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College of Agriculture, Human and Natural Sciences
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Bioenergy

Small-Scale Biodiesel Production

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"The diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries which use it." Rudolf Diesel, 1911

The production of biodiesel from vegetable oil is a viable process to create fuel that can replace traditional diesel used in existing engines. Many large biodiesel production facilities in Tennessee are using waste oils (fast food frying oils, for example) for biodiesel production, but the oil from pressed oilseed crops (i.e soybean, canola, sunflower) can also be converted to biodiesel on the farm by a farmer or farmer cooperative.

Based on estimates, a typical farm uses around 2 to 6 gallons of diesel fuel per acre per year. Depending on the oilseed crop and yield, a farmer could devote 1 to 15% of the farm acreage to producing oilseed crops for biodiesel production, and become totally self-sufficient in their diesel fuel use. This fact sheet discusses the process and equipment involved in biodiesel production and some important quality and safety issues.

Biodiesel conversion

The original diesel engines were designed to use various types of fuels, including seed oils. Over time, the diesel engine was modified to use the lower-grade byproduct of petroleum refinement. Therefore, unless retrofitted to run on straight vegetable oils, the oils must first be converted to biodiesel.

Creating biodiesel from waste or pressed vegetable oils involves a process called transesterification. This process was used in the mid-1800s in the U.S. for making glycerin soap and the esters (biodiesel) produced were considered a byproduct. Transesterification basically involves the reaction of the oil with lye (sodium hydroxide) and alcohol (methanol) to remove glycerin. The glycerin sinks to the bottom and the biodiesel floats to the top. Removing the glycerin from the oil makes the original oil thinner so that it can be used in a diesel engine.

Biodiesel equipment and supplies

Certain equipment is required to create biodiesel. Due to the hazardous nature of the chemicals involved, it is recommended to purchase this equipment rather than building your own. It is also recommended that you consult a professional to avoid production issues. Groups such as TSU Extension and the National Biodiesel Board (www.biodiesel.org) can provide contacts and information regarding biodiesel production.

Seed press: A seed press (Fig. 1) will allow for the extraction of oil from a number of different types of seeds. Prices usually range $3,000 - $12,000 depending on the manufacturer and the processing volume/speed. In addition to oil, the press also produces residual meal that can be used as an animal feed.

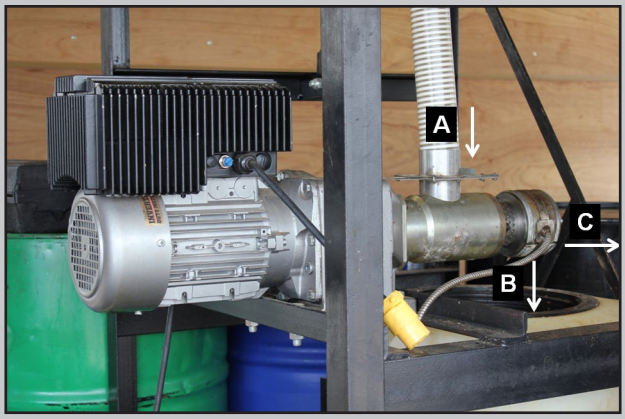

Fig. 1. Seed press for extracting oil from oilseeds. Seeds are fed into the press from above (A), oil drains out the bottom (B), and the residual meal is fed out the side of the press (C).

Biodiesel processor: The processor (Fig. 2) can hold and mix the oil and chemicals, allowing them to react and produce biodiesel. Processors usually contain some type of agitator and heating device to allow for faster reaction of the material and typically produce 40-80 gallons of biodiesel at a time. Prices can range $1,500 - $10,000 depending on the manufacturer and capacity.

