The Basics of Biodiesel Production

Biodiesel Series

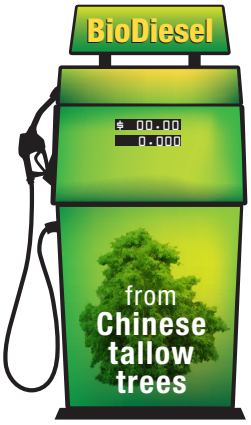
Innovative and practical information on biodiesel for the homeowner, farmer and small business owner.

Welcome to the world of making **biodiesel**– where you can make your own fuel to run in diesel engines for a fraction of what regular petroleum diesel costs. In fact, most people making biodiesel themselves are generating it for about **$1 a gallon**!

Recent increased demand for agricultural commodities for use as feedstock to produce biofuels has led to renewed rural prosperity in areas where those crops are grown. The crops that have benefitted most from the expansion of biorefineries are corn, which is used for ethanol production, and soybeans, which are used for biodiesel. Unfortunately, however, Louisiana yields of those crops are lower and production costs higher than in Midwestern states where environmental conditions are more favorable for corn and soybeans. Lower yields and higher production costs place Louisiana farmers at a competitive disadvantage – plus it is more desirable to use nonfood crops when looking for bioenergy feedstock.

One such nonfood crop is the **Chinese tallow tree**. The tallow tree has been cultivated for oil production in China for more than 1,400 years. The tallow oil and seed meal have multiple uses including fuel, cooking oil and animal feed. The per acre oil yield from tallow tree seed is 15 to 25 times that of soybeans, which currently is the primary biodiesel feedstock.

Tallow trees thrive without fertilization and are largely free of disease and insect pests. The development of a viable tallow tree industry in southwestern Louisiana promises to reverse the fortunes of some of the most impoverished areas of the state. In addition to improving on-farm income, the development of an oilseed industry likely will lead to construction of processing facilities such as crushing plants to extract oil, biodiesel refineries and facilities to produce value-added products from seed meals and other crop components. Each of the crops to be evaluated has unique components with potential for use in the pharmaceutical, food, cosmetic, chemical and other industries.



Still another area that shows promise in producing oil is **algae**. Louisiana currently has more than 18,000 acres of farm ponds that are not being effectively utilized. These ponds could be put into production for growing oil-bearing algae needed for producing biodiesel. Estimates of 5,000 gallons of oil per acre from algae are not uncommon.

In the meantime, waste vegetable oil is the feedstock of choice for those looking to make biodiesel for themselves. It is available from every restaurant and considered a waste product that can be beneficially reused in the process of making biodiesel.

PRODUCTION OVERVIEW

Biodiesel most commonly is made by chemically altering animal fats and/or vegetable oil through the use of a catalyst and an alcohol. The chemical reaction that occurs through this process breaks down the oil molecules and replaces the glycerin portion of the molecule with an alcohol molecule. The glycerin falls to the bottom of the reactor and is drained off. What remains is biodiesel. For every gallon of oil processed, you get a gallon of biodiesel.

The resulting biodiesel typically is "washed" to remove any impurities. Then it is ready to be used as a fuel in a diesel engine without making any modifications to the engine.

Biodiesel is known chemically as a "fatty acid methyl ester." But that's just a fancy way of saying it's a product made from methanol and organic oil (animal fats and/or vegetable oil) with fatty acid chains in it. It is easily made and has many benefits, including environmentally friendlier tailpipe emissions and improved engine performance.

Mixing methoxide into oil
The methoxide tank holds a mixture of catalyst and methanol–methoxide. The mixture is added to the oil in the reaction tank.

Here is a guide to some of the things you'll need to know to make biodiesel:

HOW IT'S MADE

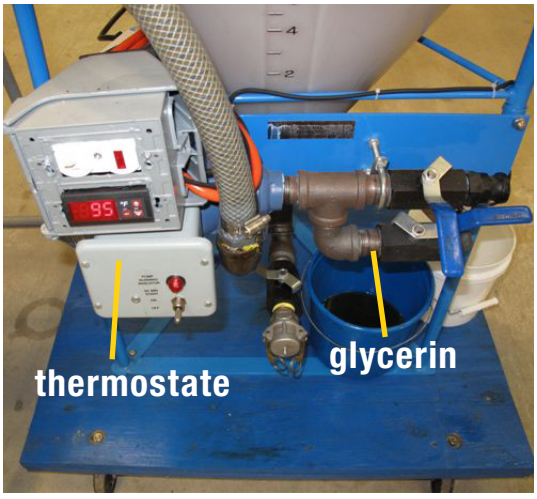
Biodiesel actually is simple to make. It is made by chemically altering the molecular structure of any organic oil through the use of a chemical catalyst and an alcohol.

