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Performance of C.I. Engine Using Blends of Methyl Esters of Palm Oil with Diesel

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Abstract: The study of the alternating fuels is necessitated due to increase of particulate emissions and depleting fossil fuel reserves. In this study, the performance and emission characteristics of single cylinder, 4-stroke, naturally aspirated compression ignition engine using alternating fuel like methyl esters of palm oil. The comparison of various properties like viscosity, density, flash point, fire point, cloud point etc. of different mixtures of diesel and methyl esters of palm oil etc. are been examined in this study. Briefly, the suitability of alternating fuels to diesel engines and the problems associated using these is the major study of this project. In the present study, the vegetable oil i.e., methyl esters of palm oil is chosen as alternative to diesel, which is due to its agricultural origin, is able to reduce net carbon dioxide emissions which is the major contributor to global warming along with import substitution of fuel for CI Engine. But the biggest hindrance to the easily adaptation of these vegetable oils is high viscosity and low volatility. In the performance analysis, the acquired data will be useful to predict the thermal efficiency, brake specific fuel consumption, carbon dioxide, carbon monoxide and hydrocarbon and smoke emissions.

Key words: C.I. engine, engine performance characteristics, methyl esters of palm oil, viscosity, volatility

INTRODUCTION

Diesel engines are the major source of transportation, power generation, marine applications etc. Hence, diesel is being used extensively, but due to gradual depletion of fossil fuel reserves and the impact of environmental pollution of increasing exhaust emissions (Bacon *et al*., 1981) there is an urgent need for suitable alternative fuels for use in C.I. engines. In view of this, various oils like jatropa, methyl esters of palm oil, sunflower oil, cotton seed in coconut mahuva oil, deccan hemp oil are considered as alternate fuels to diesel which are promising alternatives because they have the advantages-they are renewable, environmentally friendly and produced easily in rural areas, where there is an acute need for modern forms of energy. If these fuels serve the purpose of diesel to some extent they will be useful to the rural areas in providing employment as well as agriculture energy needs. If these fuels serve the purpose to a larger extent they will be good substitutes for the C.I. engine etc.

From previous studies, it is evident that there are various problems associated with vegetable oils being used as fuel in compression ignition (C.I.) engines, mainly caused by their high viscosity, low volatility, ring sticking and gum deposits (Auld *et al*., 1982). The high viscosity is due to the large molecular mass and chemical structure of vegetable oils which in turn leads to problems in pumping, combustion and atomization in the injector systems of a diesel engine. Due to the high viscosity, in long term operation, vegetable oils normally introduce the development of gumming, the formation of injector deposits, ring sticking, as well as incompatibility with conventional lubricating oils. Therefore, a reduction in viscosity is of prime importance to make vegetable oils a suitable alternative fuel for diesel engines. The problem of high viscosity of vegetable oils has been approached in several ways, such as preheating the oils, blending or dilution with other fuels, trans-esterification and thermal cracking or pyrolysis.

Using methyl esters of diesel fuel extender: Raw vegetable oil is not Biodiesel, which is the ester of vegetable oil produced through a process called trans-esterification this process is reduces the viscosity of the vegetable oil which nearer to the diesel (Barsic and Humke, 1981).

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MATERIALS AND METHODS

A naturally aspirated direct injection diesel engine is more sensitive to fuel quality. Several tests were conducted to characterize methyl esters of Palm oil vis-a`-vis diesel in order to compare various physical, chemical and thermal properties. Various procedures followed and the instruments used are given in Viscosity of methyl esters of Palm oil and diesel was measured

A typical engine system widely used in the agricultural sector has been selected for present experimental investigations (Peterson *et al*., 1981). A single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine was procured for the experiments. The technical specifications of the engines are given in Table 1. The engine operated at a constant speed of 1500 rpm. Fresh lubricating oil was filled in oil sump before starting the experiments.

The engine is coupled with a single phase, 220 V AC alternators. The alternator is used for loading the engine through a resistive load bank. The load bank consists of eight heating coils (1000 W each). A variac was connected to one of the heating coils so that load can be controlled precisely by controlling voltage in one of the coils of load bank. The schematic layout of the experimental setup for the present investigation is shown in Fig. 1.

