



## COMMONLY ASKED QUESTIONS

### **What is biodiesel?**

Biodiesel is the name of a clean burning alternative fuel produced from domestic, renewable resources. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with no major modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

**Technical Definition:** *Biodiesel, n*—a fuel composed of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM (American Society for Testing & Materials) D 6751.

### **Is biodiesel used as a pure fuel or is it blended with petroleum diesel?**

Biodiesel can be used as a pure fuel or blended with petroleum in any percentage. B20 (a blend of 20 percent by volume biodiesel with 80 percent by volume petroleum diesel) has demonstrated significant environmental benefits with a minimum increase in cost for fleet operations and other consumers.

### **Is it approved for use in the US?**

Biodiesel is registered as a fuel and fuel additive with the Environmental Protection Agency (EPA) and meets clean diesel standards established by the California Air Resources Board (CARB). Neat (100 percent) biodiesel has been designated as an alternative fuel by the Department of Energy (DOE) and the US Department of Transportation (DOT).

### **How do biodiesel emissions compare to petroleum diesel?**

Biodiesel is the only alternative fuel to have fully completed the health effects testing requirements of the Clean Air Act. The use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide, and particulate matter compared to emissions from diesel fuel. In addition, the exhaust emissions of sulfur oxides and sulfates (major components of acid rain) from biodiesel are essentially eliminated compared to diesel.

Of the major exhaust pollutants, both unburned hydrocarbons and nitrogen oxides are ozone or smog forming precursors. The use of biodiesel results in a substantial reduction of unburned hydrocarbons. Emissions of nitrogen oxides are either slightly reduced or slightly increased depending on the duty cycle of the engine and testing methods used. Based on engine testing, using the most stringent emissions testing protocols required by EPA for certification of fuels or fuel additives in the US, the overall ozone forming potential of the speciated hydrocarbon emissions from biodiesel was nearly 50 percent less than that measured for diesel fuel.

### **Can biodiesel help mitigate "global warming"?**

A 1998 biodiesel lifecycle study, jointly sponsored by the US Department of Energy and the US Department of Agriculture, concluded biodiesel reduces net carbon dioxide

emissions by 78 percent compared to petroleum diesel. This is due to biodiesel's closed carbon cycle. The CO<sub>2</sub> released into the atmosphere when biodiesel is burned is recycled by growing plants, which are later processed into fuel.

#### **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. Biodiesel emissions have decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrated PAH compounds that have been identified as potential cancer causing compounds. Test results indicate PAH compounds were reduced by 75 to 85 percent, with the exception of benzo(a)anthracene, which was reduced by roughly 50 percent. Targeted nPAH compounds were also reduced dramatically with biodiesel fuel, with 2-nitrofluorene and 1-nitropyrene reduced by 90 percent, and the rest of the nPAH compounds reduced to only trace levels.

#### **Does biodiesel cost more than other alternative fuels?**

When reviewing the high costs associated with other alternative fuel systems, many fleet managers have determined biodiesel is their least-cost-strategy to comply with state and federal regulations. Use of biodiesel does not require major engine modifications. That means operators keep their fleets, their spare parts inventories, their refueling stations and their skilled mechanics. The only thing that changes is air quality.

#### **Do I need special storage facilities?**

In general, the standard storage and handling procedures used for petroleum diesel can be used for biodiesel. The fuel should be stored in a clean, dry, dark environment. Acceptable storage tank materials include aluminum, steel, fluorinated polyethylene, fluorinated polypropylene and teflon. Copper, brass, lead, tin, and zinc should be avoided.

#### **Can I use biodiesel in my existing diesel engine?**

Biodiesel works in any diesel engine with few or no modifications to the engine or the fuel system. Biodiesel has a solvent effect that may release deposits accumulated on tank walls and pipes from previous diesel fuel storage. The release of deposits may clog filters initially and precautions should be taken. Ensure that only fuel meeting the biodiesel specification (D 6751) is used.