To do this, oil is heated to a designated temperature (130 degrees Fahrenheit) to help with the chemical reaction. Then a mixture of a catalyst (sodium hydroxide or potassium hydroxide) and an alcohol (methanol) are added to the oil. The oil, catalyst and alcohol mixture are mixed for a period of time (about two to three hours) and then allowed to settle (usually 24 hours).

If successful, the chemical reaction between the oil, alcohol and catalyst will have broken down the oil into several layers. The top layer will be biodiesel, chemically called an ester. The next layer may contain soap, and the bottom layer will be glycerin.

Once the layering has occurred, the glycerin and soap are drained off. The biodiesel is then washed with a mist-wash, a bubble-wash or both. The washing is done to remove any additional soap, alcohol or other impurities in the biodiesel.

After it's been washed, the biodiesel is dried to remove the water. Then it generally is filtered through fuel filters and made ready to use.



Draining glycerin – Glycerin settles to the bottom of the reaction tank and is drained off.

HOW LONG DOES IT TAKE

Making biodiesel typically takes a couple of days to a week from start to finish. Most people making biodiesel produce anywhere from 20 to 100 gallons at a time in a batch process.

Here's a breakdown of typical timing intervals from start to finish:

- **Start**
- **Collecting oil** – One to two hours
- **Filtering oil** – One to two hours (depends on amount of oil)
- **Titration of oil** – 10 to15 minutes
- **Transferring oil to processor** – 10 to 20 minutes
- **Heating oil** – One to four hours (depends on amount of oil, as well as voltage and wattage of heating element)
- **Making methoxide** – Five to 20 minutes (depends on amount of methanol and catalyst used)
- **Mixing methoxide into oil** – 20 to 30 minutes
- **Mixing oil and methoxide** – Two to three hours
- **Settling oil** – Eight to 10 hours (usually overnight)
- **Draining glycerin** – Five to 10 minutes
- **Transferring biodiesel to wash tank** – 10 to 20 minutes
- **First mist wash** – Two to three hours
- **Second mist wash** – Two to three hours
- **Bubble wash** – Six to eight hours (usually overnight)
- **Transferring biodiesel to drying containers** – 10 to 20 minutes (depends on amount)
- **Drying biodiesel** – Two hours to one week (depends heavily on weather and amount made)
- **Transferring to storage containers** – 10 to 20 minutes (depends on amount)
- **Finish**

40 GALLON BIODIESEL BATCH REACTOR SETUP

EQUIPMENT

Biodiesel can be made in anything from a 2-liter plastic bottle (soft drink bottle) to an elaborate processor complete with separate tanks for processing, washing, meth oxide mixing, settling and filtering.

Obtaining equipment is relatively easy. Complete processing equipment can be custom made using plans off of the Web or by buying kits that are ready to assemble.

Most people get started by making small batches with minimal equipment and then gradually move up to making large batches using large processors built specifically for making biodiesel.

Many home brewers either buy a variety of premade processors designed for processing biodiesel or custom make their own processors either from kits or from plans found on the Web, which is the most common method for home brewers.

Building a processor can be done in an afternoon. Most folks have their processors built and ready to process biodiesel within a few hours of starting. Parts are relatively cheap to obtain, and help is readily available on the Web or through forums and workshops.

In addition, most home brewers can obtain equipment, such as pumps (either manual or electric) for transferring oil, methanol and glycerin, as well as containers for storing oil and biodiesel, locally or from the Web.

For those who don't want to build it themselves, professionally built processors are available and can cost as little as $3,000 up to $15,000 or more.

Processors of 40 to 500 Gallons

USING BIODIESEL

Biodiesel can be used in any diesel engine. Once processed, washed and dried, biodiesel can be poured into any diesel fuel tank.

Biodiesel also can be mixed with petro diesel in any ratio. It easily mixes with petro diesel and is commonly sold commercially blended with petro diesel. B20 fuel is what's commonly found, and it consists of 20 percent biodiesel and 80 percent petro diesel. But there are many biodiesel users who use B100 – 100 percent biodiesel.

