

Engineered Eggshells To Help Make Hydrogen Fuel

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Engineers at Ohio State University have found a way to turn discarded chicken eggshells into an alternative energy resource.

The patented process uses eggshells to soak up carbon dioxide from a reaction that produces hydrogen fuel. It also includes a unique method for peeling the collagen-containing membrane from the inside of the shells, so that the collagen can be used commercially.

L.S. Fan, Distinguished University Professor of chemical and biomolecular engineering at Ohio State, said that he and former Ohio State doctoral student, Mahesh Iyer, hit upon the idea when they were trying to improve a method of hydrogen production called the water-gas-shift reaction. With this method, fossil fuels such as coal are gasified to produce carbon monoxide gas, which then combines with water to produce carbon dioxide and hydrogen.

The eggshell plays a critical role.

"The key to making pure hydrogen is separating out the carbon dioxide," Fan said. "In order to do it very economically, we needed a new way of thinking, a new process scheme."

That brought them to eggshells, which mostly consist of calcium carbonate -- one of nature's most absorbent materials. It is a common ingredient in calcium supplements and antacids. With heat processing, calcium carbonate becomes calcium oxide, which will then absorb any

acidic gas, such as carbon dioxide.

In the laboratory, Fan and his colleagues demonstrated that ground-up eggshells could be used in the water-gas-shift reaction. Iyer performed those early experiments; recent graduate Theresa Vonder Haar also worked on the project for her bachelor's degree honors thesis.

Calcium carbonate -- a key ingredient in the eggshells -- captures 78 percent of carbon dioxide by weight, Fan explained. That means, given equal amounts of carbon dioxide and eggshell, the eggshell would absorb 78 percent of the carbon dioxide.

That makes it the most effective carbon dioxide absorber ever tested.

Energy experts believe that hydrogen may become an important power source in the future, most notably in the form of fuel cells. But first, researchers must develop affordable ways to produce large quantities of hydrogen -- and that means finding ways to deal with the byproducts of chemical reactions that produce the gas.

According to the United States Department of Agriculture, the country produced nearly 91 billion eggs in 2006. That equates to about 455,000 tons of shell per year that could potentially be used in hydrogen production.

Still, Fan said, even if all that shell were utilized, it would only provide a portion of what the United States would need to seriously pursue a hydrogen economy.

"Eggshell alone may not be adequate to produce hydrogen for the whole country, but at least we can use eggshell in a better way compared to dumping it as organic waste in landfills, where companies have to pay up to \$40 dollars per ton disposal cost," he said.

Before they could grind up the egg shell, the engineers needed to remove the collagen-containing membrane that clings to the inside; they developed an organic acid that does the job. About 10 percent of the membrane consists of collagen, which sells for about \$ 1000/gram. This collagen, once extracted, can be used in food or pharmaceuticals, or for medical treatments. Doctors use collagen to help burn victims regenerate skin; it's also used in cosmetic surgery.

"We like that our technology can help the egg industry to dispose of its waste, and at the same time convert the waste to a useful product," Fan said.

"And in the long term, we're demonstrating that carbon-based fuel sources, like coal or biomass, can be efficiently converted to hydrogen and liquid fuel. The goal is an energy conversion system that uses a dependable fossil energy source, but at the same time has very little environmental impact."

Fan is currently working with a major egg company to produce large quantities of the eggshell granules for testing. The university plans to license the technology for further development.

Source: Ohio State University

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