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Research Article

Performance Characteristics of Karanja Biodiesel and its Blends in a C.I. Engine

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Abstract

The limited amount of petroleum resources have caused interests in the development of alternative fuels for internal combustion (IC) Engines. As an alternative, biodegradable, renewable and sulphur free biodiesel is receiving increasing attention. The use of biodiesel is rapidly expanding around the world, making it imperative to fully understand the impacts of biodiesel on the diesel engine combustion process. An experimental investigation has been carried out to analyze the performance characteristics of a compression ignition engine fuelled, first the experiment is performed with diesel, pure karanja oil and then with blends of karanja oil and diesel (75-25%, 50-50% and 25-75 %) and it is denoted by K75, K50 and K25 respectively. A series of engine tests, have been conducted using each of the above fuel blends for comparative performance evaluation. The results indicate that the performance of engine is improved with K75 blend. At full load condition, K 75 blends produce 3.78% more brake horse power & it is maximum as compare to diesel. The brake thermal efficiency of K 75 blend at full load condition is 0.93 % more than sole Diesel. Hence it can be concluded that the karanja oil (K75 blend) is a suitable alternative fuel for diesel.

Keywords: *Karanja Oil,I.C. Engines, Brake Horse Power, Brake Thermal Efficiency*

Introduction

Energy is very important for social development of people and life quality as well as economic growth. Fossil fuels have been an important conventional energy source for years. Energy demand around the world is increasing at a faster rate as a result of ongoing trends in industrialization and modernization. Most of the developing countries import fossil fuels for satisfying their energy demand. These countries have to spend their export income to buy petroleum products. The climate changes occurring due to increased Carbon Dioxide (CO_2) emissions and global warming, increasing air pollution and depletion of fossil fuels are the major problems in the present century. Biodiesel is the name of a clean blazing option fuel delivered from the household, renewable assets. Biodiesel contains no petroleum, yet it can be mixed at any level with petroleum diesel to make a biodiesel mix. The extension of biodiesel stretches the oxygen level in the mix. Additionally biodiesel have lubricating up properties that benefit the engine, and are gotten from renewable vitality sources, for example, vegetable oils and animal fats. Vegetable oils offer almost the same power output with slightly lower thermal efficiency when used in diesel engine. Moreover, commitment of bio-fuels to greenhouse effect is insignificant, since carbon dioxide (CO_2) emitted during combustion is recycled in the photosynthesis process in the plants.

The diesel engine is the most efficient prime mover commonly available today. Diesel engines move a large portion of the world's goods, power much of the world's equipment, and generate electricity more economically than any other device in their size range. But the diesel is one of the largest contributors to environmental pollution problems worldwide, and will remain so, with large increases expected in vehicle population and vehicle miles traveled (VMT) causing ever-increasing global emissions. Diesel emissions contribute to the development of cancer; cardiovascular and respiratory health effects; pollution of air, water, and soil; soiling; reductions in visibility; and global climate change. Where instituted, control programs have been effective in reducing diesel fleet emissions. Fuel changes, such as reduced sulfur and aromatics content, have resulted in immediate improvements across the entire diesel on- and off-road fleet, and promise more improvements with future control.

As the world is becoming more advanced in technology, more energy is being used to keep up with the changing requirements. At the current rate at which energy is being used, the world will shortly

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come to an end of fossil fuels- the world's primary energy resource. There are three main types of fossil fuels, coal, oil and natural gas. After food, fossil fuel is humanity's most important source of energy.

Coal is used mainly to produce electricity. It provides light, motive power from electric motors and many electronic devices. Oil provides mobility for cars, planes, trains, trucks and boats. Natural gas is used primarily to produce heat for buildings, hot water, and industrial processes. All three were formed many hundreds of millions of years ago. They are called "fossil fuels" because they have been formed from the fossilized remains of prehistoric plants and animals. Karanja oil is a thick yellow-orange to brown oil is extracted from seeds. Yields of 25% of volume are possible using a mechanical expeller. The oil has a bitter taste and a disagreeable aroma, thus it is not considered edible. The oil is used as a lubricant, water-paint binder, pesticide, and in soap making and tanning industries.

