COST EFFECTIVENESS OF THE CPO FUEL IN THE MERCEDES ELSBETT ENGINE CAR

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JULY 1992

04

PORIM INFORMATION SERIES

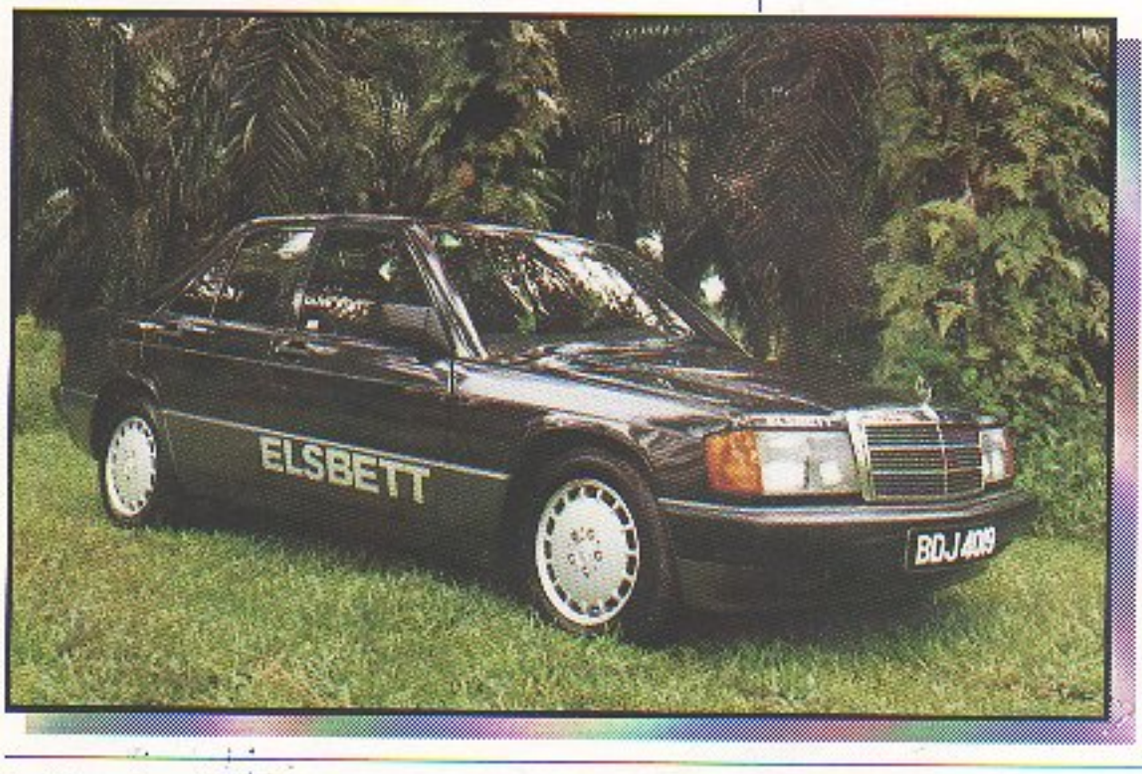
ISSN 0128-5726

It is currently possible to use vegetable oil fuel to run cars which have been fitted with new or suitably modified diesel engines. In this connection, PORIM has experimented on a car fitted with the Elsbett vegetable fuel engine and crude palm oil (CPO) has been used exclusively as the vegetable oil fuel in the experiment.

The experimental car has been running for over 35,000 km with no technical problems. While more extensive trials on the CPO fuel would be carried out, and we anticipate that CPO can be utilised technically as a fuel, it is the cost of using CPO fuel that will be the determining factor for its wide scale adoption as an alternative fuel for the future. In this paper, we have attempted to evaluate in a preliminary way, the comparative costs of using the Elsbett engine and the CPO fuel.

