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Biodiesel

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What is biodiesel?

Biodiesel is a renewable fuel made from organic feed sources. Biodiesel is an alternative fuel similar to the conventional or "fossil" diesel used in cars, buses and trucks. However, instead of being drilled from the ground, biodiesel is produced chemically from vegetable oil, animal fats, tallow and/or waste cooking oil. Some of the sources of suitable oil from crops are soybean, cotton seed, rapeseed or palm. In fact, any plant oil can be made into biodiesel (Fig. 1).

In Arkansas, soybeans currently represent the greatest potential for biodiesel production. Biodiesel derived from soybeans is sometimes called soydiesel, methyl soyate or soy methyl esters (SME). The process used to convert these organic feed sources to biodiesel is called "transesterification."

Biodiesel could also be produced from waste vegetable oil from restaurants, chip shops or industrial food producers. Waste vegetable oil can often be acquired unrefined for free or already treated for a small price.

Figure 1. Biodiesel samples from different plant oils

Waste oil must be treated to remove impurities before conversion to biodiesel.

What is not biodiesel?

Biodiesel is not the same thing as raw vegetable oil or unaltered used frying grease. Biodiesel is precisely produced by a chemical process that removes the glycerin from the oil. Other 'bio-derived' materials that do not meet American Society for Testing Materials (ASTM) D6751 standards may cause engine and fuel system problems (see Fig. 2) and void engine warranties.

Figure 2. Deposits from raw vegetable oil

How is biodiesel produced?

Almost all biodiesel is produced using a process called "base catalyzed transesterification," as it is the most economical process requiring only low temperatures and pressures and producing a 98 percent conversion yield. This process is the reaction of oil or fat with an alcohol (methanol) to form biodiesel and glycerol. A catalyst such as sodium or potassium

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hydroxide is required. Glycerol is produced as a byproduct. The approximate proportions of the reaction are as follows:

100 lbs of oil + 10 lbs of methanol → 100 lbs of biodiesel + 10 lbs of glycerol

How much biodiesel can be produced from one acre of soybean land?

- 1 acre of soybean land produces about 39 bushels
- 1 bushel of soybeans weighs 60 pounds
- 1 acre of soybean land can produce about 2,340 pounds of soybeans
- 1 bushel of soybeans produces 11 pounds of oil
- 1 acre of soybean land produces 429 pounds of oil
- 1 pound of soybean oil produces about 0.973 pounds of biodiesel
- 1 acre of soybean land produces 418 pounds of biodiesel
- 1 gallon of biodiesel weighs 7.3 pounds
- 1 acre of soybean land produces about 57 gallons of biodiesel

Therefore

- 1 bushel of soybeans produces about 1.5 gallons of biodiesel

Assume a farmer owns 100 acres of soybean land.

- This farmer will produce about 3,900 bushels of soybeans (100 acres x 39 bushels per acre = 3,900 bushels).
- This farmer will produce about 42,900 pounds of oil (100 acres x 429 pounds per acre = 42,900 pounds).
- This farmer will produce about 41,800 pounds of biodiesel (100 acres x 418 pounds per acre = 41,800 pounds).
- This farmer will produce 5,700 gallons of biodiesel (100 acres x 57 gallons per acre = 5,700 gallons).

What types of vehicles can use biodiesel?

Limited amounts of biodiesel can be used in any diesel vehicle without modification. Applications include buses, delivery trucks, waste disposal and recycling trucks, construction equipment, heavy-duty freight-hauling trucks, boats, passenger vehicles and tractors (Fig. 3). Biodiesel can be blended at any ratio with petroleum diesel to achieve cost efficiency and improve cold weather performance. It is commonly used as B20 – a blend of 20 percent biodiesel and 80 percent petroleum diesel. You can use B100 or "neat" (100 percent biodiesel) or any other mix with diesel.

Figure 3. Farm equipment fueled by biodiesel

How does biodiesel perform?

Biodiesel performs just like traditional diesel, although B100 may result in a minimal power loss under high loads and a slight reduction in fuel economy. Scientists who have tested biodiesel in vehicles have found it to be cleaner burning than normal diesel with only a very slight loss of 5 to 8 percent in fuel economy (miles per gallon). B20 users generally experience no obvious difference in fuel economy from petroleum diesel.

