



BIODIESEL / RENEWABLE DIESEL Q&A FOR THE END USER

BACKGROUND

What is biodiesel? Biodiesel is a diesel fuel alternative that is made from renewable resources, such as vegetable oils or animal fats. The most common feedstock for biodiesel in the U.S. is soybean oil, although palm oil, canola oil, poultry renderings, beef tallow, and waste grease also may be used to make biodiesel. Biodiesel is made through a chemical process called transesterification, whereby vegetable oil is mixed with methanol in the presence of a catalyst (sodium hydroxide) to produce a diesel fuel alternative. The resulting liquid must then be further processed to remove glycerin and excess methanol. To be designated as biodiesel the alternative fuel must meet the American Society of Testing Materials (ASTM) D6751 quality standards (discussed below), compliance with which assures that biodiesel may be used in low percentage blends without causing problems for the diesel engine. Low percentage blends of high-quality biodiesel may be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is biodegradable, nontoxic, and essentially free of sulfur and aromatics.

What is renewable diesel? Renewable diesel is a diesel fuel alternative that is made from renewable resources, such as vegetable oils or animal fats. Renewable diesel is sometimes referred to as second or third generation biodiesel, depending upon the production process utilized. The primary differences between biodiesel and renewable diesel are the technologies used to make the fuel and the molecules that are ultimately produced. Whereas, biodiesel is made using a chemical reaction called transesterification, renewable diesel is made using a thermal or other chemical reaction. There are currently two processing means for producing renewable diesel: stand alone and co-processing. Co-processed renewable diesel is diesel fuel produced from animal fats and/or vegetable oil by blending with petroleum feedstock and hydrotreating within an existing petroleum refinery. It has been in commercial production in the U.S. and Ireland since 2005, and is sold as diesel fuel. The resulting diesel fuel product is a fully fungible fuel that can be transported via pipeline.

The most significant difference between biodiesel and renewable diesel is that renewable diesel can meet the ASTM D975 quality standard, which is the existing standard for on-road diesel fuel. Renewable diesel has not been subjected to rigorous on-road fleet testing; however, preliminary information indicates that renewable diesel may have advantages over biodiesel for the end-user. These advantages may include a higher energy content and better cold weather performance compared to biodiesel.

What is a biodiesel blend? Both biodiesel and renewable diesel are blend stocks that are typically mixed with diesel fuel to produce a biodiesel/renewable diesel blend. Biodiesel (or neat biodiesel) refers to the pure fuel before blending with diesel fuel. Biodiesel blends are denoted as, "BXX" with "XX" representing the percentage of biodiesel contained in the blend (*i.e.*, B10 is 10% biodiesel, 90% petroleum diesel). ATA supports the voluntary use of biodiesel in blends up to 5%, providing the biodiesel blend meets the ASTM D975 quality standard. ATA has not yet taken a position on the use of renewable diesel; however, fuel that meets the ASTM D975 specification is recommended for use in all on-road diesel engines.

SUPPLY & DISTRIBUTION

How will I know if a service station is selling biodiesel? Unfortunately, there is no federal requirement to label diesel fuel in a manner that informs the end-user that they are using biodiesel. The National Conference of Weights and Measures has issued biodiesel labeling guidelines, but there is no requirement to use these label standards. Several fuel marketers use labels to indicate the dispensing of biodiesel; however, these labels are not uniform and not required at most points of sale. ATA has been pursuing a federal solution to require a three-tiered system of labels for biodiesel blends. ATA believes that biodiesel blends below 5% that meet ASTM D975 should not require separate labels; biodiesel blends between 5% and 20% should require a label to the effect that the fuel being dispensed may contain up to 20% biodiesel; and high percentage blends of biodiesel should be labeled to indicate that the fuel being dispensed contains more than 20% biodiesel. This tiered labeling system is easily implemented and will provide the consumer with the information needed to make an informed fuel choice decision.

Where can I buy biodiesel? In 2006, the U.S. biodiesel industry produced less than 250 million gallons of biodiesel. Estimates of 2007 production are in the neighborhood of 400 million gallons. When compared to the more than 38 billion gallons of diesel fuel used by the trucking industry, the amount of biodiesel in the marketplace is *de minimis*. Some fuel retailers advertise the sale of biodiesel (usually in a B20 blend). The National Biodiesel Board maintains a list of producers, distributors, and retailers where biodiesel may be obtained. To access this list, click on the following link: <http://biodiesel.org/buyingbiodiesel/guide/default.shtm>

Can I splash blend biodiesel myself? Biodiesel is intended to be used as an additive to petroleum-based diesel. Splash blending is the least effective way to blend biodiesel into petroleum diesel. Although splash blending is common for bulk loads, it is not recommended for small quantities such as in an individual truck. Obtaining a uniform mix of the resulting blended product is dependent upon the agitation of the product and it is important to ensure that the two fuels are at comparable temperatures during the blending process. Biodiesel may need to be warmed to promote homogeneity in the final blend. B100 mixes better when it is at least 10°F above the reported cloud point.

