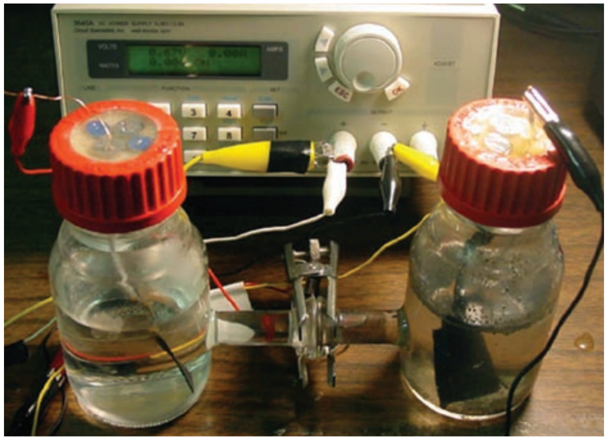
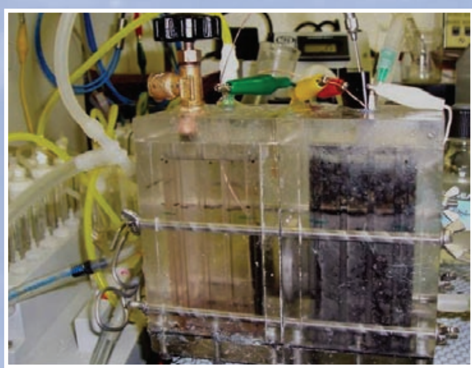


The BEAMR (bioelectrochemically assisted microbial reactor) process is a two-chambered system that produces pure hydrogen gas. The power generated by the bacteria in the anode is supplemented with a slight voltage, producing hydrogen gas in the cathode chamber (on left).



This larger BEAMR reactor was used to produce hydrogen from domestic wastewater. The anode chamber is filled with granules for the biofilm. This reactor demonstrates the feasibility of the process, but hydrogen yields are low and need to be improved.

What's Next?

We are constantly developing next-generation MFC designs in an effort to increase power, while at the same time examining materials that will provide an affordable design.

Our next generation MFCs will be modular and scalable, having high power densities and optimized for both Coulombic efficiency (recovery of electrons as power) and treatment efficiency.

For More Information

Penn State webpage:
www.engr.psu.edu/ce/ENVE/logan.htm

International Microbial Fuel Cell Website:
www.microbialfuelcell.org

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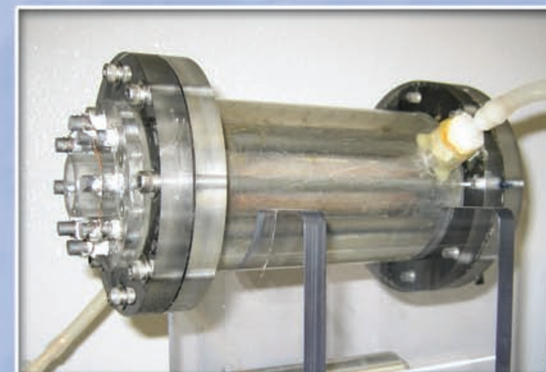
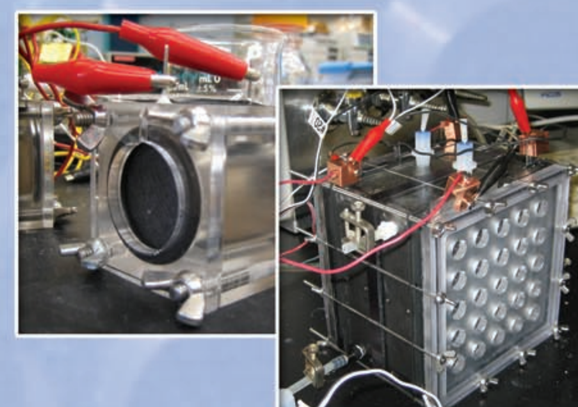
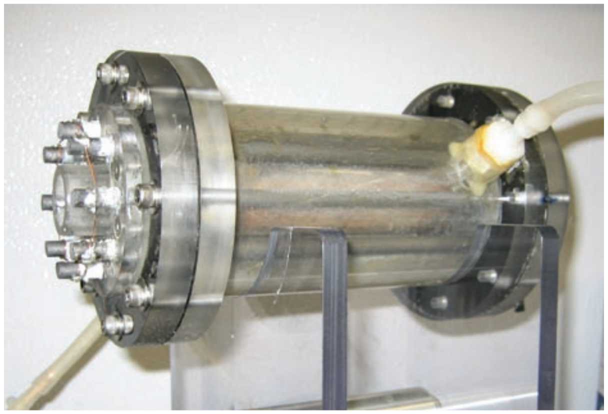
Microbial Fuel Cells
Developed at Penn State