#### **Where can I purchase biodiesel?**

Biodiesel is available anywhere in the US. The National Biodiesel Board (NBB) maintains a list of registered fuel suppliers. A current list is available on the biodiesel web site at [www.biodiesel.org](http://www.biodiesel.org) or by calling NBB at (800) 841-5849.

#### **Who can answer my questions about biodiesel?**

NBB maintains the largest library of biodiesel information in the US. Information can be requested by visiting the biodiesel web site at [www.biodiesel.org](http://www.biodiesel.org), by emailing the NBB at [info@biodiesel.org](mailto:info@biodiesel.org), or by calling NBB's toll free number (800) 841-5849.

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## **BENEFITS OF BIODIESEL**

### **Environmental Benefits**

In 2000, biodiesel became the only alternative fuel in the country to have successfully completed the EPA-required Tier I and Tier II health effects testing under the Clean Air Act. These independent tests conclusively demonstrated biodiesel's significant reduction of virtually all regulated emissions, and showed biodiesel does not pose a threat to human health.

Biodiesel contains no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. A U.S. Department of Energy study showed that the production and use of biodiesel, compared to petroleum diesel, resulted in a 78.5% reduction in carbon dioxide emissions. Moreover, biodiesel has a positive energy balance. For every unit of energy needed to produce a gallon of biodiesel, 3.24 units of energy are gained.

### **Energy Security Benefits**

With agricultural commodity prices approaching record lows, and petroleum prices approaching record highs, it is clear that more can be done to utilize domestic surpluses of vegetable oils while enhancing our energy security. Because biodiesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for *immediately* addressing our energy security issues.

If the true cost of using foreign oil were imposed on the price of imported fuel, renewable fuels, such as biodiesel, probably would be the most viable option. For instance, in 1996, it was estimated that the military costs of securing foreign oil was \$57 billion annually. Foreign tax credits accounted for another estimated \$4 billion annually and environmental costs were estimated at \$45 per barrel. For every billion dollars spent on foreign oil, America lost 10,000 – 25,000 jobs.

### **Economic Benefits**

Increased utilization of renewable biofuels results in significant microeconomic benefits to both the urban and rural sectors, and the balance of trade. A study completed in 2001 by the U.S. Department of Agriculture found that an average annual increase of the equivalent of 200 million gallons of soy-based biodiesel demand would boost total crop cash receipts by \$5.2 billion cumulatively by 2010, resulting in an average net farm income increase of \$300 million per year. The price for a bushel of soybeans would increase by an average of 17 cents annually during the ten-year period.

In addition to being a domestically produced, renewable alternative fuel for diesel engines, biodiesel has positive performance attributes such as increased cetane, high fuel lubricity, and high oxygen content, which may make it a preferred blending stock with future ultra-clean diesel.

### **Quality Benefits**

Biodiesel is registered as a fuel and fuel additive with the EPA and meets clean diesel standards established by the California Air Resources Board (CARB). B100 (100 percent biodiesel) has been designated as an alternative fuel by the U.S. Department of Energy and the U.S. Department of Transportation. Moreover, in December 2001, the American Society of Testing and Materials (ASTM) approved a specification (D6751) for biodiesel fuel. This development was crucial in standardizing fuel quality for biodiesel in the U.S. market.

The National Biodiesel Board, the trade association for the biodiesel industry, has formed the National Biodiesel Accreditation Commission (NBAC) to audit fuel producers and marketers in order to enforce fuel quality standards in the US. NBAC issues a 'Certified Biodiesel Marketer' seal of approval for biodiesel marketers that have met all requirements of fuel accreditation audits. This seal of approval will provide added assurance to customers, as well as engine manufacturers, that the biodiesel marketed by these companies meets the ASTM standards for biodiesel and that the fuel supplier will stand behind its products.

