CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

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Project Number

J0504

Project Title

What Voltage Is Needed for Steel to be Protected by Impressed Current Cathodic Protection?

Abstract

Objectives/Goals

The objective of this experiment was to find which voltage would provide Impressed Current Cathodic Protection.

Methods/Materials

I designed and conducted a 134 sample corrosion experiment to find out what voltage is needed for steel to be protected by Impressed Current Cathodic Protection (ICCP). I hypothesized that there would be a certain voltage that would give ICCP to steel. Eleven series of seven different voltages were run in batches of six in open top cups containing 250 ml of 3% salt water with aerators bubbling air and one corrosion coupon of mild steel (C01010) which was dangled by a wire connected along with a carbon rod for an anode to a constant voltage DC power supply. Controls for my experiment were series run without impressed voltage, and blanks without coupons for procedure checking. The batches were left for 96 hours in a temperature monitored environment. Prior to disconnecting the wires at 96 hours, the voltages were measured between the coupon and the electrolyte and similarly between the carbon rod and the electrolyte with a Cu/CuSO(4) reference probe. The corrosion solute was filtered and rinsed before drying and weighing; similarly the coupon was weighed for weight loss.

Results

Using the molecular weight ratio of Fe(2)O(3) to Fe, the weight loss of the coupon was equated to the weight gain of the filter. These correlated well (R^2=0.84) except for a consistent 53 mg excess filter weight. Subtracting off 53 mg from the filter weights allowed for a random error calculation. Discarding the four data points outside three standard deviations, the standard deviation became 42 mg for Fe(2)O(3) or 30mg for Fe representing the typical sample error. The corrosion amounts varied from 0 to 300 mg.

Conclusions/Discussion

For my experimental setup, applying 1.8 volts or more across the entire system, good corrosion protection was seen with only 0.05 mm/yr; applying 1.7 volts or less there is no significant protection with 0.8 mm/yr. This was true whether or not a temperature correction for corrosion rate was applied. Measuring final voltages between the coupon and electrolyte with the Cu/CuSO(4) reference probe, the protected coupons had a potential of -0.8 V or less whereas the unprotected coupons had a potential of -0.7 V or greater.

Summary Statement

I designed and conducted a 134 sample corrosion experiment with Impressed Current Cathodic Protection (ICCP) and determined that cathodic protection occurred where voltage was -0.8 V or less.

Help Received

Dad prescreened some corrosion textbooks, procured equipment and consulted throughout. Mom or dad helped with each vacuum filtration.