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Ethyl Ester of Honge Oil and Palm Oil Blends with Diesel as an Ecofriendly Fuel in Heavy Duty Vehicles: An Investigation

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The blends of ethyl esters of pongemia oil (Honge oil) and palm oil are prepared by blending/mixing esters directly 10–20% by volume with diesel (HSD) and the results were quite encouraging leading to 21% mileage improvement in honge oil ester diesel (HOED) 10% blend compared to palm oil ester diesel (POED) 10% blend. But both are the selective improvement blends compared to diesel. Thus HOED 10% shows 72% improvement and considerable reduction of exhaust emissions compared to 64% improvement in POED 10%. The best performance blend compared to HSD is HOED, and it has high calorific value, one of the oil derivatives leading to smooth drive of the vehicle/engine causing less wear and tear.

Key Words: Ethyl ester, Honge oil, Palm oil, Fuel.

INTRODUCTION

The conventional mineral oil fuels such as petrol and diesel are fast depleting; the fuel reserve available now may not be sufficient to meet the demand or need of the near future. Besides the search of fuel for the future, pollution has increased to alarming levels due to overcrowding population of vehicles on roads. Economic prosperity has forced the public to use 2 wheelers/4 wheelers etc. in large numbers. Under the circumstances, the need of the day is to promote an advent of new alternatives for fuels. Although a number of other alternatives such as solar, electric motors are available, they are not economically viable. Thus thrust is on operating the existing engines with alternative fuels with some minor modifications. A number of investigations have been made using blends of vegetable oils which are mostly non-edible in nature[1–6]. The abundance of edible oils and ease of handling enables us to supplement existing conventional fuel to a great extent. This expanded use of edible oils or their derivatives as fuels, if not as substitutes but as blended fossil fuels can help to reduce imports and also aid the growth of our agriculture economy by minimizing the particulate matter in exhaust emissions due to less sulphur content in these blended alternative fuels. The main intention of this investigation is to evaluate the performance of ethyl edible oil and non-edible oil ester blends in diesel engines.

The focus has been made on utilizing the available resources from agro based materials and also byproducts of sugar industry to make more efficient, less polluting and high performance alternative fuels in place of diesel. Even though several research projects have been carried out on the ethanol-diesel blends[7] and ethanol vegetable oil blends[1–5]. There is not much information about the usage of ethyl ester blends with diesel in general and ethyl edible oil and non-edible oil blends with diesel in particular. Thus ethanol and ethanol derivatives are one of the possible alternate fuels for diesel replacement in compression-ignition engines (CI). Besides being a biomass based renewable fuel, oxygenated fuel which has high calorific value and high cetane number (>52) strengthens the agricultural economy and reduces the diesel fuel requirement and thus reduces environmental pollution contributing in conservating the major commercial energy sources; thus the study of ethyl-groundnut oil, sesame oil-ester blends with diesel gains importance as an alternative safe solution and evaluation of this additive is to asses the improvement in Brake Specific Fuel Consumption (BSFC) and reduce in smoke emission and high thermal efficiency with increase in output by using these alternate fuels.

EXPERIMENTAL

- The ethyl esters of honge oil and palm oil are prepared by transesterification and purified by double distillation.
- Moisture removal techniques using alumina and korumud (a silica material collected from Gulbarga), molecular sieves column packing.

  Transesters of honge oil and palm oil and its blends are passed through a column; korumud absorbs the moisture contents and alumina absorbs small traces of acids or bases. Fuel from the outlet is free from moisture, acidity and impurity (Fig. 1).
- To identify the functional group of the ester and moisture content present in the blended fuels. FTIR spectra of the samples were taken in KBr medium(Figs. 2–5).

