

Baystate Roads Program Local Technical Assistance Program (LTAP) Tech Notes



Tech Note #47

BIODIESEL FUEL

Why use biodiesel?

It is a renewable diesel fuel substitute that can be made by combining any natural oil or fat with an alcohol and lye to chemically separate glycerin molecules from the biofuel. Initial interest in producing biodiesel has focused on soybean oil as the primary feedstock mainly because the U.S. is the world's largest producer of this oil. Proponents of biodiesel as a substitute for diesel fuel (neat or in blends) point to its advantages:

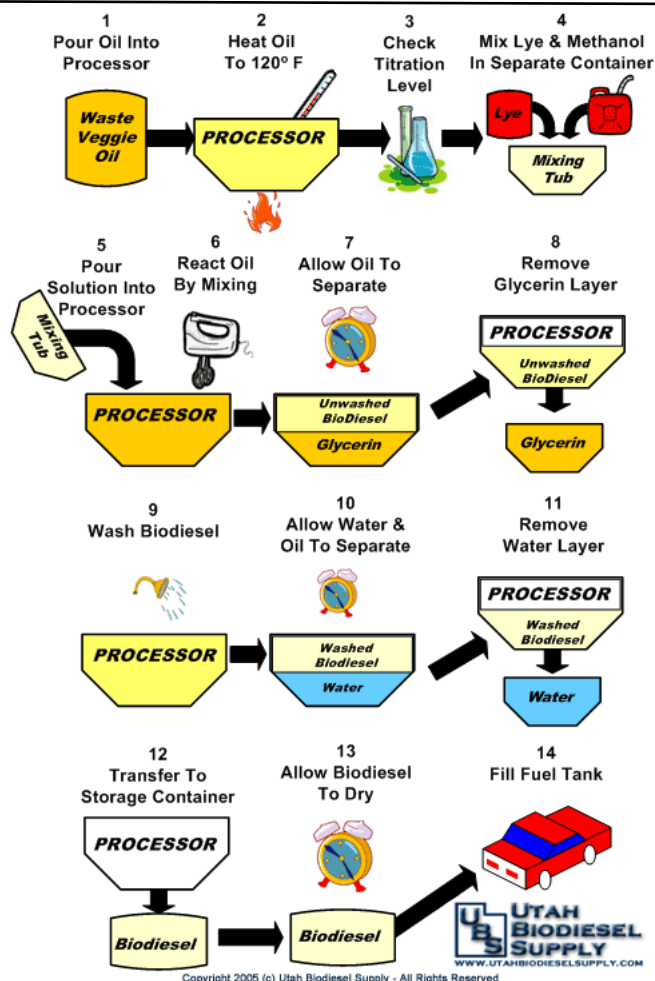
- ✓ **It can reduce our dependence on foreign petroleum.** Our transportation sector, with its great demand for gasoline and diesel fuel, relies almost exclusively on petroleum for energy.
- ✓ **It can leverage limited supplies of fossil fuels.** Regardless of which perspective is chosen, the supply of coal, oil and natural gas is ultimately limited.
- ✓ **It can help reduce greenhouse gas emissions.** Burning of fossil fuels during the past century has dramatically increased levels of carbon dioxide (CO₂) and other "greenhouse gases" that trap heat in our atmosphere.
- ✓ **It can help reduce air pollution and related public health risks** including particulate matter, carbon monoxide, hydrocarbons, sulfur oxides, nitrogen oxides, and air toxins.

What is biodiesel made from?

It can be made from a variety of renewable sources, such as vegetable oils (soybeans or other crops), recycled cooking grease, or animal fats. These feedstocks are used to manufacture a mixture of chemicals called fatty acid methyl esters (biodiesel).

Which feedstock is best?

Typically plant oils are easiest to convert to biodiesel but each feedstock can produce a high quality B100



How to make biodiesel homebrew

fuel. Different properties, especially cloud point, cetane number, and oxidative stability must be addressed during production. Cost might also factor into the selection process. Most operational differences seen with B100 are reduced when B20 is produced. Most remaining differences can be managed with additives or diesel fuel blending strategies.

Does biodiesel affect engine operation?

Biodiesel blends of 20% or less should not change engine performance in a noticeable way. Some users of biodiesel blends notice significant reductions in soot, and CO and HC emissions are reduced. Higher blend levels can reduce fuel economy, torque, and power but will also produce lower PM, HC, and CO emissions. NO_x may also rise with higher blend levels. Less noise and a better exhaust smell have also been noticed with biodiesel fuels.

