CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)

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Project Number

J0535

Project Title

An Ionic Inquiry Yields Saline Solutions: How Four Salts Affect Electrical Conductivity

Abstract

Objectives/Goals

The objective of our project is to determine which of four different salt species in solution is the best conductor of electricity. We devised this experiment because we want to build a Tesla Coil that uses a saltwater tank capacitor. Most coil builders use sodium chloride in the tank. Our current experiment, on ionic species and electrical conductivity (EC), provides us with the first information we need.

Methods/Materials

Based on our prior research, we believed that divalent salts would be more conductive than the monovalent salts. During our research we also learned that solution EC is affected by temperature and concentration, which we carefully controlled.

We tested four salt solutions, two divalent and two monovalent: calcium chloride (CaCl2), sodium sulfate (Na2SO4), sodium chloride (NaCl) and sodium bicarbonate (NaHCO3). We began each replicate with 0.1 molar (0.1M) solution of each salt and then made serial dilutions at 0.01M and 0.001M. We made 5 replicates of each salt at each of the three concentrations. Prior to measuring the replicate EC values, we calibrated the EC meter each time with two standard solutions (12.88mS and 1.413mS). We recorded the EC and temperature of each replicate for 1 min. or until the EC readings stabilized.

Results

Based on the experimental results, we ranked the salts from highest to lowest average EC values as: CaCl2, Na2SO4, NaCl, and NaHCO3. The small range and standard deviation values showed there was relatively little variation between each of the replicate values.

Conclusions/Discussion

Our project data supported our hypothesis that the divalent salts, CaCl2 and Na2SO4, would have higher EC values than the monovalent salts, NaCl and NaHCO3. CaCl2 had the highest EC value at 0.1M of all the salts we tested. NaCl had higher EC values than NaHCO3 at all three concentrations. Also, each salt solution showed a slightly different relationship between concentration and conductivity.

So, if we want to build a good saltwater capacitor for our Tesla Coil, we should use CaCl2 instead of NaCl in the tank. If we were more cautious and did not want to potentially burn down the city, then we would use NaHCO3, a poor conductor, in the capacitor. We would like to test the salts at higher concentrations and also test some other salt species, especially a trivalent salt, such as aluminum chloride (AlCl3).

Summary Statement

Our project shows that calcium chloride should be better than sodium chloride when used in salt water tank capacitors based on its higher EC value at equimolar concentrations.

Help Received

Danny Armanino helped with our project narrative and timeline. Mrs. Ingrid Erich allowed us to use the Ukiah High School Chemistry Lab. Alpha Analytical supplied us with salt solutions. Our parents helped us gather materials and put together our display board.