Name(s)

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Project Number

35836

Project Title

Use of Period IV Transition Metal Salts to Optimize Solar Powered Electrolysis of Water for Hydrogen Gas Production

Abstract

Objectives/Goals

The objective is to expand upon previous personal research and focus on a comparison of the electrical efficiency of iron (III) and copper (II) salts in phosphate solutions with the intent of optimizing the solar powered electrolysis of water for the production of hydrogen gas. This in turn may be subsequently used to produce electrical power through the use of fuel cells in the absence of sunlight.

Methods/Materials

0.1 M solutions of iron (III) nitrate and copper (II) nitrate were added to 0.1 M solutions of monobasic potassium phosphate (KH(2)PO(4)) to form a combined solution. Electrical current was supplied to 50 mL samples of the combined solutions via a 12v power supply in order to produce hydrogen gas, which was collected by the displacement of water. Input energy was calculated by the equation E=IVt, The amount of hydrogen gas was computed by the equation PV=nRT, and the potential output energy that could be obtained from a fuel cell was calculated by multiplying the moles of hydrogen gas by the molar Gibb's Free Energy of the synthesis of water. The input energy was compared to the output energy in order to calculate the efficiency of using each combined solution for the electrolysis of water.

Results

While the iron (III) solution produced a peak of 0.00042 moles of hydrogen gas at 100 mA, the copper (II) solution produced a peak of 0.00017 moles of hydrogen gas. As a result, the iron (III) solution proved to be more effective at producing hydrogen gas. Despite the success of the iron (III) solution, however, the copper (II) solution had the capacity to convert 14 percent of its input energy into output energy similar to the iron (III). This suggests that the copper (II) solution's efficiency is equal to that of the iron (III) solution, but at lower currents. Based on this, the copper (II) is optimal for conditions of low sunlight while the iron (III) is optimal for conditions of high sunlight.

Conclusions/Discussion

Because the iron (III) solution conducted twice as much current and produced twice as much gas as the copper (II) solution, this supports the hypothesis that salts with cations possessing more numerous oxidation states are better suited for use as catalysts for the electrolysis of water. Future experimentation may look into cations with more numerous oxidation states than iron, such as manganese.

Summary Statement

Optimization of phosphate-buffered transition metal catalysts for the efficient solar powered electrolytic generation of hydrogen gas to be used in hydrogen fuel cells as a renewable power source in the absence of sunlight.

Help Received

Chemicals were supplied by Norco High School, glassware, advice, and facilities were supplied by my father