THE OPERATION OF THE ELSBETT VEGETABLE OIL ENGINE

The Elsbett engine can be readily fitted to several car models to allow the car to run on vegetable oil fuels or on normal petroleum diesel. PORIM experimental car is the Mercedes 190D model that has been fitted with the Elsbett 1.45 litre three cylinder engine having a power capacity of 60 kW (80 hp). The fuel consumption is rated at 6 litres per 100 km or 7 litres per 100 km in town driving on average. The engine is offering 30% more power compared with diesel engines of similar capacity and consequently there is a lower fuel consumption.



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ANALYSIS OF COMPARATIVE COSTS

The price of palm oil tends to fluctuate more than the price of diesel and consequently the comparative cost comparison of the two fuels will be influenced by the price variability. It is then necessary to make the comparison on a range of possible prices of palm oil as experienced in the past and the operational cost of using the two fuels can then be plotted on a graph for a better comparison.

The comparative cost of using the fuel can be evaluated based on the three components making up the total operational cost. These are :-

- Comparative Running Cost
- Comparative Capital Cost
- Environmental and other Computed Costs.

COMPARATIVE RUNNING COST

Given that the density of palm oil is 0.8925 at ambient temperature, the volume of a tonne of palm oil is 1,120.45 litres. At the present palm oil price of about $900 per tonne and at a fuel consumption of 6 litres/100km, the fuel cost is calculated to be 4.8 cents per km. At other palm oil prices, the resultant cost per km can be computed and these are indicated in *Table 1*.

Compared to normal diesel engine of power output 60 to 75 kW (80 to 100 hp) such as the Mercedes 250D model, the fuel consumption is 9 litres/100 km and given the diesel price at the petrol pump as 65.3 cents per litre, the running cost is 9 x 65.3c/100km = 5.87 cents per km.

Based on equivalent power of engines, the CPO Elsbett engine is running at 4.8 c/km compared to 5.87 c/km for normal diesel engine. A lower running cost for the CPO Elsbett engine is achieved even when the CPO price is relatively high at $900/tonne or 80c/litre. The variation for running cost with different levels of CPO prices is shown in *Table 1*. It is seen in *Figure 1* that the present Elsbett engine offers a lower fuel cost even when the price of palm oil is relatively high.

TABLE 1: COMPARING THE FUEL COST PER KILOMETER

CPO Price $/tonne	CPO Fuel c/litre	CPO Elsbett Fuel Cost c/km 6 *l*/100km	CPO Elsbett Fuel Cost c/km 7 *l*/100km	Normal Diesel (250D) Engine Fuel Cost c/km 9 *l*/100km
1100	98	5.88	6.86	5.87
1000	89	5.34	6.23	5.87
900	80	4.80	5.60	5.87
850	76	4.56	5.32	5.87
800	71	4.26	4.97	5.87
750	67	4.02	4.69	5.87
700	62	3.72	4.34	5.87
650	58	3.48	4.06	5.87
600	54	3.24	3.78	5.87