Because biodiesel acts as a lubricant, it reduces wear and tear on the fuel injection system, reducing maintenance costs and extending injection pump life. Biodiesel can be blended with petroleum diesel, so it can be easily stored and dispensed in existing facilities.

Biodiesel thickens more than diesel fuel in cold weather, and special systems or minor modifications are required for use of B100. In Arkansas, no special modifications are necessary for using B20. Owners of vehicles produced prior to 1993 with rubber seals in fuel pumps and fuel systems should replace the seals with non-rubber ones.

What are the benefits of using biodiesel?

- Biodiesel has many environmentally beneficial properties. Biodiesel is commonly described as "carbon neutral." Burning biodiesel emits carbon dioxide (CO_2), but this emission is offset by the fact that the crop used to produce it uses CO_2 from the atmosphere to grow. (However, some CO_2 is released during the production of the fertilizer required to fertilize the fields in which the oil crops are grown.)
- Biodiesel is rapidly biodegradable and completely nontoxic, meaning spillages represent far less of a risk than fossil diesel spillages.

- Biodiesel has a higher flash point than fossil diesel and so is safer for storage or in the event of an accident.
- Compared with fossil diesel, biodiesel combustion emits fewer pollutants such as carbon monoxide (CO) and particulates (see Table 1). Sulfur is almost completely eliminated. Nitrous oxides may stay the same or increase but can be reduced with a catalytic converter and/or by altering the engine timing.
- Biodiesel is more lubricating than mineral diesel and so increases fuel injector pump life.
- Biodiesel can reduce waste by recycling used oil.
- Biodiesel has an energy balance of 3:1; i.e., it provides over three times the amount of energy used to produce it.

Table 1. Emissions reductions achieved by biodiesel

Emission	B100	B20
Carbon monoxide	47%	12%
Hydrocarbons	67%	20%
Particulates	48%	12%
Sulfates	100%	20%
Nitrogen oxide	+/-10%	+/-2%
Air toxics	60-90%	20%

What are the disadvantages of biodiesel?

- B100 has 8 percent less energy per gallon than fossil diesel. Miles per gallon will decrease by that amount. Using B20 will result in a miles per gallon decrease of about 1 to 2 percent.
- Old biodiesel fuel can become acidic and form sediment and varnish. Additives can prevent this.
- Biodiesel will gel (like regular diesel fuel). Blending and additives can control this.
- Biodiesel can cause filter plugging (at very low temperatures, due to polymers, fuel tank deposits and other contaminants). Filtering keeps the fuel clean.

Can I make my own biodiesel?

Yes, you can make your own biodiesel. Small scale biodiesel production is possible. Many groups across the country, including the Bioenergy group at the University of Arkansas System Division of Agriculture can provide information on the equipment and methods needed to make biodiesel. The consumer should be wary of using homemade biodiesel in an engine. If the fuel's quality is not guaranteed, engine damage could occur. This damage will not be covered by the manufacturer's warranty. Special precautions also need to be taken in handling the chemicals involved in producing biodiesel. Four requirements should be considered before manufacturing biodiesel at home:

- Learn and observe all regulatory requirements (local zoning rules may prevent the production of biodiesel in a given location).
- Establish a system to handle, store and dispose of the various chemicals associated with biodiesel (some chemicals used in biodiesel production are hazardous).
- Wear proper protective equipment while handling biodiesel's chemicals (safety goggles, gloves, chemical apron and respirator).
- Take the required steps to ensure fuel quality (many groups offer advice on how to determine if homemade biodiesel is pure enough to be used as an engine fuel).

Links for more information:

- Environmental Protection Agency www.epa.gov/otaq/models/biodsl.htm
- Association of Central Oklahoma Governments www.acogok.org
- Indian Nations Council of Governments www.incog.org
- National Renewable Energy Laboratory www.nrel.gov
- Alternative Fuels Data Center www.eere.energy.gov/afdc/
- National Biodiesel Board www.nbb.org
- Biodiesel http://www.biodiesel.org/what-is-biodiesel/biodiesel-basics

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