Is biodiesel required? There is no federal requirement to use biodiesel in an individual truck; however, the following five states have enacted biodiesel mandates: Louisiana, Minnesota, New Mexico, Oregon, and Washington. Of these five states, only Minnesota's biodiesel mandate is fully implemented. Minnesota requires all diesel fuel sold within the state to contain at least 2% biodiesel by volume. The Energy Independence and Security Act of 2007 expanded the existing Renewable Fuel Standard (RFS) and will require refiners to blend 500 million gallons of renewable diesel or biodiesel into the diesel pool in 2009. This renewable diesel requirement increases to 1 billion gallons in 2012.

What is the maximum amount of diesel fuel that could be replaced by biodiesel or renewable diesel? The trucking industry consumed 38 billion gallons of diesel fuel last year. The entire diesel fuel demand in the United States is close to 50 billion gallons. While the biodiesel industry has built over a billion gallons of production capacity in the United States, due to feedstock constraints, the biodiesel industry was only able to produce 230 million gallons of biodiesel in 2006 and 400 million gallons in 2007. Because soybean oil and other renewable feedstocks may be used for purposes other than fuel, biodiesel producers must compete for soybean oil, which has resulted in a dramatic increase in the price of this feedstock. Putting economics aside for the moment, if every drop of vegetable oil produced in the United States was used to make biodiesel, biodiesel could replace about seven percent of the diesel fuel we consume. This could change as new feedstocks and production processes become available.

Do I need special storage facilities? Biodiesel tends to have a greater affinity for water than petroleum. The presence of water may cause corrosion or promote microbial contamination and filter plugging. Biocides are available to address this concern; however, care should be taken to store biodiesel in a clean, dry, dark environment and tanks should be checked often for the presence of free water. Once water and microbial contamination are addressed, cleaning the tank is recommended to ensure that the “dead” organisms do not continue to cause filter plugging. B100 can be a challenge to handle properly in cold climates. It is important to maintain biodiesel at 10-15 degrees above its cloud point. Biodiesel blends also should be stored above their cloud point to prevent certain components, particularly saturated compounds, from crystallizing out of solution and settling at the bottom of the tank. Biodiesel has a limited shelf life and should not be stored for longer than 6 months.

In general, the standard storage and handling procedures used for petroleum diesel can be used for biodiesel. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene, and teflon. Copper, brass, lead, tin, and zinc should be avoided.

ECONOMICS

Does Biodiesel cost more than conventional diesel fuel? Just like the price of diesel fuel, the price of biodiesel fluctuates depending upon the price of the feedstock used and chemicals used to produce the biodiesel. With the availability of a \$1 per gallon biodiesel blending credit and various other incentives, biodiesel has generally been cost competitive with petroleum based diesel over the past two years. With soybean oil approaching record high prices, today biodiesel is more expensive than petroleum based diesel. Last summer, biodiesel was less expensive than petroleum based diesel in most areas of the country.

Below is a rough estimate of biodiesel costs based upon data obtained in early February 2008:

Soy Oil (7.3 lbs./gal.) @ 55 cents	\$ 4.02
Methanol (12%-20% by volume)	\$.10 - .20
Catalyst	\$.10 - .12
Electricity	\$.01
Natural Gas (boiler - heat)	\$.03 - .05
Labor and Overhead	\$.10 - .15
Maintenance	\$.03 - .05
Insurance & Tax	\$.03 - .05
Depreciation	\$.10 - .15
<u>Total Production Costs</u>	<u>\$ 4.52 - \$ 4.79</u>
Transportation Costs to Rack	05 -10 cents per 100 miles
Federal Excise Tax Credit	(\$1.00)
Wholesale price of on-road diesel	\$ 2.66 / gallon

Are there financial incentives available for biodiesel? Yes. There is a \$1 federal excise tax blending credit that is calculated based on the percent of biodiesel or renewable diesel blended into petroleum diesel fuel. B5 blends receive 5 cents, B20 blends receive 20 cents. This credit is set to expire in 2008, but we expect Congress will act to extend it. In addition, there are numerous state incentives that are available for producers, blenders, and in some instances, retailers that dispense biodiesel and renewable diesel. For example, Illinois waives state fuel tax on blends that exceed B10.

OPERABILITY

Are there advantages to using biodiesel? Biodiesel offers significant environmental benefits, which are discussed in more detail below. Biodiesel also may be used to increase the lubricity of diesel fuel. A B2 blend may be sufficient to restore the lubricity lost in the Ultra Low Sulfur Diesel (ULSD) refining process. Standard lubricating additives may be used with renewable diesel.

