



# Biodiesel

By Cory Ortiz

Scientists have played a large role in helping America break its addiction to foreign crude oils. Scientists have for many years attempted to create a cheaper, cleaner, environmentally safe alternatives. Scientists several years back created a new fuel called biodiesel which is derived from a natural ingredient, vegetable oil. The vegetable oil is taken from restaurants who would normally throw the waste oil away. Up until this point, the creation process for biodiesel hasn't been the safest. Scientists have had to use toxic chemicals such as sulfuric acid and, potassium hydroxide, and sodium hydroxide.

Students from Brown University have figured out a way, in a single chemical reaction to convert the old vegetable oil into Biodiesel using all environmentally friendly and safe catalysts. This reaction is also much faster and uses far less energy than the previously used method. The traditional method used two different reactions, which made the conversion process less efficient. The students found new chemicals for the reaction, the metal bismuth triflate and scandium triflate. Both new metals have been previously used in preparative organic chemistry. The Brown students chose to use a microwave reactor to initiate the reaction. Typically a thermal heater is used in this conversion. The new method took around 20 minutes to convert the old vegetable oil into a usable biodiesel. Performing this same task with the older, inefficient catalysts, and a conventional heater takes two hours.

The new process for converting biodiesel may have a huge impact on the environment. Making the process a cheaper more efficient process will lower the price of biodiesel which in turn will allow more everyday people and trucking industries to turn to biodiesel. This would limit the number of pollutants going up into the atmosphere. The new process also cuts out bad

toxins that were originally used in the conversion process. This makes the process more environmentally safe. Not only is burning the biodiesel better for the environment, but the procedure for converting the vegetable oil too.

This discovery of a more efficient way to create biodiesel could one day be very beneficial to everyone. Being able to reduce cost, time, energy and toxins used, could show that biodiesel may be the clean, efficient source of energy for the future which could help us break our addiction to foreign crude oil. If more people start using biodiesel, we will have a use for old used vegetable oil from restaurants. I agree with being a sustainable society. Converting what is, for the most part, considered trash for an energy source is an amazing practice.

## Science News

### Chemists Simplify Biodiesel Conversion

*ScienceDaily* (Oct. 8, 2010) — As the United States seeks to lessen its reliance on foreign oil, biodiesel is expected to play a role. According to the National Renewable Energy Laboratory, a branch of the Department of Energy, biodiesel "represents a significant energy resource and could someday supply 3 percent to 5 percent of the distillate fuel market."

---

One major obstacle to achieving that goal is figuring how to efficiently convert the abundant stocks of waste vegetable oil (oil used after cooking French fries, for example) into biodiesel fuel. Current techniques take time, are costly and are inefficient. Worse, the conversion requires the toxic chemicals sulfuric acid and either potassium hydroxide or sodium hydroxide. That's where Brown University chemist Jason Sello and postdoctoral researcher Aaron Socha come in. They write in the journal *Organic & Biomolecular Chemistry* that they were able to convert waste vegetable oil to biodiesel in a single reaction vessel using environmentally friendly catalysts. Their process is also six times faster than current methods for converting waste vegetable oil to biodiesel, so it consumes less energy.

"We wanted to develop an environmentally benign and technically simple way to convert waste vegetable oil into biodiesel," said Sello, assistant professor of chemistry. "The production of energy at the expense of the environment is untenable and should be avoided at all costs." Waste vegetable oil is made up of triacylglycerols, free fatty acids, and water. The conventional way to convert waste vegetable oil into biodiesel requires two separate reactions. The first reaction turns the free fatty acids into biodiesel, but that conversion requires sulfuric acid. The second reaction converts the triacylglycerols into biodiesel, but that conversion requires sodium hydroxide or potassium hydroxide. Sodium hydroxide/potassium hydroxide and sulfuric acid are not compatible with each other, so the reactions must be carried out in separate vessels. That makes the process less efficient.

To find a better way, Sello and Socha went looking for catalysts that would be cheap, chemically stable and of limited toxicity. They settled on the metals bismuth triflate and scandium triflate, commonly used as catalysts in preparative organic chemistry. In addition, they performed the reactions using a microwave reactor instead of a conventional thermal heater. What they found was the new catalysts converted waste vegetable oil into biodiesel in about 20 minutes in the microwave reactor, whereas current reactions without catalysts using a conventional heater take two hours. While their microwave method needs a higher temperature to pull off the biodiesel conversion -- 150 degrees Celsius versus 60 degrees Celsius under current methods -- it uses less energy overall because the reaction time is much shorter.

The chemists also were able to perform the conversion in one reaction vessel, since the catalysts can promote both the reaction that converts free fatty acids into biodiesel and the reaction in which triacylglycerols are converted to biodiesel.

The team also reports that the catalysts in the free fatty acid conversion, which is the more challenging of the two reactions, could be recycled up to five times, while maintaining the capacity to promote a 97 percent reaction yield. The fact the catalysts can be recycled lowers their cost and environmental impact, the researchers said.

"While we have not yet proven the viability of our approach on an industrial scale," Sello said, "we have identified very promising catalysts and reaction conditions that could, in principle, be used for large-scale conversion of waste vegetable oil into biodiesel in an environmentally sensitive manner."

The research was funded by the National Science Foundation through a grant to Sello and an American Competitiveness in Chemistry award to Socha. Brown also supported the work through a R.B. Salomon award to Sello.

In a separate yet related paper, a team led by Brown chemistry professor Paul Williard has created a new technique to chart the progress of a reaction in which virgin oils are converted into biodiesel fuel.

The technique, called DOSY (for diffusion-ordered nuclear magnetic resonance spectroscopy), observes virgin oil molecules as they shrink in size and move faster in solution during the reaction. The reaction is complete when all of the molecules have been converted into smaller components known as fatty acid esters. These fatty acid esters are used as biodiesel fuel.

The results are published in the journal *Energy & Fuels*. The research was funded by the National Science Foundation. Contributing authors include Sello, Socha, Brown graduate students Gerald Kagan and Weibin Li, and lab technician Russell Hopson.

*Email or share this story:*

| [More](#)

---

#### Story Source:

The above story is reprinted (with editorial adaptations by ScienceDaily staff) from materials provided by **Brown University**.

---

#### Journal References:

1. Aaron M. Socha, Jason K. Sello. **Efficient conversion of triacylglycerols and fatty acids to biodiesel in a microwave reactor using metal triflate catalysts.** *Organic & Biomolecular Chemistry*, 2010; 8 (20): 4753 DOI: 10.1039/C0OB00014K
2. Aaron M. Socha, Gerald Kagan, Weibin Li, Russell Hopson, Jason K. Sello, Paul G. Williard. **Diffusion Coefficient–Formula Weight Correlation Analysis via Diffusion-Ordered Nuclear Magnetic Resonance Spectroscopy (DOSY NMR) To Examine Acylglycerol Mixtures and Biodiesel Production.** *Energy & Fuels*, 2010; 24 (8): 4518 DOI: 10.1021/ef100545a

### Eportfolio Writing

This assignment has helped to broaden my mind in the essence of alternative energy. It also helped me to gain a better understanding of how the process for converting the old waste vegetable oil into a feasible energy source. This class, chemistry 1010, has helped me to understand topics like these. I can better understand on a molecular level what is going on. I also have a larger vocabulary now which makes it easier to understand.

I chose to put this in my EPortfolio for many reasons. This assignment shows my advancing knowledge in many fields such as science and English. I feel as if this paper shows a better understanding about science and chemistry than I had previously. I also feel as if this paper is a strongly and effectively written English paper in terms of grammar and structure.