CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S1922

Project Title
Optimizing Microbial Fuel Cell Output by Varying Relative Surface Area

Abstract

Objectives/Goals
The purpose of this research project is to optimize the output of a sediment microbial fuel cell (MFC) by varying the ratio of anode to cathode effective surface area. Sediment microbial fuel cells work by utilizing the potential difference between the anode in the biologically active mud and a cathode in the water above. The anode undergoes an anaerobic reaction; whereas, the cathode requires oxygen for its reaction. As a result, the cathode can have its effective surface area increased by oxygenating the water with an air pump, providing the required precursor for the cathode reaction. It was expected that in a 1:1 configuration, the anode would be the limiting factor due to the semi-solid transport limitations of the bacteria that must be in close proximity with the anode.

Methods/Materials
In this experiment, an initial fuel cell with a 1:1 anode to cathode ratio was constructed. Baseline measurements of voltage and current were taken with a digital multimeter. Then, MFCs were built with 2:1, 3:1, 4:1, and 6:1 ratios. The measurements taken were compared to the measurements of the initial MFC. After a baseline was established for each configuration, the effective cathode surface area was increased by oxygenating the water around the cathode.

Results
The results support a conclusion that an optimum can be reached between the effective surface areas of the anode and cathode. The 2:1 MFC seemed to produce the most voltage and current. However, worms that were indigenous to the mud started to appear in each microbial fuel cell after each cell was oxygenated. The worms, surprisingly, inhibited the fuel cell reaction as the voltage and current dropped dramatically after the air pump was removed.

Conclusions/Discussion
The unexpected appearance of mud worms in the MFC highlighted the need to consider the actual environment that the fuel cell will operate in. Before the installation of these cells in actual use, engineers need to consider and anticipate the wildlife that grow and live in the planned environment. This research project shows that MFCs can be a viable power source in the future. An effective microbial fuel cell could provide 3rd world, rural civilians with network connectivity, such as cellular and telemedicine applications. Additionally, MFCs could power long-term sensor applications for environmental monitoring and military situational awareness.

Summary Statement
My project is about sustainable, renewable energy sources for sporadic power applications.

Help Received
My stepfather helped me find the materials needed to build the microbial fuel cell, and we worked together in assembling the project.