Researchers invent 'flashy' new process to turn soy oil, glucose into hydrogen

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Anyone who's overheated vegetable oil or sweet syrup knows that neither oil nor sugar evaporates--oil smokes and turns brown, sugar turns black, and both leave a nasty film of carbon on the cookware. Now, a University of Minnesota team has invented a "reactive flash volatilization process" that heats oil and sugar about a million times faster than you can in your kitchen and produces hydrogen and carbon monoxide, a mixture called synthesis gas, or syngas, because it is used to make chemicals and fuels, including gasoline.

The new process works 10 to 100 times faster than current technology, with no input of fossil fuels and in reactors at least 10 times smaller than current models. The work could significantly improve the efficiency of fuel production from renewable energy sources. It will be published Nov. 3 in *Science*.

"It's a way to take cheap, worthless biomass and turn it into useful fuels and chemicals," said team leader Lanny Schmidt, a Regents Professor of chemical engineering and materials science at the university. "Potentially, the biomass could be used cooking oil or even products from cow manure, yard clippings, cornstalks or trees."

One up-and-coming fuel is biodiesel, which is produced from soy oil. Currently, the key step in conversion of the oil to biodiesel requires the addition of methanol, a fossil fuel. The new process skips the biodiesel step and turns oil straight into hydrogen and carbon monoxide gases by heating it to about 1,000 degrees C. About 70 percent of the hydrogen in

the oil is converted to hydrogen gas. Similarly, using a nearly saturated solution of glucose in water, the process heats the sugar so fast that it, too, breaks up into syngas instead of its usual products: carbon and water.

A difficulty in turning plant material into usable fuels has been breaking down the chemical bonds in cellulose--the material that gives plant cell walls their stiffness--to liberate simple sugars that can be fermented into ethanol or turned into other fuels. That requires special enzymes and lots of time. But the high heat of the new process breaks those bonds with ease, meaning cellulose and similar plant materials can possibly be used as feedstocks.

Schmidt and his university colleagues--graduate students James Salge, Brady Dreyer and Paul Dauenhauer--have produced a pound of synthesis gas in a day using their small-scale reactor.

Here's how the new process works: The oil and sugar water are sprayed as fine droplets from an automotive fuel injector through a tube onto a ceramic disk made of a catalyst material--the elements rhodium and cerium--that guides the breakup of the feedstock molecules toward the production of syngas and away from water and carbon "gunk." Because the catalytic disk is porous, the syngas passes through it and is collected downstream in the tube. No external heat is needed, because the chemical reactions that produce syngas release enough heat to break up subsequent molecules of oil or sugar.

"The secret is ultrafast flash volatilization [vaporization]," said Schmidt. "It happens here because we vaporize the fuel and mix it with oxygen before it sees the catalyst so it doesn't burn to char. This is potentially 100 times faster than what is currently available to make syngas and hydrogen."

Schmidt gained national attention in February 2004, when a team he headed invented a similar apparatus to produce hydrogen from ethanol.

Source: University of Minnesota