CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36252

Project Title

Inhibiting the Corrosion of Metals Using Cathodic Protection

Abstract

Objectives/Goals

In this project I determined how metal type and anode surface area affect the corrosion rate of a metal protected by cathodic protection. My hypothesis was that if two metals form a galvanic cell, then corrosion rate of the anode will increase with its surface area and electrode potential difference between metals, and corrosion rate of the cathode will decrease with anode surface area and electrode potential difference between metals over the course of the experiment. I believed that standard electrode potential could be correlated with the ability of an electrode to corrode.

Methods/Materials

I created six galvanic cells; each consisted of a copper strip in a 0.5 M solution of CuSO4. Two were connected to zinc, two to aluminum, and two to iron strips, in 0.5 M Zn(NO3)2, Al(NO3)3, and FeCl3 solutions, respectively. Salt bridges and alligator clips completed each cell. Each day I wrote down observations and found the voltage of each cell. I found the mass of each electrode before and after five days. Change in mass was measured after scraping off corrosion from the metals.

Results

After averaging the voltage of each cell over time, I found that the electrode potential difference had no observable relation to rate of corrosion between instances. All cathodes gained mass over the course of the experiment, and all anodes lost mass; iron#s change in mass was much greater than that of zinc and aluminum. I attributed this to the passivation of zinc and aluminum, which formed an oxide layer protecting the metal beneath from further corrosion. Corrosion rate was proven proportional to anode surface area, because mass lost per unit of anode surface area was the same for each instance of a metal anode.

Conclusions/Discussion

Metal type was proven to affect the rate of corrosion of electrodes, but not for the reason thought. The ability of a metal to undergo passivation, instead of its electrode potential, affects its rate of corrosion in a galvanic cell. This was contrary to my hypothesis. My experiment showed that increases in surface area increase the corrosion rate of the anode, which proved that aspect of my hypothesis correct. In practice, an effective sacrificial anode would consist of a metal that will not undergo passivation, and is of a large surface area. The gain in mass of cathodes showed that corrosion can be reversed in certain scenarios, due to the transfer of electrons to the cathode.

Summary Statement

I determined how metal type and anode surface area affect the corrosion rate of a metal protected by cathodic protection.

Help Received

My chemistry teacher and science fair moderator each provided me a laboratory setting to work in, and all the materials, instruments, and substances I needed.