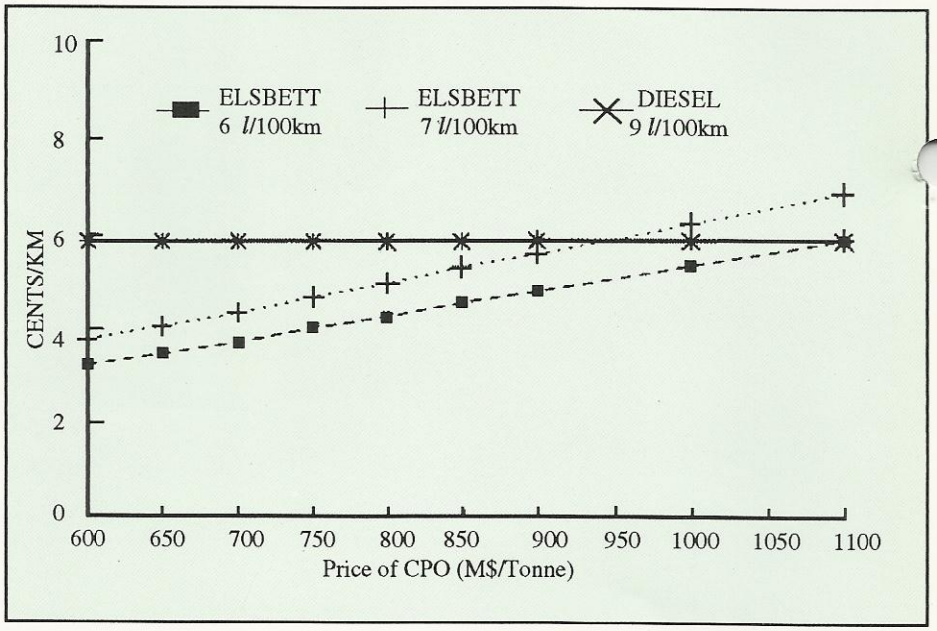

Figure 1. Comparative Running Cost of CPO Engine

Note:
Fuel consumption for Elsbett Engine is 6 litres/100km or 7 litres/100km in town driving compared to 9 litres/100km for the Mercedes 250 D.

CAPITAL COST

Presently, the cost of an Elsbett 1.45L CPO engine with fittings is $50,000.00 each. This high price is because of limited production of the engine. Such engines produced on a commercial scale could be cheaper. In comparison, a typical diesel engine of similar power such as 250D costs about $60,000.00 each.

The Elsbett engine itself is smaller and lighter than the 250D engine, and since there are only 3 cyclinders, there are less components. On a commercial production basis, it is reasonable to assume that the Elsbett engine would cost much less than a conventional diesel engine because the former has no conventional cooling system, does not need the same heavy support structure, and has an injection system that works at a lower pressure. (The Elsbett engine uses the engine lubricating oil as its cooling mechanism).

The potential capital cost of the engines can be compared based on a depreciation cost spread over 300,000 km of usage. At present prices, the depreciation cost assumming 300,000 km for the Elsbett engine is :

$$\frac{50{,}000}{300{,}000} = \$0.167/\text{km or } 16.7\ \text{c/km}$$

while the normal equivalent diesel engine (Mercedes 250D) depreciated over 300,000 km would have a depreciation cost of :

$$\frac{65{,}000}{300{,}000} = \$0.217/\text{km} = 21.7\ \text{c/km}$$

The total computed running and depreciation costs are shown on *Table 2*. The Elsbett engine offers a lower operational cost compared to the 250D Mercedes diesel engine even when palm oil price exceeds $1100/tonne.

TABLE 2: COMPARISON OF RUNNING AND DEPRECIATION COSTS BETWEEN THE TWO ENGINES.

CPO Price $/tonne	CPO Fuel c/litre	CPO Elsbett Engine (Running & Depreciation) c/km 6 *l*/100km	7 *l*/100km	Normal Diesel Engine (Running & Depreciation Cost) c/km 9 *l*/100km
1100	98	22.58	23.56	27.6
1000	89	22.04	22.93	27.6
900	80	21.50	22.30	27.6
850	76	21.26	22.02	27.6
800	71	20.96	21.67	27.6
750	67	20.72	21.39	27.6
700	62	20.42	21.04	27.6
650	58	20.18	20.76	27.6
600	54	19.94	20.48	27.6

The plots of total costs for the two engines are shown below :

