CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)
William W. Follett, V

Project Number
J0296

Project Title
Air Cathodes for Better Microbial Fuel Cells

Abstract

Objectives/Goals
The objective is to determine which type of air cathode (Gore-Tex, Tyvek, Windex cloth or Teflon) can produce the most power for the least cost in a microbial fuel cell (MFC).

Methods/Materials
I developed a unique MFC design that allows air cathodes to be easily compared while controlling for changes in the microbe community. This improves on last year's design by replacing the expensive proton exchange membranes with less expensive air cathodes, and shrinking the size by 9X for better efficiency. I spent a long time searching for MFC designs, and as far as I know mine is the only air cathode MFC to control for the microbes. I was recognized by Penn State University and my latest MFC is on their website.

The air cathodes are initially all covered with plastic to block air flow. The one to be tested is selected by removing the plastic. To determine the power output, the electrodes are connected to various resistances and the voltage is measured. The power is calculated at each resistance by using the formula V^2/R to find the maximum power. The maximum power is divided by the cost of the membrane, which gives watts per dollar. This is repeated for the various air cathode devices. Microbe samples were cultured to check for contamination.

Results
Gore-Tex produced the most peak power (0.019 microwatts), while Tyvek cost the least investment per watt generated ($0.05/microwatt, compared to $0.32 for Gore-Tex and $3.34 for Teflon.) The power changed by a factor of 6 between tests, but after scaling the results based on power, the results were repeatable because the relative performance ranks of the air cathodes stayed the same for all tests. The significant changes in power show the importance of controlling for the microbes.

Conclusions/Discussion
The hypothesis that Tyvek would provide the best value as a diffusion layer in terms of watts per dollar invested is supported by the data. Since Tyvek required a coating of Scotchguard to remain water resistant, Gore-Tex or a different type of Tyvek may be a better choice for an industrial application.

The real world application of MFCs is to generate electricity from wastewater treatment plants. The potential energy in U.S. wastewater today is equivalent to 15-20 nuclear power plants. Besides wastewater treatment, MFCs are also good for applications where batteries are hard to replace such as underwater sensors, space rovers and heart pacemakers.

Summary Statement
This project investigates the effect of different air cathodes on microbial fuel cell performance.

Help Received
Father provided guidance, Mr. Jensen loaned a kiln, Ms. Ligeti loaned a microscope, Dr. Logan suggested I try a smaller MFC.