Performance Characterization Of Single Cylinder DI Diesel Engine Fueled With Castor Biodiesel

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Abstract

Petroleum based fuels play a vital role in rapid depletion of conventional energy sources along with increasing demand and also major contributors of air pollutants. Major portion of today's energy demand in India is being met with fossil fuels. Hence it is high time that alternate fuels for engines should be derived from indigenous sources. As India is an agricultural country, there is a wide scope for the production of vegetable oils (both edible and non-edible) from different oil seeds. The present work focused only on non-edible oils as fuel for engines, as the edible oils are in great demand and far too expensive. The past work revealed that uses of vegetable oils for engines in place of diesel were investigated.

The present investigations are planned after a thorough review of literature in this area. Experiments are carried out in a more popular single cylinder, water cooled engine. Major problems associated with vegetable oils are higher viscosities, lower heating values, rise in stoichiometric fuel air ratio and thermal cracking. I am focused on Utilization of Castor oils, their blends with diesel. In this process, the performance parameters of engine such as Brake thermal efficiency and volumetric efficiency are slightly decreased, Brake specific fuel consumption and Exhaust gas temperature are increased compared to diesel for all bio-diesels.

1. Introduction

India is one of the fastest developing countries with a stable economic growth, which multiplies the demand for transportation in many folds. Fuel consumption is directly proportionate to this demand. India depends mainly on imported fuels due to lack of fossil fuel reserves and it has a great impact on economy. India has to look for an alternative to sustain the growth rate. Biodiesel is a promising alternative for our Diesel needs. With vast vegetation and land availability, certainly bio-diesel is a viable source of fuel for Indian conditions. Recent studies and research have made it possible to extract bio-diesel at economical costs and quantities. The blend of Biodiesel with fossil diesel has many benefits like reduction in emissions, increase in efficiency of engine, higher Cetane rating, lower engine wear, low fuel consumption, reduction in oil consumption etc. It can be seen that the efficiency of the engine increases by the utilization of Bio-diesel. This will have a great impact on Indian economy. Increase in petroleum prices, threat of global warming has generated an interest in developing alternative fuels for engine. Technologies now focusing on development of plant based fuels, plant oils, plant fats as an alternative fuel.

2. MATERIALS AND EXPERIMENT

Commercial diesel fuel used in India which was obtained locally is used as a base line fuel for this study. Test fuel samples are prepared at I.O.K.College of engineering and properties are tested from the third party Renata precision Services, Chemical Lab at Pune (MS). Density and Heating value of test fuels is as given in the table 1

Table – 01 Property of Fuel Samples

FUEL	Density (Kg/m3)	Calorific Value (KJ/Kg)
Diesel	861	47216.4
B20	864.3	44500
B40	870.3	44780
B60	926.6	37900.8

Experiments were performed with Kirloskar make single cylinder diesel engine. This is a single cylinder, water cooled open combustion chamber diesel engine. Technical details of the engine are given in Table 2. All

experiments were performed after ensuring the full warm-up. A plan was designed for the experimental investigation. Different blends of fuels were tested. The tests were conducted for different blends and were repeated for four times for every kind of fuel, in order to increase the reliability of the test results. For each of the fuel blend, the engine was run on five different loads, i.e. idle 0 kg, 2kg, 4kg, 6kg and 8kg of break load on dynamometer. The engine load was controlled by dynamometer.

Table – 02 Engine Specifications

Sr.No.	Parameter	Specification
1	Make	Kirloskar AV1
2	Number of Cylinder	1
3	Number of Stroke	4
4	Bore	85mm
5	Stroke	110mm
6	Power	3.75KW
7	Compression Ratio	18:01

The engine performance tests were conducted with a rope brake-diesel engine set up. The
Parameters like speed of engine, fuel consumption and torque were measured at different loads for diesel and with various combinations of dual fuel. Brake power, brake specific fuel consumption and brake thermal efficiency was calculated using the collected test data. The engine was sufficiently warmed up at every stage and the cold water temperature was maintained at 52 °C. The fuel injection pressure was maintained at 200 bar throughout the experiment. A Honey Well Chromel-Alumel thermocouple with a digital display meter was used to measure the exhaust gas temperature. Fig 01 shows the photograph of the DI Diesel engine and set-up.

