

## Biodiesel

**B**iodiesel is a renewable fuel produced from agricultural resources such as vegetable oils. In the United States, most biodiesel is made from soybean oil; however canola oil, sunflower oil, recycled cooking oils, and animal fats are also used.

### How It's Made

To make biodiesel, the base oil is put through a process called “esterification.” This refining method uses an industrial alcohol (ethanol or methanol) and a catalyst (substance that enables a chemical reaction) to convert the oil into a fatty-acid methyl-ester fuel (biodiesel).

Biodiesel in its pure form is known as “neat biodiesel” or B100, but it can also be blended with conventional diesel, most commonly as B5 (5 percent biodiesel and 95 percent diesel) and B20 (20 percent biodiesel and 80 percent diesel). Biodiesel is registered with the U.S. Environmental Protection Agency (EPA) and is legal for use at any blend level in both highway and nonroad diesel vehicles.

Most diesel engines can run on biodiesel without needing any special equipment. If you are interested in using biodiesel in your vehicle or equipment, check with the manufacturer for any recommendations and information regarding engine warranties. In addition, once you have determined the proper blend for your vehicle, make sure to purchase your fuel from a reputable dealer selling commercial grade biodiesel.

### Biodiesel -vs- Vegetable Oil

In 1895, Dr. Rudolf Diesel invented the diesel engine with the intention of running it on a variety of fuels, including vegetable oil. In fact, when he demonstrated his engine at the World Exhibition in Paris in 1900, he fueled the vehicle with peanut oil. However, biodiesel and vegetable oil are very different. Raw vegetable oil or recycled greases (also called waste cooking oil) that have not

been processed into esters are not biodiesel, and are not registered by EPA for legal use in vehicles. In addition, vehicles converted to use these oils would likely need to be certified by the EPA; to date EPA has not certified any conversions. These conversions may also violate the terms of the vehicle warranty. For more information on the certification process, please visit EPA's Web site at: [www.epa.gov/otaq/cert/dearmfr/cisd0602.pdf](http://www.epa.gov/otaq/cert/dearmfr/cisd0602.pdf) .

EPA has published guidance that explains and clarifies EPA's regulatory requirements for biodiesel producers and biodiesel blenders/users. This document is available at: [www.epa.gov/otaq/renewablefuels/420b07019.pdf](http://www.epa.gov/otaq/renewablefuels/420b07019.pdf)

## **Performance**

Vehicles have similar horsepower and torque as conventional diesel when running on biodiesel. Chemically speaking, biodiesel has a higher cetane number, but slightly lower energy content than diesel. To the average driver, this means better engine performance and lubrication, but a small decrease in fuel economy (2-8 percent). Biodiesel vehicles can also have problems starting at very cold temperatures, but this is more of an issue for higher percentage blends such as B100 and easily solved the same way as with conventionally fueled vehicles -by using engine block or fuel filter heaters or storing the vehicles in a building.

## **Availability**

In 2004, 25 million gallons of B100 were sold. By 2005, that number had tripled. Today, approximately 600 fleets nationwide use biodiesel blends in their diesel engines, and biodiesel is available in its various blends at approximately 800 locations across the United States. A complete list of stations is available at [www.biodiesel.org](http://www.biodiesel.org).

## **Affordability**

The price of biodiesel blends varies depending on geographic area, base material (corn, soybeans, etc.), and supplier. Although biodiesel can cost more than petrodiesel, diesel drivers can transition to biodiesel without purchasing new vehicles. In the case of fleets, managers can transition to biodiesel without acquiring new spare parts inventories or rebuilding refueling stations.

## **Maintenance**

Generally, the use of biodiesel does not cause many maintenance issues. However, when used for the first time, biodiesel can release deposits accumulated on tank walls and pipes from previous diesel fuel, initially causing fuel filter clogs. As a result, vehicle owners should change the fuel filter after their first tank of biodiesel. Also, biodiesel can degrade rubber fuel system components, such as hoses and pump seals. This is especially true with higher-percentage blends, and older vehicles. Many newer vehicles have biodiesel-compatible components, but it is best to consult your owner's manual or contact your vehicle manufacturers for specific information.

## Benefits

Biodiesel has a number of important benefits. As an alternative to diesel, it can help reduce U.S. dependence on foreign oil. Biodiesel also provides significant greenhouse gas (GHG) emission reductions. B100 reduces lifecycle greenhouse gas emissions by more than 50 percent, while B20 reduces GHG emissions by at least 10 percent.