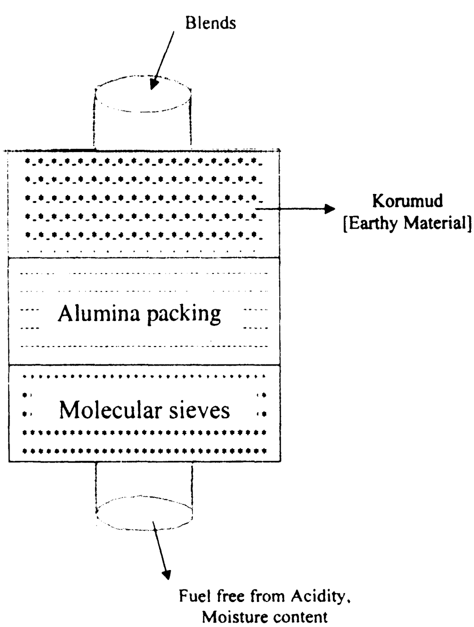


Fig. 1. Purification of ethanol derivative blends with diesel

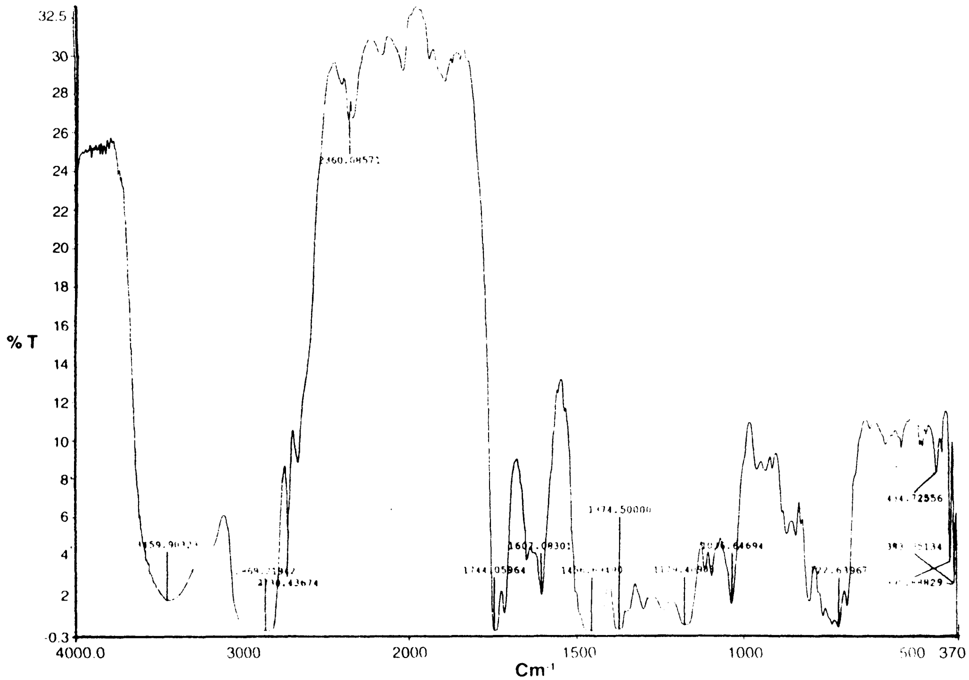


Fig. 2. FTIR spectra of HOED (10%)