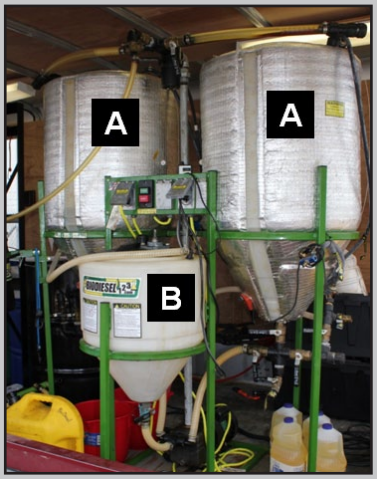

Fig. 2. Biodiesel processor containing two large tanks where oil is converted to biodiesel (A) and a smaller tank (B) where alcohol and lye are premixed before their addition to the larger tank. Only one large tank is necessary but additional tanks allow greater production capacity.

Other miscellaneous equipment: Filtering equipment or a centrifuge is advised (particularly if using waste vegetable oil) to remove particulates prior to loading oil into the biodiesel processor as some of these particulates could end up in the final product.

Alcohol: Methanol is the type of alcohol that is used in this process because it is generally cheaper than ethanol and usually has a more predictable reaction. Methanol does have safety issues that relate to its flammability and other health hazards so it is important to use it under the correct conditions with the correct personal protective equipment. Methanol usually costs around $200 (plus taxes and shipping) for a 55 gallon drum which can produce about 275 gallons of biodiesel.

Lye (catalyst): Sodium hydroxide (NaOH) is usually the chemical of choice due to its lower cost. Potassium hydroxide (KOH) can be used instead but a larger amount will be needed. As with methanol, these chemicals are also a health hazard and the proper guidelines should be followed in their use. The sodium hydroxide costs about $60 (plus taxes and shipping) for 55 lbs. which can be used to produce about 724 gallons of biodiesel.

Quality

It is important to ensure the best quality biodiesel before using it in your equipment. To legally sell biodiesel to others, the biodiesel must pass specific testing standards (ASTM 6751 for 100% biodiesel, ASTM 7467 for 6-20% biodiesel). If using biodiesel in your personal equipment, it does not have to be tested but will void the engine warranty.

Standard tests can be costly but simpler, easy tests kits are available that can give some idea of biodiesel quality. In the absence of standard tests it is even more important to ensure that proper techniques (filtration, correct ratio of chemicals, allowing enough time for conversion and proper separation of glycerin from biodiesel, "washing" and "drying" of biodiesel, proper storage) are being used to produce good quality biodiesel.

Safety

Safety is extremely important when handling the chemicals involved in producing biodiesel. Always follow the guidelines that come with the chemicals. In addition, other good resources are available that relate to safety issues involving biodiesel production. A couple of examples are below:

http://pubs.cas.psu.edu/freepubs/pdfs/agrs103.pdf
http://pubs.ext.vt.edu/442/442-885/442-885.html

Waste Disposal

There is wastewater and contaminated glycerol that is produced as part of the process that must be disposed in an environmentally sound and lawful way. For more information on proper disposal methods in Tennessee, contact the Division of Solid and Hazardous Waste Management at (615)532-0780. There is also an annually updated list of permitted hazardous waste transporters at http://www.tn.gov/environment/swm/pdf/transporter.pdf

Additional Resources

Ciolkosz, D. 2009. Using biodiesel fuel in your engine. Renewable and Alternative Energy Fact Sheet, Penn State College of Agricultural Sciences, UC204. Available at: http://pubs.cas.psu.edu/freepubs/pdfs/uc204.pdf

Jackson, S. 2008. Biodiesel: a primer. University of Tennessee Cooperative Extension Program, SP700-C. Available at: https://utextension.tennessee.edu/publications/Documents/SP700-C.pdf

Pahl, G. 2005. Biodiesel, growing a new energy economy. Chelsea Green Publishing Company: White River Junction, VT.

Sadaka, S. Biodiesel. University of Arkansas Cooperative Extension Service, FSA1050. Available at: http://www.uaex.edu/Other_Areas/publications/PDF/FSA-1050.pdf

http://www.extension.org/pages/28783/farm-energy-biodiesel-table-of-contents

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