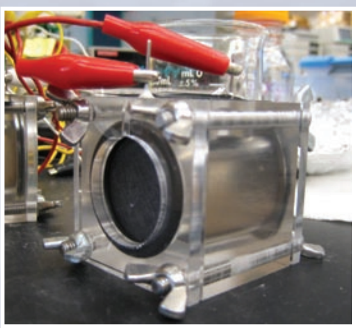


The BioEnergy Laboratory
The Pennsylvania State University
University Park, PA

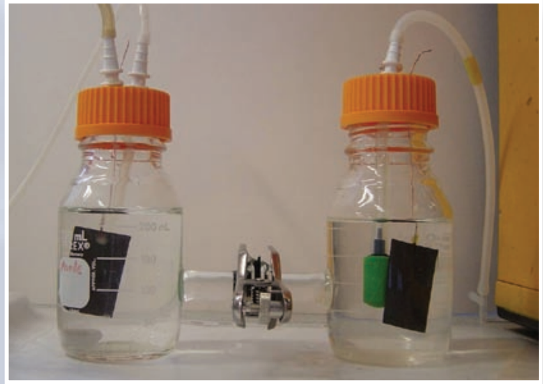
Here are a few of the microbial fuel cells that have been developed and tested at Penn State:



This is the first single chamber microbial fuel cell (MFC) design produced by our laboratory. This MFC was used to show how electricity could be continuously produced from domestic wastewater. Note the central cathode tube running down the center, surrounded by 8 graphite rods (anodes).

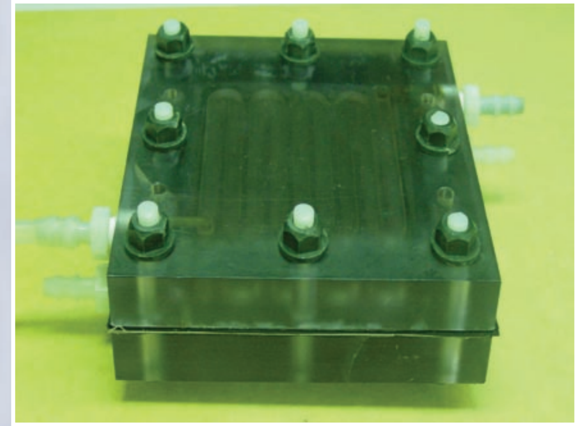


This is the most commonly used MFC in our laboratory: a single chamber air cathode system. The cathode is shown exposed to air on one side and water on the other side (inside). There is no proton exchange membrane. The anode, where the bacteria grow, is on the opposite side but is sealed so that air cannot enter.

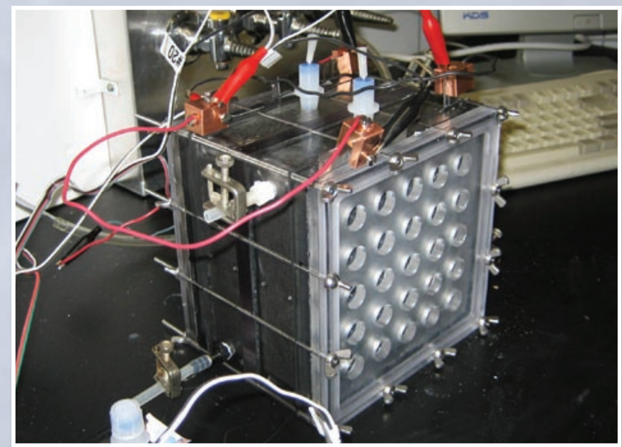


This MFC is often referred to as a "conventional two-chamber" MFC, or as the "H-design" MFC. As shown, both the anode and cathode chambers can be gas sparged: the anode chamber with N_2 to maintain anaerobic conditions where the bacteria grow; the other with air to provide oxygen in solution (cathode). A proton exchange membrane is clamped between the ends of the tubes to allow passage of protons (H+) and to limit exchange of substrate from the anode to cathode chamber, and oxygen from the cathode to anode chamber.

A very early MFC design is the "salt bridge" MFC, which is very inexpensive to make. Protons are conducted between the two chambers via a salt bridge consisting of a glass tube filled with salty agar can capped to retain the agar. The high internal resistance limits power production to less than 3 mW/m^2, but this design can be made very cheaply by anyone!



This is a flat plate MFC that operates in continuous flow mode and looks a lot like a conventional hydrogen fuel cell. This MFC has a proton exchange membrane sandwiched between two carbon paper electrodes. Channels are drilled so that the flow follows a serpentine path through the system.



Here is a larger MFC with two cells joined in series, to produce approximately1.4 V. Each anode chamber is filled with 500 grams of graphite granules (2-6 mm in diameter) and the total liquid volume is 0.5 L. Each cathode is 182 cm^2, and the system produces 2000 mW/m^2 of power.