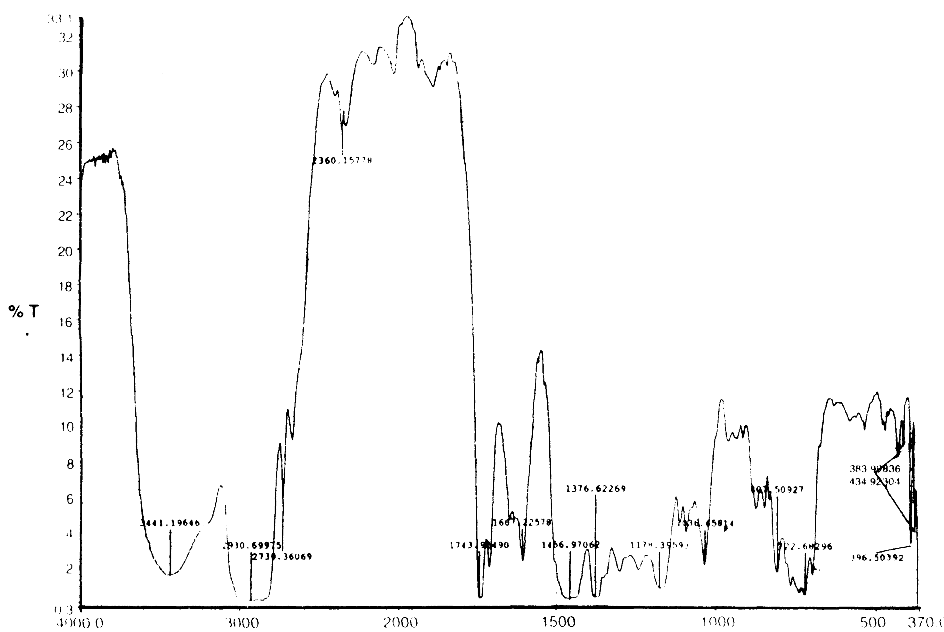


Fig. 3. FTIR spectra of HOED (20%)

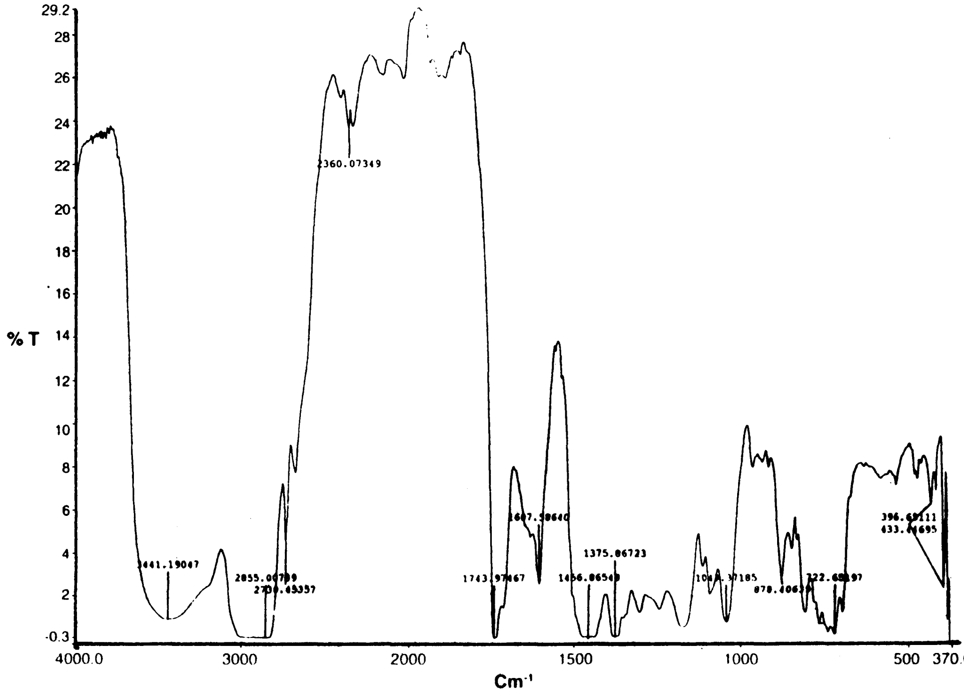


Fig. 4. FTIR spectra of POED (10%)

