Biofuel for Transportation:
Adapt the Motors to the Fuel

by Preben Maegaard, Folkecenter for Renewable Energy, Denmark

The first initiatives for more ecologically friendly cars are not coming from the well established car manufacturers. These companies, in spite of their enormous research and development capacity, are just in the process of starting to develop prospective solutions to replace a vehicle technology that, in reality, has not changed during the last 60-70 years.

An example of a new solution from a smaller company is the Elsbett engine. It was developed by a talented German engineer, Ludwig Elsbett, who established *Elsbett-Konstruktion* in 1964 - an institute for development of engines - situated in Hilpoltstein near Nürnberg, Germany.

The Elsbett engine runs on pure vegetable oil. This is not possible for a normal diesel engine, because the glycerol from the oil will deposit half-burned hydrocarbons in the cylinders of the engine. It is possible to remove the glycerol from the oil by a chemical methyl ester treatment. The treated oil, which can be used in normal diesel engines, is known as biodiesel or RME (Rapeseed Oil Methylester). Unlike vegetable oils used in cooking, RME is poisonous and contains carcinogens.

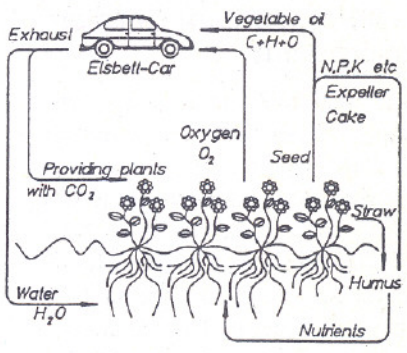
Elsbett has developed motors for many different purposes. Presently a few hundred cars are running with Elsbett engines in Bavaria. They are running on pure rapeseed oil that is pro-

Environmental Impacts

Unlike diesel oil and RME, the Elsbett engine fuel is not poisonous. This type of oil can be used to fuel the car and for cooking. It can be stored for long periods, and there is no special safety regulation needed for storage and transportation.

Spillage of plant oil has very little environmental effect. This is one of the reasons behind the demands from German and Austrian authorities to use Elsbett engines for pumps in wetlands near the Bodensee and for cogeneration systems for hotels in the Alps. This is also why a number of German farmers are having their tractors rebuilt with Elsbett engines.

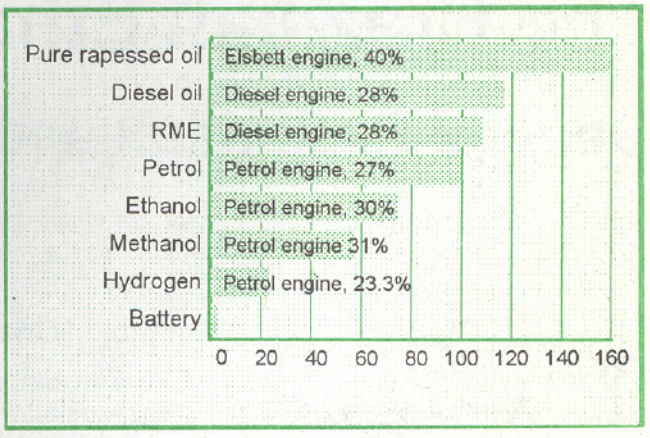
It is argued against the use of rapeseed oil that increased use of this oil will result in increased emissions of N_2O (laughing-gas) from the fields; N_2O is a greenhouse gas with an expected effect much larger than that of CO_2. This argument is based on an analysis of the *worst case*, when the rape is grown with artificial fertilizer and the resulting oil is processed into RME and used in a low-efficiency diesel engine. With artificial fertilizer, the soil gets extra nitrogen. Furthermore, the fertilizer is produced using fossil energy. In this case, there will be a net input of nitrogen and increased production of laughing-gas. If the land is farmed organically, it remains in balance. This is true for fields with organically grown food, and will also be true for organically grown biofuels.