### **EPAct Benefits**

Effective November 1998, Congress approved the use of biodiesel as an Energy Policy Act (EPAct) compliance strategy. The legislation allows EPAct-covered fleets (federal, state and public utility fleets) to meet their alternative fuel vehicle purchase requirements simply by buying 450 gallons of pure biodiesel and burning it in new or existing diesel vehicles in at least a 20% blend with diesel fuel. The Congressional Budget Office and the U.S. Department of Agriculture have confirmed that the biodiesel option is the least-cost alternative fuel option for meeting the Federal government's EPAct compliance requirements. Because it works with existing diesel engines, biodiesel offers an immediate and seamless way to transition existing diesel vehicles into a cleaner burning fleet.



## BIODIESEL PERFORMANCE

**Successful alternative fuels fulfill environmental and energy security needs without sacrificing operating performance. Operationally, biodiesel performs very similar to low sulfur diesel in terms of power, torque, and fuel without major modification of engines or infrastructure.**

**Biodiesel offers similar power to diesel fuel.** One of the major advantages of biodiesel is the fact that it can be used in existing engines and fuel injection equipment with little impact to operating performance. Biodiesel has a higher cetane number than U.S. diesel fuel. In over 15 million miles of in-field demonstrations biodiesel showed similar fuel consumption, horsepower, torque, and haulage rates as conventional diesel fuel.

**Biodiesel provides significant lubricity improvement over petroleum diesel fuel.** Lubricity results of biodiesel and petroleum diesel using industry test methods indicate that there is a marked improvement in lubricity when biodiesel is added to conventional diesel fuel. Even biodiesel levels below 1 percent can provide up to a 65 percent increase in lubricity in distillate fuels.

**Compatibility of biodiesel with engine components.** The recent switch to low sulfur diesel fuel has caused most OEMs to switch to components suitable for use with biodiesel, but users should contact their OEM for specific information. In general, biodiesel will soften and degrade certain types of elastomers and natural rubber compounds over time. Using high percent blends can impact fuel system components (primarily fuel hoses and fuel pump seals), that contain elastomer compounds incompatible with biodiesel. Manufacturers recommend that natural or butyl rubbers not be allowed to come in contact with pure biodiesel. Biodiesel will lead to degradation of these materials over time, although the effect is lessened with biodiesel blends. If a fuel system does contain these materials and users wish to fuel with pure biodiesel, replacement with compatible elastomers is recommended.

**Biodiesel in cold weather.** Cold weather can cloud and even gel any diesel fuel, including biodiesel. Users of a 20 percent biodiesel blend will experience an increase of the cold flow properties (cold filter plugging point, cloud point, pour point) of approximately 3 to 5° Fahrenheit. Precautions employed for petroleum diesel are needed for fueling with 20 percent blends. Neat (100 percent) biodiesel will gel faster than petrodiesel in cold weather operations. Solutions for winter operability with neat biodiesel are much the same as that for low-sulfur #2 diesel (i.e., blending with #1 diesel, utilization of fuel heaters, and storage of the vehicle in or near a building). These same solutions work well with biodiesel blends, as do the use of cold flow improvement additives.

## BIODIESEL PRODUCTION

The production of biodiesel, or alkyl esters, is well known. There are three basic routes to ester production from oils and fats:

- \* Base catalyzed transesterification of the oil with alcohol.
- \* Direct acid catalyzed esterification of the oil with methanol.
- \* Conversion of the oil to fatty acids, and then to Alkyl esters with acid catalysis.