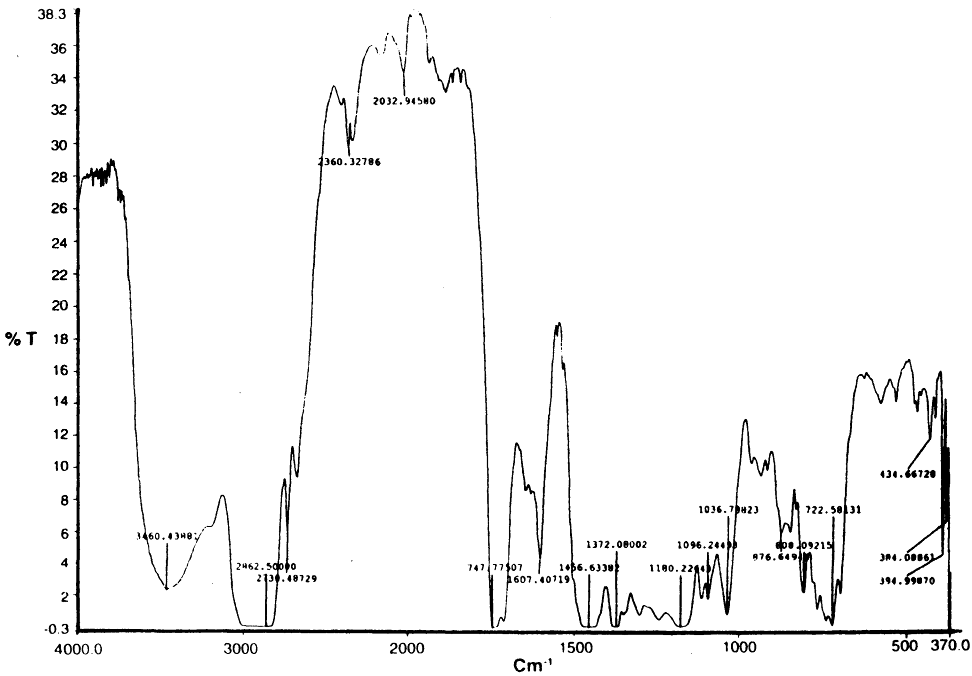
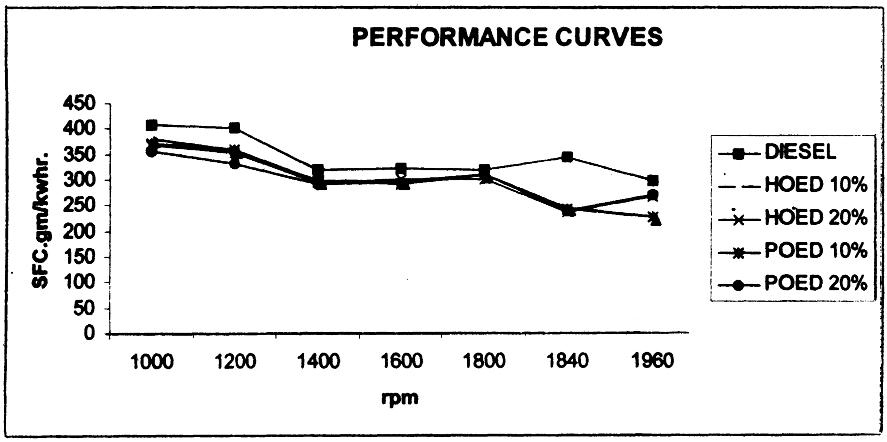
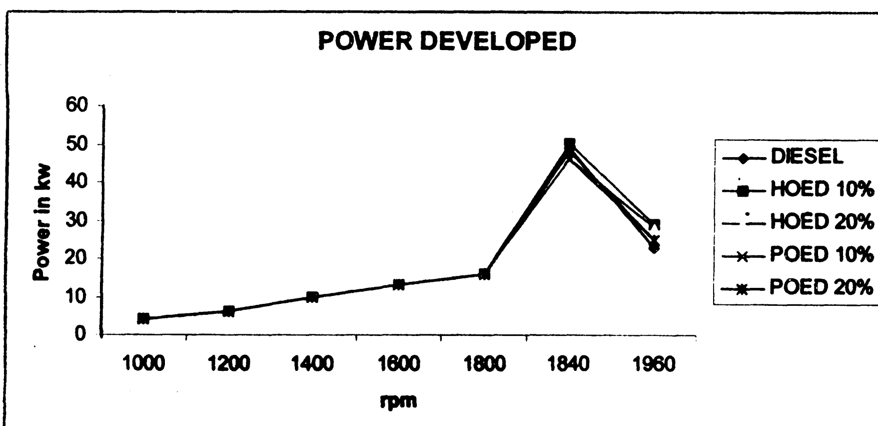


