Technical Brief

Biodiesel

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1. What is Biodiesel?

Biodiesel is a renewable fuel derived from natural vegetable oils or animal fats that can be used as diesel substitute or complement.

This fuel is obtained through a chemical process called transesterification. In this process, organic oils are combined with alcohol and chemically altered to form ethyl or methyl ester, which is called biodiesel.

2. Transesterification Process

The main reason why vegetable oils can't be used directly in diesel engines is due to their viscosity. The recommended chemical process to reduce this viscosity is transesterification.

Transesterification is a chemical process in which, through combining alcohol with a catalyst, triglyceride molecules are chemically broken down, with the glycerides in the oil being replaced by alcohol, forming a fatty ester and creating glycerol as a by-product.

Triglycerides + Alcohol ⟶ Biodiesel + Glycerol

The resulting linear ester molecules are called biodiesel and are formed by ester from fatty acid and alcohol.

These molecules have lower viscosity, lower molecular weight, a lower boiling point and flash point lower than the original triglyceride.

Additionally biodiesel has physical and chemical properties similar to petroleum diesel.

The commonly used catalysts for the transesterification process are sodium hydroxide (NaOH) known as caustic soda and potassium hydroxide (KOH), also called caustic potash or lye.

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The first step in the transesterification process consists of mixing alcohol - normally ethanol - with a catalyst, which is usually sodium hydroxide; to form sodium methoxide (Na CH_3O-) in an exothermic reaction.

This chemical is mixed with vegetable oil, which hydrolyses the bonds of the triglycerides. This gives rise to the fatty acids splitting into glycerine and chains of ester, which in turn react with methanol to give biodiesel.

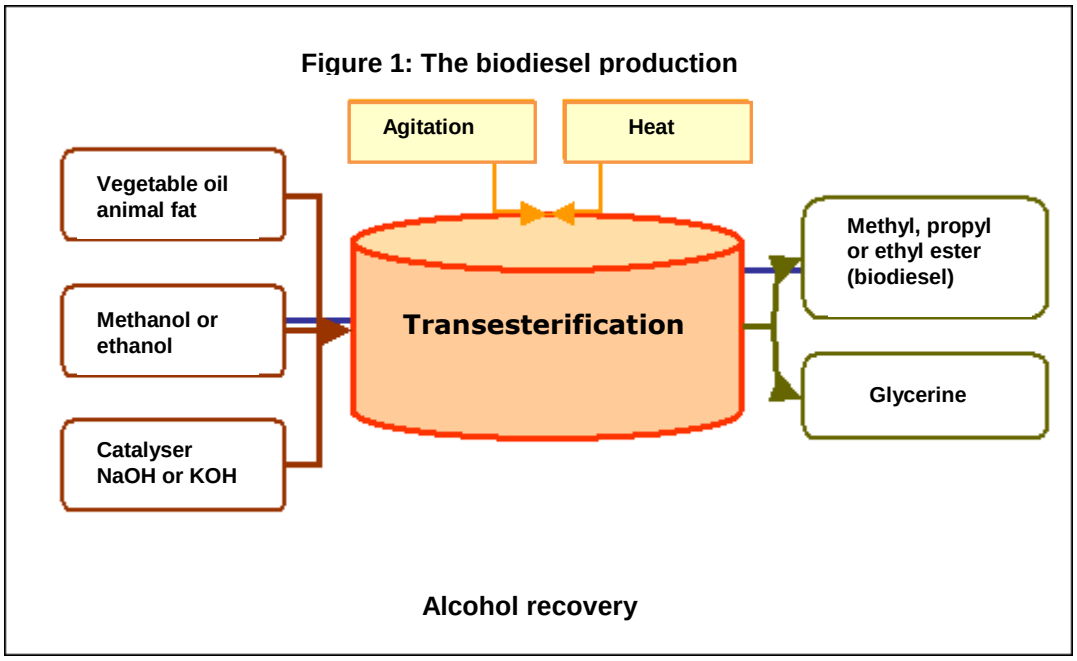

Figure 1: The biodiesel production process

This mixture is reclaimed and separated in phases to isolate glycerol, by-product used in the industry. The biodiesel is extracted and the alcohol recycling.

3. Basic Reaction

For a litre of dry and neutral oil:

200 ml of methanol.
3.5 gr. of NaOH or 8 gr. of KOH (catalyser).
The catalyser is dissolved in the alcohol.
The oil is preheated to 50-60°C.
Both components are mixed.
It is agitated at that temperature for 1.5 hours.
It is allowed to settle.

4. Advantages and disadvantages

The physiochemical characteristics of the biodiesel are very similar to those of petroleum diesel. Thanks to this, their utilization does not require great changes in the conventional diesel engine. Therefore, biodiesel can be used directly in diesel engines. Biodiesel can also be added to or mixed in with diesel, in any proportion of biodiesel to diesel.

Biodiesel can be pumped, stored and manipulated with the same procedures, infrastructure and equipment as with diesel. The ignition, yield, torque and engine power do not vary significantly, but the consumption can increase slightly by up to 5%.

Additionally, biodiesel also has many advantages over conventional diesel, for example:

- It does not contain sulphur, thus reducing emissions of solid particulates and improving the lubricating properties of the fuel, even in mixtures with very low concentrations of biodiesel, therefore increasing the lifespan of the engine.

- It has a relatively high flash point (150ºC), which makes it less volatile and safer to use and transport than diesel.

- It can be produced from local products such as oil crops or recycled vegetable oils, helping to reduce dependence on oil imports, save foreign exchange and create jobs.

- It is extremely biodegradable in water, so in the event of a leak it degrades much faster than conventional diesel and even as fast as sugar. This means that biodiesel is an ideal fuel for water transport in fresh or salt water whose ecosystems are either fragile or protected.

- It is practically non-toxic in the case of ingestion by fish and mammals. Its toxicity is so low that a person of 80 kg would have to consume around 1.6 litres of biodiesel for it to have a lethal effect. The common salt (NaCl) is approximately ten more toxic.

- It contributes to the reduction of the global warming, since less CO_2 is emitted in its life cycle than that fixed by the process of photosynthesis by the plants used to produce it. On the other hand, it avoids to release the carbon that was captured over millions years in fossil fuels.

- It substantially reduces emissions of most pollutants. Because biodiesel is an oxygenated fuel, its combustion is more complete than diesel and reduces SO_2, CO, particulates and unburnt hydrocarbon emissions. As a result, biodiesel combustion produces less visible smoke and less harmful gases. The use of biodiesel helps to reduce air pollution.

Some disadvantages that can occur in their use are:

- At low temperatures it can begin to solidify and to form crystals, that can obstruct the conduits of the fuel.

- Because of its solvent properties, it can soften and degrade certain materials, such as natural rubber and polyurethane foam. This is why it may be necessary to change some engine hoses and seals before using biodiesel, especially with older vehicles.

- Its cost can still be higher than the cost of petrol diesel. The cost basically depends on the source of oil used during production.

For more information on the topic:

www.solucionespracticas.org.pe/biodiesel/

Sources:

This technical Brief was translated by Do Some Good from the Spanish Technical Brief *Biodiésel* by Soluciones Prácticas.
http://www.itdg.org.pe/fichastecnicas/pdf/FichaTecnica18-Biodiesel.pdf

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