How to Make Biodiesel With a Commercial Kit

With a wide variety of new biodiesel kits, it's easier than ever to turn used fry-oil waste into diesel fuel. Here's how to make clean, high-quality biodiesel for cheap.

// BY JOHN DECKER SEP 29, 2009

Senior editor Mike Allen (who used to teach organic chemistry in a previous career) gloves up to pump methanol into the processor.

"**Make your own diesel** for 70 cents a gallon," the Internet ad claimed. I was tired of paying for 30 gallons of regular diesel each week to fill my pickup, so I downloaded

the instructions. It wasn't long before I was sucking used fry oil out of tanks behind a restaurant, and mixing it with lye and methanol in a 5-gallon bottle before pouring it into an old water heater.

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It's basically part snowmobile part tank.

Two hours later, I opened the valve at the bottom of the heater and black goo oozed from the hose, a biodegradable substance called glycerin. Before long the glycerin drained and gave way to a thin, clear, amber liquid: I had my first batch of biodiesel.

I made that first batch of fuel five years ago. If you factor in all the time I spent making the homebuilt biodiesel processor (a converted electric water heater) and experimenting with the design (some batches went, umm, less than perfectly--I had to replace two injection pumps on my truck), my experience with DIY fuels was often a frustrating and, occasionally, very expensive process.

Since then, the biodiesel industry and the technology have evolved. With the professionally engineered biodiesel systems available today, the process is simpler, safer, takes less time and yields more consistent results. So I decided to try one of the commercially available processors--it came boxed with all of the equipment and reagents needed to turn out consistent, high-quality biodiesel fuel. The FuelMeister processor used here has five fewer valves than the eight in my old homemade one. It also mixes the lye and methanol inside the tank to prevent the chance of dangerous spills.

Biodiesel Safety

Yes, you can make biodiesel in a plastic bucket with little more than some drain cleaner, gas-line de-icer and a wooden spoon, if you know what you're doing. But it

can be dangerous. Splashing lye and/or methanol into your eyes can blind you. And electrical pumps unattended in the presence of hundreds of gallons of flammables will make your local fire marshall understandably nervous. In addition, poor-quality product will damage your very expensive diesel-injection pump. Our advice? Research biodiesel production properly before doing the mad-scientist routine.

1. Start by filtering your waste vegetable oil to remove chunks of food left over from the fryer. We used a paint filter. The filtrate is mostly breading, with the occasional chunk of ... something. Mix all your oil from different sources to achieve a uniform sample.

2. Next we need to titrate to see how acidic the oil is. Add a small amount of phenolphthalein indicator dye to a carefully prepared mixture of methanol and

sodium hydroxide. Add a sample of the acidic waste oil to the mix with a calibrated pipette.

3. Trickle in a prepared basic reagent until the mixture stays purple for 10 seconds of swirling. The quantity of reagent you add here determines the amount of methoxide (methyl alcohol/sodium hydroxide mixture) to add to the oil to complete the transesterification process. It takes some simple math or a look-up table to calculate the amount.

There's quite a bit of chemistry involved in transforming vegetable oil into biodiesel, in a process known as transesterification. Vegetable oil (VO) is made up of chains of fatty acids held together by glycerol molecules. Methanol breaks those chains of fatty acids apart. The corrosive, alkaline lye (sodium hydroxide, although you can also use potassium hydroxide) breaks the glycerol (a heavy alcohol) off those chains and the methanol (a light alcohol) in turn takes the place of the glycerol, leaving shorter, lighter, more combustible molecules. The result is an oil that burns well as a direct replacement for petroleum-based diesel fuel, with 12 to 15 percent glycerin left over at the bottom of the tank. The lye acts only as a catalyst in this case, and isn't consumed in the process.

On the other hand, waste vegetable oil (WVO) , like we get out the back door of restaurants, is somewhat acidic because it has free fatty acids, which are produced during heating and cooking. Fortunately, that acidity is neutralized by the extremely

alkaline lye essential to the transesterification. Adding lye converts free fatty acids to a form of soap, most of which will drain out with the glycerin. The remaining soap is removed in the wash. Of course, we have to be sure that the amount of alkaline lye is just enough to counterbalance the acidity, or we wind up with poor-quality fuel.

