Move Cuts Prototype Costs

Penn State (University Park, PA 16802; Tel: 814/865-9142) environmental engineers have removed and replaced one of the most expensive parts of their prototype microbial fuel cell, and the device now costs two-thirds less and produces twice as much electricity from domestic wastewater. The Penn State team modified their original fuel cell by removing the polymeric PEM that previously was bonded to the cathode, substituting instead carbon paper for the electrodes.

Earlier this year, the Penn State team was the first to develop a microbial fuel cell (MFC) that generated electricity whilst simultaneously cleaning domestic wastewater skimmed from the settling pond of a sewage treatment plant. Now, they have shown that by modifying their original MFC to make it cheaper, they can boost electricity production from about 26 milliwatts per square meter to about 146 milliwatts per square meter.

Bruce Logan, the Kappe professor of environmental engineering, directs the project. He says, "The new design has moved the technology closer to our goal of 1,000 milliwatts per square meter."

He notes that they have hooked up an MFC built on the Penn State design principles to run a three-milliwatt fan. Calculations show that a hybrid wastewater treatment plant that had a Penn State MFC in place could power the fan with just 5.5 ounces of wastewater or a reactor smaller than a tea cup.

The advance is described in a paper, "Electricity Generation Using an Air-Cathode Single Chamber Microbial Fuel Cell in the Presence and Absence of a Proton Exchange Membrane," released online and scheduled for a future issue of Environmental Science and Technology. The authors are Hong Liu, postdoctoral researcher in environmental engineering, and Logan.

Microbial fuel cells produce current through the action of bacteria that can pass electrons to an anode, the negative electrode of a fuel cell. The electrons flow from the anode through a wire to a cathode, the positive electrode of a fuel cell, where they combine with hydrogen ions (protons) and oxygen to form water.

The naturally occurring bacteria in wastewater drive power production via a reaction that allows them to transport electrons from their cell surface to the anode. In addition, a reaction (oxidation) that occurs in the interior of the bacterial cell lowers the biochemical oxygen demand, cleaning the water.

The new prototype consists of carbon paper placed on opposite ends of a plastic tube about an inch and a half long and a little over an inch in diameter. Carbon paper on one end is the anode and carbon paper, which also contains a small amount of platinum, forms the cathode on the other end. Platinum wire completes the circuit. The carbon paper allows oxygen in air to directly react at the cathode. So, there is no need to bubble air into the water as the cathode as is required in a typical two-chamber MFC.

Logan notes, "By eliminating the PEM, which was one of the most expensive components, we bring the cost down significantly. Substituting carbon paper for graphite rods further reduces the cost. I'm optimistic that MFCs may be able to help reduce the $2.5 billion annual cost of wastewater treatment in the U.S. and provide access to sanitation technologies to countries throughout the world."