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Research Article

Karanja Bio Diesel-A Future Alternative Oil with High Efficiency and Improved Performance Parameters with Diesel Blends

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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 increasing around the world, making it imperative to fully understand the impacts of biodiesel on the diesel engine combustion process. Biodiesel is known as the mono-alkyl-esters of long chain fatty acids derived from renewable feedstock such as vegetable oils or animal's fats for use in compression ignition engines. An experimental investigation has been carried out to analyze the performance characteristics of a compression ignition engine fuelled first with the diesel, pure Karanja oil and then with blends of Karanja oil and diesel (70-30%, 50-50% and 30-70 %) and it is denoted by K70, K50 and K30 respectively. A series of engine tests, have been conducted using each of the above fuel blends for comparative performance evaluation. The performance parameters evaluated include horse power, thermal efficiency, brake specific fuel consumption (BSFC), brake specific energy consumption (BSEC), and exhaust gas temperature. These parameters were evaluated in a single cylinder compression ignition medium duty engine typically used in agriculture sector of developing countries. The results of the experiment in each case were compared with baseline data of pure diesel oil. Significant improvements have been observed in the performance parameters of the engine. The results indicate that the performance of engine is improved with K70 blend. At full load condition, K 70 blends produces more brake horse power and brake thermal efficiency than pure Diesel. Hence it can be concluded that the K70 blend of karanja oil is a suitable alternative fuel for diesel.

Keywords: *Karanja oil, Diesel Engine, transesterification, brake thermal efficiency, brake horse power.*

1. 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 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 properties that benefit the engine, and are gotten from renewable 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. Alternative fuels should be easily available at low cost, be environment friendly and fulfil energy security needs without sacrificing engine's operational performance. For the creating nations, fuels of bio-origin provide a feasible solution to the twin crises of fossil fuel depletion and environmental degradation.

Vegetable oils and their subsidiaries in diesel engines have a higher cetane number than diesel because of long chain fatty acids with 2-3 double bonds, high temperature of vaporization, and stoichiometric air/fuel proportion with mineral diesel. Moreover, they are biodegradable, non-toxic; it has no

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aromatics and contains 10– 11% oxygen by weight these qualities of bio-diesel decrease the outflows of carbon monoxide (CO), hydrocarbon (HC), and particulate matter (PM) in the exhaust gas compared with the case of diesel fuel; however, NO_X emissions increase by about 11% & lead to substantial reductions in emissions of sculpture oxides, poly aromatic hydrocarbons (PAH), smoke, particulate matter (PM). Some of fuels of bio origin can be used directly while others need to be formulated to bring the relevant properties close to conventional fuels.

Since straight vegetable oils are not suitable as fuels for diesel engines, they have to be modified to bring their combustion related properties closer to diesel. This fuel modification is mainly aimed at reducing the viscosity to eliminate flow/atomization related problems. Four techniques can be used to reduce the viscosity of vegetable oils; namely preheating, dilution/blending, micro-emulsion, and transesterification. Biodiesel is an option diesel fuel got from the transesterification of vegetable oils with basic alcohols to give the comparing mono alkyl esters.

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 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.

Karanja oil is a thick yellow-orange to brown oil is extracted from seeds of karanja tree. Yields of 30% of volume are possible using a mechanical expeller. The oil has a bitter taste and a disagreeable aroma, thus it is not considered edible. In India, the oil is used as a fuel for lamps. The oil is known to have value in herbal medicine for the treatment of rheumatism, as well as human and animal skin diseases.

Table 1 Property of comparative Fuels (Diesel and Karanja oil)

Property parameter	Diesel	Karanja oil (biodiesel)
Viscosity at 40^0C, cm^2/s	2.6	38.8
Flash point, ^0C	70	212
Pour point, ^0C	-20	-3
Density at 15^0C, gm/cc	0.850	0.9358
Calorific value, KJ/kg	43000	37470
Oxygen content, wt%	0	11
Cetane number	46	38

Figure 1 Karanja tree

Figure 2 Karanja seed

2. Bio Diesel Production

2.1 Transesterification

Albeit mixing of oils and different solvents and micro emulsions of vegetable oils brings down the consistency, engine performance issues, for example, carbon store and greasing up oil defilement still exist. Pyrolysis creates a bigger number of biogas lines than biodiesel fuel. Transesterification is by a long shot the most well-known strategy for the generation of biodiesel. As the name proposes it is the transformation of one ester into other. At the point when the first ester is responded with an alcohol, the transesterification procedure is called alcohol sis. The transesterification is a catalytic reaction and the change happens basically by blending the reactants. Keeping in mind the end goal to attain a high return of the ester, the alcohol must be utilized as a part of overabundance.

Generally, transesterification can proceed by base or acid catalysis. However, in homogeneous catalysis, alkali catalysis (sodium or potassium hydroxide; or the corresponding lakesides) is a much more rapid process than acid catalysis.

2.2 Production

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 reaction is done at 60ºC and atmospheric pressure for around 1 hour. Shown in fig 2.1.
- **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 in standing funnel to settle down. Shown in fig 3.2.