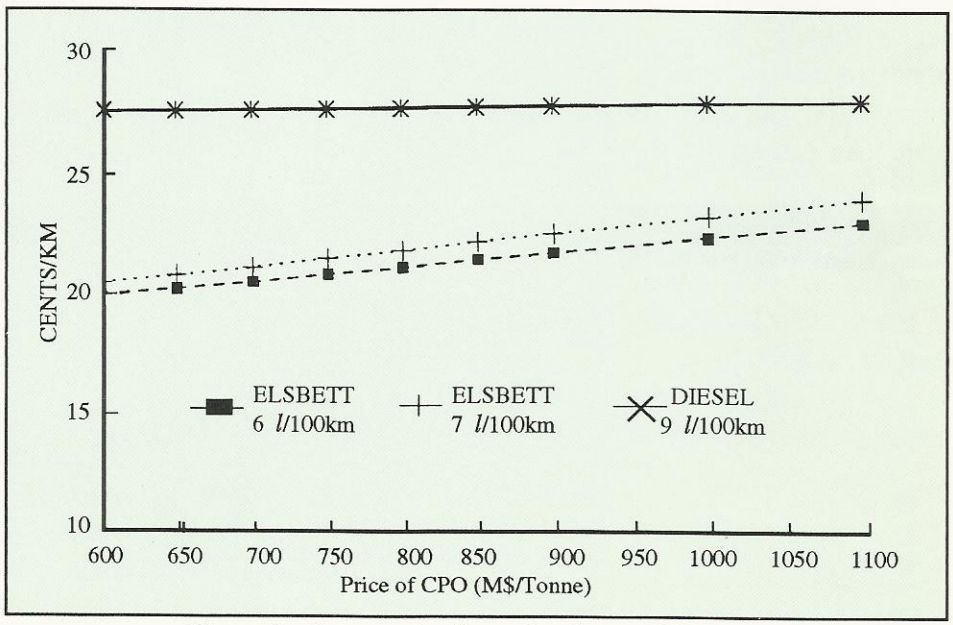

Figure 2. Comparative Operational cost of CPO engine

ENVIRONMENTAL AND OTHER IMPLIED COSTS

The CPO fuel is new, and users may not have the convenience of the fuel being available at all fuel stations. Cost of transportation and distribution at the fuel station pumps is estimated at 5 c/litre or 0.3 to 0.35 c/km for the Elsbett engine. This does not change the favourable running or operational costs of the Elsbett engine as shown in *Table 1* and *Table 2*. For the time being, users may have to carry spare fuel which can be used to cater for adhoc shortages. Otherwise the supply of CPO should be in drums at the house or location at where the car is kept. As the fuel tank of the Mercedes car is 70 litres and lasts for a journey of 1,000 to 1,400 km, there is essentially no big need to refuel halfway for normal medium distance journey in Malaysia, and the car can be refuelled at base. Owners could fill their own tanks using suitable hand pumps.

The financial value of the environmental friendly nature of the fuel cannot be easily costed. Exhaust fumes from the CPO engine are cleaner as essentially there are no sulphur or metallic oxides present compared with petroleum diesel fuel. Lower use of fossil fuel in itself may be beneficial as conservation objectives are obtained. The concept of renewable fuel is interesting as the CO_2 generated by the engine is counter-balanced by the CO_2 absorbed by the palms during photosynthesis.

The flash point of CPO is about 240^{o}C; this value is much higher than that for diesel fuel of 52^{o}C. This means that the storage and the transportation of CPO is safer, requiring a lower safety standard; hence cheaper handling and storage charges.

CONCLUSION

From the experiment so far carried out, the Elsbett engine has demonstrated its suitability for the passenger car. It also showed that CPO can be used as fuel. Handling of this fuel is safer and requires no stringent safety precautions. The potential of using the engine in other vehicles such as farm machinery should also be evaluated.

The running cost (i.e. fuel cost) of this Elsbett engine depends on the cost of CPO. From the analysis, it seems that with the present price of diesel fuel ($0.653/liter), the CPO fuel remains economical to use even when CPO price is as high as $1,100/tonne.

The depreciation costs over 300,000 km of Elsbett engine of equivalent power seems to be much lower than that of the conventional diesel engine. This difference will be more pronounced if the Elsbett engine is mass produced.

The burning of CPO as fuel, like any vegetable oil, produces CO_2 and moisture as exhaust emissions. The CO_2 emissions are taken back by plants; hence theoretically, no excessive emissions are thrown into the atmosphere as pollutants.

It is envisaged that vegetable oil will be the fuel of the future as the energy is renewable, environmental friendly and in case of CPO the production is all year round thus ensuring supply stability. The Elsbett engine seems to be capable of running economically on palm oil and provides vast opportunities for using palm oil as a source of alternative fuel for the future.

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