UConn reactor uses more efficient process to make biodiesel fuel

March 21 2011, By Bret Eckhardt, Colin Poitras, and Tim Stobierski

Deep inside the University of Connecticut’s chemical engineering building in Storrs, Professor Richard Parnas and a team of students quietly monitor a murky brown emulsion bubbling inside an enormous 6-inch diameter glass tube like doctors carefully observing a patient undergoing surgery.

Moving among an array of flexible tubing and metal rods surrounding the nearly floor-to-ceiling device, Parnas keeps a watchful eye on a series of multicolored charts blinking on a nearby laptop. The display represents the real-time readings of a high-tech fiber-optic probe monitoring the chemical reactions taking place inside the tube. It helps Parnas, a UConn professor of chemical, materials, and biomolecular engineering, maintain the precise recipe he needs to turn a mixture of methanol, potassium hydroxide, and waste vegetable oil into nearly pure, cheap, environmentally-friendly biodiesel fuel.

Parnas’ patented biodiesel reactor is unique in both its simplicity and efficiency. In conventional biodiesel production, vegetable oil is converted into biodiesel fuel and glycerol, a byproduct of the conversion process. Then, the glycerol must be mechanically separated from the diesel fuel, as part of a two-step process. Parnas’ reactor is different in that it uses gravity, heat, and natural chemical reactions to make the biodiesel and separate the glycerol in one step.

As the chemical reactions take place inside the giant tube, temperatures reach more than 100 degrees Fahrenheit. The glycerol starts to coagulate in opaque swirls inside the tube. Because the glycerol droplets are heavier than the biodiesel fuel, they gradually sink to the bottom, where they are siphoned off. At the same time, the biodiesel fuel floats to the top of the tube and is pumped into a holding tank, where it undergoes refinement before being mixed with petroleum-based diesel fuel and used in the University's bus fleet.

"What is unique about our reactor and why we have a patent on it, is that it gives a much better performance for the separation of the glycerol, and we don't need a special separate step as is used in most other processes," says Parnas, who also serves as chairman of UConn's biodiesel consortium research group.

"That motion and those swirls you are seeing when you look at the reactor are the result of both a chemical reaction and phase separation in real time," Parnas says. "Phase separation is like what happens when you have an oil and vinegar salad dressing … In other biodiesel processes out there, the reactants are very highly mixed and come out of the reactor together."

The first UConn biodiesel reactor was built by Greg Magoon, a UConn chemical engineering undergraduate student, in 2004. In 2006, a larger continuous flow biodiesel reactor was designed by UConn graduate student Cliff Weed, under Parnas' tutelage. The reactor in place today was constructed by students Matthew Boucher and Ryan Couture. Undergraduate and graduate students from chemical engineering, chemistry, economics, and natural resources and the environment have been involved with the project over the years. Every chemical engineering student at UConn learns how to make biodiesel as part of the academic program.

Igor Anisimov, a third-semester chemical engineering student, was one of the students helping Parnas with the reactor during a recent production run.

“The biodiesel reactor is exploiting the molecular differences of the elements,” says Anisimov. “By exploiting the natural properties of these chemicals, we can separate the biodiesel from the glycerol. It’s very cool seeing it happening here, compared to seeing it in the classroom on pen and paper.”

The existing facility produces about 2,000 gallons of biodiesel fuel a year. Parnas and colleagues Yi Li of the plant science department, Steven Suib of the chemistry department, Fred Carstensen of the economics department, and Harrison Yang of the Department of Natural Resources and the Environment are preparing to build a larger pilot biodiesel production facility using part of a two-year, $1.8 million grant from the Department of Energy. The reactor will be capable of producing up to 200,000 gallons of biodiesel a year. Parnas says the pilot plant’s production can easily be magnified for larger-scale commercial production.

In an era of rising gasoline prices and increasing worry about global warming and the emission of greenhouse gases, biodiesel is proving to be a valuable and important substitute for traditional petroleum-based fuels.

Biodiesel releases more energy than is consumed during its production, making it four times more efficient than traditional diesel fuels. It is a renewable fuel source that can be produced locally, cutting down on transportation costs, greenhouse gas emissions, and the nation’s reliance on foreign oil reserves. And, since it is made from plant materials, biodiesel is 100 percent biodegradable.

Provided by University of Connecticut