Table 1: Engine specifications

Make	Kirloskar oil engines Ltd.India
Type	single cylinder DI, NA CI engine
Rated output	3.68 kW at 1500 rpm
Injection timing	26.4 BTDC
Loading device	Variac
Stroke	110 mm
Compression ratio	15: 1
Bore	80 mm

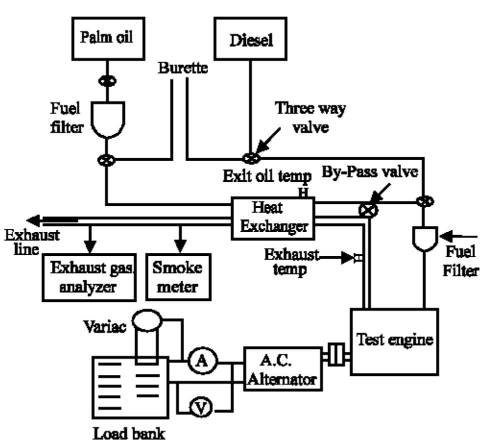

Fig. 1: Schematic diagram of experimental setup

The main components of the experimental setup are 2 fuel tanks (Diesel and Methyl esters of palm oil), fuel conditioning system, heat exchanger, exhaust gas line, by-pass line and performance and emissions measurement equipment. Two fuel filters are provided next to the methyl esters of Palm oil tank so that when one filter gets clogged, supply of fuel can be switched over to another filter while the clogged filter can be cleaned / replaced without stopping the engine operation. The engine is started with diesel and once the engine warms were conducted using blends of methyl esters of Palm oil with mineral diesel, while operating the engine on optimum fuel injection pressure. For this purpose, several blends of varying concentrations were prepared ranging from 0% (mineral diesel) to 100% (methyl esters of Palm oil) through 10, 20, 30, 40, 50 and 75%. These blends were then subjected to performance and emission tests on the engine. The performance and emissions data were then analyzed for all experiments.

RESULTS AND DISCUSSION

The fuels (Diesel and methyl esters of Palm oil) are analyzed for several physical, chemical and thermal properties and results are shown in Table 2.

Density, cloud point and pour point of Palm oil was found higher than diesel. Higher cloud and pour points reflect unsuitability of methyl esters of Palm oil as diesel fuel in cold climatic conditions. The flash and fire points of methyl esters of Palm oil was quite high compared to diesel. Hence, methyl ester of Palm oil is extremely safe to handle. Higher carbon residue from methyl esters of Palm oil may possibly lead to higher carbon deposits in combustion chamber of the engine. CHNOS were measured for diesel and methyl esters of Palm oil. Low sulfur content of methyl esters of Palm oil results in lower sox emissions. Presence of oxygen in fuel improves

Table 2 : Properties of mineral diesel and methyl esters of Palm oil

Property	Mineral diesel	Palm oil
Density (kg m^{-3})	840	917
API gravity	35.65	22.81
Kinematic viscosity at 40°C (cSt)	2.44	0.05
Cloud point (°C)	3	9
Pour point (°C)	-6	4
Flash point (°C)	71	229
Fire point (°C)	103	274
Conradson carbon residue (%, w w^{-1})	0.1	0.8
Ash content (%,w w^{-1})	0.01	0.03
Calorific value (MJ kg^{-1})	45.343	39.071
Carbon (%,w w^{-1})	80.33	76.11
Hydrogen (%,w w^{-1})	12.36	10.52
Nitrogen (%,w w^{-1})	1.76	0
Oxygen (%,w w^{-1})	1.19	11.06
Sulphur (%,w w^{-1})	0.25	0

combustion properties and emissions but reduces the calorific value of the fuel. Methyl esters of Palm oil have approximately 90% calorific value compared to diesel. Nitrogen content of the fuel also affects the NOx emissions (by formation of fuel Nox).

Effect of brake horse power (bkw) on specific fuel consumption (SFC): Figure 2 compares the specific fuel consumption of diesel and various blends of methyl esters of Palm and diesel oil at varying brake loads in the range 0-3.74. It was observed that the specific fuel consumptions of the oil as well as the blends were decreased with increasing load from 0.77-3.078 and tended to increase with further increase in BKW. The fuel consumptions were also found to increase with a higher proportion of methyl esters of Palm oil in the blend (Pramanik, 2003). Though the blends as well as the methyl esters of Palm oil maintained a similar trend to that of diesel, the SFC in the case of the blends were higher compared to diesel oil in the entire load range. This is mainly due to the combined effects of the relative fuel density, viscosity and heating value of the blends. However, blends containing 30: 70 and 40: 60 P/D have SFC very close to that of diesel oil. The SFC values were found to be 0.338 and 0.365 at 3.078 BKW; the corresponding value for diesel is 0.316. The specific fuel consumption of 0.693 was observed using 50: 50 P/D blend as fuel which is comparable to the SFC obtained with diesel oil under the same load. The higher density of blends containing a higher percentage of methyl esters of palm oil has led to more discharge of fuel for the same displacement of the plunger in the fuel injection pump, thereby increasing the SFC.

