CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

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Project Number

31315

Project Title

Microbial Fuel Cell Year Four: The Effect of Thermally Enhanced Oxide Layer Growth on Power Generation in an Air-Cathode

Abstract

Objectives/Goals

My project was to determine at what temperature heat-treated aluminum anode electrodes maximize the power density from secondary treatment water in a single chamber air-cathode microbial fuel cell system at the end of 168 hours. Based on literature, I believe that heating the electrodes at 125°C will generate the most power.

Methods/Materials

Air-cathode fuel cell systems were constructed and aluminum anode electrodes were heated to 50°C, 75°C, 100°C, and 125°C for 15 minutes. The anode chambers were filled with secondary treatment water and distilled water. The nineteen MFC systems were connected to an external circuit with a 1000 U resistor and multi-meter. Millivolt and milliamp readings were recorded three times daily for 168 hours and the power density was calculated. Also, the amount of oxide layer growth and bacterial mass on the aluminum anode electrodes were measured.

Results

An electrode heated to a temperature of 100°C generated the highest power density of 25.8±0.16 mW/m2 in secondary treatment water, at 120 hours. The electrode not heat-treated and in secondary treatment water produced a power density reading of 5.8±0.02 mW/m2. The electrode heated to a temperature of 125°C generated the second highest power density of 17.8±0.11 mW/m2 in secondary treatment water, at 104 hours.

Conclusions/Discussion

The data does not support the hypothesis that heating electrodes at 125°C will generate the most power. Anodizing the surface of the electrodes at 125°C resulted in an oxide layer that may have become too thick, reducing electron flow from the bacteria to the anode. The electrode heated to 100°C had the highest power density of 25.8±0.16 mW/m2. The results show that additional research regarding heating aluminum anode electrodes may further increase power density produced by microbial fuel cells. Wastewater treatment plants could benefit greatly if an efficient, commercial scale microbial fuel cell design could be developed.

Summary Statement

Determine at what temperature heat-treated aluminum anode electrodes maximize the power density from secondary treatment water in a single chamber air-cathode microbial fuel cell system at the end of 168 hours.

Help Received

Dr. Michael Toney, Ph.D. at Stanford Linear Accelerator provided answers to my questions during the research and Dr. P.J. Utz of Stanford University Medical School provided access to lab space and equipment.