



University of Hawai'i at Mānoa

Hawai'i Natural Energy Institute

School of Ocean & Earth Science & Technology

High-yield Hydrogen or Electricity Generation from Biomass using Microbial Fuel Cell Technologies

Microbial fuel cells (MFCs) represent a new approach to renewable bioenergy production based on the direct conversion of organic matter to electricity. Certain bacteria, called exoelectrogens, can oxidize organic matter and transfer electrons outside the cell to the electrode (anode) under anaerobic conditions. The electrons flow to the counter electrode (cathode) where they combine with oxygen and protons (from the anaerobic chamber) to form water. We have shown that it is possible to directly generate electricity from virtually any biodegradable organic matter in an MFC. Using simple organic compounds such as acetate or glucose, we can produce up to 2400 mW/m^2 (based on cathode surface area) or 115 W/m^3 (total reactor volume). Power can be generated using any type of biodegradable organic matter, including pure compounds (acetic acid, glucose, amino acids, protein, etc.) or complex organic matter in wastewaters (domestic, animal, food and other industries) that have the added benefit of wastewater treatment. Agricultural materials such as corn stover hydrolysates or cellulose powders can also be used in these systems. While power densities produced with MFCs are lower than with hydrogen or other types of fuel cells, these power densities will make it possible to transform wastewater treatment plants and farms into power plants. Modifying the MFC by removing oxygen and adding a small voltage to the circuit makes it possible to produce hydrogen gas at very high yields and energy efficiencies. For example, we can produce up to 3.9 moles of hydrogen per mole of acetate (versus a theoretical yield of 4 mol/mol) at an overall energy efficiency of up to 88% (based on heats of combustion). These findings show that it is possible to recover bioenergy in the form of hydrogen or electricity from readily available sources of biodegradable organic matter including wastes.

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