4. Heat your oil to 120 F, then add the calculated amount of methanol/hydroxide mixture. The FuelMeister processor we used conveniently lets you do the methanol/lye mixing inside a tank mounted to the lid. Agitate for an hour by running the transfer-pump hose back into the vessel. At this point the oil will have been converted into biodiesel. Allow the heavier glycerin to settle out for a few hours.

5. Drain the glycerin from the bottom until you get lighter-colored, thinner biodiesel pouring from the valve. Then use water to wash the excess methanol, lye and soapy residue from the biodiesel. The water will settle to the bottom of the vessel in a few hours, where you can drain it out.

6. Allow the fuel to air out for a day or two with the top off to let any cloudiness (caused by a small amount of remaining water) dissipate.

You can't make biodiesel if you don't have a couple of high-quality restaurants in your area. Greasy spoons need not apply. That's because the more pure the WVO is, the better the biodiesel. Restaurants that overcook their food, don't change their oil frequently or cook lots of frozen food will have oil with high free-fatty-acid content.

As for water, less is better. As little as 5 percent in the WVO can leave you with a batch of soapy glop instead of biodiesel in your processor. You don't want to deal with the mess of cleaning up, so care in selecting feedstock will pay off in the long run. Heat a couple of ounces of the WVO in a frying pan. If it sizzles, there's too much water. This water can be removed by heating the oil to above 220 degrees in an open container, and then letting it cool down. But that consumes a lot of energy, and you'll need to baby-sit the whole business because of the danger of fire. Best just to find higher-quality WVO.

Busy restaurants are like food-cooking assembly-lines. They heat their oil at the same time, at the correct temperature, and fry about the same amount of food every day. They also change their cooking oil at the same time and in the same way every week. Other places aren't as careful, and their oil gives me less, and poorer quality, biodiesel per batch. I get almost all my WVO from two local restaurants, and I've never had water in the oil. Biodiesel processing has become popular. Restaurants used to be thrilled when I took the old oil away without charging them. Now WVO is a commodity not unlike crude oil. When regular diesel is about $2.50 a gallon, I pay $0.30 per gallon. When diesel was $4.85 a gallon, I paid $0.60 a gallon.

The 40-gallon processor we used here costs nearly three grand. We saved about $1.20 a gallon over the current price of petro-diesel, if you don't count the $2995 price tag for the processor. That means we'd have to make 62 or more batches to pay back the investment, or one batch every six days--for a year. A couple of batches can be fun, but spending every Saturday with greasy hands can get to be a chore. You'll also need to set up a place to store the WVO, the methanol and the biodiesel, all of which are flammable, and a place to work. Don't forget you'll also need to dispose of leftover poor-quality WVO, a fair amount of glycerin and the occasional batch of glop. There's an excess of methanol and alkali remaining after the transesterification, and commercial biodiesel producers recover the methanol and use it for the next batch. Your local authorities may have an opinion as to the proper, legal disposal of glycerin.

You'll still need to run a fair amount of conventional mineral diesel in your tank along with your home-brew fuel, especially in the winter when low temperatures turn even the best-quality biodiesel into jello.

Also, the current crop of direct-injection diesels don't fare well on concentrations of bio higher than 10 percent. Why? To thermally purge the diesel particulate filter (DPF), the injection system periodically injects fuel into the cylinder during the exhaust stroke to raise exhaust temperatures high enough to ignite the carbon inside the DPF. The carbon simply burns off, leaving the DPF ready to filter out more particles. Biodiesel, more viscous than mineral diesel, sticks to the cylinder walls and washes past the rings into the crankcase. This can dilute the engine oil, potentially causing engine damage. Most car manufacturers prohibit the use of more than 10 percent biodiesel if you expect any warranty protection. Biodiesel works best in older diesel vehicles with precombustion-chamber mechanical injection.

Caveats aside, you can make diesel fuel sustainably while also reducing pollution. Getting a good supplier of WVO when fuel prices are low should ensure an adequate supply when demand rises. Biodiesel stores very well in a cool, dry place if you squirt a little nitrogen from a welding supply shop into the top of the barrel. Making a lot of the stuff now might be one way to have your own little investment in home-brew biodiesel futures as regular diesel prices climb.

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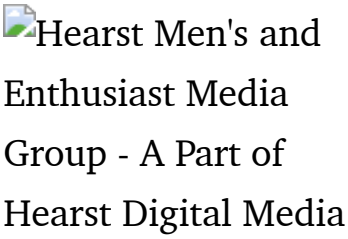

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