Fig.01 Experimental setup diagram of Diesel Engine

3. ENGINE TEST RESULTS AND DISCUSSION

3.1. Effect on Break Power of the Engine

Experimental results shows that the break power developed by the engine at all the loads for different blends of the fuel is more or less is same. Fig 02 represents the effect of break powers. the load on the engine. Brake power for Castor fuel is observe to be slightly higher compare with diesel. At 70% loading the brake power Castor fuel is 1.75% higher than that of diesel. For other blends the brake power for Castor is also observed to be at higher side.

3.2. Effect on Fuel Consumption of the Engine

Fig 03 shows the effect of fuel consumption of the engine for various blends. Results shows that about 20 % loading of the engine fuel consumption for Castor fuel for all the blends is smaller compare with higher load on the engine. With increase in load on the engine, fuel consumption for Castor is more. For a blend of BC 40 it is observed that the fuel consumption is less than that of pure diesel. At maximum loading @ 70% the fuel consumption for pure diesel is lower than any other blend. Fig 04 represents Break Specific Fuel Consumption BSFC with respect to the loading of the engine.

3.3. Effect on Fuel Consumption of the Engine

Fig 05 shows the effect on Mechanical Efficiency with respect to the load on the engine. No any significant changes are observed over the entire range of the loading of the engine and different blend %.

3.4. Effect on Break Thermal Efficiency of the Engine

Fig 06 shows the effect on break thermal efficiency of the engine. It is observed that the efficiency of the pure Castor Biofuel (K) is more than that of the diesel engine. Pure Castor fuel is having a more fuel consumption as compare with the diesel fuel however the heating value is less than that of the diesel fuel. It is also observed that the break power developed by the engine is almost same at all the loads. These observations may be the cause that the thermal efficiency of the Castor fuel is more than that of the diesel fuel. It is also observed that the break thermal efficiency is quite better for biodiesel blends (B 20 to B 60) compare with the Castor fuel only. The break thermal efficiency at above 60 % loading is observed as quite high this may be due to the lower exhaust gas temperature as compare with diesel.

3.5. Effect on Volumetric Efficiency of the Engine

Fig 07 shows the effect on Volumetric Efficiency of the engine. Efficiency of the engine with pure Castor biodiesel is observed to be greater than that of the diesel fuel. This may be due to low exhaust gas temperature.

3.6. Effect on Exhaust Gas Temperature of the Engine

Fig 08 shows the effect on the exhaust gas temperature of the engine. With increase in load on the engine the exhaust gas temperature increases however for Castor biodiesel the gas temperature is lower than that of the diesel fuel at higher load, whereas at low and part load operation it is observed to be greater than that of the diesel fuel.

IV. Conclusion

Experimental investigations were performed on single cylinder DI diesel engine. Test where conducted on water cooled 3.75 kW diesel engine. Different fuel blends of Castor biodiesel, diesel and Castor biodiesel only where tested. Result shows that the break power of the engine was almost same for all the loads. However break thermal efficiency of the Castor biodiesel where improved by 3 to 8%, Volumetric efficiency is also improved with reduction in exhaust gas temperature. Results obtained here shows that the Castor biodiesel can itself directly used in the engine without any major modification. It is also observed that the blends of B 40 and B 60 will have the optimum performance for the given conditions as explained earlier

10. References

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Result Tables and Graphs

Comparative results analysis of fuel

Parameter	B20	B40	B60
BP (KW)	0.152	0.096	0.03
BMEP (bar)	0.197	0.118	0.035
bsfc kg/kwh)	30.26	4.52	14.03
Bth (%)	2.834	1.89	0.61
Air flow (kg/h)	28.34	28.26	28.26
Vol.eff.(%)	93	92	93
A/F Ratio	61.66	68.49	68.92
FP(KW)	0.4596	0.41	0.75

Comparative Heat balance sheet analysis of fuel

Parameter	B20	B40	B60
Heat eq. of work	0.28	0.89	0.61
Heat in jacket cooling	23.58	26.18	39.88
Heat to exhaust	27.33	34.12	33.75
Heat unaccounted	25.76	26.33	25.76