Closed natural cycles
of Carbon, Hydrogen, Oxygen and Nutrients

The emission of NO_X is 10% higher per unit of emission for an Elsbett engine compared to that of a normal diesel engine; but because the efficiency is higher, the total emission for a given energy production is lower. Consequently, the Elsbett engine turns out to be better also as regards NO_X emissions.

duced at the farms and delivered to special filling stations, where it is sold for about 0.80 DM/liter. The engine for cars has 3 cylinders with a total volume of 1,500 cm^2 and is equipped with a turbo-charger. At the institute in Hilpoltstein, cars are rebuilt by changing the original engine to an Elsbett engine. In addition to the car engines, Elsbett makes small plant-oil-fuelled cogeneration systems for heat and electricity.



Comparing action radius for a vehicle with a given volume of fuel; but with different fuel and engine types. The petrol engine is used as basis = 100%.

The Elsbett engine runs on pure vegetable oil. The oil can be used to the fuel the car or for cooking.

Large Perspectives

The Elsbett engine has far-reaching possibilities, especially in the tropical developing countries, where this technology will be very valuable because it uses natural plant oils. All over the tropics there are plants with high oil contents from which the oil can be derived locally. The ordinary oil-palm can give 7,000 kg oil/hectare in a year, and many other plants have yields above 2,000 kg oil/hectare.

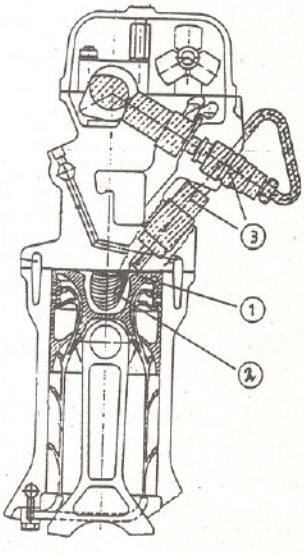
In Denmark and other Western European countries, agricultural lands are taken out of production because of over-production. In Denmark alone, 200,000 hectares of agricultural land are not in use. On this land, rape can be grown organically with a yearly production of about 1,000 kg rapeseed oil. Thus, this area can supply organically grown fuel to 400,000 cars, each running 10,000 km/year.

It is part of the Folkecenter's 1994 Program of Action to work more on biofuels, including plant-oil engines for transport and cogeneration of heat and power. At the Folkecenter, we have replaced an ordinary car with a VW Passat with Elsbett engine to introduce and demonstrate this technology in Denmark. Following this, we are planning to start a permanent collaboration with the Elsbett Institute.

Based on articles by Preben Maegaard in Bioenergi 15, June 1994, Denmark and Vedvarende Energi og Miljø 3/94, Denmark. Shortened and translated by Gunnar Olesen.

The Technology

To burn the glycerol that is in the plant oil, without the formation of deposits in the engine cylinders, the Elsbett engine has a special injection system combined with a spherical combustion chamber placed in the piston. This construction gives combustion with a high-temperature core surrounded by a layer of colder excess air. In this way, there are low heat losses to the walls of the cylinder and the glycerol is burned without leaving deposits on the walls.



The piston is made of two parts. The upper part, which includes the combustion chamber, has a small surface facing the cylinder walls, and therefore has reduced heat transfer to them. This part, which also holds the piston rings, is made of cast iron, which can stand the high temperatures. The lower part of the piston is made of aluminum, and the total piston has a lower weight than a normal piston made in one piece.

An ordinary car engine has an efficiency below 30%, while that of the Elsbett engine is about 40%. The high temperatures make the engine capable of working with many types of fuel, like rapeseed oil, fish oil, and used cooking oil as well as ordinary diesel oil. The high efficiency gives a 30% better mileage.

In a petrol engine, 28% of the combustion heat is removed by the coolant. In a diesel engine, this figure is about 30%. In an Elsbett engine only 14-16% of the combustion heat is removed from the cylinder. This is done by oil cooling, which is simpler and more reliable than water cooling. The rest of the excess combustion heat, about 40%, remains in the exhaust gas. The engine can be characterized as exhaust-gas cooled, which makes it especially suitable for cogeneration, because it can deliver more heat at high temperatures (4-500°C).