oilgae

WVO as Biofuel

Many vegetable oils have similar fuel properties to diesel fuel, except for higher viscosity and lower oxidative stability. If these differences can be overcome, vegetable oil may substitute for #2 Diesel *fuel*, most significantly as engine fuel or home heating oil.

For engines designed to burn #2 diesel fuel, the viscosity of vegetable oil must be lowered to allow for proper atomization of fuel, otherwise incomplete combustion and carbon build up will ultimately damage the engine. Many enthusiasts refer to vegetable oil used as *fuel* as waste vegetable oil (WVO) if it is oil that was discarded from a restaurant or straight vegetable oil (SVO) or pure plant oil (PPO) to distinguish it from *biodiesel*.

Energy

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History

The first known use of vegetable oil as *fuel* in a diesel engine was a demonstration of an engine built by the Otto company and designed to burn mineral oil, which was run on pure peanut oil at the 1900 World's Fair. Late in his career, Rudolf Diesel investigated using vegetable oil to *fuel* engines of his design, and in a 1912 presentation to the British Institute of Mechanical Engineers, he cited a number of efforts in this area and remarked, "The fact that fat oils from vegetable sources can be used may seem insignificant today, but such oils may perhaps become in course of time of the same importance as some natural mineral oils and the tar products are now."

Periodic petroleum shortages spurred *research* into vegetable oil as a diesel substitute during the 30s and 40s, and again in the 70s and early 80s when straight vegetable oil enjoyed its highest level of scientific interest. The 1970s also saw the formation of the first commercial enterprise to allow consumers to run straight vegetable oil in their automobiles, Elsbett of Germany. In the 1990s Bougainville conflict, islanders cut off from oil supplies due to a blockade used coconut oil to fuel their vehicles.

Academic *research* into straight vegetable oil fell off sharply in the 80s with falling petroleum prices and greater interest in *biodiesel* as an option that did not require extensive vehicle modifications.

Application and usability

While engineers and enthusiasts have been experimenting with using vegetable oils as fuel for a diesel engine since at least 1900, it is only recently that the necessary fuel properties and engine parameters for reliable operation have become apparent. A number of peer reviewed studies exists that show reliable long term use of vegetable oil; the German Deutz F3l912W. and a high speed common rail engine fitted to a Mercedes-Benz 220 C Class

Most diesel car engines are suitable for the use of SVO, also commonly called Pure Plant Oil (PPO), with suitable modifications. Principally, the viscosity and surface tension of the SVO/PPO must be reduced by preheating it, typically by using waste heat from the engine or electricity, otherwise poor atomization, incomplete combustion and carbonization may result. One common solution is to add a heat exchanger, and an additional fuel tank for "normal" diesel fuel (petrodiesel or biodiesel) and a three way valve to switch between this additional tank and the main tank of SVO/PPO. (This aftermarket modification typically costs about $1200 USD.)[5] The engine is started on diesel, switched over to vegetable oil as soon as it is warmed up and switched back to diesel shortly before being switched off to ensure that no vegetable oil remains in the engine or fuel lines when it is started from cold again. In colder climates it is often necessary to heat the vegetable oil fuel lines and tank as it can become very viscous and even solidify.

Single tank conversions have been developed, largely in Germany, which have been used throughout Europe. These conversions are designed to provide reliable operation with rapeseed oil that meets the German rapeseed oil fuel standard DIN 51605. Modifications to the engines cold start regime assist combustion on start up and during the engine warm up phase. Suitably modified indirect injection (IDI) engines have proven to be operable with 100% PPO down to temperatures of -10°C. Direct injection (DI) engines generally have to be preheated with a block heater or diesel fired heater. The exception is the VW Tdi (Turbocharged Direct Injection) engine for which a number of German companies offer single tank conversions. For long term durability it has been found necessary to increase the oil change frequency and to pay increased attention to engine maintenance.

With unmodified engines the unfavorable effects may be reduced by blending, or "cutting", the SVO/PPO with diesel fuel; however, opinions vary as to the efficacy of this. Some WVO mechanics have found higher rates of wear and failure in fuel pumps and piston rings.[1] This can generally be attributed to the use of oils with properties or contaminants that make them unsuitable for use in this type of application, poorly maintained engines, unsuitable engine modifications or operating regimes.

Many cars powered by indirect injection engines supplied by in-line injection pumps, or mechanical Bosch injection pumps are capable of running on pure SVO/PPO in all but winter temperatures. Indirect injection Mercedes-Benz vehicles with in-line injection pumps and cars featuring the PSA XUD engine tend to perform reasonably, especially

as the latter is normally equipped with a coolant heated fuel filter. Engine reliability would depend on the condition of the engine. Attention to maintenance of the engine, particularly of the fuel injectors, cooling system and glow plugs will help to provide longevity. Ideally the engine would be converted.

Properties

The main form of SVO/PPO used in the UK is rapeseed oil (also known as canola oil, primarily in the United States and Canada) which has a freezing point of -10°C. However the use of sunflower oil, which freezes at -17°C, is currently being investigated as a means of improving cold weather starting. Unfortunately oils with lower gelling points tend to be less saturated (leading to a higher iodine number) and polymerize more easily in the presence of atmospheric oxygen.