Before Heating After Heating

Figure 2.1 Different stages during the reaction process

Figure 2.2 Solution after treatment left in standing funnel for settlement

- **Purification of crude biodiesel:** Water washing is used to remove both glycerol and alcohol as they are soluble in water

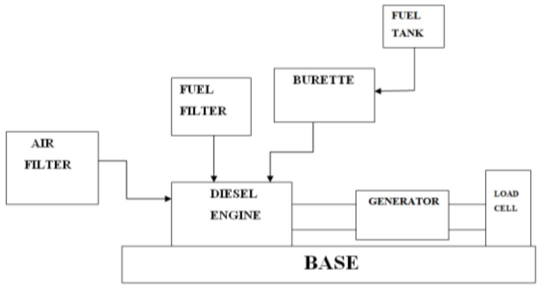

Figure 2.3 Schematic diagram of Engine Test Rig

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 (70-30%, 50-50% and 30- 70 %) and it is denoted by K70, K50 and K30 respectively. All tests were steady state and were set at constant engine speed 1500 RPM.

3. Testing of Bio diesel and its blends

Effect on Brake Horse Power (BHP)

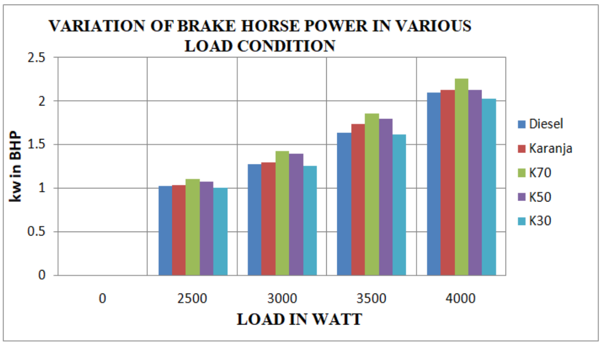

Figure 3.1 variation of Brake Horse Power

Figure 3.1 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 elps in complete burning of the fuel inside the combustion chamber.

Effect on Brake Thermal Efficiency

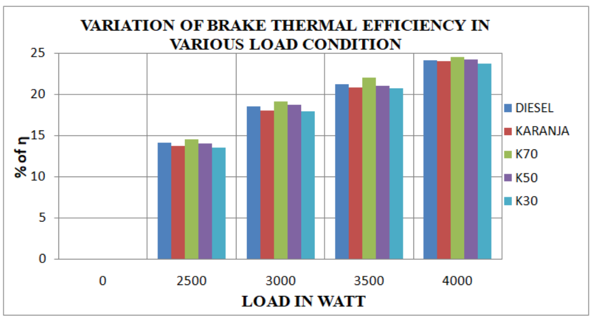

Figure 3.2 Variation of Brake Thermal Efficiency

Fig. 3.2 shows the brake thermal efficiency (BTE) variation with respect to load for Diesel and karanja oil blends. At full load condition, K70 has 0.94 % 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)

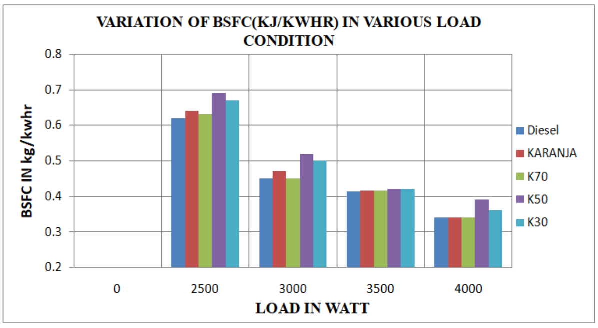

Fig. 3.3 Variation of Brake Specific Fuel Consumption

The variation of BSFC with load for different blends and loads are presented in fig. 3.3. 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 K70, the BSFC is almost same as that of diesel.

Effect on Brake Specific Energy Consumption (BSEC)

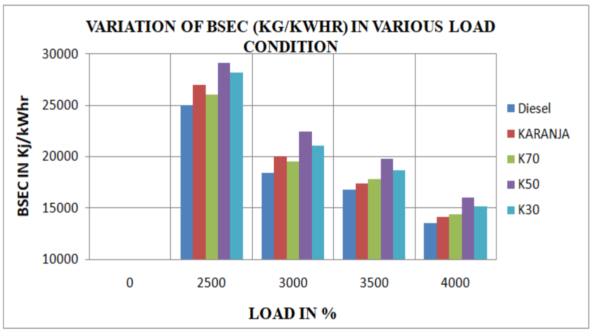

Figure 3.4 Variation of Brake Specific Energy Consumption

The variation of BSEC with load for different blends and loads are presented in fig. 3.4. 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)

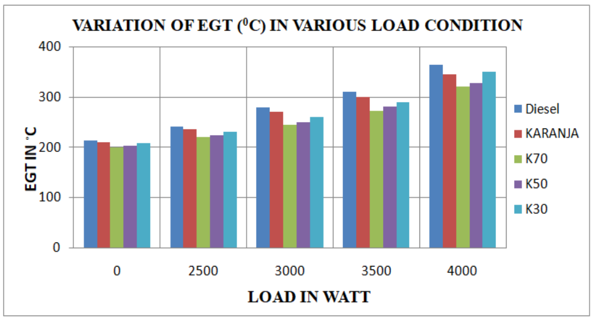

Fig. 3.5 Variation of Exhaust Gas Temperature

Fig. 3.5 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 K70 (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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