How will biodiesel affect fuel economy? Neat biodiesel (B100) has about a 9% lower energy content (BTU content) than petroleum-based diesel. A B5 blend would likely reduce fuel economy by less than one percent and may not be measurable in an individual truck. Use of a B20 blend is expected to reduce fuel economy by two percent when compared to ultra low sulfur diesel. Notwithstanding, across the entire fleet the use of biodiesel will require end-users to purchase more fuel to perform the same amount of work. Renewable diesel proponents have indicated that there is no difference in the BTU value of renewable diesel when compared to petroleum-based diesel; however, we do not have sufficient data to verify this claim.

Will biodiesel work in all climates? Biodiesel offers reduced cold weather performance compared to ultra-low-sulfur diesel. While the cloud point and pour point of diesel fuel varies greatly, generally ULSD will gel at 16°F. B100 derived from soy bean oil will typically gel at 32°F. B20 will raise the cloud point of the base fuel by 3° - 10°F. Low percentage blends (<B5) should perform comparably to petroleum based diesel. Different feedstocks will have different cold weather performance capabilities. Biodiesel derived from canola oil will have better cold-flow properties than biodiesel derived from soy. Biodiesel derived from animal tallow will have poor cold weather performance compared to soy-based biodiesel. Renewable diesel proponents have indicated that renewable diesel may actually improve the cold weather performance of the diesel fuel with which it is blended; however, we do not have sufficient data to verify this claim.

Will biodiesel require any additional vehicle maintenance? Biodiesel blends tend to act like a solvent and will clean out the sediment that naturally accumulates in diesel fuel systems. For this reason, use of biodiesel will require end-users to closely monitor their fuel filters and likely will require a fuel filter change that coincides with the initial introduction of biodiesel. Subsequent fuel filter changes may need to occur ahead of regularly scheduled maintenance until the fuel system is free from accumulated sediment.

Will biodiesel affect my warranty? Most Original Equipment Manufacturers (OEMs) approve the use of biodiesel in blends up to 5% (B5), provided that the biodiesel used conforms to the ASTM D6751 standard and it is blended with diesel fuel that meets ASTM D975 specifications. Renewable diesel that meets the ASTM D975 specifications will have no impact on manufacturers' warranties.

OEMs warrant their equipment against defects in material or workmanship. They do not warrant the fuel that is used in the engines. As such, damage caused by off-spec fuel typically is not covered by an OEM warranty. This is no different from OEM warranty positions with any regular diesel fuel. For this reason, it is important to ensure that the diesel fuel or biodiesel blend being used is a high quality product that meets the applicable ASTM specifications.

Caterpillar supports the use of higher percentage biodiesel blends in certain engines (see Caterpillar's website for more information). Recently, Cummins announced that it would support the use of biodiesel in blends up to B20, provided that the neat biodiesel meets ASTM D6751 and comes from a BQ-9000 certified producer and marketer (see discussion of BQ-9000 below). In addition, the blended fuel must meet the Engine Manufacturers Association B20 specifications; unfortunately, virtually no fuel marketers are testing fuel to certify compliance with this industry specification. Cummins also limits the use of B20 blends to post-2002 equipment that uses its

StrataPore fuel filter and requires a new filter to be installed when switching to biodiesel as well as a 50% reduction in fuel filter change interval for the next two fuel filter changes.

Are certain materials incompatible with biodiesel? Natural rubber, nitrile and butyl rubber are particularly susceptible to degradation when exposed to high percentage biodiesel blends. Also, copper, bronze, brass, tin, lead and zinc can cause deposit formations. The use of these materials and coatings must be avoided for fuel tanks and fuel lines. OEMs recommend that you contact your vehicle manufacturer to determine if any of the OEM-supplied components are at risk with biodiesel in order to prevent engine or vehicle damage.

QUALITY

Are there accepted biodiesel specifications to measure its suitability for use in a truck?

The only accepted biodiesel specification in the U.S. is the ASTM D6751 specifications applicable to neat biodiesel (B100). ASTM is in the process of developing specifications for specific biodiesel blends; however, this process is not yet complete. The incorporation of biodiesel that meets the ASTM D6751 specifications into ULSD in amounts up to 5% should produce a high quality biodiesel blend that is suitable for use in heavy duty diesel engines.

Are there fuel quality issues associated with biodiesel? Quality control is one of the most significant challenges facing biodiesel distribution in the United States. It is relatively easy to make biodiesel; however, it is rather difficult to consistently manufacture high quality biodiesel. Biodiesel producers are a diverse group. Some facilities look like modern petroleum refineries and have deployed quality controls including on-site testing laboratories. Other producers utilize small batch systems where quality may vary significantly from batch-to-batch. In 2006, the National Renewable Energy Laboratory conducted a random survey of biodiesel producers and found that 50% of the samples taken failed to meet the applicable ASTM quality specifications.

