

New fuel cell uses germs to generate electricity

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By Gareth Cook, Globe Staff, 9/8/2003

Scientists at the University of Massachusetts at Amherst announced yesterday that they have built a novel device that uses bacteria to turn garbage into electricity.

The new "microbial fuel cell," an early prototype, cannot generate enough power to run an appliance, but it can operate virtually indefinitely without interruption, and is far more efficient than anything like it ever built.

"We are not going to be adding to the power grid at any significant rate soon," said Derek Lovley, a professor of microbiology at UMass-Amherst. "But with an electric lawn mower, you could use the leaves and clippings to power up the battery for next week."

The bacteria in the battery generate electrical current when they feed on sugars, which are found virtually everywhere in nature. The technology could create electricity from a wide variety of materials, from human sewage to compost.

At the heart of the advance, which will be described in the October issue of the journal *Nature Biotechnology*, is a newly discovered organism that is part of a group of bacteria known as "iron breathers," so called because they rely on iron instead of oxygen. Yesterday's announcement is part of a broader effort to tap the unusual properties of various iron breathers, now being discovered across the far reaches of the planet, to generate power or clean up oil spills or other pollutants.

As it has become clear that the world will need energy alternatives, some researchers have turned to the idea of finding new ways of releasing the enormous amount of energy trapped in plants and other organic matter. This is the idea behind ethanol, a fuel made from corn. But instead of using organic matter to make a fuel, the battery announced yesterday converts organic matter directly into electricity.

"We need people thinking outside of the box, and these researchers are clearly thinking outside the box," said Mark Finkelstein, group manager of bioprocess research and development at the government's National Bioenergy Center in Golden, Colo. "And this has shorter-term possibilities than the hydrogen research that is getting so much funding."

The battery relies on a colony of tiny bacteria, called *Rhodoferax ferrireducens*, first brought up from underground by a research drill in Oyster Bay, Va. The bacterium is unusual because it is able to completely break down sugars without using oxygen. In its natural environment, the bacterium breaks down sugars for energy and deposits electrons on iron as a byproduct.

The research team, which included UMass-Amherst postdoctoral research associate Swades Chaudhuri, placed these bacteria in a closed glass container with a sugar solution and a graphite electrode. As the bacteria ate the sugar, they took up residence on the electrode and began depositing electrons on it.

When the researchers connected a wire between the electrode and a separate electrode exposed to the air, a current started to flow.

Other researchers have built similar devices but they have been far less efficient at converting the sugar to electricity. Of all the electrons that could theoretically be moved by the process, the battery captured more than 80 percent, compared with less than 1 percent for a previous battery, according to the paper.

The Defense Department, which helped fund the research, is interested in the device because it could be used to run low-power antennas in remote locations without the need for replacing batteries, Lovley said. The electrode could be placed at the bottom of a pile of waste, along with a colony of the bacteria, which would thrive in the sugar-rich, oxygen-poor environment.

The biggest problem right now is the amount of power generated. The test battery generates just enough energy to power a calculator or a single Christmas tree light, Lovley said. Simply changing the electrode, so that more of the microbes can touch it, can increase the amount of power it generates.

The team is exploring the idea of genetically engineering the microbe so that the colony delivers even more electrons to the electrode, boosting the power.

Lovley said he hopes the technology could be used to generate electricity from sewage or other waste. One company has already contacted him about using the technology with waste from pigs. The process could both generate electricity and break apart some of the compounds that make the waste so foul.

"There is a scene in 'Back to the Future' where they throw a banana in the car and off it goes," said Lovley. "We are not at that stage yet, but this is a big step from what these fuel cells were able to do before."

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