In addition, biodiesel offers several criteria emissions benefits for the existing vehicle fleet. It reduces emissions of carbon monoxide, particulate matter (PM), and sulfates, as well as hydrocarbon and air toxics emissions.

A 2002 EPA summary analysis of existing data suggests vehicles using biodiesel may emit slightly more nitrogen oxide (NO<sub>x</sub>) (about 2% for B20 and 10 percent for B100). Subsequent studies have yielded mixed results, with some showing small increases and others showing small decreases. EPA plans a further investigation to fully assess this issue, including the emissions impact of using biodiesel in vehicles equipped with PM traps and NO<sub>x</sub> aftertreatment designed to meet strict new emission standards.



## Pacific Southwest, Region 9

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## Benefits and Concerns

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## Benefits

### Environment

#### Air Quality

Reduces emissions of harmful air pollutants such as asthma-causing fine particles, greenhouse gases, and acid rain forming sulfur dioxides.

Reduces carbon dioxide emissions.

#### Waste Minimization

When waste cooking oil is used in the production of biodiesel, a waste is diverted from municipal solid waste landfills and sewer systems.

The energy from waste cooking oil is recovered and converted into a product - a domestic, renewable, alternative fuel.

#### Water Quality

Local water quality is significantly improved. Therefore, fewer sewer spills contaminating streams, lakes, and bays happen because less fat, oil and grease accumulates in the public sewer pipes.

#### Environmental Risk

Unlike conventional diesel, biodiesel is non-toxic, biodegradable and safer to ship. Spills do not require emergency response clean-up activities.

### Energy

- Biodiesel is a renewable resource that can be produced domestically from animal fat, vegetable oil or used cooking oil. This decreases the country's dependence on imported foreign oil.
- The Department of Energy analyzed the full biodiesel life-cycle and found that for every unit of fossil fuel used to produce biodiesel, 3.2 units of energy were gained. By contrast, petroleum diesel's life cycle yields only 0.83 units of fuel product energy.

### Economics

- Diesel fleets do not require costly conversion methods or technologies to switch from petroleum diesel to biodiesel unless the existing equipment is older than 15 years.
- The [IRS runs a tax credit program](#) EXIT Disclaimer with a subsidy of 50 cents to \$1 per gallon of biodiesel produced.
- The Department of Agriculture and the Congressional Budget Office have stated that biodiesel is the cheapest alternative fuel for meeting the Energy Policy Act (EPAct) requirements.

***"Biodiesel is one of our nation's most promising alternative fuel sources. And by developing biodiesel, you're making this country less dependent on foreign sources of oil."*** - President George W. Bush remarks at Virginia Biodiesel Refinery May, 2005



Biodiesel can be made from sunflower oil.

## Concerns

### Quality and Performance

If biodiesel is to be sold in the US, it has to meet quality and performance standards of many agencies and organizations.

- The American Society of Testing Materials created a [standard for biodiesel sold in the US \(PDF\)](#) (1pp, 27kb).
- EPA approved biodiesel as an alternative fuel and a fuel additive.
- Biodiesel meets most clean diesel standards established by the California Air Resources Board.
- Biodiesel offers increased lubricity, high cetane and high oxygen content, which helps with performance and extends the life of engines.
- The National Biodiesel Board established a quality assurance program entitled BQ-9000 to monitor the quality of biodiesel in response to differing fuel qualities offered on the market.

#### Did You Know?

- There were 75 million gallons of biodiesel sold in the U.S. in 2005. That's enough to fill 115 Olympic size swimming pools!
- That every hour there is enough waste grease produced in the United States to fill 130 tanker trucks.
- Clark County School District in Nevada is the largest school bus

## Nitrogen Oxide Emissions

Nitrogen oxides (NOx) are a group of gases that form when fuel is burned at high temperatures. These gases contribute to ground-level ozone, acid rain, and visibility impairment. Over half of human made NOx emissions come from fuel combustion in motor vehicles.

The trend of NOx emissions from use of biodiesel is still uncertain. Several studies show an increase in NOx emissions, while others show a decrease. Further research is still needed on NOx emissions from engines burning biodiesel.



EPA has funded several projects to address the NOx emissions. In the ["Fields to Fuel" San Joaquin Valley Biodiesel Project](#), the grantee will test a NOx reduction additive in real world applications on the farm. In another project, the [University of Nevada at Reno \(UNR\)](#) focuses on removing nitrogen before fuel production and will build a large-scale mobile continuous processing unit to lower costs of biodiesel.

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fleet in the United States to run on biodiesel.



The use of biodiesel in farm equipment can help reduce harmful air emissions.