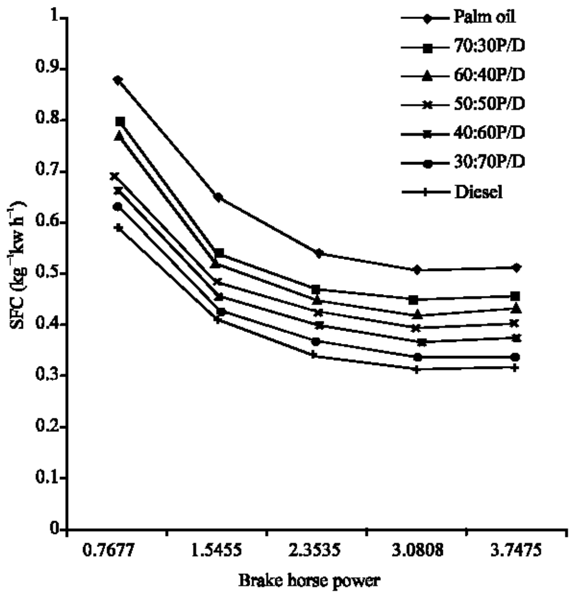

Fig. 2: Effect of brake power on specific fuel consumption for diesel, methyl esters of palm oil and various blends

Effect of BKW on brake thermal efficiency: The variation of brake thermal efficiency of the engine with various P/D blends and methyl esters of Palm oil is shown in Fig. 3 and compared with the brake thermal efficiency obtained with diesel. From the test results it was observed that i nitially with increasing BKW the brake thermal efficiencies of the vegetable oil, diesel and the blends were increased and the maximum thermal efficiencies were obtained at BKW of 3.078 and then tended to decrease with further increase in BKW. There was a considerable increase in efficiencies with the blends compared to the efficiency of methyl esters of Palm oil alone, but the brake thermal efficiencies of the blends and the methyl esters of Palm oil are lower than that with diesel fuel throughout the entire range (Sapaun *et al*., 1996). The maximum values of thermal efficiencies with 60: 30 and 70: 30 P/D were observed as

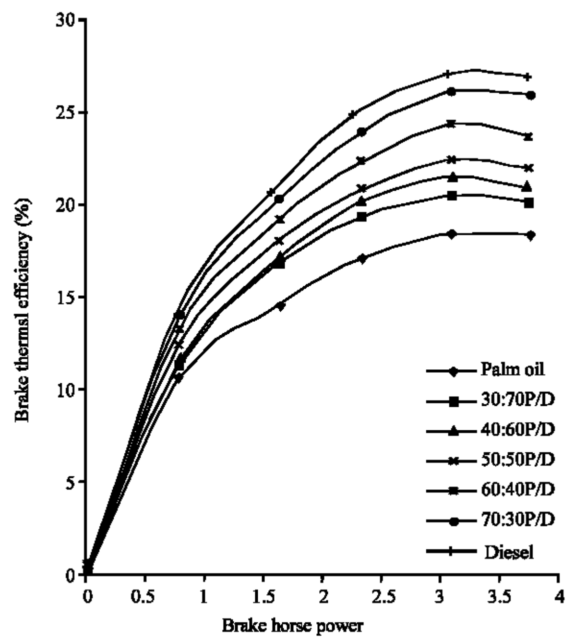

Fig 3: Variation of brake thermal efficiency with brake power for diesel, methyl esters of Palm oil and various blends

22.65 and 21.55%, respectively. Among the blends tested, in the case of 30: 70 P/D, the thermal efficiency and maximum power output were close to the diesel values, followed by the 40: 60 P/D blend. Corresponding maximum

