Biodiesel Quality: Is All Biodiesel Created Equal?

EXPERT REVIEWED

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As fuel prices continue to climb, consumers and entrepreneurs alike are looking at biofuels to decrease both fuel costs and our reliance on foreign oil, as well as provide investment opportunities. A considerable amount of research has already been conducted comparing the quality of B100 fuel (biodiesel) made from different oil and fat sources. In this publication, we discuss the specific chemical properties related to biodiesel and why consumers should not home brew their own fuel.

Chemical and Fuel-Related Properties of Oils

Biodiesel is made from fats and oils by reaction with methanol to create long carbon chain methyl esters, which are similar in chemical structure to diesel fuels (Knothe, Dunn, and Bagby, 1997). Because B100 is made from domestic fats and oils, it is usually composed of a mixture of saturated and unsaturated fatty acid chains.

These components have different physical and combustion properties, with saturated (no carbon double bonds) methyl esters having higher freezing points and unsaturated (1-3 double bonds) methyl esters having much lower freezing points (Table 1, U.S. Department of Energy, 2006). Unsaturated methyl esters have lower cetane (ignition quality) numbers and decreased fuel stability and are believed to generate higher NO_x emissions.

Energy Content of Biodiesel

The conventional method to measure energy output from diesel engines is BTU's per gallon.

Table 1. *Fuel Properties as a Function of Fuel Composition in Diesel Engines*

Chemical property	Fatty acids: Saturated 12:0, 14:0, 16:0, 18:0, 20:0, 22:0	Monounsaturated 16:1, 18:1, 20:1, 22:1	Polyunsaturated 18:2, 18:3
Cetane number	High	Medium	Low
Cloud point	High	Medium	Low
Stability	High	Medium	Low
NO_x emissions	Reduction	Slight increase	Large increase

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Table 2. *Cold Flow Properties for B100 Fuels*

B100 Fuel	Cloud point	Pour point	Cold filter plug point
	----Temperature °F----		
Soy methyl ester	38	25	28
Canola methyl ester	26	25	24
Lard methyl ester	56	55	52
Edible tallow methyl ester	66	60	58

One advantage that biodiesel has over #2 diesel is consistent energy output. The energy produced from domestic biodiesel is similar regardless of oil source (soybean, rapeseed, etc.), whereas the energy output produced from #2 diesel fuel can vary from source to source by up to 15% (due to variations in petroleum blending).

In general, however, the average energy output for #2 diesel fuel is approximately 8% greater than for B100. In a typical B20 blend, this would equate to an approximately 1% loss in fuel economy and an insignificant drop in torque and power.

Another advantage that biodiesel has over #2 diesel is a higher cetane number. The cetane number is a measure of the ignition quality of fuel based on ignition delay in an engine. The higher the cetane number, the shorter the ignition delay and the better the ignition quality. Most B100 fuels have a cetane number over 47, whereas #2 diesel ranges between 42 and 44. This means that B100 fuel is easier starting and quieter to operate than #2 diesel.

Cold Flow Properties of Biodiesel

In northern climates, we must be very mindful of the cold flow properties of diesel and biodiesel alike. This is especially true as fuel sources are readily transported across the country. The three critical tests used to measure cold flow properties are:

Cloud point (**CP**): the temperature at which a sample of fuel just shows a cloud or haze of methyl or ethyl ester crystals when it is cooled under standard test conditions.

Cold Filter Plug Point (**CFPP**): the temperature at which fuel crystals cause a fuel filter to plug. This test is considered a better indicator than cloud point of low temperature operability.

Pour Point (**PP**): the lowest temperature at which a fuel will just flow when tested under standard conditions

A comparison of the most common sources of oil and fat in the United States indicates that the cold flow properties of B100 soybean and canola biodiesel are substantially better than those of grease, lard, or tallow (Table 2). This suggests that soybean and canola are currently the best feedstocks for Midwest biodiesel facilities.

Unfortunately, the cold flow properties of both soybean and canola will not allow them to be used as neat (B100) biofuels in Indiana. The addition of cold flow additives coupled with diesel blends (B1, B5, B20) generally enhances the cold flow properties of soybean and canola biodiesel in the Midwest.

Another recent problem that has been observed with biodiesel during cold weather is the engine filter plugging due to high levels of monoglycerides. Monoglycerides result due to incomplete reaction of fats and oils in making biodiesel. They are not a problem with combustion, assuming ASTM standards are met. However, because monoglycerides are only partially soluble in biodiesel, as biodiesel gets cold, monoglycerides drop out of solution, resulting in a slimy gum that quickly clogs paper filters. This problem was not anticipated by the ASTM standards and may occur even if fuel meets ASTM standards. Studies are underway to determine appropriate monoglyceride levels for biodiesel fuels.

Canola as an Alternative to Soybean

Currently, yield of spring canola varieties does not make this an economically viable substitute for soybean in Indiana. Winter canola, however, may someday have a place in southern Indiana cropping systems. Winter canola is planted in the fall (September) and harvested in late June. Growers can then follow canola with soybean. This cropping system allows Indiana growers to harvest two oil seed crops from the same acreage in one growing season. Because this crop is best placed (most economical) in southern Indiana, it will not replace any soybean acres.

The historical problem that canola has faced in Indiana is winterhardiness. However, through a significant breeding effort, the winterhardiness of winter canola has significantly

Photo by John O'Neill

Canola Field

increased over the last decade, and it is potentially a viable crop for southern Indiana.

Safety and Risks of Producing Your Own Biodiesel

A simple search of the Internet will produce several recipes and do-it-yourself biodiesel kits. While it is true that biodiesel is relatively simple to produce, we recommended that individuals not produce their own biodiesel. This is due to issues of safety, product quality, engine warranty, and potential legal liability.

Below are a few reasons why individuals should not make their own fuel (U.S. Department of Energy, 2006).

1. Methanol is extremely flammable and volatile. Catalysts used in making biodiesel, such as sodium/potassium hydroxides, are very caustic and can cause chemical burns.
2. Engine warranties may not be covered if your fuel does not meet ASTM standards.
3. Biodiesel can only be stored for 6 months or less before there is a risk of contamination.
4. In a northern climate, cold flow properties as well as vehicle manufacture warranties based on blends are issues that must be confronted.
5. Transportation fuels are usually taxed federally if used on public roads. Those using homemade biodiesel in trucks driven on public roads may be in violation of federal tax laws. Those selling homemade biodiesel must be prepared to face the legal issues involved with selling fuel.

Conclusion

This is an exciting time to be a grower and an entrepreneur. It is also a time to become educated on the biofuel industry before you invest. If you have questions related to any phase of biodiesel production, please contact Shawn Conley at <conleysp@purdue.edu>.

References

Knothe, K, Dunn, R. O.; M. O. Bagby. *Biodiesel: the Use of Vegetable Oils and Their Derivatives as Alternative Biodiesel Fuels*. National Center for Agricultural Utilization Research, USDA/ARS. (1997).

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