

MAKING BIODIESEL

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“Biodiesel is a non-toxic, biodegradable diesel fuel made from vegetable oils, animal fats, and used or recycled oils and fats” (Biodiesel, 1).

Biodiesel is made using the process of *transesterification*.

Transesterification is the process of using an alcohol (e.g., methanol or ethanol) in the presence of a catalyst, such as sodium hydroxide or potassium hydroxide, to chemically break the molecule of the raw renewable oil into methyl or ethyl esters of the renewable oil with glycerol as a by-product (1991) (TRANSESTERIFICATION, 1).

Biodiesel can be made from various components such as; vegetable oil, animal fats, and waste or recycled oils and fats, such as waste fryer oil. Biodiesel is made by mixing methanol and sodium hydroxide (lye) to make sodium methoxide. The sodium methoxide is then mixed with vegetable oil and allowed to settle. Glycerin forms on the bottom, while the methyl esters (biodiesel) float to the top (TRANSESTERIFICATION, 1).

Biodiesel Production

First the methanol and the catalyst (sodium hydroxide) are mixed. After the methanol and catalyst are mixed, they go into a reactor, where the oil is added to the mix. Used oil is first run through a filter to remove the fatty acids. This mixture is agitated continuously for 1 to 8 hours and may also be heated. The fat or oil used is converted to esters during this stage.

Excess methanol must be removed in the next stage of production. The methanol is removed by a flash process or by distillation. Excess methanol can also be removed after the glycerin and esters have separated. The removed methanol can be reused, in later biodiesel production.

Glycerin and methyl esters are the two major products created after the reaction is complete and the excess methanol has been removed from the mixture. Gravity is used to separate the two products, since they have different densities. Glycerin is the denser of the two products. Glycerin has a density of (10lbs/gallon), while methyl esters have a density of (7.35lbs/gallon). The glycerin is then drawn off the bottom of the tank and can be sold either as crude glycerin, or if potassium hydroxide was used as the catalyst, the salt can be used for fertilizer.

After the separation of the glycerin and methyl esters, the methyl esters must be washed to remove residual catalyst or soaps. The methyl esters are washed using water (Biodiesel Production Technology Overview, 2,3).

Refer to the figure at the back of this document, which may help you visualize the process better.

Three Basic Methods to Making Biodiesel

There are three basic methods of biodiesel (methyl ester) production from oils and fats. They are;

- Base catalyst transesterification of the oil with methanol.
- Directed acid catalyzed esterification of the oil with methanol.
- Conversion of the oil to fatty acids, and then to methyl esters with acid catalysis. .

Production of biodiesel is usually done today using the base catalyzed reaction, as the base catalyzed reaction is the most economic process. This process is the most economic, because the process uses a low temperature, 150F, and pressure, 20psi, there is also a high conversion of 98% and there is a direct conversion to biodiesel with no intermediate steps (Biodiesel Production Technology Overview, 1).

If you would like to find out more about these three different processes, visit this web site: <http://www.biodiesel.org/reports/GEN-004.html>

An Interesting Recipe

Here is a recipe from the University of Idaho, taken off the website <http://www.woodwind.com/dancing-rabbit/biodiesel/newoil.html>. This recipe is taken directly from the above web site and the recipe is titled *Production and Testing of Ethyl and Methyl Esters by Charles L. Peterson, et al. 1994*, there are also one or two other recipes at this site for making biodiesel.

