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Biodiesel Basics

Czarena Crofcheck, Tim Stombaugh, Mike Montross, Biosystems and Agricultural Engineering

Quick Biodiesel Facts

Biodiesel is a renewable fuel for diesel engines. Biodiesel, defined by ASTM International (D6751), consists of long-chain fatty acid alkyl esters and is made from renewable vegetable oils, recycled cooking oils, or animal fats. It can be used at full strength, but it is typically blended with petroleum diesel. A blend of 2 percent biodiesel and 98 percent diesel is referred to as B2. Other typical blends include B5, B10, and B20; pure biodiesel is sometimes referred to as B100. Biodiesel is safer for the environment and produces significantly less air pollution compared to petroleum diesel. Biodiesel can be produced locally and can be integrated into the existing petroleum infrastructure.



How Is Biodiesel Made?

Biodiesel can be made from vegetable oils, recycled cooking oils, or animal fats. The vegetable oil could be from soybeans, canola, cottonseeds, sunflowers, or peanuts. Recycled cooking oil can also be converted into biodiesel, which means we're converting a waste product into a value-added product. There are slight processing modifications that may need to take place depending on the properties of the input oils and fats. One great advantage of the biodiesel process is that there are no waste products to be disposed of. Everything that comes out of the process can be reused in a future batch or sold as a product.

The process of making biodiesel starts with the addition of vegetable oil, catalyst, and methanol into a reactor. The oil and methanol are converted to biodiesel and glycerin through a process called transesterification. The biodiesel and glycerin are separated and further processed so that the result is a biodiesel product, which meets government

For every 100 pounds of oil and 10 lbs of methanol, the transesterification will yield 100 pounds of biodiesel and 10 pounds of glycerin.

fuel standards, and a crude glycerin product. The resulting crude glycerin will be refined further into a more concentrated material and can be used in health care products, rubber, moisture enhancers, or even applied to surfaces for dust control.

Why Use Biodiesel?

There are multiple benefits to using biodiesel compared to using petroleum diesel.

- Using biodiesel decreases this dependency on foreign oil. In 2004, 58 percent of petroleum in the United States was imported from foreign countries, while there were raw materials available across the nation to produce enough biodiesel to displace 5% of the petroleum diesel used in this country.
- Using biodiesel increases revenue for U.S. farmers and rural communities.
- Biodiesel improves air quality, which makes the environment healthier for our communities.
- Biodiesel contains more energy than what was used to produce it. For every one unit of energy that goes into making a gallon of biodiesel, 3.24 units of energy are stored for future use. For every one unit of energy that is used to make a gallon of petroleum diesel, only 0.83 units of energy (0.17 less than the amount of energy used to produce the fuel) are stored for future use.

Biodiesel Economics

Traditionally, a blend of biodiesel would cost one penny more than petroleum diesel for each percent of biodiesel blended, such that a B20 blend would cost 20 cents more than petroleum diesel per gallon. More recently, the price of petroleum diesel has increased, sometimes making it more expensive than pure biodiesel. The difference in price is also directly related to current tax incentives and credits.

Biodiesel can have a significant economic impact for Kentucky, according to a recently completed study at Murray State University. By using a 5-percent biodiesel blend across Kentucky, soybean processing capacity would increase by 158 percent, adding \$571 million dollars to Kentucky's economy as well as 3,020 new jobs. Total tax revenue would be increased by \$68.5 million.

Biodiesel and Community Health

You don't have to take too many deep breaths behind a vehicle using petroleum diesel to be able to appreciate that cleaner exhaust would be beneficial. The exhaust emissions of particulate matter, typically referred to as soot, are a recognized contributor to respiratory disease. When using pure biodiesel, particulate matter decreases by 30 percent. In addition, the exhaust emissions of suspected carcinogenic compounds are substantially reduced for biodiesel compared to petroleum diesel.

Biodiesel degrades in the environment as fast as sugar and is 10 times less toxic than table salt.

