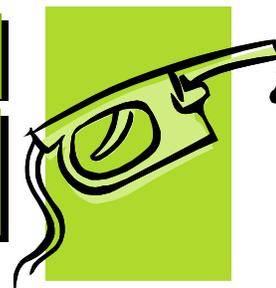




Section	Page(s)
Table of Contents	1
Introduction	2 – 3
General Safety	4
Materials	5 – 6
Stage A: Preparation	7
Stage B: Mixing	8 – 11
Stage C: Separation	12 – 13
End Use	14
Troubleshooting	15
References and Resources	15

How To Make Your Own Biodiesel

Introduction



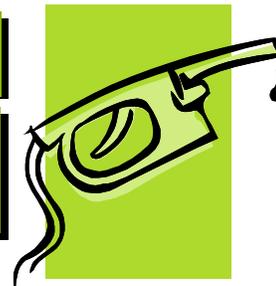
Hello Eco-Friendly Driver!

Welcome to our Biodiesel Instructions. Before proceeding, we commend your decision to make biodiesel. The benefits of biodiesel are numerous, providing not only a source of economical fuel, but also helping our environment through lowering your vehicle's emissions. Do not be discouraged if your initial tries do not work. The manufacture of biodiesel is an art, and as such, takes time and practice to master.

Prior to working through these instructions, you should establish the grade of biodiesel that is required for your automobile. These protocols have been optimized for Volkswagen Jetta™ TDI models made between '96 and '99, although they can be tailored to other TDI models as well. This pamphlet will instruct you on the synthesis of biodiesel from new vegetable oil only. At the end of the process, you will have purified an arbitrary quantity of high-purity diesel from any off-the-shelf brand of oil.

How To Make Your Own Biodiesel

Introduction contd.



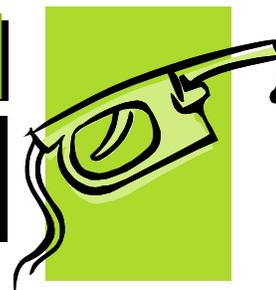
The process is a two-step reaction. In consideration of this, we have partitioned the instructions into three stages:

- **STAGE A:** Preparation
- **STAGE B:** Mixing
- **STAGE C:** Separation

These instructions are designed to be followed in one session. Many of the reagents you will be using will lose their reactivity over time. Where necessary, we have indicated when steps are time-sensitive. This process was developed to be done within 24 hours. In addition to the procedure, you will find a troubleshooting table. To conclude this introduction, we advise you to be aware of the warning and caution labels that accompany potentially hazardous steps. Information used in the chemical processes in these instructions, as well as the pictures, are credited to *Dangerous Laboratories* (see asterisked notes and references).

How To Make Your Own Biodiesel

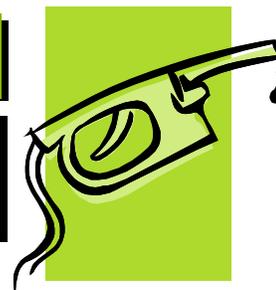
General Safety



We have annotated these instructions when there are hazards to health or equipment. These will be signaled to you in the form of warnings, cautions, and notices. Heeding these labels will minimize the risk of harming yourself and/or your apparatus. Most notably, you should be aware that:

- Methanol (methyl alcohol) is highly poisonous and flammable. Intake (either by swallowing or inhalation) may be lethal or cause blindness.
- Lye is a powerful oxidant and can cause burns to the skin.

When using these two chemicals, wear gloves and safety glasses. To avoid cross-contamination with other household items, use proper disposal techniques. Contact your local hazardous waste center for instructions on how to properly dispose of any of the chemicals used in these instructions.



◆ Ingredients

- 1 Liter (1.1 Quarts) of *new* vegetable cooking oil. Do not use oil that has already been used for cooking.
- One 12 ounce (oz.) bottle of lye-based drain cleaner. It must contain sodium hydroxide. We recommend Red Devil™.
- 200 milliliters (ml.) of methanol-based gas tank antifreeze. It must contain methanol. We recommend Heet™.

◆ Equipment

- Safety goggles
- Rubber gloves
- A variable speed blender with a glass pitcher with a lid
- A balance scale that measures in grams
- A glass beaker that can measure 200 milliliters
- A small glass measuring bowl
- A minute timer



How To Make Your Own Biodiesel

Materials contd.



Our instructions pertain to the preparation of exactly 1 liter (L) of biodiesel. To scale the reaction up to the volume of your choice, use the universal formula provided below (Table 1), which is based on 1 L of initial vegetable oil. Using the equipment specified above (Page 5) is appropriate, provided that they can hold the desired amounts of materials.

Table 1: Ingredients for 1 liter of biodiesel

Amount (per L of product)	Material
200 mL	Methanol
3.0 g	Lye
1 L	Vegetable oil

Step A1: Read through the entire procedure before you begin mixing ingredients so you know what is expected in the process.

Step A2: Bring all of the ingredients and equipment required for this procedure before you begin. A complete list of ingredients and equipment is listed on page 2.

Step A3: Label all mixing containers used in the procedure as poisonous.

Step A4: Put on *all* of your safety equipment (goggles, gloves) before you continue.

Step B1: Measure 200 milliliters (ml) of methanol with the 200ml beaker (Figure 1).



