



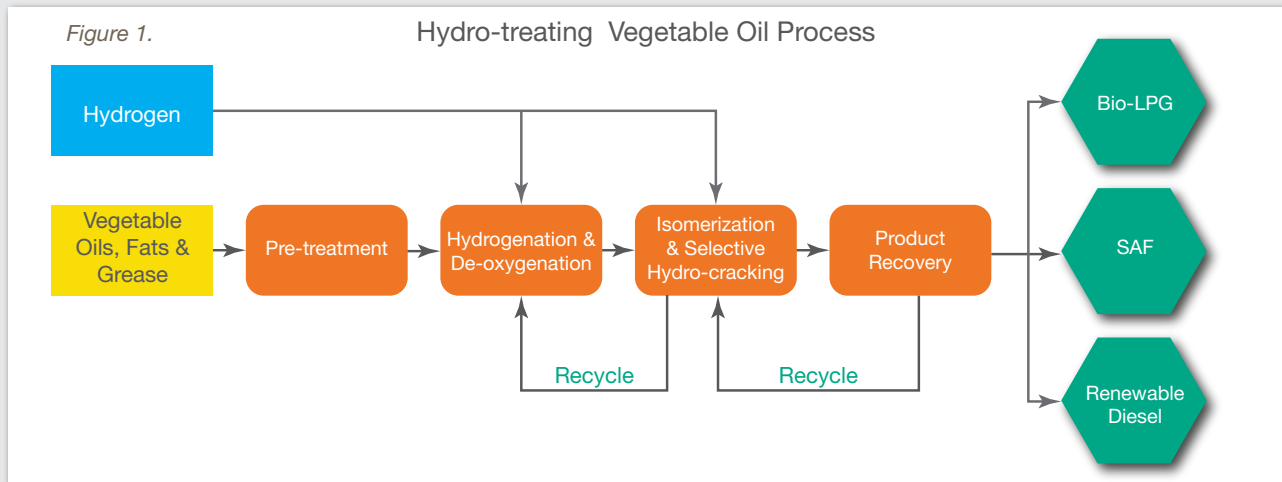
As regulatory bodies, users, and manufacturers of engine driven generator systems advance towards zero carbon emissions and an overall reduction in various exhaust emissions defined as harmful to individuals and the environment, alternative technologies are being applied to bridge the timescales required to development and apply zero emission technology, such as fuel cells. One such development is switching existing diesel engine driven generator systems to run on HVO instead of diesel. HVO has several advantages over other forms of biofuels and many engine manufacturers have already approved HVO as an alternative to diesel fuel. This information sheet explains what HVO is and discusses its advantages, how it can be applied to existing and new diesel generator systems, and how carbon emissions can be greatly reduced, as we move towards the application of zero carbon emission technology.

