

## Biodiesel

Biodiesel is a mono-alkyl ester based oxygenated fuel made from vegetable or animals fats. It is commonly produced from oilseed plants such as soybean or canola, or from recycled vegetable oils. Biodiesel has similar properties to petroleum diesel fuel and can be blended with petroleum diesel fuel at any ratio. The most common blend rate is 20 percent biodiesel, 80% petroleum diesel. This mixture is referred to as “B20”. Pure or neat biodiesel is termed B100.

Biodiesel is a domestically produced, renewable motor fuel which is non-toxic and biodegradable. Biodiesel is registered as a fuel and fuel additive with the U.S. Environmental Protection Administration (EPA) and has passed the EPA’s Tier 1 Health Effects Testing under the Clean Air Act section 211(b). Neat biodiesel, B100, has also been classified as an alternative fuel by the U.S Department of Energy, and meets California Air Resources Board (CARB) clean diesel standards. The American Society of Testing and Materials, the U.S fuel standard-setting body, recently issued a new specification for biodiesel fuel. Specification D 6751 applies to all biodiesel bought and sold in the U.S. (1)

### Emissions

There is a growing body of emission data for biodiesel. Compared to conventional diesel, the use of B100 significantly reduces PM, CO, and HC but increases NOx.(1,2,3) In comparing B20 to conventional diesel fuel, the changes in emissions are directionally the same, but smaller. CARB reports that B100 and B20 reduce PM emissions by 30% and 22%, respectively when compared to conventional diesel fuel (CARB iv). The National Biodiesel Board indicates similar emissions benefits, and report PM reductions of 40% for B100 and 8% for B20 . (NBB) In their 2002 draft report on biodiesel emissions, EPA reported an average PM reduction of 10.1% for soybean based B20 fuel, and a 2% increase in NOx emissions. (3) EPA also reported that emissions varied with the type of biodiesel used (soybean, rapeseed, animal fats), and that emissions benefits appeared consistent across engine model years.

In a recently completed study on life-cycle emissions from biodiesel and petroleum diesel, the U.S. Department of Energy (DOE) concluded that tailpipe PM10 emissions are 68% lower for biodiesel, while biodiesel life-cycle particulate emission are 32% lower than conventional diesel fuel. (4) A summary of biodiesel emissions is presented in table X. Actual emission reductions will vary with application.

### Biodiesel Emissions Compared to Diesel Fuel

Pollutants	CARB		NBB	
	B100(%)	B20(%)	B100(%)	B20(%)
PM	-30	-22	-40	-8
NOx	+13	+2	+6	+1
PAH	-80	-13	-80	-13

Source: California Air Resources Board; National Biodiesel Board

Blending biodiesel with conventional diesel can be used to reduce the sulfur content of petroleum diesel fuels. Because biodiesel contains 0 to 1 ppmw of sulfur, exhaust emissions of sulfur oxides and sulphates are eliminated. (1) Further, the absence of fuel sulfur suggests that after-treatment technologies such as diesel oxidation catalysts and particulate traps would perform well with biodiesel. In fact, a study conducted by Southwest Research Institute showed that catalyst conversion efficiency of total particulates improved with increased biodiesel content.(5) PM reductions for B20 versus conventional diesel went from 5%-15% percent, to 10%-22% when an oxidation catalyst was used. Similarly, PM reductions for B100 as compared to conventional diesel fuel averaged 30%-50%, while PM reductions increased to 50%-60% with the addition of a catalyst.

Biodiesel can also be blended with ultralow sulfur diesel. The Washington Metropolitan Area Transit Authority recently investigated bus emissions resulting from the use of conventional diesel fuel, ultralow diesel fuel (ULSD) and a blend of 20 percent biodiesel and 80 percent ULSD (BD20). (6) During the ULSD and BD20 tests the transit bus was equipped with a catalyzed particulate trap. The BD20 fuel showed virtually similar PM reduction efficiencies as the ULSD fuel and reduced PM emissions by greater than 98% as compared to the baseline diesel fuel. While showing a slight increase in NOx emissions, the BD20 blend also reduced both CO and HC emissions by 90% over the ULSD fuel.

#### **Cost:**

The cost of biodiesel depends primarily on the market price for vegetable oils or other feedstock. At a feedstock price of \$0.10 per/pound, a production cost of about \$1 per gallon is projected for a 10 million gallon per year (MGY) facility. If the price of feedstock increases to \$0.20 per pound, plant production costs increase to as much as \$2 per gallon for a 10 MGY plant. (7) Transportation costs will also impact the sale price for biodiesel. Currently biodiesel sold into Washington markets is shipped from the mid-west or east coast. A local biodiesel distributor estimates that transportation or freight charges add about \$0.20 per gallon to the price of B100 sold in Washington. (8)

Nationally, B20 costs about \$0.15 to \$0.30 above the cost of diesel.(9) B100 costs about \$0.50 to \$1.00 more than conventional diesel fuel. Price will vary locally due to production, transportation and distribution costs, and on the volume of fuel purchased. The City of Seattle recently received a price quote from World Energy for B20 fuel. (10) The price for B20 ranged from \$0.259 per gallon over diesel for 500-2500 gallon lots, to a price premium of \$0.199 per gallon for 5,001 gallons or more. Currently, City of Tacoma is getting B20 delivered by mobile refueling for \$1.20 per gallon.(11) About 13 cents per gallon of this price is a delivery charge. Lilyblad Petroleum, located in Tacoma, Washington, recently quoted an ex-tax bulk purchase price of \$1.60 per gallon B100 fuel. (12).