Figure 1: Measure the methanol antifreeze*.

⚠ DANGER		⚠ WARNING	
	METHANOL IS HIGHLY FLAMMABLE. KEEP AWAY FROM HEAT SOURCES. USE ONLY IN A PROPERLY VENTILATED AREA.		METHANOL IS CAUSTIC AND TOXIC. HARMFUL OR FATAL IF INGESTED OR CONTACTED WITH EYES. KEEP OUT OF REACH OF CHILDREN.
⚠ CAUTION		NOTICE	
	PLASTIC PITCHERS WILL BE CORRODED BY METHANOL. USE GLASS PITCHERS ONLY.		REACTION WILL NOT WORK WITH ISOPROPYL (RUBBING) ALCOHOL. BE SURE SOLVENT CONTAINS METHANOL.

*Photo by: *Dangerous Laboratories*

Step B2: Place the measuring bowl on the scale and find its weight. Then add 3 grams to the scale slider with the bowl still on the scale so that the final weight is weight of the bowl plus 3 grams.

Step B3: Use the scale to measure 3 grams (g) of lye into the mixing bowl (Figure 2).



Figure 2: Weigh 3 grams of lye*.

⚠ WARNING		NOTICE	
	LYE IS CORROSIVE. MAY CAUSE CHEMICAL BURNS IF CONTACTED WITH SKIN. KEEP OUT OF REACH OF CHILDREN.		REACTION WILL NOT WORK WITH CHLORITE-BASED DRAIN CLEANERS. BE SURE SOLUTE CONTAINS LYE.

*Photo by: *Dangerous Laboratories*

Step B4: Pour the measured methanol and lye into the blender and put the lid on the top of the blender (Figure 3).



Figure 3: Pour methanol (left) and lye (right) into the mixer*.

Step B5: Mix the ingredients for 2 minutes. Be sure all of the lye is dissolved. If you still see particles of lye in the mixture, mix on slow once more for another 30 seconds.

*Photo by: *Dangerous Laboratories*

Step B6: Measure one liter of canola oil and pour it into the blender with the other ingredients (Figure 4).



Figure 4: Pour canola oil into the mixer*.

Step B7: Put the cap back on the blender and mix the ingredients on the slow setting for 30 minutes.

*Photo by: *Dangerous Laboratories*

Step C1: After you have completed **Stage B** mixing, pour the mixture from the blender into your wide glass container (Figure 5).



Figure 5: Pour the mixture into the glass container*.

Step C2: Set the container in a safe place away from the reach of children and let it sit for a long time period of no less than 10 hours but no more than 24 hours.

*Photo by: *Dangerous Laboratories*

Step C3: After step C2 is complete, you should notice two distinct color differences between the upper and lower halves of the solution (Figure 6). Do not mix the solution.



Figure 6: The two distinct solutions*.

Step C4: Carefully pour off the top layer of liquid from the glass container into a second wide container. Be careful not to pour any of the heavy dark liquid into the second container.



Step C5: You should now have one jar with light liquid, and one jar with dark liquid. Discard of the dark brown liquid at your local hazardous materials disposal site.

*Photo by *Dangerous Laboratories*



Congratulations!

At the end of this process, you will have a container with only a light-colored liquid, which is your biodiesel. If your container does not look like this, or if in step C3, the substance in the jar does not match the graphic and description, refer to the troubleshooting guide on the proceeding page.

End-Use

Now that you have refined your own Biodiesel, it is important to keep in mind its cold-weather characteristics. Many users have reported having issues cold-starting their engines, as well as longer warm-up times in cars operating on pure (100%) biodiesel under 40°F ambient temperature. This is the temperature at which the oil begins to solidify. To remedy this issue, many people mix in varying amounts of conventional petrol-diesel. A trial-and-error approach is best used to determine the appropriate mix for your climate and conditions; however, a good baseline mix to start at would be 85% bio-diesel and 15% petrol-diesel (a so called B85 mix) in the Jetta TDI.

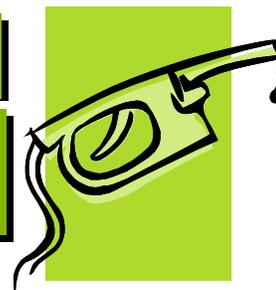


Table 2 shows typical problems and methods of solving these problems:

Table 2: Troubleshooting*

Problem	Diagnosis	Solution
Jelly or soapy residue forming between the two layers of the final settled mixture.	Too much water content in initial oil used. While this is rare in new oil, it can occur from time to time.	Properly discard mixture. Restart process from A1, pour initial oil content onto a frying pan and heat to 212°F until boiling has slowed or stopped.
Three levels instead of two have formed in the final settled mixture.	Not enough lye was used in the reaction. This mistake can occur when trying to scale the ingredients up to make larger quantities of biodiesel.	Properly discard mixture using the General Safety section as a guide. Restart process using additional lye proportional by mass of oil used. 3 grams of lye per 1 liter of oil used.

*Troubleshooting content sourced from *Journey to Forever*.

References:

"How to make your first batch of biodiesel." *Dangerous Laboratories*. 2006. <<http://www.dangerouslaboratories.org/body.html>>.

"Biodiesel recipe from Mike Pelly." *Journey to Forever*. 2006 <http://journeytoforever.org/biodiesel_mike.html>.