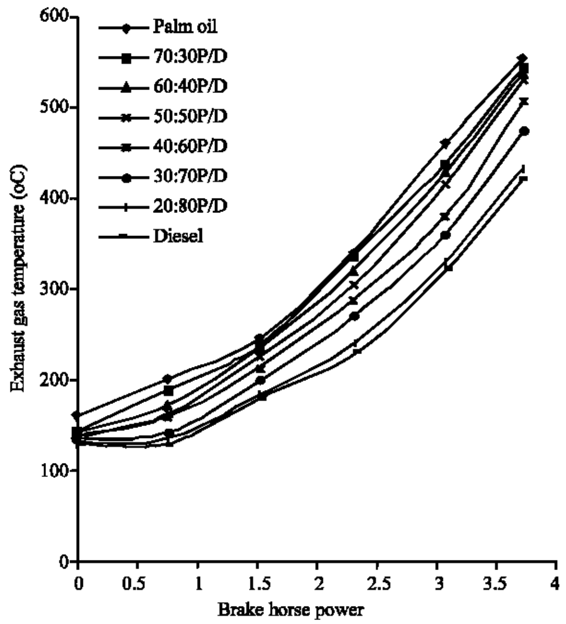

Fig. 4: Effect of brake power on exhaust gas temp. for diesel, methyl esters of Palm oil and various blends

brake thermal efficiencies of 26.09 and 24.36% were observed with these blends. A reasonably good thermal efficiency of 22.44% was also observed with the 50: 50 P/D blend.

Effect of BKW on exhaust gas temperature: Figure 4 shows the variation of exhaust gas temperature with load in the range of 0-3.74 BKW for diesel, methyl esters of Palm oil and various blends. The results show that the exhaust gas temperature increased with increase in BKW in all cases. The highest value of exhaust gas temperature of 554°C was observed with the methyl esters of Palm oil, whereas the corresponding value with diesel was found to be 425°C only. The combustion characteristics of the blends were improved by increasing the proportion of diesel fuel in the P/D blend. The exhaust gas temperature for 20: 80 P/D was observed to be very close to diesel oil and the temperatures were comparable to those with diesel oil blends with 30: 70 and 40: 60 P/D over the entire load. The maximum exhaust temperature was recorded as 550 and 540°C with 70: 30 and 60: 40 P/D blends, respectively at 3.74 BKW. With 50: 50 P/D, the value was found to be 535°C.

CONCLUSION

The main aim of the present investigation was to reduce the viscosity of methyl esters of Palm oil close to that of conventional fuel to make it suitable for use in a C.I. engine and to evaluate the performance of the engine with the modified oils. Methyl esters of Palm oil have viscosity values close to that of diesel fuel.

Acceptable brake thermal efficiencies and SFCs were achieved with the blends containing up to 50% methyl esters of Palm oil. Blends with diesel lower percentage of vegetable oils showed slightly higher exhaust gas temperatures when compared to an engine running with diesel but they were much lower than the methyl esters of Palm oil in all cases. Therefore, from the engine test results, It has been established that up to 50% methyl esters of Palm oil can be substituted for diesel for use in a C.I. engine without any major operational difficulties. However, the properties of the blends may be further improved to make use of higher percentage of methyl esters of Palm oil in the blend using methyl esters of Palm oil of purer grade which may be obtained by pretreatment of the oil. Moreover, the long term durability of the engine using bio-diesel as fuel requires their study.

REFERENCES

Auld, D.L., B.L. Bettis and C.L. Peterson, 1982. Production and fuel characteristics of vegetable oilseed crops in the pacific northwest vegetable oil fuels: Proceedings of the international conference on plant and vegetable oils fuels. St. Joseph, MI: ASAE.

Bacon, D.M., F. Brear, I.D. Moncrieff and K.L. Walker, 1981. The use of vegetable oils in straight and modified form as diesel engine fuels. Beyond the energy crisis-opportunity and challenge. Third Int. Conf. Energy Use Manage. Berlin (West). Fazzolare, R.A. and Smith, C.R. (Eds.). Pergamon Press, Oxford, III: 1525-1533.

Barsic, N.J. and A.L. Humke, 1981. Vegetable oils: Diesel fuel supplements? Automotive Engin., 89 (4): 37-41.

Peterson C.L., D.L. Auld, V.M. Thomas, R.V. Withers, S. Smith M and B.L. Bettis, 1981. Vegetable oils as an agricultural fuel for the Pacific Northwest. University of Idaho Experiment Station Bulletin No. 598. Moscow, ID: University of Idaho.

Pramanik, K., 2003. Department of Chemical Engineering, Regional Engineering College, Warangal 506004, India 2003, Properties and use of jatropha curcas oil and diesel fuel blends in compression ignition engine. Renewable Energy, 28: 239-248.

Sapaun, S.M., H.H. Masjuki and A. Azlan, 1996. The use of palm oil as diesel fuel substitutes. Journal of Power and Energy (Part A), 210: 47-53. Renewable Energy, 28: 239-248.