CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S0912

Project Title
Converting Chemical and Biological Energy into Electricity using the ZAFC and MFC: Maximizing Energy Output

Abstract

Objectives/Goals
The objective of this project is to generate electricity using the Zinc-Air Fuel Cell (ZAFC) and the Microbial Fuel Cell (MFC). I demonstrate that these renewable energy fuel cells can be used in series to produce enough electricity in off-grid locations to power small appliances, and potentially meet the power demands of many households.

Methods/Materials
Zinc-Air Fuel Cell: Zinc,Powdered Graphite,Nonmetallic Mesh Tube,Gauge Pad,Salt,Water. Microbial Fuel Cell: Sediment from a Pond (microbes),Agar Jelly,Carbon Cloth, Copper Wire,Aerator Pump,Tube,Brick,PVC pipes of various shapes. Zinc-Air Fuel Cell Method: Make the cathode (zinc); wrap a gauze strip around the zinc; insert into a mesh tubing. Make the anode (air) by spreading powered graphite paste on a gauze strip; wrap the gauge around the mesh tube. Create in-series fuel cell by connecting zinc cathodes to successive air anodes using copper wires. Make the electrolyte by dissolving salt in water; dip cathodes and anodes into the electrolyte. Microbial Fuel Cell Method: Prepare agar jelly by boiling water, mixing agar and salt. Pour agar jelly inside a PVC pipe, the salt bridge. Make the anode and cathode chambers with PVC pipes. Join them with the salt bridge. Make the electrodes using two pieces of carbon cloth and sowing copper wires to them. Add pond sediment (microbes) to the anode. Put cooking oil on top to make the chamber anaerobic. To the cathode add salt water solution. Aerator pump, tubing, and brick are placed for oxygen circulation.

Results
Both ZAFC and MFC cells work at room temperature, can be store and transported easily, and can be built using inexpensive, and non-toxic materials. The steady state voltage reading for the single MFC was 0.16 V, for single ZAFC was 0.59 V, and for two ZAFC's in-series was 1.17V. Increasing the area of zinc increased the current and power of the ZAFC. The ZAFC in-series resulted in increased voltage and power production.

Conclusions/Discussion
I conclude that zinc-air fuel cells with solar regeneration process and microbial fuel cells with continuous flow possess great potential for producing safe electricity at competitive prices to power small appliances and meet the power needs of several households at a large scale. Unlike solar power and wind, which are intermittent and dependent on weather, fuel cells have the advantage of being able to run 24 hours a day, 365 days a year.

Summary Statement
Increase electricity production by an order of magnitude using the ZAFC and MFC.

Help Received
Daniel Tate, a UCSC student helped me to measure the electricity using high-precision instruments. Mark Akeson, UCSC professor, and Joe Jordan, Cabrillo Faculty, helped me to find places for materials used in this project.