Methyl Ester Biodiesel Ingredients:
For Methyl Ester Biodiesel

MeOH=.225 x Oil
KOH= Oil/100

Where:

- Oil = desired amount of oil in liters
- MeOH = amount of methanol in liters
- KOH = amount of potassium hydroxide required in Kg

For Ethyl Ester Biodiesel

$$\text{EtOH} = .2738 \times \text{Oil}$$

$$\text{KOH} = \text{Oil}/85$$

Where:

- Oil = desired amount of oil in liters
- EtOH = amount of ethanol in liters
- KOH = amount of potassium hydroxide required in Kg

Methods

The catalyst is dissolved into the alcohol by vigorous stirring in a small reactor. The oil is transferred into the biodiesel reactor and then the catalyst/alcohol mixture is pumped into the oil and the final mixture is stirred vigorously for 2 hours. A successful reaction produces two liquid phases: ester and crude glycerol. Crude glycerol, the heavier liquid will collect at the bottom after several hours of settling. Phase separation can be observed within 10 minutes and can be complete within 2 hours of settling. Complete settling can take as long as 20 hours.

After settling is complete, water is added at the rate of 5.5 percent by volume of the oil and then stirred for 5 minutes and the glycerol is allowed to settle again. After settling is complete the glycerol is drained and the ester layer remains. Washing the esters is a two- step process, which is carried out with extreme care. A water wash solution at the rate of 28 percent by volume of oil and 1 gram of tannic acid per liter of water is added to the ester and gently agitated. Air is carefully introduced into the aqueous layer while simultaneously stirring very gently. This process is continued until the ester layer becomes clear. After settling the aqueous solution is drained and water alone is added at 28 percent by volume of oil for the final washing (Biodiesel Recipe from New Oil, 2).

Washing must be done gently to ensure that the esters are not washed away, as harsh washing will decrease yield.

Tips for Successful Biodiesel Production

Here are some helpful tips to keep in mind.

When a biodiesel batch is first started, water should not be present in great amounts in the catalyst ingredients (sodium hydroxide, caustic soda). If water is present, large clumps of caustic soda may form and these are hard to break up. The presence of water in the batch also affects downstream processing negatively.

An excess of methanol is also normally used in biodiesel production, to be sure that the fat or oil used will be fully converted to esters. If the fats are not all converted to esters

and the fatty acid level is too high, above .5% to 1%, the soap formed will form an emulsion with the methanol and oil. An emulsion will also occur if water is present. The emulsion prevents the reaction from taking place and biodiesel will not form.

Before the oil is added the fatty acids should be removed from it, to help prevent the formation of an emulsion. Filtering is done with used oil (Biodiesel Production Technology Overview, 2).

More information about Biodiesel:

Here is a little more information about biodiesel and some of its benefits.

- Biodiesel reduces carbon dioxide emissions and other particulate matter emissions.
- Biodiesel use helps to stabilize greenhouse gases.
- When biodiesel is used in place of conventional diesel, “auto ignition, fuel consumption, power output, and engine torque are relatively unaffected...” (Why Biodiesel?, 2).

Here is a table that illustrates the difference in emissions when blends of diesel and biodiesel and #2 EPA diesel were run in a 1977 model year DDC 6V-71N coach engine.

Table 1. Emissions

	Total	Soluble				
Fuel	Particulate	(%)	CO ₂	CO	NOx	THC
#2 EPA Diesel	0.833	87.5	760	3.59	9.96	2.01
20%/80% Blend	0.814	89.7	773	2.73	10.18	1.48
%Change	-2.3	2.5	1.7	-23.9	2.2-	-26.4

(DDC 6V-71N Emission Testing on Diesel and Biodiesel Blend, 1)

The results of this study show that particulate matter is reduced when a 20%/80% blend is used. However the amount of NOx increased when this blend is used.

To read the entire text for the study done, visit this site: http://204.118.51.192/cgi-local/search.cgi?action=view_report&id=TRA-011. A little searching at the site will have to be done to find this article, but there are also other great articles on biodiesel to look at too.

Want to find out more?

Here are some sites where you can find more information about biodiesel and also more information on how to make your own biodiesel at home! These sites also have great links to even more biodiesel sites.

- <http://www.nbb.org/faq.htm>
- <http://www.vegievan.org/biodiesel.html>
- <http://www.biodiesel.org/reports/GEN-004.html>

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