Examples

Some Pacific island nations are using coconut oil as fuel to reduce their expenses and their dependence on imported fuels while helping stabilize the coconut oil market. Coconut oil is only usable where temperatures do not drop below 17 degrees Celsius (62 degrees Fahrenheit), unless two-tank SVO/PPO kits or other tank-heating accessories, etc. are used. Fortunately, the same techniques developed to use, for example, canola and other oils in cold climates can be implemented to make coconut oil usable in temperatures lower than 17 degrees Celsius.

Home heating

With often minimal modification, most residential furnaces and boilers which are designed to burn No. 2 heating oil can be made to burn either *Biodiesel* or filtered, preheated waste vegetable oil. These are generally not as clean-burning as petroleum fuel oil, but if processed at home, by the consumer, can result in considerable savings. Many restaurants will give away their used cooking oil either free or at minimal cost, and processing to *biodiesel* is fairly simple and inexpensive. Burning filtered WVO directly is somewhat more problematic, since it is much more viscous, but it can be accomplished with suitable preheating. WVO can thus be an economical heating option for those with the necessary mechanical and experimental aptitude.

Combined heat and power

A number of companies offer compressed ignition engine generators optimized to run on plant oils where the waste engine heat is recovered for heating.

Availability

Waste vegetable oil

As of 2000, the United States was producing in excess of 11 billion liters of waste vegetable oil annually, mainly from industrial deep fryers in potato processing plants, snack food factories and fast food restaurants. If all those 11 billion liters could be collected and used to replace the energetically equivalent amount of petroleum (an ideal case), almost 1% of US oil consumption could be offset.[6] However, use of waste vegetable oil as a fuel competes with some already established uses.

Pure vegetable oil (pure plant oil)

Pure plant oil (PPO) (or Straight Vegetable Oil (SVO)), in contrast to waste vegetable oil, is not a byproduct of other industries, and thus its prospects for use as fuel are not limited by the capacities of other industries. Production of vegetable oils for use as fuels is theoretically limited only by the agricultural capacity of a given economy.

Legal implications

The conversion of an automobile engine to burn vegetable oil is not legal under US Environmental Protection Agency guidelines.[7] The EPA has not fined anyone for doing so, but certain laws may have to change — or a certification process may need to be established — before VO conversions become more popular in the US.

Taxation of fuel

Taxation on SVO/PPO as a road fuel varies from country to country, and it is possible the revenue departments in many countries are even unaware of its use, or feel it insufficiently significant to legislate. Germany offers 0% taxation, resulting in their leading on most developments of the fuel use. However SVO/PPO as a road fuel will be taxed with 0,09 €/liter on January, the 1st of 2008 in Germany. From thereon it will rise up to 0,45 €/liter until 2012.

In the USA

There seems to be no clear federal taxation system in the USA. Production of biodiesel in some US regions may require motor fuel taxes to be paid, which are typically used to fund road construction costs.

In Canada

The Government of Canada exempted biodiesel from the federal excise tax on diesel in the March 2003 budget. In Ireland a pilot scheme is currently running (as of April 2006) whereby eight suppliers have been approved to sell SVO/PPO for use as a fuel without the payment of excise duty (Value Added Tax at 21% still applies, SVO from any other source still attracts excise duty at 36.8058 Euro cents per litre plus 21% VAT). Despite its use being common in France, it would appear there has been no legislation to cover this.

In the UK, it is legal once duty on the fuel is paid. In the UK, drivers using SVO/PPO have been prosecuted for failure to pay duty to Her Majesty's Revenue and Customs. The rate of taxation on SVO was originally set at a reduced rate of 27.1p per litre, but in late 2005, HMRC started to enforce the full diesel excise rate of 47.1p per litre.

Following a review late 2006, HM Revenue & Customs has announced changes regarding the administration and collection of excise duty of biofuels and other fuel substitutes (Veg Oil). The changes came into effect on June 30, 2007. There is no longer a requirement to register pay duty on vegetable oil used as road fuel if you 'produce' or use less than 2500 litres per year. For those producing over this threshold the biodiesel rate now applies.

HMRC argued that SVOs/PPOs on the market from small producers did not meet the official definition of "biodiesel" in Section 2AA of The Hydrocarbon Oil Duties Act 1979 (HODA), and consequently was merely a "fuel substitute" chargeable at the normal diesel rate. Such a policy seemed to contradict the UK Government's commitments to the Kyoto Protocol and to many EU directives and had many consequences, including an attempt to make the increase retroactive, with one organization being presented with a £16,000 back tax bill. This change in the rate of excise duty has effectively removed any commercial incentive to use SVO/PPO, regardless of its desirability on environmental grounds; unless waste vegetable oil can be obtained free of charge, the combined price of SVO/PPO and taxation for its use usually exceeds the price of mineral diesel. HMRC's interpretation is being widely challenged by the SVO/PPO industry and the UK pure Plant Oil Association (UKPPOA) has been formed to represent the interests of people using vegetable oil as fuel and to lobby parliament.