

Hydrogen Gas Made From Renewable Organic Material

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for [National Geographic News](#)

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Hydrogen may be getting a step closer to becoming a mainstream, renewable fuel.

Researchers have invented a way to harvest protons and electrons from bacteria in a reactor and create small quantities of hydrogen gas.

The process can use any biodegradable organic material, potentially freeing the production of clean-burning hydrogen fuel from its current dependence on nonrenewable energy sources such as natural gas.

"Hydrogen is an excellent transportation fuel, but you've got to make it in a sustainable way," said study author Bruce Logan of Pennsylvania State University.

"We think this is the key method to do that."

Electric Power

Many of the world's transportation systems are being set up to utilize hydrogen, but "almost none is made from electrolysis, and almost none of that is made from renewables," Logan said.

Electrolysis is a process in which an electric current is forced through a cell, sparking a chemical reaction.

"The idea is that this would be renewable technology."

Logan and study author Shaoan Cheng, also of Penn State, developed their new method based on previous work with microbial fuel cells, which generate electricity instead of hydrogen.

[\(Get the basics on fuel cells.\)](#)

The researchers first grew bacteria, derived from soil and wastewater, in compact fuel cells.

The cells were modified to increase bacterial growth and also to force the bacteria to release electrons to an electrode—an electricity conductor—and protons into a solution.

Next they added acetic acid, which acted as a catalyst to cause the charged particles to form hydrogen.

Acetic acid, which occurs naturally in body fluids and plant juices, also gives vinegar its sour taste and smell.

The reactor was able to extract up to 99 percent of available hydrogen, which could theoretically be produced from the organic materials inside.

Cheng and Logan showed that such a microbial electrolysis cell can produce hydrogen from many renewable biomass resources, including acetic acid, cellulose, and glucose.

The paper was published in this week's issue of the journal *Proceedings of the National Academy of Sciences*.

Fledgling Market

Research into sustainable hydrogen fuel is moving at a brisk pace, with several emerging technologies racing to get the fuel to market.

(Related news: ["Addicted to Oil: How Can U.S. Fulfill Bush Pledge?"](#) [February 14, 2006].)

Jerry Woodall is a professor of electrical and computer engineering at Purdue University who was not involved in the new research.

He invented the red light-emitting diodes (LEDs) that are used in a variety of modern technologies, such as stoplights, CD players, TV remote controls, computer networks, high-speed transistors used in cell phones and satellites, and the weight-efficient solar cell.

Now he's working on a way to generate hydrogen from an aluminum alloy and water. He said this method is "already practical."

As for the new Penn State-led research, "the results may be interesting scientifically, but not from a practical technology point of view," Woodall said.

"Getting a cubic meter of hydrogen per day is not very interesting."

George Sverdrup, technology manager of hydrogen, fuel cells, and infrastructure technologies for the National Renewable Energy Laboratory in Boulder, Colorado, had a similar reaction to the new findings.

The new electrolysis technology, after more development, "could provide one pathway to generate hydrogen from nonfossil fuel sources," he said.

"We don't see it as a major pathway for the U.S. transportation sector. It would need to be complemented by other nonfossil pathways, which we are working on."

Logan, one of the study authors, is more optimistic.

The new method requires less energy input to make water electrolysis viable than what the Department of Energy has estimated, so it is economically sound, he said.

The researchers say their process stands to make hydrogen easier to produce than ethanol, which relies on cumbersome technologies and can only be produced from simple sugars.

(Related news: ["Ethanol Not So Green After All?"](#) [July 11, 2006].)

Future for Gas?

It's too soon to pin down a cost estimate for the use of hydrogen as a renewable fuel, Logan said.

But the main obstacle for the widespread use of hydrogen, he said, is the infrastructure to transport it.

"Right now our gasoline stations are filled with liquid fuels and trucked around in tanks," he said.

"For hydrogen, we'd probably need lots of pipelines and cars set up to utilize gaseous fuels instead of liquid fuel. Quite doable, but it would take a big advancement."

Even if its future use for fuel turns out to be limited, there will continue to be a demand for hydrogen in the use of fertilizers and other products.

"Local production of fertilizers from cellulose-derived hydrogen gas," the authors wrote, "could greatly reduce transportation costs for fertilizers and improve global agricultural yields and economics."

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