How does the buyer know whether biodiesel meets the specification? Short of sending a sample to a fuel testing laboratory, there is no way for the end-user to tell whether biodiesel blends meet the appropriate quality standards. For this reason, it is important to purchase biodiesel only from producers or distributors that are committed to producing on-spec product. Many biodiesel producers are testing each batch of fuel and can furnish a purchaser with a certificate of analysis that demonstrates compliance with the applicable ASTM specifications. To address quality concerns in the biodiesel industry, the National Biodiesel Board instituted a quality assurance program called BQ-9000. Companies that are BQ-9000 certified have demonstrated that they are capable of consistently producing high quality biodiesel and have implemented quality assurance controls. Purchasing biodiesel from a BQ-9000 producer or distributor greatly increases the likelihood that the biodiesel meets applicable quality specifications.

Who is responsible for enforcement of the biodiesel standard? Biodiesel quality enforcement can occur at several different levels (e.g. federal and state). Unfortunately, there hasn't been a concerted push to ensure biodiesel quality through an enforcement program.

Biodiesel has been registered for sale as a motor vehicle fuel with the U.S. Environmental Protection Agency. As such, EPA has the legal authority to ensure that all biodiesel offered for sale complies with the ASTM D6751 specifications. The sale of off-spec biodiesel is a violation of the Clean Air Act and subjects the person to civil penalties not to exceed \$32,500 per violation.

Only biodiesel that meets ASTM D6751 is eligible for the \$1 per gallon federal tax credit. As such, the IRS has the legal authority to pursue individuals claiming the tax credit on biodiesel that does not comply with the ASTM D6751 specifications.

Finally, each state, usually through its department of weights and measures, has the authority to ensure that fuel dispensed meets applicable requirements. Minnesota has done a particularly good job in ensuring that only on-spec biodiesel is offered for sale within the state, however, other states have not devoted the resources necessary to create a robust biodiesel inspection and enforcement program.

If you suspect quality issues, what is your recourse? Damages caused by off-spec biodiesel are difficult to prove for a variety of reasons, including the fact that the damage may not occur immediately upon refueling and the fuel used in an individual truck may be purchased from several different suppliers. If an end-user can identify that a particular problem was caused by a specific biodiesel provider, the end-user may initiate a legal claim against that fuel provider. In addition, EPA, the IRS, and the appropriate state enforcement authority should be notified.

ENVIRONMENTAL ISSUES

What impact does biodiesel have on tailpipe emissions? Biodiesel offers numerous environmental benefits, including reduced particulate matter and hydrocarbon emissions. A life cycle analysis of biodiesel shows that the fuel significantly reduces greenhouse gas emissions. There is an ongoing debate as to the impact biodiesel has on nitrogen oxide emissions, with EPA concluding that biodiesel causes a slight increase in the emissions of this ozone precursor. Pure biodiesel contains no hazardous materials and biodegrades more rapidly than ULSD.

Emission Type	B100	B20	B2
PM	(47%)	(20%)	(2.2%)
NOx	+10%	+2%	+0.2%
CO	(48%)	(12%)	(1.3%)
CO ₂ ¹	(71%)	(14%)	(1.4%)
HC	(67%)	(20%)	(2.2%)

Note, we do not have data concerning the impact that renewable diesel has on tailpipe emissions.

¹ NOTE: Traditional diesel fuel at the point of combustion produces roughly 22.2 lbs/gal of CO₂ and 27.09 lbs/gal of CO₂ if taking into account "lifecycle" emissions. B100 produces roughly 20.54 lbs/gal of CO₂ at the point of combustion and 7.95 lbs/gal of CO₂ if accounting for lifecycle emissions. Both EPA's FLEET Model (used for estimating CO₂ tailpipe emissions) and GREET Model (used for estimating lifecycle CO₂ emissions) are currently under review by the agency to verify their accuracy in measuring CO₂ output.

The information presented herein is derived from a variety of sources. Additional information may be obtained from the following sources:

Advanced Biofuels Coalition contact: mmcadams@hartenergy.com

Archer Daniels Midland Company: www.admworld.com

Cummins, Inc: http://www.everytime.cummins.com/every/customer/faq_biodiesel.jsp

Caterpillar, Inc: www.cat.com

Engine Manufacturers Association: <http://www.enginemanufacturers.org/info/>

National Biodiesel Board: www.biodiesel.org

National Renewable Energy Laboratory: www.nrel.gov/biomass/

Neste Oil: www.nesteoil.com

Volvo: www.volvo.com/trucks/global/en-gb/aboutus/environmental_care/Alternative_Fuels

U.S. Environmental Protection Agency: www.epa.gov/OMS/models/biodsl.htm