New Biofuel Technique Could Have Huge Impact on Chemical Industry

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(PhysOrg.com) -- A new method of converting biomass feedstock into sustainable fuel developed by researchers at the University of Massachusetts Amherst and University of Minnesota has the potential to have a profound effect on the chemical industry. The “gasification” process developed by this team of researchers not only greatly reduces greenhouse gas emissions, but doubles the amount of fuel that can be made from an acre of biomass feedstock, says Paul J. Dauenhauer of the UMass Amherst chemical engineering department.

Dauenhauer explained the new process in a recent story in Technology Review, published by the Massachusetts Institute of Technology. He says using the new approach, researchers gasify biomass in the presence of precisely controlled amounts of carbon dioxide and methane in a special catalytic reactor they have developed. The result is that all the carbon in both the biomass and the methane is converted to carbon monoxide.

He says applying this new technique allows the researchers to use 100 percent of the carbon in that biomass for making biofuels. That doubles the proportion of fuel-producing carbon produced by a conventional gasification process done in one reactor while converting biomass to biofuels.

The new method, when perfected in as few as two years, would be a major step forward in the quest for a production-ready process to convert biomass to biofuel, Dauenhauer says. His colleagues at Minnesota are Professor Aditya Bhan and Regents Professor Lanny Schmidt.

Dauenhauer explains that currently, biomass can be converted to fuels by gasification, which uses high temperatures to break feedstock down into carbon monoxide and hydrogen, which can then be made into various fuels, including hydrocarbons. But there’s a major drawback - about half of the carbon in the biomass gets converted to carbon dioxide rather than into carbon monoxide, a precursor for fuels. The question for Dauenhauer and the research team was how to improve that technology. One of the ways is to control the “breakdown environment.”

To increase the yields from gasification, the researchers add carbon dioxide, which promotes a well-known reaction: the carbon dioxide combines with hydrogen to produce water and carbon monoxide. But adding carbon dioxide isn’t enough to convert all of the carbon in biomass into carbon monoxide instead of carbon dioxide. It’s also necessary to add hydrogen, which helps in part by providing the energy needed to drive the reactions. The new gasification process uses methane, the main component of cheap and available natural gas, to generate the hydrogen within the reactor. While it has long been possible to do each of these steps in separate chemical reactors, the researchers’ innovation was to find a way to combine all of these reactions in a single reactor, the key to making the process affordable, Dauenhaer says.

It could be especially profound considering the high stakes. “Our ability to provide fuels and chemicals in a sustainable manner for future generations presents the largest global challenge for reaction engineering in the 21st century,” says Dauenhauer.

A commercial version of the process could be set up near an existing natural gas power plant, which would provide ready access to methane and carbon dioxide. But, as the Technology Review notes, the process isn’t yet ready for commercialization. The researchers will need to demonstrate that it works with biomass, not just with cellulose derived from biomass. Biomass contains various contaminants not found in pure cellulose. Those contaminants could have a negative effect on the catalyst, and this could make it necessary to reengineer the reactor. And there could be challenges scaling up the process, including ensuring that heat moves through the reactor the same way it does on a small scale.

Dauenhauer notes that those challenges are minor compared to what his research team has already overcome: “If you have an industrial facility developing this process, I believe it could be brought to market within a couple of years.”

Provided by University of Massachusetts Amherst