Electricity Generation during Biosurfactant Production in a Microbial Fuel Cell

P. Prashanth, J. Liu and C. Vipulanandan
Center for Innovative Grouting Material and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
Phone: (713) 743-4278
Email: ppuviraj@mail.uh.edu, jliu@mail.uh.edu, cvipulanandan@uh.edu

Abstract

Electricity generation during the biosurfactant production from used vegetable oil in a two chamber Microbial Fuel Cell (MFC) was investigated. The constant open circuit voltage was between 0.8-1.0 V, with 1.12 V being the maximum value reached after 77 hours of operation. The maximum power density of 0.32 mW/m^2 was achieved when the external resistor was 50 kΩ. The surface tension dropped to 32 mN/m after 100 hours of operation and remained unchanged during the testing period.

1. Introduction

Electricity generation using renewable and environmental friendly energy sources is of increasing interest as the currently used non renewable energy sources are facing extinction and the global energy need is increasing rapidly. In recent years, Microbial Fuel cells (MFCs) are drawing increasing attention as an effective means of electrical energy production from complex organic wastes. Some families of microorganisms are found to be able to degrade (oxidize) the organic matter and produce electrons. The development of processes that can use bacteria to produce electricity represents a unique method for bioenergy production. The major constrain associated with the generation of electricity using MFC is the high internal resistance. Many studies have been conducted on reducing the internal resistance and optimizing the generation of electricity. UH-biosurfactant has been successfully produced from used vegetable oil (Hariharan 1996).

In this study, a two chamber MFC arrangement was used to investigate the feasibility of producing electricity from used vegetable oil while producing biosurfactant. Effect of various characteristics of MFC on the electricity generation and biosurfactant production were analyzed.

2. Objectives

The overall objective of this study was to investigate the ability of microorganisms to produce electricity while producing biosurfactant from used vegetable oil in continuously stirred batch reactors.

3. MFC Arrangement and Data Recording

A two chamber MFC arrangement used in this study is shown in Fig.1. Aluminum sheets (Area 5" × 1") are used as electrodes and salt bridge is used to connect anode and cathode chambers. Two square shaped plastic bottles were used as the chambers with working volume of 1000 mL each. Used vegetable oil was used as carbon source for bacteria in the anode which is slowly stirred by a magnetic stirrer during the operation, and salt buffer is used for cathode. External air was injected into the cathode chamber.

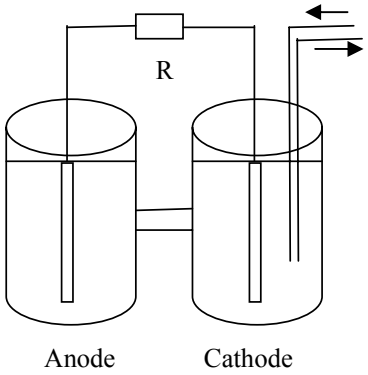

Fig. 1. MFC Arrangement

During the experiment, open circuit voltage, closed circuit voltage and current were measured using a multi-meter by changing external resisters. pH and Oxygen Reduction Potential (ORP) of the substrate were measured by pH-ORP meter. Surface tension of anode fermentation liquid was measured by Du-Nouy

tensiometer. Absorbance of anode fermentation liquid which indicates bacteria concentration was measured using UV-Vis spectrophotometer.

4. Analysis and Discussions

After 9 days of operation, the MFC still had an Open Circuit Voltage (OCV) of 0.88 V, which was changing constantly between 0.8-1.0 V after 2 days of operation, and with 1.12 V being the maximum value reached after 77 hours of operation. The maximum power density of 0.32 mW/m^2 was achieved (Fig.2.(b)) when the external resistor was 50 kΩ. Internal resistance obtained as 50 kΩ after calculation with Power Density Peak Method and Polarization Slope Method (Logan 2008). Very high internal resistance was the main reason for the relatively low power density achieved in this study. The surface tension drops to 32 mN/m after 100 hours of operation and remained unchanged during the testing period, which indicates the production of biosurfactant in MFC. During the steady state operation of the MFC pH and ORP have average values of 8 and -60 mV respectively and as shown in Fig.2.(a), the highest open circuit voltage was obtained at the same time as the lowest ORP value of -126.4 mV, which indicate anaerobic condition favored the higher energy output in MFC.

