Biodiesel Fuel Basics

Biodiesel is a renewable, biodegradable fuel manufactured domestically from vegetable oils, animal fats, or recycled restaurant grease. Biodiesel meets both the biomass-based diesel and overall advanced biofuel requirement of the Renewable Fuel Standard (/laws/RFS). Renewable diesel (https://afdc.energy.gov/fuels/renewable_diesel.html) is distinct from biodiesel.

Biodiesel is a liquid fuel often referred to as B100, pure, or neat biodiesel in its unblended form. Like petroleum diesel, biodiesel is used to fuel compression-ignition engines. See the table below for biodiesel's physical characteristics.

Biodiesel performance in cold weather depends on the blend of biodiesel, the feedstock, and the petroleum diesel characteristics. In general, blends with smaller percentages of biodiesel perform better in cold temperatures. Typically, No. 2 diesel and B5 (up to 5% biodiesel) perform about the same in cold weather. Both biodiesel and No. 2 diesel have some compounds that crystallize in very cold temperatures. In winter weather, fuel blenders and suppliers combat crystallization by adding a cold flow improver (/glossary#FlowImprovers). For the best cold weather performance, users should work with their fuel provider to ensure the blend is appropriate.

Biodiesel's Physical Characteristics (for B100)	
Specific gravity	0.88
Kinematic viscosity at 40°C, mm^2/s	1.9 to 6.0
Cetane number	47
Lower heating value, Btu/gal	˜119,550
Density, lb/gal at 15.5°C	7.3
Carbon, wt%	77
Hydrogen, wt%	12
Oxygen, by dif. wt%	11
Boiling point, °C	330-357
Flash point, °C	130
Sulfur, % mass (ppm)	0.0015-0.05
Cloud point, °C	-3 to 15
Pour point, °C	-5 to 10

Source: Biodiesel Handling and Use Guide (https://www.afdc.energy.gov/uploads/publication/biodiesel_handling_use_guide.pdf)

Biodiesel Blends

Biodiesel can be blended and used in many different concentrations. The most common are B5 (up to 5% biodiesel) and B20 (6% to 20% biodiesel). B100 (pure biodiesel) is typically used as a blendstock to produce lower percentage blends and is rarely used as a transportation fuel.

Low-Level Blends

ASTM International develops specifications for a wide variety of products, including conventional diesel fuel (ASTM D975). This specification allows for biodiesel concentrations of up to B5 to be called diesel fuel, with no separate labeling required at the pump. Low-level biodiesel blends, such as B5, are ASTM-approved for safe operation in any compression-ignition engine designed to be operated on petroleum diesel. This can include light-duty (/vehicles/diesels_light.html) and heavy-duty (/vehicles/diesels_heavy.html) diesel cars and trucks, tractors, boats, and electrical generators.

B20

B20 is a common blend because it represents a good balance of cost, emissions, cold-weather performance, and compatibility with conventional engines. Most biodiesel users purchase B20 or lower blends from their normal fuel distributors or from biodiesel marketers. Regulated fleets that use biodiesel blends of 20% or higher qualify for biodiesel fuel use credits under the Energy Policy Act of 1992 (/laws/key_legislation#epact92).

B20 must meet prescribed quality standards as specified by ASTM D7467 (/fuels/biodiesel_specifications.html).

Generally, B20 and lower-level blends can be used in current engines without modifications. In fact, many diesel engine original equipment manufacturers (OEMs) approve the use of B20 (see the Engine Technology Forum's list of diesel vehicles available in the United States (https://dieselforum.org/diesel-vehicles-available-in-the-us) for light-duty diesel vehicles and a fact sheet from Clean Fuels Alliance America for original equipment manufacturer positions on biodiesel and renewable diesel (https://cleanfuels.org/wp-content/uploads/2023/07/oem-support-summary.pdf). Users should always consult their vehicle and engine warranty statements before using biodiesel. For more information about biodiesel use in vehicles, see the Biodiesel Handling and Use Guide (https://afdc.energy.gov/files/u/publication/biodiesel_handling_use_guide.pdf).

Engines operating on B20 have similar fuel consumption, horsepower, and torque to engines running on petroleum diesel. B20 with 20% biodiesel content will have 1% to 2% less energy per gallon than petroleum diesel, but many B20 users report no noticeable difference in performance or fuel economy. Biodiesel also has some emissions benefits, especially for engines manufactured before 2010. For engines equipped with selective catalytic reduction (SCR) systems, the air quality benefits are the same whether running on biodiesel or petroleum diesel.

