Name(s)

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Project Number

S1122

Project Title

Turning Farm Waste into Usable Energy: Investigating Energy Production of 3-D Printed Microbial Fuel Cells

Abstract

Objectives/Goals

The purpose of this experiment is to economically engineer and test 3-D printed Microbial Fuel Cells (MFC) in a series connection for use in large scale application like a dairy or wastewater treatment facility. I hypothesized that CAD 3-D printing software can be used to design an MFC that will be able to produce a measurable amount of energy. Furthermore, I hypothesized 3-D printed MFCs will produce a greater amount of energy in series connections than by themselves.

Methods/Materials

The research and design phase reviewed multiple CAD 3-D printing software programs to determine the most functional and economic tool for designing the MFCs. Using Tinkercad STL files were prepared for printing on Lulzbot Taz 4, a second model was printed on a Flash Forge Creator Pro. Alpha filament and PLA plastic materials were used to print the prototypes. Then, multiple trials were conducted using 45 mg of cow manure farm waste in the anode, and 35mg of saltwater solution in the anode chamber. Electrodes sized 3 cm x 3 cm were placed in the chambers, and an agar solution was used for the salt bridge. Twice daily readings were taken for amperage, volts and wattage.

Results

An MFC was printed using economical CAD software. However, due to printer limitations there were dimension constrains. The experimentation demonstrated that both the individual and series connected MFC could consistently produce measurable energy. However the individual MFC produced a greater amount of energy, 1.08 watts; in comparison the series connection yielded 0.88 watts. In general the individual MFC produced a greater amount of voltage, 154 mV versus 85 mV; but, a similar amperage between 4 and 11 mA for the individual and 1 to 5 mA for the series connection.

Conclusions/Discussion

A functioning MFC was engineered, and the results indicate that the individual MFCs are more efficient than the MFCs in series connection. The next step in this research would be to increase the size of the 3-D printed MFC, and make modifications to the salt bridge, from an agar solution to a proton exchange membrane to increase output. Additionally, development of a power management system, including a boost converter, for energy to then be stored in an external battery for future consistent flow of energy will be reviewed. These modifications will be necessary before applying this technology to a large scale use on a dairy or waste water treatment facility.

Summary Statement

Using CAD software I designed economical 3-D printed MFC prototypes to use in series connections for the purpose of creating an inexpensive way to turn farm waste into usable energy, for large scale use.

Help Received

I designed the MFCs prototypes using CAD software. Then, I submitted STL files to Doug Cairns of TCOE and Nelson Sebra of Fresno State#s Lyles Center, they printed my prototypes MFC on 3-D printers.