1.0 HVO IS A BETTER ALTERNATIVE TO OTHER BIOFUELS:

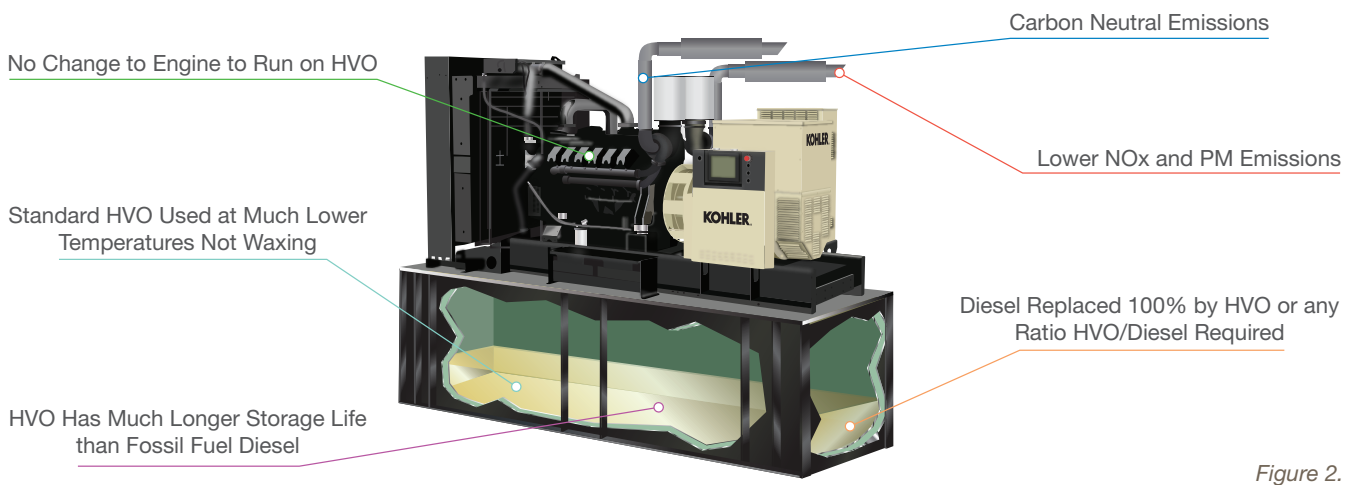
HVO is Hydrotreated Vegetable Oil and is produced by utilizing hydrogen at a high temperature and pressure for hydrogenation and hydrocracking of waste and residual fat from the food industry and other non-food grade vegetable oils. (See figure - 1)

Hydrocracking is the process of using hydrogen to break larger molecules into smaller molecules and in the process hydrogenation adds hydrogen to the molecules. As hydrogen is the combustible element of fuel, this process can be used to create substitutes for gasoline, diesel, propane and kerosene. Diesel fuel created by Hydrotreating is termed "green diesel" or "renewable diesel".

Explanation and Benefits of HVO Fuel



HVO Advantages When Used as Fuel for Compression Ignition Engine Generator Systems



The installation information provided in this information sheet is informational in nature only, and should not be considered the advice of a properly licensed and qualified electrician or used in place of a detailed review of the applicable National Electric Codes and local codes. Specific questions about how this information may affect any particular situation should be addressed to a licensed and qualified electrician.

1.0 HVO IS A BETTER ALTERNATIVE TO OTHER BIOFUELS: (CONTINUED):

While still in the biofuel category, as opposed to a fossil fuel, there are differences in HVO to the first generation of biofuels. The following makes HVO a more suitable as a bio-replacement for regular diesel produced from fossil fuels.

1.1 HVO IS A 2ND GENERATION BIODIESEL - Most people are familiar with ethanol, which in its simplest form is an alcohol product produced from corn, wheat, sugar cane, and biomass, and that it is used as an additive in gasoline to increase its octane level. Biodiesel, on the other hand, is derived from natural oils such as soybean oil or animal fats.

1.2 ADVANTAGES OVER ETHANOL - Biodiesel releases less air pollutants per net energy gain than ethanol. These advantages of biodiesel over ethanol come from lower agricultural inputs and more efficient conversion of feedstocks to fuel.

1.3 BIODIESEL AND HVO - Unlike conventional biodiesel, the HVO production process uses hydrogen (rather than methanol) as a catalyst, which makes HVO a cleaner burning fuel with a longer shelf life.

2.0 THE ENVIRONMENTAL ADVANTAGES OF HVO:

The scientific evidence for climate change, also referred to as Global Warming, can be attributed to increased levels of Carbon Dioxide (CO₂) in the atmosphere. While the general population has been aware of the term Global Warming in the last two decades, the phenomenon was first observed by a French mathematician, Joseph Fourier. In the 1820s, Fourier calculated that an object the size of the Earth, and at its distance from the Sun, should be considerably colder than the planet actually is if warmed by only the effects of incoming solar radiation. While Fourier discovered earth's atmosphere was trapping solar radiation in the atmosphere, another scientist John Tyndall, in 1859 established that carbon dioxide and water vapor were among the gases that absorbed heat and the reason the earth was not as cold as would be assumed due to its distance from the sun.

