CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35373

Project Title

Drinking the Ocean: Desalinating Water Using Clean Energy

Abstract

Objectives/Goals

The objective of my project is to build a microbial desalination cell to desalinate seawater using only the energy produced by bacteria digesting organic waste. The microbial desalination cell helps 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 desalination cell solves both of these problems cheaply, so even people in developing countries can use the technology and benefit from it. It has a simple and reliable design which can be scaled from a small portable unit that could serve an individual family to a large installation in a wastewater treatment plant.

Methods/Materials

I built my microbial desalination cell from scratch, using acrylic plastic cylinders, semipermeable ion exchange membranes, and carbon felt electrodes. I simulated organic waste using benthic mud from a nearby lake. I measured water salinity with a digital refractometer, and I measured voltage and current output with a digital multimeter.

Results

Over a period of 30 days my microbial desalination cell successfully desalinated the simulated seawater from 35 parts per thousand of total dissolved solids (equivalent to seawater) to 24 parts per thousand. The output voltage and current generally decreased over time.

Conclusions/Discussion

My results show it is possible for a microbial desalination cell to use the energy it produces to desalinate seawater. 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 (seawater can be 100 times more conductive than fresh water), so the cell cannot produce enough electricity to desalinate all the seawater. Some ideas to improve desalination performance include: make the anode chamber bigger with a lot more organic waste so more bacteria would generate more electrons, recirculate the solid waste to prevent bacteria from dying from the excess chlorine in the anode chamber, and make the desalination chamber smaller so more electric current can pass through and to enable more sodium and chlorine ions to pass through the membranes.

Summary Statement

Using the biological properties of exoelectrogenic bacteria and the chemical processes of electrolysis and reverse osmosis, a microbial desalination cell can desalinate seawater using only the energy produced from organic waste.

Help Received

My Dad helped me build my microbial desalination cell, as some power tools were required, and Dr. Bruce Logan of Penn State University advised me regarding the semipermeable ion exchange membranes.