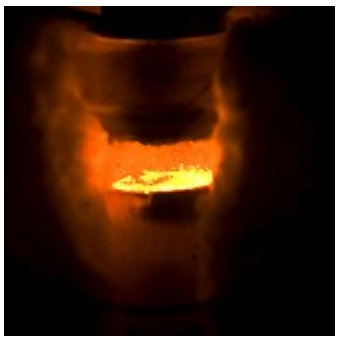
Fuel in a flash

A new process breaks down barriers to extracting energy from biomass



Hydrogen is being generated from soy oil at the glowing ring in this closeup of a reactor invented by Lanny Schmidt and three graduate students. The chemical reaction has heated the ring to 1,000 degrees C.

Photo by Patrick O'Leary

By Deane Morrison

He's done it again. Chemical engineering wizard Lanny Schmidt made waves in 2004 with an invention to extract hydrogen from ethanol.

Now, he and his research team have found a way to do the same with vegetable oil and sugar, a first step toward creating usable fuels from plant wastes like sawdust or cornstalks.

Schmidt, a Regents Professor of Chemical Engineering and Materials Science, and graduate students James Salge, Brady Dreyer and Paul Dauenhauer describe their work in the Nov. 3, 2006, issue of *Science*.

The process yields a mixture of hydrogen and carbon monoxide gases called synthesis gas, which is now used to make synthetic diesel fuel (dimethyl ether, also a substitute for propane gas) and ammonia, a constituent of fertilizer. Hydrogen is also the energy source for fuel cells and may someday be burned in car engines instead of fossil-based gasoline.

If scaled up, their process could slash the cost of producing renewable fuels and chemicals from plant-derived materials, or "biomass," while eliminating the fossil fuel input now needed for turning vegetable oil into usable "biofuel." The new process works 10 to 100 times faster than current technologies and could be done in facilities about 10 times smaller than today. Facilities could be placed on farms to produce fertilizer or energy for local consumption, or in centralized locations to produce fuels for transportation.

While the Schmidt team used fresh soybean oil and a sugar-glucose-in their experiments, those were just practice materials. In particular, glucose was a stand-in for related starchy compounds like cellulose, a major building block of plant cell walls. The real targets of the research are underutilized plant oils and fibers.

"What Lanny does is sorcery," says Frank Bates, head of the chemical engineering and materials science department. "This is classic Minnesota chemical engineering."

"It's a way to take cheap, worthless biomass and turn it into useful fuels and chemicals," says Schmidt. "Potentially, the biomass could be used cooking oil or even products from cow manure, yard clippings, cornstalks or trees. It's better than bringing oil from Saudi Arabia to fuel your gas station."

Currently, soy oil can be modified to make a fuel called biodiesel, but the process requires the addition of methanol, a fossil fuel derived from natural gas. And while cellulose can be digested into simple sugars-which can be fermented into ethanol or turned into other fuels-these processes require special enzymes and lots of time.

What makes vegetable oil, sugars and starches so hard to turn into fuels is the fact that they don't evaporate when heated. As a drop of oil sits on a hot surface, its bottom layer is exposed to heat but not oxygen. In the absence of oxygen, the heat will break down the molecules of oil into water vapor and carbon "gunk" rather than into synthesis gas. A similar situation applies to crystals of sugar.

The new process quickly vaporizes the oil and sugar and exposes them to extreme heat. There's no time for carbon gunk to form because oxygen in the air snatches the carbon atoms and transforms them into carbon monoxide. It's over in one-hundredth of a second, potentially 100 times faster than current means of making synthesis gas and hydrogen.

Schmidt's 'flash volatilization' process

The researchers start with either pure soy oil or a thick sugar syrup. Using an automotive fuel injector, they spray the oil or syrup as fine droplets through a tube. Sitting like a plug in the tube is a porous ceramic disk made of a special catalyst material. As the droplets hit the disk-whose surface temperature is 1,000 degrees C-the heat and oxygen break apart the molecules of oil or sugar. The catalyst guides the breakdown toward the production of synthesis gas rather than toward water vapor and carbon. The synthesis gas passes through the porous disk and is collected downstream in the tube. No external heating is needed because the chemical reactions release enough heat to break up molecules of oil or sugar following in their wake.

"What Lanny does is sorcery," says Frank Bates, head of the chemical engineering and materials science department. "This is classic Minnesota chemical engineering in the tradition of understanding how to steer chemical reactions to get more of the products you want and less of those you don't."

"We need radically new technologies on the road to renewable fuels. This is a possibility," says Schmidt. "We need a lot of research like this to make renewable technologies work."

Read about Lanny Schmidt's previous work on ethanol in Harvesting Hydrogen.

Fonte: University of Minnesota - http://www1.umn.edu/twincities/index.php