Process Input Levels = Process Output Levels

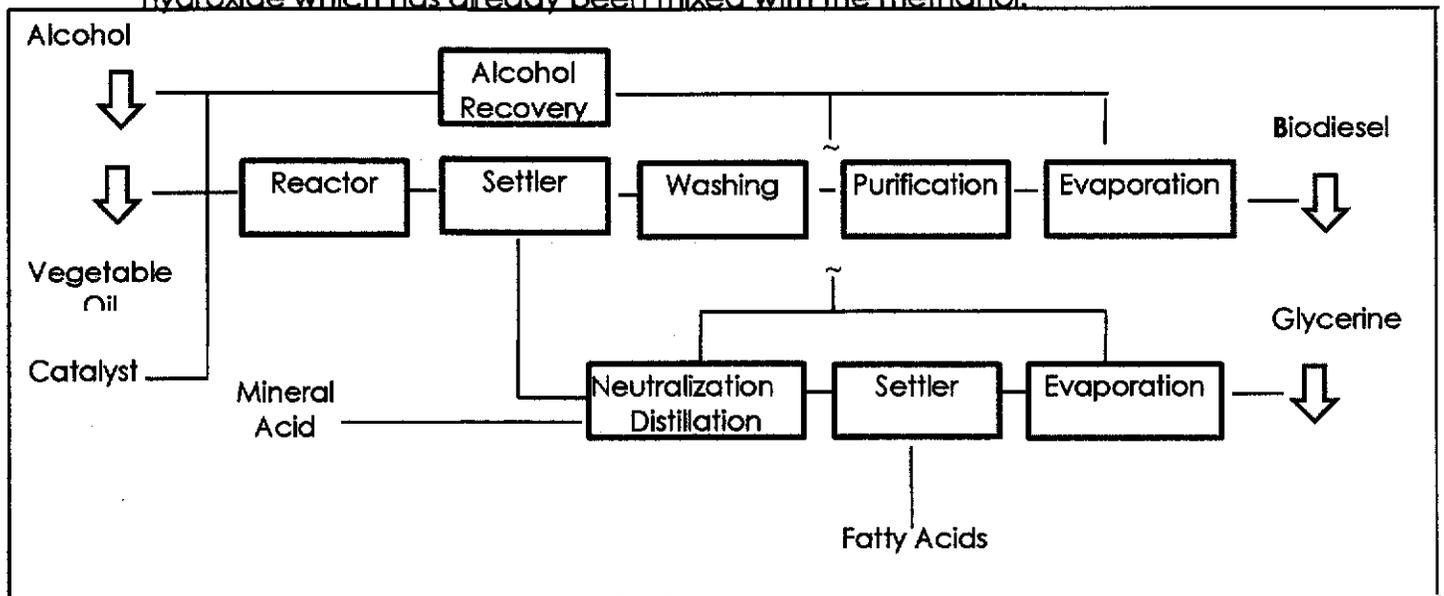


Nothing is wasted

The majority of the alkyl esters produced today are done with the base catalyzed reaction because it is the most economic for several reasons:

- \* Low temperature (150 F) and pressure (20 psi) processing.
- \* High conversion (98%) with minimal side reactions and reaction time.
- \* Direct conversion to methyl ester with no intermediate steps.
- \* Exotic materials of construction are not necessary.

The general process is depicted below. A fat or oil is reacted with an alcohol, like methanol, in the presence of a catalyst to produce glycerine and methyl esters or biodiesel. The methanol is charged in excess to assist in quick conversion and recovered for reuse. The catalyst is usually sodium or potassium hydroxide which has already been mixed with the methanol.





## Biodiesel Myths and Facts

**Myth:** Biodiesel is an experimental fuel and has not been thoroughly tested.

**Fact:** Biodiesel is one of the most thoroughly tested alternative fuels on the market. A number of independent studies have been completed with the results showing biodiesel performs similar to petroleum diesel while benefiting the environment and human health compared to diesel. That research includes studies performed by the U.S. Department of Energy, the U.S. Department of Agriculture, Stanadyne Automotive Corp. (the largest diesel fuel injection equipment manufacturer in the U.S.), Lovelace Respiratory Research Institute, and Southwest Research Institute. Biodiesel is the first and only alternative fuel to have completed the rigorous Health Effects testing requirements of the Clean Air Act. Biodiesel has been proven to perform similarly to diesel in more 50 million successful road miles in virtually all types of diesel engines, countless off-road miles and countless marine hours. Currently more than 300 major fleets use the fuel.

**Myth:** Biodiesel does not perform as well as diesel.

**Fact:** One of the major advantages of biodiesel is the fact that it can be used in existing engines and fuel injection equipment with little impact to operating performance. Biodiesel has a higher cetane number than U.S. diesel fuel. In more than 50 million miles of in-field demonstrations, B20 showed similar fuel consumption, horsepower, torque, and haulage rates as conventional diesel fuel. Biodiesel also has superior lubricity and it has the highest BTU content of any alternative fuel (falling in the range between #1 and #2 diesel fuel).