Studies have shown that petroleum diesel exhaust adversely affects children with asthma and bronchitis and increases the effects of some allergens. Using biodiesel would lessen these effects. Biodiesel was the first renewable fuel to successfully complete the Environmental Protection Agency required Health Effects Testing. EPA's clinical studies, which study the toxicity of fuels, showed no adverse health effects with B100, pure Biodiesel.

Actually, the same compound that's used in biodiesel – fatty acid methyl esters – is listed as an animal feed additive with the Food and Drug Administration.

Reduced Environmental Impact

As concentrations of greenhouse gases in the environment have been increasing, we need to find ways to decrease man's impact on the environment. Biodiesel is safe for the environment and produces less air pollution compared to petroleum diesel.

When using pure biodiesel, the exhaust emissions of carbon monoxide (a poisonous gas and a factor in local smog formation) are 50 percent lower than when using petroleum diesel. The exhaust emissions of hydrocarbons, which also contribute to smog formation, are 95 percent lower.

The exhaust emissions of sulfur oxides (So_x) and sulfates, which are major components of acid rain, from biodiesel are almost completely eliminated. However, studies have shown that the nitric oxide (No_x) emissions are increased.

Biodiesel can actually be used as a solvent to clean up oil spills.

Using Biodiesel Basics

Biodiesel has a higher cetane rating than petroleum diesel. The cetane number is an indication of how well the fuel will ignite when it is compressed, which is the fundamental operating principle of a compression ignition (diesel) engine. Cetane is analogous to the octane rating of gasoline. The higher cetane of biodiesel can help an engine with cold starting and with reduction of noise at lower RPM's. However, if the cetane of the fuel gets too high, some engines may experience problems. The fuel may ignite before it is completely mixed with the air in the engine cylinder, which could cause incomplete combustion and an increase in undesirable emissions.

Pure biodiesel (B100) has a slightly lower (5 to 8 percent) energy content per gallon than petroleum diesel. While the energy loss in lower blends of biodiesel is relatively small, users may experience a slight power loss with biodiesel.

Biodiesel has high lubricity and reduces friction in your engine. This will become even more important when ultra low sulfur diesel is mandated in 2006, because sulfur provides lubricity. By adding just 1 percent biodiesel to ultra low sulfur diesel, the lubricity is increased to a satisfactory level. Additives could be used to accomplish the same thing, but by adding biodiesel we're adding a fuel not just an additive.

A B2 biodiesel blend has roughly the same cold flow properties as petroleum diesel, while B20 will increase the gel

point by 3 to 5° F. B20 has been successfully used in cold weather temperatures down to -13° C by utilizing the same winterizing steps taken when using petroleum diesel.

Biodiesel is very safe and nonflammable. However, rags soaked in biodiesel should still be stored in a safety can or dried individually before being disposed of.

Biodiesel has outstanding cleaning properties and will clean your fuel tank and lines. For this reason, it is recommended that fuel filters should be monitored and may need to be changed after the first tank of biodiesel.

Using pure biodiesel, B100, can degrade natural rubber, which may affect an engine's gaskets, seals, and hoses. However, this shouldn't cause a problem with the lower biodiesel blends, specifically B20 or less. If a higher biodiesel blend is desired, natural rubber engine components may need to be replaced more often. Gaskets, seals, and hoses made of Viton are compatible with biodiesel. If you're concerned, check with your manufacturer.

Overall, biodiesel is safer than petroleum diesel to use, handle, and store. Manufacturers such as Caterpillar, Cummins, Detroit Diesel, International, Ford, DaimlerChrysler, General Motors, and John Deere will recommend up to B5. Higher blends, though not recommended at this time, will not void engine warranties. If you have any concerns, check with the individual manufacturers.

A companion publication to this one (AEN-90) contains answers to questions commonly asked by biodiesel users.