Within minutes of biodiesel being added to the fuel tank, and especially when used in high blend ratios (50 percent to 100 percent), a noticeable difference in engine noise occurs. Most people report a **reduction in engine noise**, a smoothing of the engine and a noticeable change in the smell of the exhaust. The longer biodiesel is run in an engine, the better the engine runs.

Research has been done comparing biodiesel to petro diesel across a wide range of measurements. One of the most significant differences is the drastic **reduction in the tailpipe emissions** biodiesel produces compared to petro diesel. Reductions in hydrocarbons, carbon dioxide and particulate matter have been significant. For many using biodiesel, these emission reductions are reason enough to use this incredible alternative fuel.

In addition to better emissions, research has indicated an **increase in engine longevity**, a decrease in engine maintenance and a better-performing engine. Because biodiesel has solvent properties by nature, it acts as a cleaning agent on the fuel system in diesel engines. This means it cleans things up the more it's used.

Because of these solvent properties, some have noted fuel lines in older diesel engines (pre-1993 engines) may degrade because the biodiesel breaks them down. Particularly susceptible are fuel lines made from natural rubber. Most of the susceptible fuel lines easily can be replaced, however, with inexpensive fuel lines that are biodiesel compatible. If in doubt, check with your local dealer. The lines usually degrade over time and develop small seeping leaks instead of large leaks.

Diesel engines made after 1993 and sold in the United States typically won't have this problem because the fuel lines already are biodiesel compatible. This resulted from a reduction in sulfur in diesel fuel in 1993 in the United States that necessitated manufacturers changing fuel lines to lines that weren't made of rubber.

Home brewers use biodiesel in varying blends, but most commonly it's used in blends from 20 percent (B20) to 100 percent (B100), although 100 percent is the preferred method when weather allows. When the weather drops below 50 degrees F, it's recommended to blend biodiesel with petro diesel or to mix in anti-gel additives to prevent biodiesel from gelling.

Another thing most people do when getting started is to **change the fuel filters** before using biodiesel and then change them again a few thousand miles later. This is to prevent the filters from plugging up due to biodiesel's solvent properties. As it's used, biodiesel may knock some of the "gunk" that built up from previous use of petro diesel off the walls of the fuel tank and the fuel lines. Replacing the fuel filters is just a precaution to ensure the engines keep running smoothly.

TAXES AND REGULATIONS

Biodiesel, if used as an on-road fuel in a vehicle, may be subject to road taxes. The taxation laws are changing all the time, so check with your local tax consultant to identify which taxes biodiesel may be subject to. You also will need to check your state tax code for exemptions from state excise taxes.

It's also important to check with your local fire marshal regarding fire codes concerning the manufacture and storage of biodiesel as well as the chemicals and alcohol used to make it. These laws and regulations are there in most cases to protect you and your neighbors.

PRECAUTIONS

1. When making biodiesel, it's important to be safe. Because you are dealing with toxic chemicals, there is the potential to seriously hurt, injure and even kill yourself and others.
2. You'll be dealing with some fairly caustic chemicals, an alcohol called methanol, fair amounts of heat and transferring flammable fluids from one container to another, so it's a good idea to have a fire extinguisher around that is capable of putting out an oil-based fire.
3. Biodiesel should always be made in a well-ventilated area away from children and pets, and be sure to use the proper safety equipment.
4. Before making large batches of biodiesel, check with your local municipality and fire marshal to ensure that any chemicals, alcohol or other substances you will use are being stored and used within the proper laws and ordinances for your area. Some areas refer back to state and federal fire codes. It's always a good idea to check these regulations before you get started.
5. Using homemade biodiesel in a diesel engine vehicle may void your manufacturer's warranty. Although the steps outlined to make it are fairly straightforward and have been tested in several thousands of vehicles all over the world, there's no guarantee your engine manufacturer will honor your warranty.
6. Biodiesel is considered a fuel, so if you plan to use it in a vehicle for on-road use, it may be subject to taxes. Check with your state and federal tax agencies for information.
7. Biodiesel itself, when properly made, is quite safe. It's less toxic than table salt and degrades faster than sugar. It has a higher flash point (point at which it ignites) than regular petro diesel and isn't considered toxic even if it's spilled.

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