Vegetable Oil Powered Tractors
Converting tractors to run on vegetable oil

Case Study Vegetable Oil
Idea and motivation

For many years, the “HUBER Agrar & Alternativ Technik” agricultural vehicle workshop in Nikitsch has been focused on converting diesel engines to run on vegetable oil. In addition to converting automobiles, the company also specialises in adapting tractors to operate on vegetable oil.

The conversion workshop is situated near a vegetable oil press in the village of Kroatisch Minihof. Consequently, the necessary vegetable oil technology expertise – from pressing the fuel to the various conversion options – is readily available.

Conversion

Almost every diesel engine can be run on vegetable oil once it has been successfully converted. In fact, a few tractor manufacturers already offer vegetable oil powered tractors. In most cases, however, tractors must be converted. Following a meeting with the farmer and a thorough assessment of the tractor, a conversion plan is devised. During this process, the vehicle’s current condition (such as fuel injection pump, engine data, etc.) is determined and appropriate servicing is accomplished. This is an essential prerequisite for deciding whether or not the vehicle can be converted and which conversion system will be used. Where tractors are concerned, the equipment’s total number of operating hours represents a particularly decisive factor.

Technical details

Only diesel vehicles can be converted, and two different conversion systems are available: (a) one-tank system and (b) two-tank system.

One-tank system

With this system, the main tank is filled with vegetable oil. Smooth running can be guaranteed to a temperature of -15°C. If lower temperatures prevail, the system can be preheated to enable starting at temperatures below -15°C.

Two-tank system

Here, a smaller tank is used for diesel while the main tank is used for vegetable oil. The engine is started using diesel, and once the optimum running temperature is reached, operation is switched to 100% vegetable oil. The two-tank system is the conversion option preferred by HUBER Agrar & Alternativ Technik.

The two-tank system with fuel preheating is a tried-and-true conversion solution for running diesel engines with untreated vegetable oils. Available in different designs, the conversion system is suitable for almost all diesel vehicles.

The main components of this conversion kit include:
- Controller
- Certified additional tank (optional)
- Electrical switch unit
- Electrical fuel preheating
- Heat exchanger
- Control electronics
- Pre-assembled cable set
- ATG controller (approx. 7 x 5 cm)

The additional tank is available in different shapes and sizes to permit retrofitting of a variety of vehicles. The electrical switch unit alternates between the fuel tanks and rinses the fuel system. To protect the cold engine and its injection system, cold starting generally relies on diesel fuel.

Once the required engine running temperature has been reached, the system automatically switches over to vegetable oil operation. The transition from diesel to vegetable oil is smooth. In combination with the electrical fuel preheater, the heat exchanger warms the vegetable oil to an optimum temperature. The heated fuel travels to the injection pump from which it is misted by the injection nozzles. This allows easier ignition and more complete combustion of the vegetable oil, thus saving fuel and protecting the engine.
As long as the engine remains at operating temperature, it can be stopped while in vegetable oil mode and restarted. If the vehicle’s engine will remain stopped for more than an hour, the tractor must be switched back to diesel mode shortly beforehand. An automatic quick-rinse feature cleans the piping system and injection pump with diesel, thus ensuring that the cold engine can be started later without problem. Conveniently, a brief warning signal reminds forgetful operators to switch back to diesel.

**Conversion costs**

Prices for conversion kits range from € 600 to € 3,000 for automobiles and from € 1,000 to € 8,000 for tractors. Essentially, the costs involved are related to engine size and/or the number of cylinders. Installation expenses must be added to these costs.

**Example:** Conversion of a Deutz-Fahr tractor, 120 HP, 4 cylinders, 2-tank system

<table>
<thead>
<tr>
<th>Conversion costs (excl. VAT)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion kit (xy)</td>
<td>€ 3,000</td>
</tr>
<tr>
<td>Installation</td>
<td>€ 2,000</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td><strong>€ 5,000</strong></td>
</tr>
</tbody>
</table>

**Amortisation**

The financial viability of converting a vehicle to operate on vegetable oil is influenced by the following factors:

- Level of investment costs
- Fuel savings when using vegetable oil compared to diesel
- Amount of fuel required annually

The greater the annual distance travelled or the higher the operating hours, the faster the investment will pay for itself. For this reason, the annual distance travelled should be around 30,000 km for a car, while the annual operating time should amount to approximately 400 hours for a tractor.

For obvious reasons, the price difference between diesel fuel and vegetable oil is a primary factor where financial viability is concerned. Thus, that difference should amount to at least 30 cents per litre.

**Example:** Amortisation for a Deutz-Fahr tractor, 120 HP, 4 cylinders, 2-tank system

- Conversion costs: € 5,000
- Price difference to diesel: 30 cents/litre
- Operating hours: 400 hours
- Average fuel consumption/hour: 8 l
- **Amortisation:** 5.8 years

Amortisation = cost of conversion / (diesel price – rape-seed oil price) x annual fuel consumption in litres x 0.9

**After conversion**

Converted vehicles can still be run on diesel should no vegetable oil be available. As a rule of thumb, engine oil change intervals become shorter (halved at most). For automobiles, an oil change is recommended at 15,000 km and for tractors at around 300 operating hours. There is, however, a very simple test that can be used to determine oil change intervals.

Place a drop of engine oil on a round piece of paper with the dipstick. If an outer ring forms, the oil needs to be changed. If not, the engine oil can continue to be used.

**Advantages of conversion**

Expert conversion ensures that the automobile or agricultural vehicle will run smoothly. In addition, an insurance policy can be purchased to provide protection against any conversion-related problems.

Particularly for farmers, conversion is an interesting alternative as they only need to pay the pressing costs and the expenses related to fuel transportation if there is no vegetable oil fuelling station in the immediate vicinity. The exhaust gas levels required for approval can be achieved without difficulty. Additional consumption due to the differing energy density is marginal: 1 litre of vegetable oil has almost the same energy density as 0.94 litres of diesel.
Environmental considerations and positive consequences for the region

Vegetable oil is a locally produced and environmentally sustainable fuel. The ecological footprint indicates how many square metres of land are needed to naturally break down the emissions and imissions generated during the production, transport and use of energy. Essentially one passenger kilometre fuelled by diesel entails a land use of 58 m²/year of the earth’s surface. In comparison, fuel made from rapeseed needs only one-third of that area, or 20 m²/year.

The regionality of vegetable oil is also a considerable incentive. The local agriculture is stimulated and benefits from the cost effectiveness of locally produced fuel. As a result, fuel supply dependency is reduced and a certain degree of self-sufficiency is achieved. The decentralised production of oil helps to create regionalised feedstuff potential, which can be exploited by local farms. The shorter fuel transportation distances and lower overall energy use mean that newly created material flow and value cycles can be utilised to the best possible effect.

### Ecological footprint by fuel type

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Ecological Footprint (m²/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel (fossil)</td>
<td>58</td>
</tr>
<tr>
<td>RME (60% waste oils)</td>
<td>35</td>
</tr>
<tr>
<td>Rapeseed oil (VO)</td>
<td>32</td>
</tr>
<tr>
<td>Rapeseed oil (VO upstream chain)</td>
<td>20</td>
</tr>
<tr>
<td>Biogas (refined)</td>
<td>14</td>
</tr>
<tr>
<td>Camelina oil (VO upstream chain)</td>
<td>12</td>
</tr>
</tbody>
</table>

*0 6 12 18 24 30 36 42 48 54 60 m²/year per passenger kilometre*