Using microbes to fuel the US hydrogen economy

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"If the U.S. is to have a future hydrogen-based economy, we'll need a way to generate abundant quantities of hydrogen safely and economically," said Daniel (Niels) van der Lelie, a biologist at the U.S. Department of Energy's Brookhaven National Laboratory.

Van der Lelie discussed the prospect of using vats of microbes to brew up the hydrogen in a talk at the 232nd national meeting of the American Chemical Society in San Francisco, California.

The focus on hydrogen as a future fuel source is compelling given dwindling supplies of oil and natural gas, as well as escalating costs and the fact that burning fossil fuels releases large amounts of carbon dioxide, a "greenhouse" gas, into the atmosphere. In contrast, burning hydrogen gas (for example, in a fuel cell) produces no pollution. And hydrogen, a constituent of water, is widely abundant. However, finding simple, inexpensive ways to extract that abundant element and produce it in a pure gaseous form -- a crucial step toward making the "hydrogen economy" a reality -- has been a technological challenge.

Van der Lelie's group reports that experimental setups using Thermatoga neapolitana bacteria given a simple glucose feedstock can generate copious amounts of hydrogen gas at temperatures between 158 and 185 degrees Fahrenheit at atmospheric to elevated pressure. In his talk, van der Lelie will describe the complex biochemistry of these reactions as well as the potential to scale up this system for continuous, farm-based, economical hydrogen production. One significant finding was that

Thermatoga neapolitana produced hydrogen most efficiently in a moderately low-oxygen environment. Previously, hydrogen production by bacteria has only been reported under anaerobic, or oxygen-free, conditions.

"Oxygen normally kills anaerobic microbes like Thermatoga neapolitana," van der Lelie said. That would be a problem for any real-world production facilities, as eliminating all oxygen from production lines could be very expensive. "Our research provides the first evidence that bacteria can efficiently produce hydrogen gas when oxygen is present."

In collaboration with Paul King, a scientist at the National Renewable Energy Laboratory, the Brookhaven team is now elucidating the mechanisms by which Thermatoga neapolitana can avoid oxygen toxicity during hydrogen production. "Understanding the oxygen tolerance of Thermatoga neapolitana will facilitate its practical application to produce hydrogen from agricultural resources," van der Lelie said.

Source: Brookhaven National Laboratory