Bacteria Can Treat Wastewater and Generate Electricity

Scientists have known for more than a decade that bacteria can be manipulated to generate electricity. But new research under way at Pennsylvania State University is suggesting an intriguing possibility: using bacteria both to produce energy and to treat wastewater. (Bruce Logan, a civil and environmental engineer at the school’s University Park campus, realized this, making the bacteria work overtime, the science community may have devised one solution for two problems.)

"If you look at the big picture of the global need for power and the need to provide sanitation to a billion people that currently lack it, the economics are overwhelming," says Logan, who believes that developing nations would be interested in this technology because it is cost effective when compared with establishing separate generating plants and sewage treatment facilities.

The device Logan developed is called an air cathode single chamber (ASC) microbial fuel cell (MFC). The 15 by 6.5 cm open chamber allows wastewater and particulate matter to pass through unimpeded. In contrast to most other MFCs, the ASC device does not require that oxygen first be dissolved in the water, a need that has hindered the use of other MFCs. In a 0.59 L MFC, bacteria oxidize the substrate—human wastewater and organic material—and then transfer electrons to an anode formed by eight graphite rods 150 mm long and 6.19 mm in diameter located at the top and bottom of the MFC. Electrons travel across the circuit and at the cathode recombine with protons and oxygen to create water, which evaporates into the air. Logan’s research results that there is a potential difference reducing electrons flow and that bacteria can provide the electrons to produce electricity.

With the ASC MFC, nothing need be added to induce substrate oxidation. Research carried out by other scientists working with electricity production by bacteria has required the addition of costly "noxic chemicals," says Logan, to act as mediators to transfer electrons from the cell to the electrode. The ASC MFC tests have revealed a generating capacity of approximately 26 mW/m², although recent improvements have increased the capacity to approximately 150 mW/m². Further research will be focused on improving the generating capacity per cell, which ideally would reach 5,000 mW/m². "If we collected the wastewater from a city of a hundred-thousand people, we could produce 2.5 megawatts of electricity, enough for about fifteen hundred homes," Logan speculates. He theorizes that a treatment facility would require 1,250 m² tank and would be able to treat 16.4 x 10³ L per year to accommodate a town of that size, based on 450 L per day per person.

The National Science Foundation provided a startup grant for the project to determine the feasibility of the nascent technology. Logan hopes that larger-scale testing will take place in the near future, noting that his lab has now "optimized the size of the microbial fuel cell."—James Bunt