CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

J0612

Project Title

Drinking the Ocean: Desalinating Seawater and Generating Hydrogen Using Organic Waste

Abstract

Objectives/Goals

The object of my project is to determine the effect of hydrogen generation on the amount of desalination produced by a microbial electrolysis desalination cell (MEDC). An MEDC desalinates seawater and also generates hydrogen using only the energy produced by bacteria digesting organic waste. I built two cells - a regular microbial desalination cell (MDC) which does not generate hydrogen as a control, and an MEDC to compare the desalination rate with the MDC. A microbial electrolysis desalination cell can help solve two important global problems: it generates clean energy which reduces greenhouse gas emissions, and it provides drinkable water for the world's expanding population. Due to the abundance of organic waste and seawater, the microbial electrolysis desalination cell can solve these problems cheaply, so even people in developing countries can use the technology and benefit from it. The design can be scaled from a small portable unit for an individual family to a large installation in a wastewater treatment plant.

Methods/Materials

I built my MEDC and MDC from scratch using acrylic plates and cylinders, semipermeable ion exchange membranes, carbon felt electrodes, and an Arduino microprocessor kit and breadboard. I simulated organic waste using benthic mud from a nearby lake. I measured water salinity with a digital refractometer, hydrogen output using an MQ-8 hydrogen gas sensor, and voltage and current output with a digital multimeter.

Results

Over a period of one month my MDC desalinated simulated seawater from 35 parts per thousand (ppt) of total dissolved solids (equivalent to seawater) to 19 ppt, and the MEDC desalinated to 20 ppt. The hydrogen output slowly rose over the month, leveling out at the end of the month to around 650 parts per million. The output voltage and current generally decreased over time.

Conclusions/Discussion

My results show that the MDC and MEDC both can use exoelectrogenic bacteria to desalinate seawater, and although it is generating hydrogen, the MEDC desalinates only a little less than the MDC. Therefore an MEDC is more beneficial than an MDC since it has the added advantage of producing hydrogen, another form of clean energy. I was not able to completely desalinate my simulated seawater because as the water becomes desalinated, the central chamber of my 3-chamber cell loses conductivity, so the cell cannot produce enough electricity to desalinate all the seawater.

Summary Statement

Using a microbial electrolysis desalination cell to generate hydrogen gas has only a small effect on its ability to desalinate seawater.

Help Received

My dad helped me use a power drill and epoxy to build the two cells.