**Myth:** Biodiesel doesn't perform well in cold weather.

**Fact:** Biodiesel will gel in very cold temperatures, just as the common #2 diesel does. Although pure biodiesel has a higher cloud point than #2 diesel fuel, typical blends of 20% biodiesel are managed with the same fuel management techniques as #2 diesel. Blends of 5% biodiesel and less have virtually no impact on cold flow.

**Myth:** Biodiesel causes filters to plug.

**Fact:** Biodiesel can be operated in any diesel engine with little or no modification to the engine or the fuel system. Pure biodiesel (B100) has a solvent effect, which may release deposits accumulated on tank walls and pipes from previous diesel fuel use. With high blends of biodiesel, the release of deposits may clog filters initially and precautions should be taken to replace fuel filters until the petroleum build-up is eliminated. This issue is less prevalent with B20 blends, and there is no evidence that lower-blend levels such as B2 have caused filters to plug.

**Myth:** A low-blend of biodiesel in diesel fuel will cost too much.

**Fact:** Using a 2% blend of biodiesel is estimated to increase the cost of diesel by 2 or 3 cents per gallon, including the fuel, transportation, storage and blending costs. Any increase in cost will be accompanied by an increase in diesel quality since low-blend levels of biodiesel greatly enhance the lubricity of diesel fuel.

**Myth:** Biodiesel causes degradation of engine gaskets and seals.



## Biodiesel Myths and Facts

**Fact:** The recent switch to low-sulfur diesel fuel has caused most Original Equipment Manufacturers (OEMs) to switch to components that are also suitable for use with biodiesel. In general, biodiesel used in pure form can soften and degrade certain types of elastomers and natural rubber compounds over time. Using high percent blends can impact fuel system components (primarily fuel hoses and fuel pump seals) that contain elastomer compounds incompatible with biodiesel, although the effect is lessened as the biodiesel blend level is decreased. Experience with B20 has found that no changes to gaskets or hoses are necessary.

**Myth:** No objective biodiesel fuel formulation standard exists.

**Fact:** The biodiesel industry has been active in setting standards for biodiesel since 1994 when the first biodiesel taskforce was formed within the American Society for Testing and Materials (ASTM). ASTM approved a provisional standard for biodiesel (ASTM PS 121) in July of 1999. The final specification (D-6751) was issued in December 2001. Copies of specifications are available from ASTM at <http://www.astm.org>.

**Myth:** Biodiesel does not have sufficient shelf life.

**Fact:** Most fuel today is used up long before six months, and many petroleum companies do not recommend storing petroleum diesel for more than six months. The current industry recommendation is that biodiesel be used within six months, or reanalyzed after six months to ensure the fuel meets ASTM specifications (D-6751). A longer shelf life is possible depending on the fuel composition and the use of storage-enhancing additives.

**Myth:** Engine warranty coverage would be at risk.

**Fact:** The use of biodiesel in existing diesel engines does not void parts and materials workmanship warranties of any major US engine manufacturer.

**Myth:** The U.S. lacks the infrastructure to prevent shortages of the product.

**Fact:** There are presently more than 14 companies that have invested millions of dollars into the development of the biodiesel manufacturing plants actively marketing biodiesel. Based on existing dedicated biodiesel processing capacity and long-term production agreements, more than 200 million gallons of biodiesel capacity currently exists. Many facilities are capable of doubling their production capacity within 18 months.

**Myth:** There is no government program to support development of a biodiesel industry.

**Fact:** The U.S. Department of Agriculture announced in January 2001 the implementation of the first program providing cost incentives for the production of 36 million gallons of biodiesel. Bills supporting the use of biodiesel and ethanol were also introduced to the U.S. Congress in 2003, including one that would set a renewable standard for fuel in the U.S. and one that would give biodiesel a partial fuel excise tax exemption. More than a dozen states have passed favorable biodiesel legislation.