



## D40b

(the following is a transcript of the information on engine adaptation on [www.gotaverde.org](http://www.gotaverde.org))

# Diesel engine adaption

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Vegetable oil or Pure Plant Oil (PPO) is an alternative fuel for diesel engines and for heating oil burners. For engines designed to burn #2 diesel fuel, the viscosity of vegetable oil must be lowered to allow for proper atomization of the fuel, otherwise incomplete combustion and carbon build up will ultimately damage the engine. Rudolf Diesel's first attempts were to design an engine to run off of coal dust, but later designed his engine to run off of vegetable oil. The idea, he hoped, would make his engines more attractive to farmers having a source of fuel readily available. Now the history seems to repeat itself and PPO application in rural areas is a realistic alternative to diesel use.

To lower the viscosity of the PPO, different systems based on preheating the vegetable oil, has been developed tested and evaluated.

Beside the introduction of new technologies, the transfer of knowledge on engine adaptation for the use of biofuels is considered an indispensable part of the Gota Verde Project. The introduction and training of an appropriate technology with lot of potential for the region, considering the applicability of the technology and the availability of the prime material on which this technology functions is expected to have its impact on the area of influence of the project.

In this case, the technology introduced is the ELSBETT conversion kit that is implemented in diesel engines to make it function on Pure Plant Oil (PPO) or Waste Vegetable Oil (WVO). With the supervision of PPO expert Niels Anso from the Danish company DAJOLKA, this German technology has been introduced in the Yoro region and local technicians of first- and second-level Honduran organizations like CEVER and CADERH has been trained.

Also for big stationary engines and agro-industrial installations like forced driers the use of PPO might be interesting even without the need to adapt the engines to PPO. It is also an interesting combustible to generate electricity in isolated areas just like the FACT ([www.fact-fuels.org](http://www.fact-fuels.org)) project in Garaló in Mali ([http://www.fact-fuels.org/en/FACT\\_Projects/Mali](http://www.fact-fuels.org/en/FACT_Projects/Mali)).

The ELSBETT technology consists of the following adaptations:

- An additional fuel pump (optional)

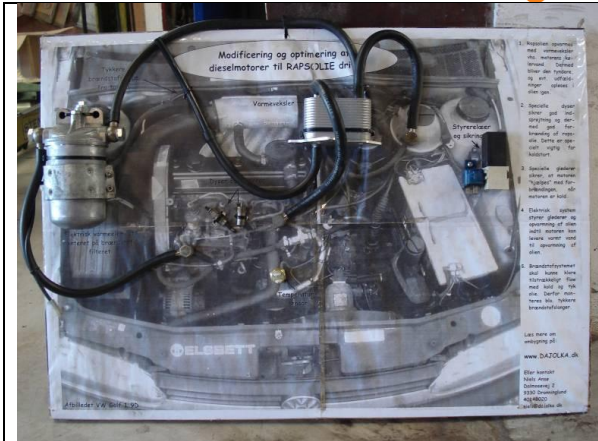


- Heat exchanger
- Additional filter
- Electrical resistance
- Change of the glow plugs (glow plugs for the PPO system are about 4mm longer)
- Increase injection pressure of the combustible
- Increase the preglow time of the glow

Advantages of this system are the fact that no additional fuels tank has to be installed and that the engine can use PPO, biodiesel or diesel in pure form or in mixes. The system costs around € 1000,- but can be recovered on the medium/long term because of the lower PPO price per gallon.

The first step in the technical process of the engine adaptation is a decent engine selection. The selection process is necessary to identify the injection pump and its suitability for the use of pure oil. Moreover the type of injection (direct or indirect) is of vital importance on the decision on the type of engine adaptation. Engines with a indirect injection are suitable for the one tank engine adaptation because the appearance of the prechamber in the cylinder head allows the fuel to be preheated before combusted, while the direct injection engines are more suitable for a two tank adaptation system. The absence of the prechamber in the indirect injected engine may cause polymerisation in the lubricant oil caused by uncombusted oil fuel leaked into the lubricant trough the space between the piston(rings) and the cylinder. This problem occurs when the engine is still not heated up. To avoid problems with the lubrication of direct injected engines it is recommended change the lubricant oil more often or to convert these kind of engines with the two tank system that allows the engine to start on diesel or biodiesel and switch to PPO/SVO ones the engine is heated up. Before turning of the engine the engine should be switched back to diesel or biodiesel fuel until the whole fuel system is filled with it to avoid problems with the next start of the engine.

With the Technical assistance of Niels Ansø of the Danish PPO company DAJOLKA, four cars has been adapted in with this technology.



The ELSBETT technology



Toyota Hilux using PPO, Biodiesel or diesel



Niels Ansø training local technicians in the new technology






Adaptation of Nissan Frontier with ELSBETT technology

Appropriate technology (local materials)

An other way to convert diesel engines for the use of PPO is a system with two fuel tanks. The engine is started on normal biodiesel or diesel and switched to PPO ones the engines get hot enough to preheat the PPO with its water from the radiator. Switching can be done manually but also by electrical 3-way valves.

Some examples of engine adaptation with local materials are:

	
<p>Irrigation pump using PPO biodiesel or diesel</p>	<p>A simple heat exchanger</p>
	<p>Adaptation of this car is done with local materials and an extra fuel tank in the back of the car under supervision of Sebastian Africano of the Honduran NGO ENASA</p>

Oil quality is a vital issue to reach a commercial success, Gota Verde PPO meets the German Quality Standard for Rape Seed Oil as an engine fuel.

#### V DIN 51 605 – Quality Standard for Rape Seed Oil as engine fuel

Parametre	Limit	Unit
<i>Characteristic/natural properties <sup>1)</sup></i>		
Density at 15 °C	900 - 930	kg/m <sup>3</sup>
Flashpoint Pensky- Martens	min. 220	°C
Kinematic viscosity at 40 °C	max. 36,0	mm <sup>2</sup> /s
Calorific value (incl. H <sub>2</sub> O –Correction)	min. 36.000	kJ/kg
Cetane number	min. 39	-
Carbon residue CCR (from Original)	max. 0,40	% (m/m)
Iodine number	95 - 125	g Jod/100 g
Sulfur content	max. 10	mg/kg
<i>Variable properties <sup>2)</sup></i>		
Total contamination	max. 24	mg/kg
Acid number	max. 2,0	mg KOH/g
Oxidation stability	min. 6,0	h
Phosphorus content	max. 12	mg/kg



Earth alkali content (Ca + Mg)	max. 20	mg/kg
Ash content	max. 0,01	% (m/m)
Water content	max. 0,075	% (m/m)

- 1): *The natural properties which are independent from the process, handling and storing.*
- 2). *the variable properties which are influenced by the process, handling and storing.*

Main actors in the diesel engine adaption component are:

Niels Ansø de DAJOLKA  
Sebastian Africano ENASA  
CEVER