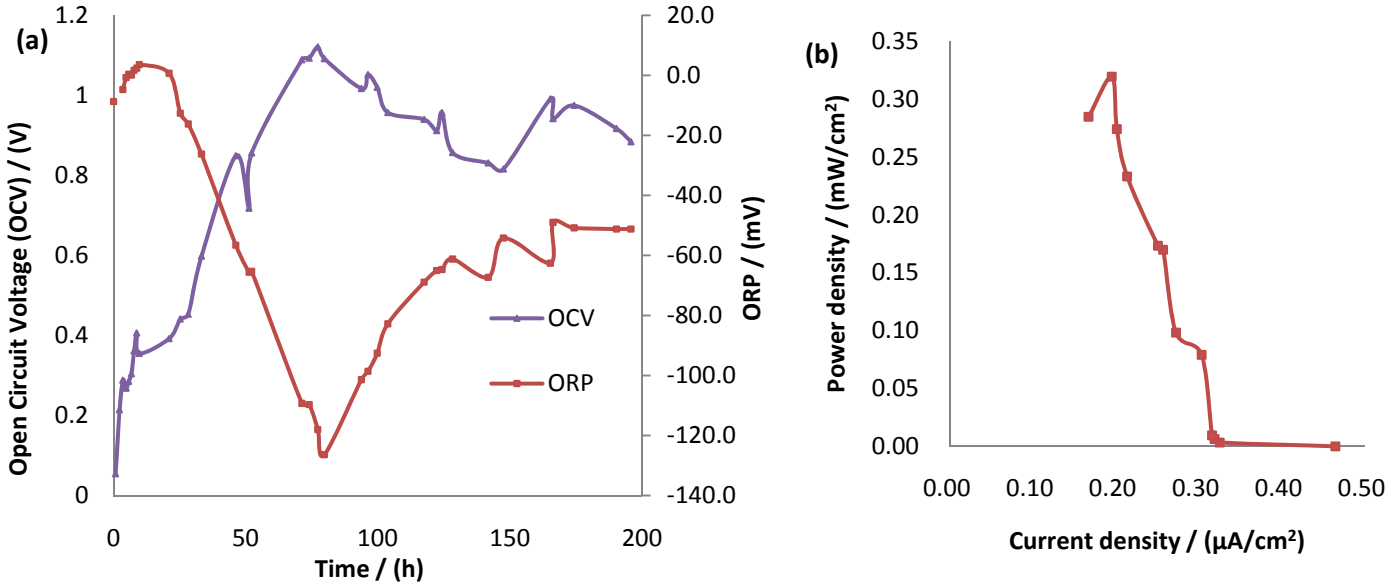

Fig. 2.(a) Variation of OCV and ORP during MFC operation **(b)** Variation of Power density with Current density

5. Conclusion

With the MFC configuration built in this study, relatively constant open circuit voltage of 0.8-1.0 V, maximum power density of 0.32 mW/m^2 and surface tension of 32 mN/m were obtained after 8 days of operation. This proves that the microorganisms that produced the UH-biosufactant have the ability to produce electricity in a MFC while producing the biosurfactant.

6. Acknowledgement

This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT).

7. References

1. Hariharan S (1996). Production of Biosurfactant from Used Vegetable Oil and Use for Lead Precipitation. University of Houston. Thesis 628 1996.H37: 41

2. Logan BE (2008). Power Generation. Microbial Fuel Cells. Wiley Inter-Science: 54-55