the environmental materials have more oxygen, then the steel nipples will have more corrosion. Since the environmental materials have different properties, they should affect how much the steel nipples corrode. Snow salt is magnesium chloride, which doesn't have any oxygen in it, and for that reason the first nipple had no change in its weight and the second nipple had a 0.1 grams change. All purpose sand and beach sand has a chemical formula of SiO2, which shows that both sands have oxygen in them. This explains why the third nipple had a 0.2 grams change and why the fifth and sixth nipples increased by 0.1 grams and 0.2 grams. Since soil is 25% air, the nipples that were in those bins increased by 0.6 grams and 1.3 grams, which shows that the weight of the nipples did increase even if some of the weight added was due to excess soil stuck to the nipples.

Since the chemical formula for steel to rust is $Fe_2O_3.nH_2O$, which has oxygen, how much oxygen the environmental materials have affects how much the steel is going to rust. In addition to oxygen, steel also needs water, which was present in the bins throughout the experiment. The weight in the nipples increased because there were more oxygen molecules from the environmental materials present because that is what happens to steel before it starts to corrode. Since all purpose sand, beach sand, and potting soil all have oxygen in them, the nipples that were in those bins experienced the most change. The nipples in the snow salt always had very little change in the weight because snow salt doesn't have any oxygen in it, but still had the change since some oxygen was present in the bins.

Works Cited

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