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BioEnergy

Fueling America Through Renewable Resources

What Is Biodiesel?

Shawn P. Conley, Department of Agronomy
Bernie Tao, Department of Agricultural and Biological Engineering
Purdue University

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Biodiesel Defined

The use of vegetable oil as a fuel source in diesel engines is as old as the diesel engine itself. However, the demand to develop and utilize plant oils and animal fats as biodiesel fuels has been limited until recently. The technical definition of biodiesel is: "The mono alkyl esters of long fatty acids derived from renewable lipid feedstock such as vegetable oils or animal fats, for use in compression ignition (diesel) engines" (National Biodiesel Board, 1996). In simple terms, biodiesel is a renewable fuel manufactured from methanol and vegetable oil, animal fats, and recycled cooking fats (U.S. Department of Energy, 2006).

The term "biodiesel" itself is often misrepresented and misused. Biodiesel only refers to 100% pure fuel (B100) that meets the definition above and specific standards given by the American Society of Testing and Materials (ASTM) International (D 6751) <http://www.biofuels.arc.ab.ca/Biofuels/Specifications/ASTM+D+6751-03a/Default.ksi>. However, it is often used to describe blends of biodiesel with petroleum diesel. Such blends are generally referred to as "B2," "B5," "B20," etc., where the number indicates the percent of biodiesel used.

The most common method to produce biodiesel is through a process called "transesterification," which involves altering the chemical properties of the oil by using methanol (Fangrui and Hanna, 1998). Transesterification of plant oils with methanol is a relatively simple process that yields high conversions with only glycerin as a byproduct.

One hundred pounds of plant oil is reacted with 10 pounds of methanol to yield 10 pounds of glycerin and 100 pounds of biodiesel. While the process is relatively straightforward, due to quality concerns, legal liability, and vehicle warranty restrictions, we strongly recommend that individuals not try to produce biodiesel fuels.

The properties of biodiesel differ depending on the source of plant oil/fat source. This is mainly related to their chemical structure, such as the number of carbons and the number of double bonds in the hydrocarbon chain. For an explanation of these differences, see the Purdue Extension publication "Biodiesel Quality: Is All Biodiesel Created Equal?" (ID-338).

Benefits of Biodiesel

There are several significant advantages and limitations of using biodiesel to replace petroleum-based diesel (U.S. Department of Energy, 2006).

Table 1. *Impact of Oil Content and Grain Yield on B100 (Gallons) Production per Acre*

Soybean Yield (bu per acre)	Percent Oil		
	18	19	20
	Gallons of B100 per acre		
40	59.2	62.5	65.8
45	66.6	70.3	74.0
50	74.0	78.1	82.2
55	81.4	85.9	90.4
60	88.8	93.7	98.6

[1]One gallon of biodiesel weighs 7.3 pounds.

Advantages

1. B100 can be produced from renewable, domestic resources.
2. B100 is energy efficient. (The total fossil fuel energy efficiency of biodiesel is 320% vs. 83% for petroleum diesel.) (National Biodiesel Board, 1998)
3. B100 can be used directly in most diesel engine applications.
4. B100 can reduce global warming and tailpipe emissions (-41%) (Hill, Nelson, Tilman, Polasky, & Tiffany, 2006).
5. B100 is nontoxic and biodegradable.
6. B100 is a good solvent and may clean out fuel line and tank sediments. (Note that this may result in fuel filter clogging during initial use.)

Limitations

1. B100 contains approximately 8% less energy per gallon.
2. B100 generally has a higher cloud and pour point (will freeze at a higher temp) than conventional diesel.
3. B100 is not compatible with some hose and gasket materials, which may cause them to soften, degrade, and rupture.
4. B100 is not compatible with some metals and plastics.
5. B100 may increase nitrogen oxide emissions.

The most common method used to overcome the limitations of B100 is called "blending." Blending biodiesel with diesel to produce B20 (20% biodiesel), B5 (5% biodiesel), and B1 (1% biodiesel) retains many of the advantages of biodiesel while overcoming some of its limitations.

Gallons of Biodiesel per Acre of Soybeans

The gallons of biodiesel an Indiana soybean grower can produce per acre is based on two factors: 1) average yield (bushels per acre) and 2) percent oil content. Because soybean yield and oil content are influenced by both genetic and environmental factors, we may see significant year-to-year variability (Table 1). Fortunately, the relationship between pounds of oil produced per acre and pounds of biodiesel produced per acre is 1:1. This simple relationship allows us to make reasonable estimates as the soybean growing season progresses.

Conclusion

Though the implementation and use of biodiesel in the United States are significant steps forward, it is critical to understand that biodiesel is only a partial solution to our fuel problem. If we converted all U.S. soybean acres to biodiesel, we would only replace 6% of the U.S. demand for diesel (Hill, Nelson, Tilman, Polasky, & Tiffany, 2006). Therefore, we must continue to look towards new sources of fuel to decrease our reliance on petroleum-based fuels.

References

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