Preliminary Observations of Using Palm Oil As Fuel for Cars Fitted with Elsbett Engine

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INTRODUCTION

Automobiles consume a high proportion of fossil oil which is a significant contributor to major global problems such as oil supply and through the associated emission, to global warming, acidification and urban air pollution. Several approaches in dealing with these problems involving automobiles must include their fuel economy, emissions and choice of fuel. In 1983 a symposium on vegetable oils as diesel fuels revealed that vegetable oils have good potential as alternative fuels if the problems of high viscosity, low volatility and the reactivity (polymerization) of the unsaturated hydrocarbon chains can be overcome.

The Elsbett engine was first introduced to Malaysia in 1984. It started with a joint study between Elsbett Konstruktion Germany, Mitsui of Japan and PORIM. In that joint study, four units of Elsbett engines were brought in to undergo trials to determine suitability of neutralised palm oil and palm diesel as fuel. Two units were used as generator sets running on palm diesel and palm oil as fuel. The other two units were used on two cars; each running on either palm diesel or neutralised palm oil. The palm oil car covered nearly 65,000 km and the palm diesel car covered 75,000 km. The results of this trial seemed to be satisfactory.

Based on that trial, several developments had to be made which includes:

- providing heaters to the fuel lines from the tank to the fuel filters,
- providing starting fuel which filled the injectors before the engine is switched off,
- providing collar heaters to the casing of the fuel filters,
- automatic changing over from starting fuel to crude palm oil (CPO) supply when the CPO fuel is in liquid state.

THE ELSBETT ENGINE

The Elsbett engines used in this trial were developed and manufactured by Elsbett Konstruktion Germany. The technical development of these engines has created the thermodynamic condition required for the use of slow-vaporising liquid fuel. The engineers have developed this engine from the diesel engine concept which had improved the performance, consumption and emission levels. The injection and spraying of the fuel into the combustion chamber by the injector system coupled by the duothermic combustion system developed by Elsbett Konstruktion, create the ideal condition for the burning of different fuels, including vegetable oils. The relevant characteristics as density, viscosity and boiling point became secondary importance to this engine.

To enable palm oil to be used as fuel in diesel engine, it must be able to be pumped through fuel pressure line and injectors in liquid form. The palm oil must also be flammable enough for spontaneous combustion to occur upon compression. This could be met by heating the palm oil in the fuel tank, fuel lines (supply and back flow) and at the fuel filters. Electrical heaters used were powered from the battery. By heating the palm oil reduces its viscosity hence resulting in a smooth flow to the injectors.

Table 1 shows some of the fuel properties of diesel and that of neutralised palm oil. From this table, the heat of combustion of palm oil is 39,600 kJ/kg as compared to 45,800 kJ/kg in the case of diesel. This resulted in higher specific fuel consumption.

To avoid difficulty in morning starting, the cars are equipped with starting fuel and its system. Diesel is used as the starting fuel. When the ignition switch is turned off, the starting fuel pump starts to fill the nozzles with diesel. Thus on igniting the engine again, it starts with the diesel fuel while heating the palm oil fuel. When the palm oil is liquefied the starting fuel pump stops automatically and the valve for the palm oil fuel is switched on. For first time starting in the morning, the time taken for the taking over could be from 60 to 90 seconds. *Figure 1* shows the fuel line system.

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TABLE 1. PROPERTIES OF MALAYSIAN DIESEL AND CRUDE PALM OIL

Fuel Characteristic	Malaysian Diesel	Crude Palm oil (CPO)
Specific gravity	0.8330 @60.0 ^{o} F	0.899 @122 ^{o} F
Sulphur content (%Wt)	0.50	0.02
Kinematic Viscosity @ 55 ^{o}C (CST)	4.0 @37.8 ^{o}C	24.3 @ 55 ^{o}C
Pour point (^{o}C)	15.0	12.8
Final recovery (%)	98.0	
Cetane Index	53	37
Gross heat of combustion (kJ/kg)	45,800	39,600
Flash point (^{o}C)	98	240
Distillation temperature 90% point	3338 max	359
Conradson carbon residue (% wt)	0.14	1.34
Moisture % wt		0.30
Free Fatty Acid (% wt)		3.26
Iodine Value		53-57