Biodiesel prices are expected to increase if the current US Department of Agriculture Commodity Credit Corporation (CCC) US Bioenergy Program is stopped. The program provides reimbursements for bioenergy producers for converting targeted commodities into bioenergy. These direct payments to producers were passed on to consumers and reduced the price of biodiesel by over \$1.00 per gallon. This price cut has been the single biggest contributor to making biodiesel market acceptance possible.

Although biodiesel demands a price premium, it does not require engine modifications, nor does it require any infrastructure changes. To offset biodiesel's higher price, many states have reduced the state fuel tax paid for biodiesel. National energy policy and agricultural legislation is considering similar federal tax incentives for biodiesel blends.

### **Other issues:**

Biodiesel fuel offers additional advantages over petroleum diesel. Biodiesel is biodegradable, non-toxic, and has a higher flash-point than petroleum diesel fuel. Biodiesel is also a renewable, domestically produced fuel that can provide local economic benefits. According to an energy lifecycle study completed by the US Department of Energy, biodiesel yields 3.2 units of fuel energy for every unit of fossil fuel consumed.(4) By comparison, petroleum diesel yields 0.83 units of fuel energy per unit of fossil energy consumed. Because biodiesel is derived from vegetable oils, carbon is also recycled. As a result, biodiesel can reduce CO<sub>2</sub> emissions by as much as 78% over petroleum diesel.(4)

Availability and use – Currently more than 12 companies actively produce and market biodiesel fuel. The dedicated production capacity in the U.S. is estimated at around 80 million gallons per year. (1) However, new plants are being proposed throughout the country, including Washington State, with a typical facility taking approximately one year to come on-line. Additional production capacity may be available within the oleo-chemical industry, where it is estimated that as much as 200 million gallons of capacity may be available for biodiesel production.

Biodiesel is commercially available in Washington State. Currently, Lilyblad Petroleum, Tacoma, WA, Albina Fuels, Vancouver, WA, and Soundoil.com, Oak Harbor, WA have biodiesel available for delivery or pick-up. The only retail outlet for biodiesel is Dr.Dan's Alternative Fuel Works, in Seattle. Arrangements can also be made for bulk purchase deliveries from national suppliers including World Energy, Chelsea, Massachusetts, and U.S. Pacific Northwest Biodiesel, located in Aloha, Oregon. A list of biodiesel suppliers is available at the National Biodiesel Board website at [www.nbb.org](http://www.nbb.org).

Handling- Handling of biodiesel is similar to petroleum diesel fuels, with some notable differences. Because of its inherent solvent properties, there may be some material compatibility issues when handling neat biodiesel. Rubber seals and hoses should be replaced as they will degrade after prolonged exposure to biodiesel. Fuel filters should also be checked when first using biodiesel as they may become plugged with accumulated

sediments. Also, spills need to be cleaned up quickly, as biodiesel is an effective paint remover.

Biodiesel should not be stored for more than one year to avoid fuel quality problems. In addition, operators should be aware of biodiesel's cold flow properties and take any necessary precautions, including adding pour point depressants in colder climates. Finally, to ensure fuel quality, biodiesel should meet ASTM specification D6751. It is important that biodiesel meets this specification and that the fuel provider guarantees fuel quality in case of engine related problems. A guidebook entitled "Biodiesel and Handling and Use Guidelines" is available from the U.S. Department of Energy at [http://www.afdc.doe.gov/altfuel/bio\\_papers.html](http://www.afdc.doe.gov/altfuel/bio_papers.html).

Fuel Economy- Because of its lower BTU content, engine fuel economy and power are about 10 percent lower when running on neat biodiesel, and about 2% for a B20 blend. Biodiesel also has excellent lubricity characteristics, and can be added to petroleum diesel fuel in quantities as low as 1 to 2 percent to provide significant lubricity improvements meeting or exceeding OEM specifications.

Warranty- Although engine manufacturers warranty their engines and not the fuel, most major engine companies have stated formally that the use of biodiesel blends up to 20 percent will not void their parts and workmanship warranties. Some engine companies have already specified that the biodiesel must meet ASTM D-6751 as a condition, while others are still in the process of adopting D-6751 within their company. (NBB) The National Biodiesel Board maintains a list of engine manufacturer comments on biodiesel use in their engines at [www.nbb.org](http://www.nbb.org).

## References

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