Microbial fuel cells big and small: Social justice through bioenergy

Don Comfort, Ph.D.
Department of Chemical and Materials Engineering
University of Dayton

Bioenergy is the production of energy from biological sources. The use of biofuels dates back to ancient times with wood burning stoves, charcoal, and peat moss. Modern biofuels share the renewable nature of these original biofuels, but look more like modern energy sources. These include ethanol from corn/wood, biodiesel from plant oils, and gas biofuels such as synthetic natural gas or hydrogen produced by microorganisms. Beyond these gas and liquid fuels, other bioenergy sources exist such as the conversion of biological energy sources to electricity via fuel cells. One type of fuel cell could utilize biohydrogen to produce electricity, however, this requires means of storing and charging the hydrogen. Alternatively, electricity can be directly generated from biological energy sources such as sugars, organic acids, lipids, or even pollutants through a microbial fuel cell (MFC).

Microbial fuel cells operate like other fuel cells in that they produce protons and electrons from an energy source. Unlike traditional methanol or hydrogen fuels cells, which can only process methanol or hydrogen, MFCs are capable of utilizing a wide variety of energy sources. This array of energy sources is determined by the microorganism, whose metabolism serves as the biocatalyst for producing electrons and thus electrical power. The ability of microorganisms to process a wide variety of energy sources means that abundant stocks of sugars (fruits and juices) can be used in remote locales to provide basal levels of electrical power, perhaps to charge batteries or a cell phone. This can provide a vital means of supporting contact with remote villages using indigenous energy sources and generating nearly free electricity for these people.

MFCs have applications for waste water treatment to produce electricity concomitantly with contaminant removal down to miniature MFC systems for low level continuous power delivery such as on MAVs. This presentation will describe the use of the bacterium *Pseudomonas aeruginosa* in a MFC. We have shown that MFCs utilizing *P. aeruginosa* are capable of generating electricity from both glucose and succinate and that the power densities are similar for both substrates. Furthermore, to evaluate applications for small devices, the development of a miniature MFC will be discussed as demonstration of methods to increase the surface-area to volume ratios in a membraneless MFC. Through this technique, an increase in the gravimetric and volumetric energy densities should follow.