TABLE 2. LIST OF PARTICIPANTS

OIL PALM INDUSTRY	
EPA	Chauffeur driven
EAC	Chauffeur driven
Sime Darby	Chauffeur driven
Guthrie	Chauffeur driven
Lam Soon	Chauffeur driven
Bukit Jalil Keratong O P P	Chauffeur driven
LAWYERS	
Dato Kandan	Chauffeur driven
Christina Wong	Chauffeur driven
GENERAL BUSINESS	
Tee Teh Sdn Bhd	Chauffeur driven
Mofaz (M) Sdn Bhd	Chauffeur driven
Perhubungan Sarawak	Chauffeur driven
C A Sheimer (M) Sdn Bhd	Chauffeur driven
Lau Ming	Self driving
Mdm Lee Kui Yok	Self driving
Benard Keet	Self driving
City Computer Centre	Self driving
Chin Leong Thye Sdn Bhd	Self driving
P & G Industries Sdn Bhd	Self driving
Koh Heng Jin Holdings	Self driving

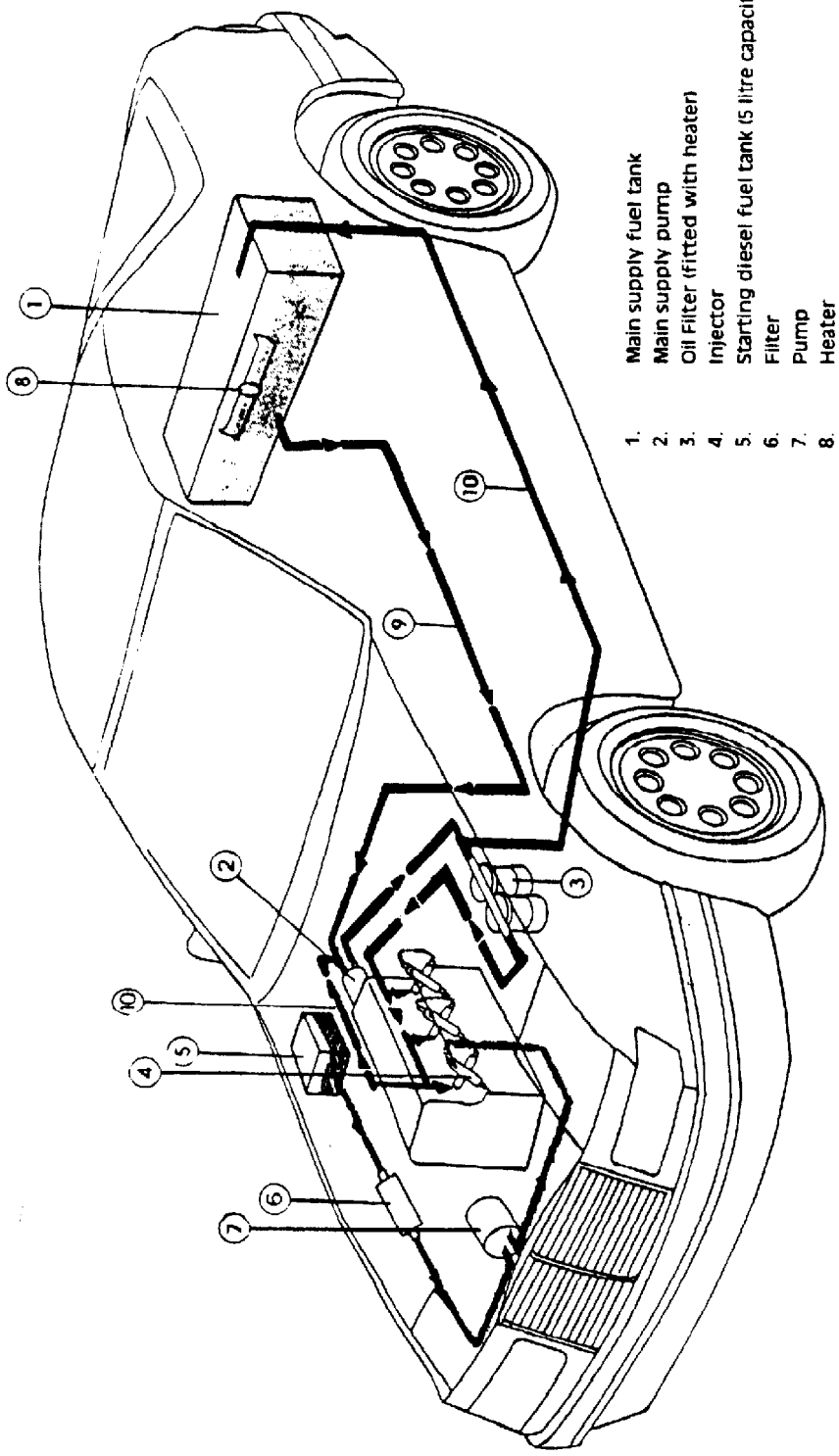

Figure 1. Fuel system of the Mercedes Benz 190D

THE TRIAL

In late 1992, PORIM embarked in a long term, exhaustive field trial in using palm oil as fuel for the Elsbett engines. 20 engines were fitted to twenty Mercedes Benz cars Series 124 for this trial.

The car owners taking part in this trial consist of six from oil palm industry, two lawyers, one official from the government sector and ten businessmen. Twelve of the cars are chauffeur driven *(Table 2)*. Fuels were supplied to their premises in 200 litres drums. The cars were subjected to the normal driving conditions involving both urban and highway driving. At the end of this exhaustive field trial we would be able to determine the possibility of using unprocessed palm oil as fuel in internal combustion engines.

The Objectives

The main objectives of this exhaustive field trial are:

- to assess the capability of unprocessed palm oil as fuel for the Elsbett engine, and
- to monitor the long term effects on this engine in using palm oil as fuel.

Methodology

The trial was scheduled for each car to cover a distance of 300,000 km with provision to dismantle the engines for checking at every 100,000 km. During the stripping of the engines at 100,000 km, wear and tear of moving parts in the engine will be noted. Periodical analysis of the lubricating oil is to be carried out to monitor its properties after running for 5,000 km. This exhaustive field trial records the following data/characteristics to enable the following to be monitored:

- Fuel consumption.