Table 1 Properties of Comparative Fuels (Diesel, Karanja)

Property parameter	Diesel	Karanjaoil(biodiesel)
Viscosity at 40^0C, cm^2/s	2.6	38.8
Flash point, ^{0}C	70	212
Pour point, ^{0}C	-20	-4
Density at 15^0C, gm/cc	0.850	0.9358
Calorific value, KJ/kg	42500	37470
Oxygen content, wt%	0	11
Cetane number	46	38

Fig. 1 Karanja Tree

Fig. 2 Karanja Seeds

Biodiesel Production

For the present work Karanaja oil is utilized as feedstock for biodiesel generation. Alcohol and catalyst used are methanol and KOH.

Following are the steps in biodiesel production

- **Mixing of alcohol with catalyst:** In the present work, 250 ml of methanol and 7.5 gm of Potassium hydroxide (KOH) was blended in round bottom flask
- **Reaction:** The alcohol/catalyst mixture is added to 1000 ml of karanaja oil. The response is done at 60oc and atmospheric pressure for around 2 hours.
- **Separation of glycerine and biodiesel:** Once the response is finished, the two major products are glycerine and biodiesel. The glycerol stage is much denser than biodiesel stage and settles at the bottom of the reaction vessel and can be divided easily. The arrangement is left for 24 hours to settle down.
- **Purification of crude biodiesel:** Water washing is used to remove both glycerol and alcohol as they are soluble in water.

Fig. 3(a) Steps during reaction

Fig. 3(b) Steps during reaction

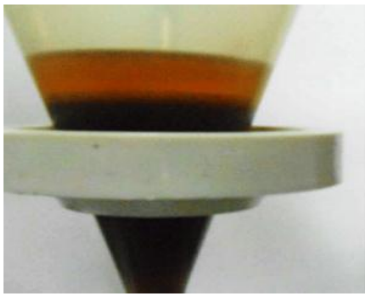

Fig. 4 Biodiesel Left For Settlement

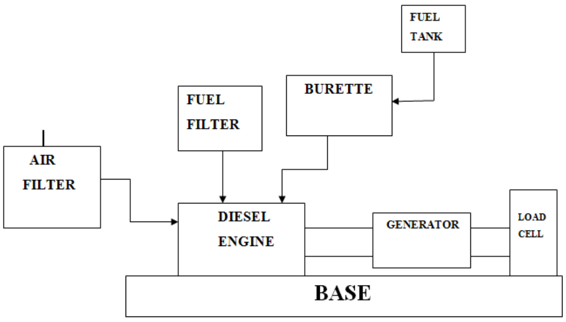

Fig.5 Schematic arrangement of the test rig

For getting the base line data of the engine, first the experiment is performed with diesel, pure karanja oil and then with blends of karanja oil and diesel (75-25%, 50-50% and25- 75 %) and it is denoted by K75, K50 and K25 respectively. All tests were steady state and were set at constant engine speed 1500 RPM.

Effect on Brake Horse Power (BHP)

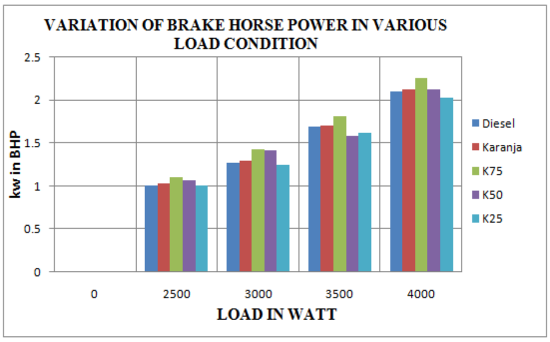

Fig. 6 Variation of Brake Horse Power

Fig. 6 shows the engine power output (Brake Horse Power) under the changing load operating conditions. The energy densities of karanja oil and diesel are 33.4 Mj/l and 37.7 Mj/l, respectively. It is clear from the chart that the power of engine increases with the amount of karanja oil and blend in the fuel. This is due to presence of oxygen available in the blend, which helps in complete burning of the fuel inside the combustion chamber.

Effect on Brake Thermal Efficiency (η)

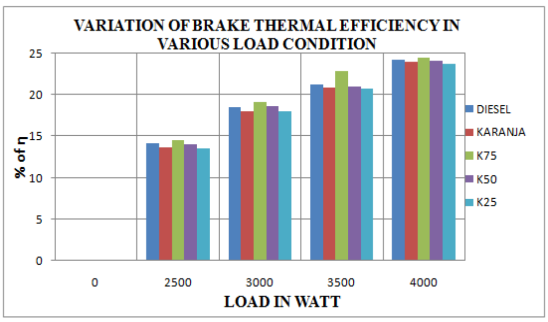

Fig. 7 Variation of Brake Thermal Efficiency

Fig. 7 shows the brake thermal efficiency (BTE) variation with respect to load for Diesel and karanja oil blends. At full load condition, K75 has 0.93 % higher brake thermal efficiency than sole Diesel. The improvement is due to increase in constant volume combustion and the larger increase of molecules by fuel injection, which leads to better combustion efficiency especially at higher loads.