Does biodiesel void my warranty?

OEMs provide a material and workmanship warranty on their products. Such warranties do not cover damage caused by external conditions, such as fuel. Thus, if an engine using biodiesel experiences a failure unrelated to the biodiesel use, it must be covered by the OEM's warranty. Federal law prohibits the voiding of a warranty just because biodiesel was used--it has to be the cause of the failure. If an engine experiences a failure caused by biodiesel (or any other external condition, such as bad diesel fuel), it will not be covered by the OEM's warranty.

Who is using biodiesel?

The largest user of B20 is the U.S. Department of Defense but many other federal, state, and alternative fuel provider fleets are also using it because it allows them to comply with the EPA regulation. B20 is even sold at retail pumps throughout the country. Producers, distributors and retailers can be found on the website of the National Biodiesel Board at:

www.biodiesel.org/buyingbiodiesel

Agencies across Massachusetts are required to substitute a biofuel for a portion of their petroleum fuel in all diesel vehicles and equipment and in boilers that use #2 heating fuel beginning in FY08. The mandate is the result of ANF Bulletin #13, issued in August 2006 as part of former Governor Romney's Energy Plan.

Equipment that has been successfully used with biodiesel blends includes on-road vehicles; construction, logging, and farming equipment; power generators; boats and barges; heating oil boilers; and even locomotives.

How much does biodiesel cost?

The cost difference between diesel and biodiesel depends on the size of the biodiesel producer, the feedstock cost, transportation costs, production incentives,

tax incentives, and other local variables. According to the Clean Cities Alternative Fuel Price Report for July 2007, a B20 blend in New England costs about 5 cents less per gallon than regular diesel fuel. Recent bids for B5 on Cape Cod have come in at about the same price as regular diesel. Actual costs would depend on global prices and efficiencies gained when increasing production of biofuels comes on line.

How can I tell if the biodiesel is good quality?

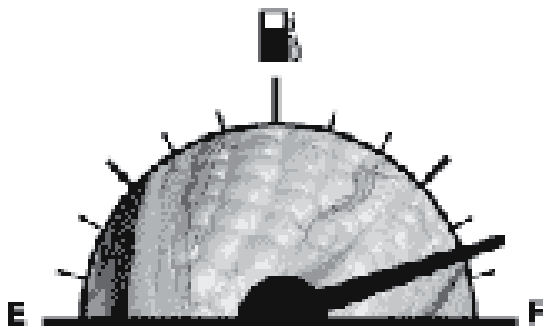
The biodiesel industry has developed a voluntary quality control program for producers and distributors to ensure that biodiesel is produced according to ASTM specifications and contamination or degradation does not occur during distribution, storage, or blending. That program is called the BQ9000. It is managed by an independent organization--the National Biodiesel Accreditation Commission. There are "Accredited Producers" and "Certified Distributors" depending on which activity a firm specializes in. The firm receives the accreditation, not the fuel, but the fuel supplied by either an accredited producer or a certified distributor must meet all applicable standards for sale and use in the U.S. There is no logo for an accredited producer but the certified distributor logo is shown below.



The certified distributor must:

- Purchase its B100 from an accredited producer, *or*
- Conduct fuel quality testing on all biodiesel purchased from non-accredited producers.

Testing each batch of biodiesel is the only way to ensure good quality--just like with conventional fuels. The simple tests that consumers may perform such as looking at clarity by filling a clear glass container and doing a visual inspection, cannot determine the qual-



ity of the fuel. Supervisors should regularly inspect bulk deliveries before accepting a batch to be sure that it doesn't contain water. The distillate Fuel Bar Chart can be used to detect the presence of water or wax in the tank. Large fleets may conduct more extensive tests either in-house or by sending the fuel to independent testing laboratories for more specialized testing of fuel properties. The consumer saves money on testing by purchasing biodiesel fuels through certified marketers.

Are there standards or specifications for biodiesel?

ASTM has a biodiesel blend stock standard (ASTM D6751) that describes the minimum standards for biodiesel properties. The Department of Defense has specifications for B20 blends at:

<http://assist.daps.dla.mil/docimages/0004/29/73/AA59693.PD0>.

Do vehicles have to be modified to use biodiesel?