- Fuel filter service life
- Exhaust emissions
- Smoothness of the engine in operation, and
- Cold starting.

A record book is being provided for each car to each driver to fill in order to obtain the above data. The drivers were also interviewed when they send their cars for servicing.

RESULTS

The first car that runs on palm oil as fuel has covered about 80,000 km. On the average, the consumption of these cars is 8 litres per 100 km for city driving and about 7 litres per 100 km for motorways driving.

Fuel filters were monitored closely. It was observed that the fuel filters were in good condition at 5,000 km changing interval when neutralised palm oil was used.

During the initial part of the trial, problems with the sudden stall of the engine from cold starting were experienced. It was later found that the fuel lines were not fully heated, thus there was insufficient fuel going to the engine. After rectification this problem was overcome. All the cars now had their fuel lines fully heated.

Another observation made was on the standard hoses for the fuel lines. These hoses could withstand use up to 30,000 km after which they have to be changed as the ends swelled and caused leakage. This leakage results in intake of air in the fuel lines. These air bubbles had to be removed by hand pump.

CONCLUSION

The preliminary results showed that palm oil under controlled condition could be effectively used as fuel for the Elsbett engine. As long as the fuel can flow smoothly from the fuel tank to the engines, without any hindrance from solid particles or air bubbles the engine should be able to run smoothly.

This smooth running of the engine seems to results in the modification of conventional diesel engine parts which include the development of the nozzle, redesigning of the combustion chamber configuration and the engine cooling system.

None of the engines has been dismantled yet as the highest mileage is only 80,000 km. Thus the effects on engine parts could not be reported.

This trial has shown that palm oil can be used as fuel for indirect injection diesel engine with the above modifications. More work has to be done to use palm oil as fuel on modern diesel engine.

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