Fig. 5. FTIR spectra of POED (20%)

- Blends of ethyl ester of honge oil and palm oil are prepared by blending ester 10%, 20% by volume with diesel (HSD).
- Calorific values of blands (HOED 10%, HOED 20%, POED 10%, POED 20%) are calculated by using automatic bomb calorimeter AC 350 (Lecomake) at central power research institute (CPRI) Bangalore Table-1, (Fig. 6), *i.e.*, HOED = Honge oil ester diesel blend, POED = Palm oil ester diesel blend.
- Basic fuel test reports for blends from IOCL (Indian Oil Corporation) at Korukkpet, Regional Laboratory, Chennai (Table-2).
- Basic test bid trials were conducted on Hino engine at Kengeri regional workshop, KSRTC Bangalore. Performance curves were plotted (Graphs 1, 2)
- Blends were put on training vehicle of Karnataka State Road Transport Corporation (KSRTC), vehicle number KA-09F2677. Replacement of



Graph 1. Relations between specific fuel consumption and full load rpm for different fuels



Graph 2. Horse power developed by engine using different blends and diesel at different rpm

diesel, to check the mileage and percentage of improvement in comparison with diesel are tabulated. Here regular full load governed speed is 1960 engine RPM (Table-3).

- Smoke meter AVL-437 is used to check the opacity, *i.e.*, smoke density in terms of particulate matter is measured and percentage improvement is given. (Table-4).
- Fuel tests were conducted at IOCL (Indian Oil Corporation) at Chennai (Table-2).

TABLE-1
GROSS CALORIFIC VALUE OF DIESEL AND OIL ESTER BLENDS

Sample	Gross calorific value (kcal/kg)
Diesel	10004
Honge oil ester 10% + 90% diesel	10398
Honge oil ester 20% + 80% diesel	10359
Palm oil ester 10% + 90% diesel	10410
Palm oil ester 20% + 80% diesel	10312
Palm oil pure ester	8902
Honge oil pure ester	8896

TABLE-2
PROPERTIES OF DIESEL AND OIL ESTER BLENDS

Characteristics	Diesel 1	HOED (10%)	HOED (20%)	POED (10%)	POED (20%)	(P) of I.S. 1448
Specific gravity at 60°F	0.8500	0.8902	0.8908	0.9040	0.91	P : 2
Cetane No	50	52	51	53	54	P : 9
ASTM density 15° C kg/m^3	835	838	841	842	824	P : 32
Flash point °C min	36	39	41	40	40	P : 20
Distillation 90% vol. recovery °C min	90 mL 335	90 mL 343	90 mL 342	90 mL 330	90 mL 332	P : 18
Kinematic viscosity at 40°C cst	2.52	2.92	3.20	3.09	3.02	P : 25
Water content % by volume	0.03	0.01	0.01	0.01	0.01	P : 40
Ramsbottom carbon residue % m/m	0.35	0.14	0.15	0.24	0.23	P : 8
Ash content % m/m	0.010	0.002	0.001	0.008	0.009	P : 4
Sulphur content weight %	0.25	0.18	0.19	0.10	0.08	P : 33

TABLE-3
EFFECT OF DIESEL AND OIL ESTER BLEND ON MILEAGE IMPROVEMENT IN A HEAVY DUTY BUS

Particulars	km/L	Improvement (%)
HOED (10%)	7.00	21
HOED (20%)	6.90	20
POED (10%)	6.20	14
POED (20%)	6.59	16.59

Note: Results are based on performance of engine while running on high speed diesel which has an yield on 5.5 kmpl

TABLE-4
BURNING QUALITY & EXHAUST EMISSION OF THE DIESEL AND OIL ESTER BLEND FUEL

Particulars	1st smoke mean value	Smoke value with blend	Difference	Improvement (%)
Diesel	36	—	—	—
HOED (10%)	36	26.2	9.8	72.78
HOED (20%)	36	25.4	10.6	70.56
POED (10%)	36	23.2	12.8	64.40
POED (20%)	36	23.4	12.6	65.00

RESULTS AND DISCUSSION

Table-1 shows that calorific value of HOED and POED blended fuels is greater than pure diesel (HSD). This shows that higher calorific values give less fuel consumption. Pure esters of palm oil and honge oil can also be used as a substitute to the diesel because it has high calorific value compared to diesel resulting in complete combustion of fuel.