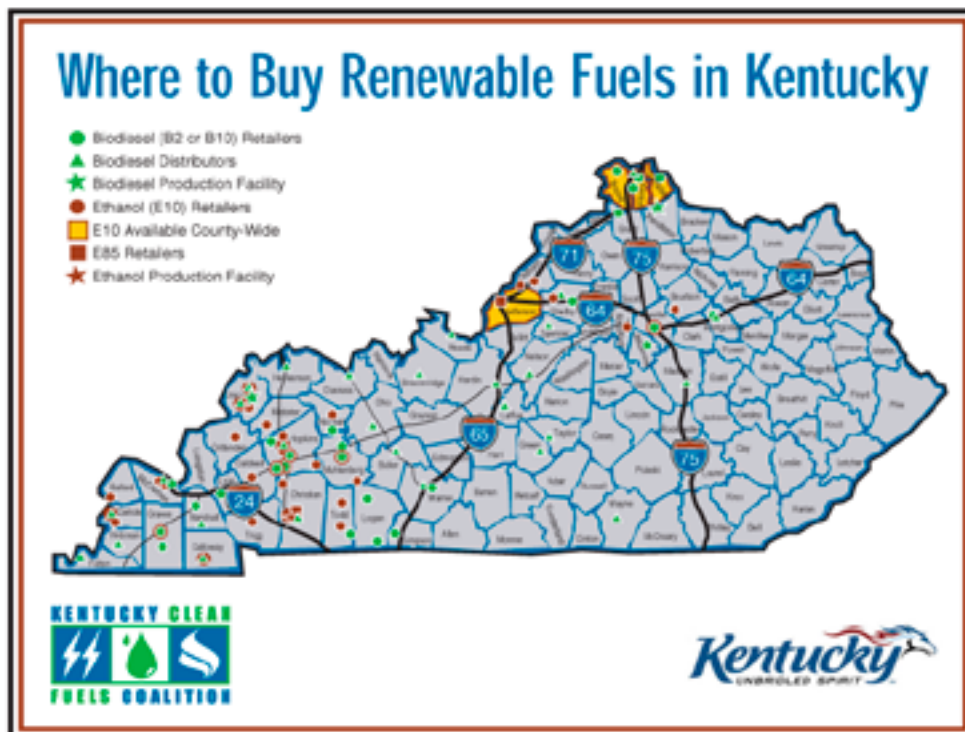
Where Is Biodiesel Made and Sold in Kentucky?

In Kentucky, motor fuels inspection and testing are administered by the Kentucky Department of Agriculture, Division of Regulation and Inspection. The Commonwealth's regulations specify that ASTM standards, supplements, and revisions shall be applied to ensure compliance with Kentucky Statutes. The Division tests motor fuels to ensure that the quality of the fuel meets Kentucky law and ASTM standards. For more information consult the Kentucky Office of Energy Policy (www.energy.ky.gov).

In Kentucky, Griffin Industries has a biodiesel plant in Butler. Biodiesel is available from retailers across Kentucky, shown in the map below (provided by the Kentucky Clean Fuels Coalition, December 2005). For updated maps, consult www.kentuckycleanfuels.org or www.kysoy.org.

Who Is Using Biodiesel in Kentucky?

In Kentucky, public school districts, universities, national and state parks, local governments, and the Transportation Cabinet are using biodiesel blends. Across the country, users include the U.S. Forest Service, the U.S. Postal Service, the U.S. Department of Agriculture, and our armed services. Minnesota has a statewide mandate that all diesel fuel sold will contain 2 percent biodiesel, effective June 2005.



In addition to being used in diesel engines, biodiesel blends can also be used in off-road equipment, agriculture vehicles, locomotives, and marine vehicles and as a heating oil in stationary generators and boiler applications.

Other References:

National Biodiesel Board (www.biodiesel.org)

Kentucky Soybean Board (www.kysoy.org)

Kentucky Clean Fuels Coalition
(www.kentuckycleanfuels.org)

Kentucky Office of Energy Policy (www.energy.ky.gov)

Griffin Industries Inc. (www.biog3000.com)

2004 Biodiesel Handling and Use Guidelines (www.osti.gov/bridge). Search for DOE/GO-102004-1999

U.S. Department of Energy, Energy Efficiency and Renewable Energy (www.eere.energy.gov/afdc/altfuel/biodiesel.html)