Since the start of the Industrial Revolution, the burning of fossil fuels has steadily increased the levels of CO₂. Fossil fuels were created millions of years ago by vegetation that absorbed CO₂ from the atmosphere, and as coal, gas and oil are burnt, this CO₂ has been released back into the atmosphere, so much so that this is now the main reason for rising global atmospheric temperatures.

The generally accepted view now is to stop the increase of CO₂ by moving away from fossil fuels. HVO is made up of vegetable-based material that as it grows absorbs CO₂ from the atmosphere, on burning HVO no more CO₂ is released than was absorbed in growing the vegetable material, hence it is termed carbon neutral and not a contributor to increased CO₂.

3.0 DEFINITION OF HVO FUEL:

HVO is defined as a paraffinic drop-in diesel alternative fuel, manufactured from 100% renewable sustainable waste. As a paraffinic synthetic diesel HVO has nearly zero sulfur and a very low aromatic content (unlike fossil derived fuels) which greatly reduces exhaust emissions of toxic hydrocarbons, nitrous oxides (NO_x) and particulate matter (PM).

3.1 EXPLANATION OF PARAFFINIC FUELS - Paraffinic diesel fuel has normally very high cetane numbers, no sulfur, nitrogen, oxygen or aromatics. Paraffins can be produced with various processes from fossil or renewable feedstocks. While diesel fossil fuels have some paraffinic content, it also contains naphthenics and aromatics, which are not so favorable for combustion. HVO as a paraffinic synthetic fuel has the good components for a diesel compression ignition engines (CI) without the bad elements.

3.2 FOSSIL FREE DIESEL FUEL REPLACEMENT - HVO Renewable Diesel is a premium fossil-free diesel product made of 100% renewable raw materials, which does not release any new carbon dioxide into the atmosphere. It is produced by hydrotreatment of vegetable oils and/or animal fats, and the result is a premium quality fuel with a chemical structure almost identical to regular diesel and can therefore fully replace fossil diesel.

4.0 ADVANTAGE OF HVO OVER DIESEL:

As has already been stated the principal argument for replacing diesel with HVO is that it is carbon neutral and not a contributor to increased levels of CO₂ in the atmosphere. However, there are numerous other advantages to using HVO instead of another fossil and biofuels. (See figure - 2)

4.1 HVO IS NOT AN ADDITIVE, BUT A REPLACEMENT FUEL - Other fuels grown from vegetables/crops such as ethanol are mainly used as additives to fossil fuels, and if fossil fuels are part of the combustion process, atmospheric net levels of CO₂ will continue to increase.

4.2 HVO DOES NOT REQUIRE ANY CHANGE TO THE ENGINE - First generation biofuels required some changes to the fueling and materials of the engines combustion system. Major engine manufacturers around the world have approved switching over to HVO from diesel, including the Kohler KD series, without any changes to the engine.

4.3 HVO HAS A MUCH LONGER STORAGE LIFE - A major problem with fossil-based diesel fuel is it deteriorates when left standing for several months. Diesel is prone to absorbing water which contributes to the growth of contaminants in the fuel which ultimately will retard combustibility and engine performance. It can also lead to clogged up fuel filtration.

4.4 HVO PERFORMED ACROSS LARGER TEMPERATURE SPAN - Another problem with diesel fossil fuel is its tendency to wax at low temperatures. In cold environments additives must be added to diesel to stop waxing below freezing temperatures and the use of heaters in stored fuel. HVO will perform down to minus 30° C.

4.5 HVO REQUIRES LESS EXHAUST AFTER TREATMENT - While there is a big push to carbon neutral and other renewable energy sources of power to reduce atmospheric CO₂, regulatory standards such as the EPA are also requiring for health reasons levels of NO_x and other hydrocarbons to be reduced. As stated HVO as a pure paraffinic fuel when burnt, has very low levels of PM, NO_x and other hydrocarbons in the exhaust stream.

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our Information Sheets are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.



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