However, biodiesel still offers greater greenhouse gas emissions benefits than conventional diesel fuel. The emissions benefit is roughly commensurate with the blend level; that is, B20 would have 20% of the emissions reduction benefit of B100.

B100 and High-Level Blends

B100 and other high-level biodiesel blends are less commonly used directly as a transportation fuel than B20 and lower blends due to a lack of regulatory incentives and pricing. Biodiesel-compatible material for certain parts, such as hoses and gaskets, allow B100 to be used in some engines built since 1994. B100 has a solvent effect; it can clean a vehicle's fuel system and release deposits accumulated from petroleum diesel use. The release of these deposits may initially clog filters and require frequent filter replacement in the first few tanks of high-level blends.

When using high-level blends, several factors should be considered. Pure biodiesel contains less energy on a volumetric basis than petroleum diesel. Therefore, the higher the percentage of biodiesel (above 20%), the lower the energy content per gallon. High-level biodiesel blends can also impact engine warranties, gel in cold temperatures, and may present unique storage issues. B100 use could also increase nitrogen oxide emissions, although it greatly reduces other toxic emissions.

B100 requires special handling and may require equipment modifications. To avoid engine operational problems, B100 must meet the requirements of ASTM D6751 (http://www.astm.org/Standards/D6751.htm), Standard Specification for Biodiesel Fuel Blendstock (B100) for Middle Distillate Fuels (summary of requirements (biodiesel_specifications.html#b100)). ASTM Specification D6751 includes a No.1-B and a No.2-B grade. The No.1-B grade has stricter limits on monoglycerides and filterability than the No.2-B grade. The No.1-B grade is a special-purpose biodiesel grade for use in applications where low temperature operability is needed.

Find Biodiesel Fueling Station Locations (biodiesel_locations.html). Use Alternative Fuel Price Report (/price_report.html) to understand the cost of biodiesel.

(mailto:technicalresponse@icf.com) **Need project assistance?**
Email the Technical Response Service (mailto:technicalresponse@icf.com) or call 800-254-6735 (tel:800-254-6735)

Biodiesel Production and Distribution

Production

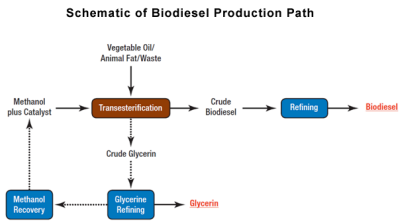
Biodiesel is produced from vegetable oils, yellow grease, used cooking oils, or animal fats. The fuel is produced by transesterification—a process that converts fats and oils into biodiesel and glycerin (a coproduct). Approximately 100 pounds of oil or fat are reacted with 10 pounds of a short-chain alcohol (usually methanol) in the presence of a catalyst (usually sodium hydroxide [NaOH] or potassium hydroxide [KOH]) to form 100 pounds of biodiesel and 10 pounds of glycerin (or glycerol). Glycerin, a coproduct, is a sugar commonly used in the manufacture of pharmaceuticals and cosmetics.

Raw or refined plant oil, or recycled greases that have not been processed into biodiesel, are not biodiesel and should not be used as a vehicle fuel. Fats and oils (triglycerides) are much more viscous than biodiesel, and low-level vegetable oil blends can cause long-term engine deposits, ring sticking, lube-oil gelling, and other maintenance problems that can reduce engine life. (See Straight Vegetable Oil as a Diesel Fuel? (https://www.afdc.energy.gov/pdfs/47414.pdf))

Research is being conducted on developing algae (https://www.nrel.gov/bioenergy/algae-analysis.html) as a potential biodiesel feedstock. It is expected to produce high yields from a smaller area of land than vegetable oils.

Renewable diesel (/fuels/renewable-diesel) is distinct from biodiesel and is produced through a different process.

Schematic of Biodiesel Production Path



Enlarge illustration (/vite/assets/Biodiesel-production-schematic-t7hePwZ-.png)

Distribution

Biodiesel is distributed from the point of production to fuel terminals and wholesalers by truck, train, or barge. B5 is sometimes shipped by pipeline. Most biodiesel distributors will deliver B20 or B100 depending on the retailer's preference.