Electric ears

Corn waste may provide more than just ethanol
A fter the corn harvest, whether for cattle feed or corn on the cob, farmers usually leave the stalks and stover in the field. But now a team of Penn State researchers think corn stover can be used not only to manufacture ethanol, but to generate electricity directly.

"People are looking at using cellulosic to make ethanol," says Bruce Logan, the Kappe Professor of Environmental Engineering. "You can make ethanol directly from exploded corn stover, but once you have the sugars, you can make electricity directly."

Logan's process uses a microbial fuel cell to convert organic material into electricity. Previous work has shown that these fuel cells can generate electricity from glucose and from municipal wastewater and that these cells can also directly generate hydrogen gas.

Corn stalks and leaves, amounting 250 million tons a year, make up a third of the total solid waste produced in the United States.

Currently, 80 percent of corn stover is left unused in the field. Corn stover is about 70 percent cellulose or hemicellulose, complex carbohydrates that are locked in chains. A steam explosion process releases the organic sugars and other compounds in the corn waste, and those compounds can be fed to microbial fuel cells.

The microbial fuel cells contain two electrodes and anaerobic bacteria—bacteria that do not need oxygen—that consume the sugars and other organic material and release electrons. These electrons travel through a wire and flow in a wire to the cathode, producing electrical current. The water in the fuel cell generates positive hydrogen ions that combine with the electrons and oxygen to form water.

The microbial fuel cells were inoculated with domestic wastewater and a nutrient medium containing glucose, the researchers reported in the journal Energy and Fuels. Once established, the bacteria colonies fed the sugars, organic liquid obtained from steam expelling of corn stover.

The researchers, who include Logan, Yi Zhuo, a graduate student in environmental engineering, and Fans-Ching Ma, a senior scientist with the National Renewable Energy Laboratory, reported that the conversion of organic matter to electricity, on the basis of biological oxygen demand removal, was relatively high with greater than 93 percent of the biological oxygen demand removed."

In essence, there is no organic matter left to cause problems with disposing of the remaining liquid because there is nothing left to anaerobe. The process conserves all of the available energy to electricity. The electrical production is about one watt for every square meter of surface area at about 0.5 volts. A typical light bulb uses 60 watts. To increase wattage, the surface area needs to increase. To increase voltage, fuel cells can be linked in series.

"Producing electricity from steam-explored corn stover adds to the energy diversity of our portfolio," Logan says. "Electricity can be used to pump water uphill for later use, directly run light, heat and equipment, or electrolyze water to create hydrogen."

The Penn State researchers and colleagues have also used microbial fuel cells and wastewater to produce hydrogen gas directly.

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