Creativity buoys outlook for hydrogen economy

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Columnist

Engineers who want to produce hydrogen for fuel have to think outside the box. Standard processes are too costly and inefficient. A sample of research reported this year illustrates the unexpected possibilities such creative thinking opens up.

How about a portable hydrogen generator so compact it could power a lawn mower? Or how about coaxing bacteria to produce hydrogen from plant material with unprecedented efficiency?

It also pays to look at traditional processes in new ways. L.S. Fan at Ohio State University met that challenge with the process that makes hydrogen by using carbon monoxide released by gasified coal. The gas reacts with water to make carbon dioxide and hydrogen. The trick to making this work as a viable fuel source is to find a cheap way to get rid of the CO2.

"We needed a new way of thinking," Dr. Fan says. So he and his colleagues thought "eggshells." They are mostly calcium carbonate, a mineral that soaks up CO2. They are also abundant and cheap. Last September, the team reported it had successfully tested a process using eggshells to remove CO2 efficiently. The CO2 can be recovered and sequestered so it doesn't enter the atmosphere. The eggshell CO2 sponge can then be used again. The team also developed a way to recover collagen - a high-value product - from eggshells. "We're demonstrating that carbon-based fuels like coal or biomass can be efficiently converted to hydrogen," Fan says.

Meanwhile Bruce Logan and Shaoan Cheng at Pennsylvania State University have shown how bacteria can produce hydrogen from biomass efficiently. They built an electrolysis cell using naturally occurring bacteria and acetic acid (i.e., vinegar). The bacteria eat the acid and produce electrons and protons, which together make up hydrogen atoms. Add a little electricity from an outside source, and hydrogen gas bubbles up.

Their report appeared earlier this month in the Proceedings of the National Academy of Sciences online. Dr. Logan says this process produces 286 percent more energy in hydrogen than the electrical energy that is added.

By comparison, the energy represented by hydrogen produced through standard hydrolysis (using electricity to break water into hydrogen and oxygen atoms) represents only 70 to 80 percent of the electrical energy needed to make the process run.

Hydrogen has to be transported and made readily available if it is to become a widely used fuel. Jerry Woodall at Purdue University in West Lafayette, Ind., thinks aluminum can do the job. He described the scheme at a university symposium last May. It uses pellets of an alloy of aluminum and gallium.

When water hits the pellets, aluminum, which reacts strongly with oxygen, releases hydrogen from the hydrogen-oxygen (H2O) water molecule. Aluminum usually forms a skin that protects it from oxygen. Gallium inhibits that skin formation.

"The hydrogen is generated on demand, so you only produce as much as you need when you need it," noted Dr. Woodall. Such a hydrogen generator could be small enough to fuel a lawn mower.

Woodall explained that much development is needed to make this hydrogen scheme practical. Meanwhile, the fact that research engineers are demonstrating such outside-the-box ideas in their laboratories indicates that the hydrogen economy may emerge in unexpected ways.