CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
S0509

Project Title
Improving Hydrogen Production in the Electrolytic Cell of a Solar Hydrogen System: A Third Year Study

Abstract

Objectives/Goals
My objective is to increase the amount of hydrogen evolved in the electrolytic cell of a solar hydrogen system by varying the type and the concentration of the electrolytes, the surface area of the electrodes, and the distance between the electrodes.

Methods/Materials
The manipulative variables were the cations and anions of the electrolytes with varying molarity, and the size and the distance between the electrodes. The controls throughout the experiments were the steel electrodes and the input voltage. The performance parameters were the amount of hydrogen evolved with respect to the electrolytic concentration, distance and size of electrodes, and conductivity of the electrolytes. Using stoichiometric calculations, aqueous solutions of varying molarity for each electrolyte were created. The distances between the electrodes and the surface area of the electrodes were varied. The volume of hydrogen, conductivity and pH was measured for each molarity. Mean and standard deviation were computed for error estimation. Materials: 4 photovoltaic panels, electrolyzer, electrolytes of varying sizes and charges of the cations/anions, steel electrodes of different surface areas, digital multimeter, conductivity meter, pH meter, 0.1 ohm resistor.

Results
Hydrogen production increased with increasing electrolytic concentration for all electrolytes with KOH producing the most hydrogen. The electrodes with a larger surface area produced more hydrogen ($R^2=0.9796$). The amount of hydrogen produced increased as the distance between the electrodes was reduced ($R^2=0.9899$).

Conclusions/Discussion
The increase in hydrogen evolution with increased electrolytic concentration is because of a greater number of effective ionic collisions in unit time. The production of hydrogen increased in the order of increasing ionic radii with respect to both anions and cations, following the Hofmeister series. Hydrogen production also increased with increasing electrolytic conductivity. With decreasing distance between electrodes, the electrical charge increases and the resistance of the solution decreases, thereby producing more hydrogen. The electrodes with larger surface area produce more hydrogen because there is more surface area for the reaction to occur. Consistent with Faraday's first law of electrolysis, the charge passed was directly proportional to the amount of hydrogen produced.

Summary Statement
The amount of hydrogen evolution in the electrolytic cell of a solar hydrogen system can be increased by increasing the electrolytic concentration, the surface area of the electrodes, and by decreasing the distance between the electrodes.

Help Received
Used lab equipment at California State University, Fullerton, under the supervision and guidance of Prof. Katherine Kantarjieff and Dr. Steven Herron. Ms. Shannon Regli, my science teacher, provided advice. Parents helped make the display board.