Study: cow-powered fuel cells grow smaller, mightier

August 21 2007

Cows could one day help to meet the rise in demand for alternative energy sources, say Ohio State University researchers that used microbe-rich fluid from a cow to generate electricity in a small fuel cell.

This new microbial fuel cell is a redesign of a larger model that the researchers created a few years ago. The new cell is a quarter of the size of the original model, yet can produce about three times the power, said Hamid Rismani-Yazdi, a doctoral student in food, agricultural and biological engineering at Ohio State University.

Experiments showed that it took two of the new cells to produce enough electricity to recharge a AA-sized battery. It took four of the first-generation fuel cells to recharge just one of these batteries.

Rismani-Yazdi is the lead author of a new study of cellulose-based microbial fuel cells. The source of power for these fuel cells comes from the breakdown of cellulose by a variety of bacteria in rumen fluid, the microbe-rich fluid found in a cow's rumen, the largest chamber of a cow's stomach. To create power, researchers fill one compartment of a microbial fuel cell with cellulose and rumen fluid.

“Energy is produced as the bacteria break down cellulose, which is one of the most abundant resources on our planet,” said Rismani-Yazdi. Indeed, cellulose is plentiful on most farms, as harvesting usually leaves plenty behind in the form of crop residue in fields. Other prime sources of cellulose include waste paper and items made of wood.

Rismani-Yazdi and his colleagues are continuing to refine their microbial fuel cells, as well as trying to figure out how to grow mass amounts of rumen microbes in the laboratory for possible large-scale use in the future.

The researchers reported the findings August 21 at the American Chemical Society meeting in Boston. Rismani-Yazdi worked with his mentor Ann Christy, an associate professor of food, agricultural and biological engineering at Ohio State and with Olli Tuovinen, a professor of microbiology at the university.

The team collected rumen fluid from a living cow, extracting the fluid through a cannula, a surgically implanted porthole that leads directly into its rumen. They filled one compartment of a fuel cell with this microbe-rich fluid and with cellulose.

The microbial fuel cell, which has two compartments, is about two inches wide and three inches in height and length. A thin membrane made of special material separates the two compartments. This material allows protons to move from the negative (anode) compartment into the positive (cathode) compartment.

This movement of protons, along with the movement of electrons across the wire and resistor that connect the two compartments, creates an electrical current.

A small piece of graphite placed inside each compartment served as a fuel cell's electrodes (an electrode draws and emits electrical charge.) The researchers filled the anode chamber with cellulose and with microbes derived from rumen fluid. Electrons are released as the microorganisms break down the cellulose.

These electrons are then transferred to the anode electrode.

The researchers filled the other chamber, the cathode, with potassium ferricyanide, a chemical that acts as an oxidizing agent and helps close the electrical circuit by accepting electrons from the cathode electrode. Once the circuit is closed, electrons flow from the anode to the cathode, creating electricity.

The microbial fuel cells with the least amount of resistance produced the most power – enough to run a miniature Christmas tree light bulb, Christy said. That's about three times more power than their first-generation fuel cells were capable of producing.

“The amount of electricity that we can get out of one of these cells is ultimately related to the resistance of the object that we want to power,” Rismani-Yazdi said.

He said that he typically adds cellulose to the fuel cells every two days, although that amount can vary depending on how quickly power is drained from the cell.

“But the power output of these fuel cells is sustainable indefinitely as long as we keep feeding the bacteria with cellulose,” Christy said. “We ran these cells for three months.”

Although the technology is still in its infancy, the researchers are encouraged by how far they've come in the last two years, and they are continuing their efforts to increase the amount of power these microbial fuel cells can produce.

Source: Ohio State University

Citation: Study: cow-powered fuel cells grow smaller, mightier (2007, August 21) retrieved 23