No vehicle modifications appear to be necessary for blends of biodiesel as high as 20% biodiesel mixed with diesel fuel. Higher blend levels may require minor modifications to seals, gaskets, and other parts. Tank and fuel line/fuel filter heaters (arctic packages) are recommended for blends of more than 20% biodiesel. Detailed long-term engine durability data have not been established for B20 in the U.S. so good maintenance practices are recommended.

Does dispensing equipment need to be modified?

Dispensing equipment does not need to be modified for blends of 20% biodiesel or lower, unless there is an issue with specific elastomers that are not compatible with B20. Occasional fuel filter plugging has been reported and some people filter the biodiesel fuels entering and/or leaving the tank. Some exposed parts of the dispensing systems may need protection from freezing in cold climates. Some people recommend tank cleaning before switching to B20 fuels. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene and teflon. Copper, brass, lead, tin and zinc should be avoided.



How do biodiesel B20 and B100 emissions compare to diesel emissions?

The EPA conducted a comprehensive study of biodiesel emission tests in CI engines as illustrated below.

AVERAGE BIODIESEL EMISSIONS COMPARED TO CONVENTIONAL DIESEL PER EPA

Emission Type	B100	B20
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NO _x	+10%	+2%/-2%
Non-Regulated		
Sulfates	-100%	-20% *
PAH**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50% ***
Ozone potential of speciated HC	-50%	-10%

* Estimated from B100 result

** Polycyclic Aromatic Hydrocarbons - Average reduction across all compounds measured.

*** 2-nitrofluorine results were within test method variability.



Does biodiesel take more energy to make than it gives back?

No. Biodiesel actually has the highest “energy balance” of any transportation fuel. The DOE/USDA lifecycle analysis shows for every unit of fossil energy it takes to make biodiesel, 3.2 units of energy are gained. This takes into account the planting, harvesting, fuel production and fuel transportation to the end user.

Is biodiesel better for human health than petroleum diesel?

Scientific research confirms that biodiesel exhaust has a less harmful impact on human health than petroleum diesel fuel. Pure biodiesel emissions have decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrated PAH compounds that have been identified as potential cancer causing compounds. Also, particulate matter, an emission linked to asthma and other diseases, is reduced by about 47 percent, and carbon monoxide, a poisonous gas, is reduced by about 48 percent.

What are the drawbacks of biodiesel use?

It contains 8% less energy per gallon than typical #2 diesel in the U.S. or 12.5% less energy per pound. This difference is caused by the fact that biodiesel is slightly more dense than diesel fuel.

It has less favorable cold flow properties compared to conventional diesel. Petrodiesel and biodiesel can both start to freeze or gel as the temperature drops which can clog filters or eventually cease to pump from fuel tank to engine.

How are these products transported?

Unlike diesel fuel and other petroleum products which are transported to New England by tanker ships, biofuel is transported in rail cars which typically hold 23,000 gallons. As the demand for biodiesel grows, it is anticipated that improved connections to rail facilities will have to be made. If demand increases dramatically, tanker ship distribution may take place someday. It should be noted that much of this country’s biofuel production is currently transported by ship to Europe.

Can I use biodiesel in cold climates?

B20 blends have been successfully used in very cold climates such as Minnesota and Wyoming where winter temps routinely fall below -30F, as well as in New Hampshire and Boston’s Logan Airport shuttle for over four years with no problems. MA Statewide Contract



(ENE23), however, recommends the use of a B5 blend in winter (November-March) and a B20 blend otherwise for vehicle use to ensure that users are comfortable with the handling and performance of the product.

Adapted from the *2006 Biodiesel Handling and Use Guide--Third Edition* by K.W. Tyson and R.L. McCormick, Project Number NREL/TP-540-40555, available from the National Technical Information Service.

Thanks to Neil Andres, Baystate Roads Advisory Board member, for his assistance with this article.

RESOURCES

Environmental Protection Agency

www.epa.gov/OMS/models/biodsl.htm

Iowa State University

www.me.iastate.edu/biodiesel/Pages/biodiesel1.htm.1

National Biodiesel Accreditation Program

www.bq-9000.org OR 573-635-3893

National Biodiesel Board

www.biodiesel.org OR 800-841-5849

National Renewable Energy Laboratory

www.nrel.gov

U.S. Department of Energy

www.eere.energy.gov/biomass/document_database.html