

Straight Vegetable Oil as a Diesel Fuel?

Concerns about U.S. reliance on imported petroleum and fluctuating fuel prices have led to growing interest in using biodiesel, an alternative fuel made from vegetable oils. Some people have expressed interest in using straight vegetable oil (SVO), or waste oils from cooking and other processes, as fuel. These oils seem to be appealing because they are obtainable from U.S. agricultural or industrial sources without intermediate processing. However, SVO and other waste oils are generally not considered acceptable vehicle fuels for large-scale or long-term use.

Performance of SVO

While straight vegetable oil or mixtures of SVO and diesel fuel have been used by some over the years, research has shown that SVO has technical issues that pose barriers to widespread acceptance.

The published engineering literature strongly indicates that the use of SVO will lead to reduced engine life. This reduced engine life is caused by the buildup of carbon deposits inside the engine, as well as negative impacts of SVO on the engine lubricant. Both carbon deposits and excessive buildup of SVO in the lubricant are caused by the very high boiling point and viscosity of SVO relative to the

required boiling range for diesel fuel. The carbon buildup doesn't necessarily happen quickly but instead over a longer period. These conclusions are consistent across a significant body of technical information in multiple articles and reports.

An SAE technical paper¹ reviews published data on the use of SVO in engines. Quoting from this paper:

“Compared to No. 2 diesel fuel, all of the vegetable oils are much more viscous, are much more reactive to oxygen, and have higher cloud point and pour point temperatures.

Diesel engines with vegetable oils offer acceptable engine performance and emissions for short-term operation. Long-term operation results in operational and durability problems.”

Some investigators have explored modifying the vehicle to preheat the SVO prior to injection into the engine. Others have examined blends of vegetable oil with conventional diesel. These techniques may mitigate



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Straight vegetable oil is not the same as biodiesel and is generally not recommended for long-term vehicle use.

the problems to some degree, but do not eliminate them entirely. Studies show that carbon buildup continues over time, resulting in higher engine maintenance costs and/or shorter engine life. Figure 1 shows how the tendency to form carbon deposits increases when blending vegetable oil into a diesel fuel.²

Another issue that is particularly critical for use of SVO is fuel viscosity. As Figure 2 (see back) indicates, the viscosity of pure SVO is much higher than that of diesel fuel at normal operating temperatures.³ This can cause premature wear of fuel pumps and injectors and can also dramatically alter the structure of the fuel spray coming out of the injectors to increase droplet size, decrease spray angle,

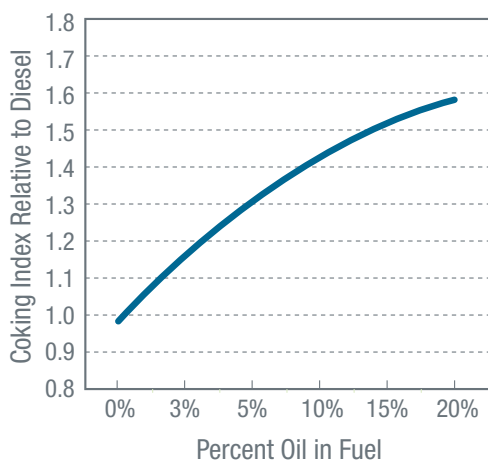


Figure 1. Buildup of Carbon Deposits in Engine as a Function of Oil in Fuel²



¹ Babu, A.K.; Devaradjane, G. “Vegetable Oils and Their Derivatives as Fuels For CI Engines: An Overview.” SAE Technical Paper No. 2003-01-0767.

² Jones, Samuel T.; Peterson, Charles L.; Thompson, Joseph C. *Biological and Agricultural Engineering Department, University of Idaho, Moscow, Idaho.* “Used Vegetable Oil Fuel Blend Comparisons Using Injector Coking in a DI Diesel Engine.” Presented at 2001 ASAE Annual International Meeting, Sacramento, Calif., July 30–August 1, 2001. SAE Paper No. 01-6051.

³ Bruwer, J.J., et al. “Use of Sunflower Seed Oil in Diesel Engine Tractors.” *Proceedings of the IV International Symposium on Alcohol Fuels Technology*; October 5, 1980, Guarujá, SP, Brazil.