Table-2 shows that basic fuel tests were done on blended fuels, *i.e.*, cetane number is enhanced; as cetane number increases (45–55), delay period decreases, compression ratio increases (density of air increases), which has an excellent ignition quality with high self-ignition temperature. Due to high volatility of these ethyl derivatives better mixing of air and fuel takes place. It affects both power and efficiency and gives less fuel consumption (refer performance curves). Here in the blended fuels water content per cent by volume is less (0.01%) compared to diesel. This complete reduction of moisture content is due to purification of ester by korumud. Sulphur content is low compared to diesel; this will avoid sulphur dioxide formation during combustion of fuels. Because it produces little soot (particulate matter), smooth running of engines due to its oil derivatives (lubricant), it is one of the ecologically sound and safe alternate fuels.

Table-3 indicates 14–21% increase in mileage compared to diesel by fueling blended HOED and POED fuels due to its high calorific values with less fuel consumption. Optimum blends of ethyl esters of oil and diesel based on trade off particulate matter and NO_x increases as the blends of ethyl ester increase above 20% by volume due to its high self-ignition temperature. Fueling with these ethyl derivatives of pongemia oil (Honge) and palm oil strengthens the agriculture economy and reduces environmental pollution.

Table-4 indicates that the performance of blended fuels put on heavy duty results in 64–72% improvement in smoke reduction. Performance curves (Graphs 1 and 2) shows that fuelling with HOED and POED 10%, 20% blends on HINO engines Break Specific Fuel Consumption (BSFC) is decreased when compared to diesel alone and power developed is more or equivalent to power developed by diesel when fuelling with blended mixtures. So by this thermal efficiency increases.

The FT infrared spectra of POED 10%, 20%, HOED 10%, 20% (Figs. 2–5) show presence of moisture content ranging from 3200 to 3,700 spectrum range of wave number, presence of (C═O) functional group in the range of 1750–1700 cm^{-1} in all spectra. This blend has a property of absorbance of moisture, *i.e.*, property of hygroscopy.

The range of 3700–3300 cm^{-1} indicates that blends show moisture absorption.

HOED and POED blend has molecules of simple hydrocarbon chains containing no sulphur or less. It is an oxygenated organic carbon compound and it is a renewable bio-based fuel and as such, has lower life cycle CO_2 emissions than diesel derived from mineral oils and reduces the non-soluble fraction of the particles and acts as a lubricity improver, can be used in existing diesel engines and also indicates that blends of 10–20% HOED and POED with diesel in heavy duty vehicles is expected to meet all Euro 3–4 standards. Production of this alternate eco-friendly fuel is based on availability of agricultural feedstock. Kinematic viscosity of these blended fuels has same value as diesel fuels, so this does not affect fuel atomization during injection, it is hygroscopic and its production should be sufficiently standardized.

The analysis of variance indicates that HOED and POED have a little difference in BSFC, is a reflection of the differences in fuel density and calorific values. These findings compare well with those reported earlier for alcohol blends[5]. In order to meet emission regulations, upgradations in fuel quality are being made through blending HOED and POED. These blends reduce carbon monoxide (CO), ozone forming higher hydrocarbons, diesel particulates, acid rain causing SO_2, life cycle carbon dioxide (CO_2).

Conclusion

Ethyl ester palm oil and honge oil blended with diesel act as an ecofriendly oxygenated fuel, with less sulphur content and functioning as an efficient lubricant, an economically and technically feasible substitute fuel to diesel in the transport sector. Ethyl oil ester blended fuel considerably decreases the particulate matter, carbon monoxide (CO); mileage per litre of fuel is increased by 1.5 km as against pure diesel.

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