Effect on Brake Specific Fuel Consumption (BSFC)

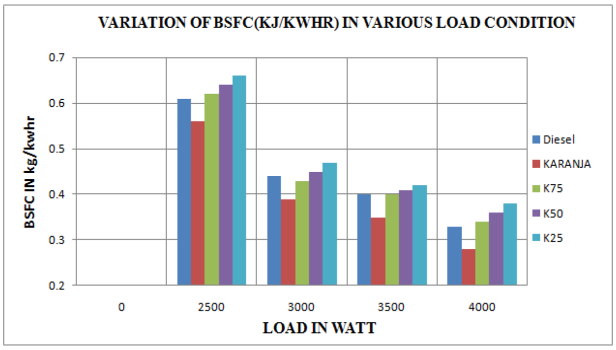

Fig. 8 Variation of Brake Specific Fuel Consumption

The variation of BSFC with load for different blends and loads are presented in fig. 8. It is observed from the chart that the BSFC for all the fuel blends tested decrease with increase in load. This is due to higher percentage increase in Break power with load as compared to increase in the fuel consumption. For K75, the BSFC is almost same as that of diesel.

Effect on Brake Specific Energy Consumption (BSEC)

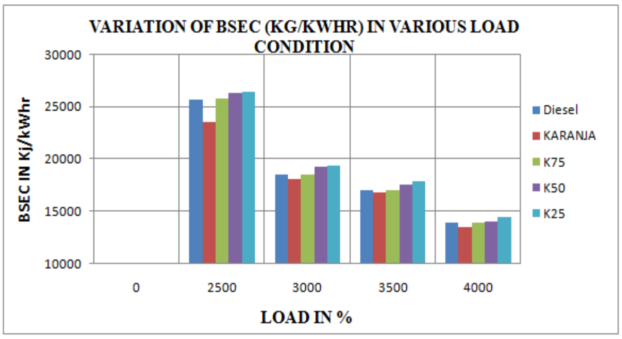

Fig. 9 Variation of Brake Specific Energy Consumption

The variation of BSEC with load for different blends and loads are presented in fig. 9. It is observed from the chart that the BSEC for all the fuel blends tested decrease with increase in load except base fuel at 50% load. This is due to higher percentage increase in brake power with load as compared to increase in the fuel consumption.

Effect on Exhaust Gas Temperature (EGT)

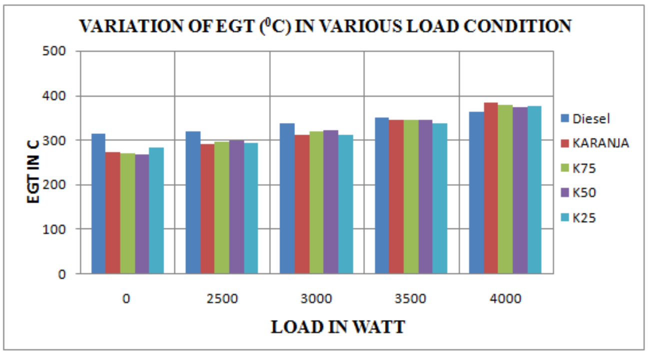

Fig. 10 Variation of Exhaust Gas Temperature

Fig. 10 shows the variation of exhaust gas temperature (EGT) with respect to load. For pure karanja oil is slightly decrease in temperature. For karanja blend it is greater decrease then sole of diesel and it increases with the increase in load.

Conclusion

The results from this experimental study lead to the following conclusions:

- Karanja oil blend can be used as supplementary fuel in compression ignition engine. The engine operates in a comparative way with the Karanja oil blend as with the diesel fuel, as reviewed in the engine stability data.
- The result from the experimental study highlights the increase in the brake horse power, break thermal efficiency, exhaust gas temperature using karanja oil blends in C.I.Engines
- With K75 (75% karanja oil and 25% diesel) blend C.I.Engines produce 3.78% more brake horse power then sole diesel fuel and 0.93 more brake thermal efficiency as compare to diesel fuel

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