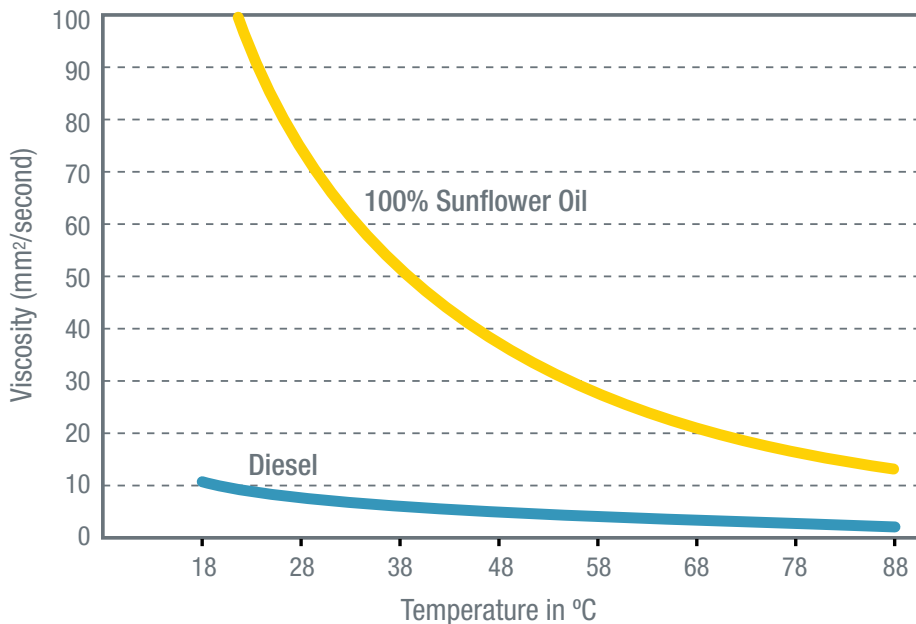


Figure 2. Impact of Temperature on the Viscosity of Sunflower Oil and Diesel Fuel

and increase spray penetration. All of these changes to the fuel spray will tend to increase wetting of engine internal surfaces with the fuel, leading to an increased tendency to form carbon deposits and dilute the lubricant.

The long-term effect of using SVO in modern diesel engines that are equipped with catalytic converters or filter traps is also a matter of concern. Buildup of fuel in the lubricant is more significant in these engines—even for petroleum diesel—and would likely be severe with SVO. In general, these systems were not originally designed with SVO in mind and can be seriously damaged or poisoned by out-of-spec or contaminated fuel.

Biodiesel: Fuel made from SVO

Biodiesel is an alternative fuel that can be made from SVO in a chemical

process called transesterification that involves a reaction with methanol using caustic soda (sodium hydroxide) as a catalyst. Biodiesel has substantially different properties than SVO and results in better engine performance. In particular, biodiesel has a lower boiling point and viscosity than SVO. Because of its improved qualities, vehicle and engine manufacturers generally approve the use of biodiesel blends in their products, though not all approve blend levels as high as 20%.

To ensure good performance in engines, biodiesel must meet quality specifications developed by ASTM International. The ASTM D6751 specification is for pure biodiesel (B100), which can be used in blends up to 20%. Any biodiesel used for blending should meet this specification. Biodiesel that meets ASTM D6751 is also legally registered as a fuel and fuel additive with the U.S. Environmental Protection

Where can I get more information?

- The U.S. Department of Energy’s (DOE) Alternative Fuels Data Center at www.afdc.energy.gov is a vast collection of information on alternative fuels and alternative fuel vehicles.
- The DOE’s Office of Energy Efficiency and Renewable Energy Web site at www.eere.energy.gov/biomass contains information on biodiesel and ethanol production and policy.
- The National Biodiesel Board is the national trade association representing the biodiesel industry. Its Web site, www.biodiesel.org, serves as a clearinghouse of biodiesel-related information.
- The National Renewable Energy Laboratory’s Nonpetroleum Based Fuels Web site, located at www.nrel.gov/vehiclesandfuels/npbf, provides links to a variety of biofuels documents.
- The EPA Biodiesel Emissions Analysis Program at www.epa.gov/otaq/models/biodsl.htm contains a biodiesel emissions database.

Agency (EPA). For a complete list of ASTM biodiesel requirements, see the Biodiesel Handling and Use Guidelines at www.nrel.gov/vehiclesandfuels/npbf/pdfs/43672.pdf. In addition, the biodiesel industry has instituted a quality assurance program for biodiesel producers and marketers. To learn more about the BQ-9000 program, visit www.bq-9000.org.