



CALIFORNIA STATE SCIENCE FAIR 2010 PROJECT SUMMARY

Name(s) Matt A. West	Project Number S1928
Project Title Air Capacitor Based Oscilloscope Impedance Spectroscopy: An Effective Method for Characterizing Oil-Water Emulsions	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Crude oil is often contaminated with water or brine when recovered from reservoirs. These oil-water emulsions can cause corrosion in pipes, posing problems such as equipment failure in refineries. The focus of the project was to evaluate the effectiveness of Air Capacitor Based Oscilloscope Impedance Spectroscopy (ACOIS) to measure the properties of oil-water emulsions in terms of dielectric constant and resistivity.</p> <p>Methods/Materials The emulsions were prepared by blending SAE 30 HD motor oil, surfactants, and various amounts of water/salt-water/acid/base. The emulsions were poured into plastic containers that have various types of metals inside. Next, an air capacitor is placed into the oil-water emulsion. Then, a function generator applies a signal across the circuit while the oscilloscope measures the applied and resultant signals. These signals are then plotted on a Lissajous graph, and the phase angle and magnitude of impedance are found. Finally, the data is then plotted as real and imaginary components of impedance, and then fitted using data fitting software.</p> <p>Results There are several key findings in my study. First, in the 3% water-oil-air emulsion additions of 0.29 weight% of salt were added sequentially, and the value for the modeled resistor decreased as a function of salt concentration, confirming the fact that ACOIS can measure a very small change in dissolved ion concentration. Second, water concentration was varied over several oil-water-air emulsions, ranging from 0 to 15% of water, and the dielectric constants for the emulsions were calculated. The increase of the dielectric constants as the % of water increases proves the point that ACOIS can detect changes in the dielectric constants of oil-water emulsions. Third, aluminum soaked in NaOH-oil emulsion exhibited a decrease in emulsion resistance after 125 days of soak time, which is a clear sign that corrosion of the aluminum alloy occurred, measured by ACOIS.</p> <p>Conclusions/Discussion From this study, it has been found that ACOIS can measure very small changes in dissolved ion concentration, and dielectric constants in varying oil water ratios. It can clearly measure instances when corrosion occurs when the corrosion products are soluble, which is evident through the Aluminum Base 10% sample. However, ACOIS cannot measure corrosion when the corrosion byproduct is insoluble. This was apparent in most steel soaked samples.</p>	
Summary Statement By measuring the magnitude/phase angle of a circuit soaked in oil water emulsions, I calculated the real/imaginary components of impedance as a function of time, content, and metals present to determine the properties of the emulsions.	
Help Received My dad purchased the oscilloscope for me, and taught me how to make measurements. In addition my advisor Professor Ravi of Cal Poly Pomona helped me along with the project, and suggested some more specific directions to follow.	