International Journal of Scientific & Engineering Research, Volume 6, Issue 1, January-2015
ISSN 2229-5518

Karanja and Rapeseed Biodiesel: An Experimental Investigation of Performance and Combustion Measurement for Diesel Engine

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Abstract—The interest on alternative fuels is continuously increasing to meet the growing energy requirement and protect the environment. The comparison of fuel performance and combustion characteristics of two biodiesel (Karanja biodiesel and Rapeseed biodiesel) with diesel fuel has been carried in direct injection diesel engine and best one for diesel engine application was evaluated. In this research work the detailed investigation on performance and combustion characteristics of four stroke single cylinder engine with karanja and rapeseed biodiesel and its blends with diesel (in proportions of 20% and 50% by volume) under various load i.e. at no load, 25%, 50% and full load was assessed. At full load KB50 (karanja biodiesel blend) has been recorded lowest rate of pressure rise. KB20 has lowest recorded BSFC as compared to all others of biodiesel for all loading condition even than diesel. The RB20 (rapeseed biodiesel blend) recorded maximum BMEP at full load. KB20 was recorded with maximum brake thermal efficiency at full load. So on the basis of performance and combustion parameters KB20 appears to be best alternative fuel than other blends of karanja biodiesel and rapeseed biodiesel even than diesel.

Index Terms— Karanja Methyl Ester, Rapeseed Methyl Ester, Transesterfication, Internal Combustion Engine, Engine Performance, Engine Combustion.

1 Introduction

RECENTLY, biodiesel is become very popular and highlighted as the world has been face to face with the energy crisis due to the diminution of the natural resources. Also due to its other benefits such as renewable, biodegerable, non-toxicity biodiesel become one of the most capable fuels to meet the problems [1-5]. Biodiesel may be formed from various vegetable oil and also from animal fats. It contains the three long- chain fatty acid which is also known as Triglycerides [6-8]. But these triglycerides have are viscous due to which it cannot be used as fuel. To use as fuel the viscosity has been reduced by the process of transesterification in which triglycerides are converted into esters. Through this process, three smaller molecules of ester and one molecule of glycerin which re obtained from one molecule of fat/oil. Glycerin is separated as a byproduct and ester are known as diesel. Also most important and crucial advantage of biodiesel is that it required very little modification or no modification to operate the biodiesel in compression ignition [9,11].

Biodiesel innately provides better lubricity than diesel fuel [12]. Also biodiesel have anti-wear characteristics of palm oil methyl ester (05, 3%, 5%, 7%, and 10%) in lubricant which is investigated by the Masjuki and Maleque [13,14,12]. [Jatropha curcas and salvadora] were more corrosive for ferrous and non- Ferrous metal [18]. Geller et.[18] conducted immersion test in fat based biodiesel for different ferrous and non-ferrous metals. They observed that Copper alloys were more level to corrosion in biodiesel as compare to ferrous level.

The objective of this research paper is to investigate the performance and combustion characteristic of single cylinder, four stroke diesel engine with diesel and blends of Karanja and rapeseed biodiesel with diesel in proportions of 20%, 50% and 100% by volume and investigate under various loading conditions i.e. at No load, 25%, 50% and full load in direct injection diesel engine.

2 Materials and Methods

2.1 Experimental fuels

In this research paper, commercially available karanja and rapeseed biodiesel purchased from a local company have used as a fuel for analysis. The biodiesel was produced by transesterification process from oil with methanol using potassium hydroxides as catalyst. In this research four blends were prepared 20% (v/v) biodiesel with 80% (v/v) diesel fuel denoted by KB20 (karanja biodiesel blend) or RB20 (rapeseed biodiesel blend) as fuel.

2.2 Experimental setup and procedure

The experiment setup consists of single cylinder, four stroke direct injection diesel engine coupled with eddy current dynamometer for obtaining different loading condition. The engine setup includes all necessary instruments and sensors like temperature sensor, pressure sensor etc. for measuring the cylinder pressure, injection pressure, temperature, power output, load, fuel and air flow measurements. The computer was connected with our engine and electronic panel with the help

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International Journal of Scientific & Engineering Research, Volume 6, Issue 1, January-2015
ISSN 2229-5518

of Engine soft software.

Tests were performed on a single cylinder, four stroke, and direct injection diesel setup shown in figure 1. The main specifications of the test engine are given in table 1. In order to get different load condition the engine power output shaft is coupled to eddy current dynamometer. The electronic panel with dynamometer loading unit is show in figure 1. The Schematic overview of experimental setup is show in figure 2. The speed of engine is fixed at 1500 rpm. The cylinder pressure and injection measured versus crank angle were measured with the help of piezo sensor and crank angle sensor and different temperature were also measured with the help of temperature sensor as shown in table 2.

All tests were performed under steady state condition for that engine was operated at least 10-20 minutes minimum so that the fuel of previous test was consumed. The results related to engine combustion and performance characteristics were obtained with the blends were determined and compared with diesel.

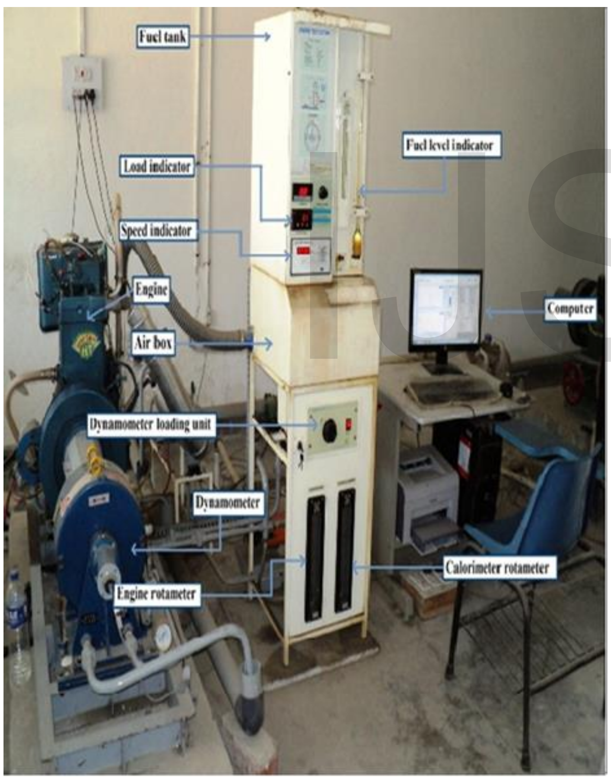

Figure 1 Experimental Setup.

The experiments were carried put at five different load condition (no load, 25%, 50% and full loads) at 1500 rpm of the diesel engine test setup.

The different parameters were evaluated at each load listed as below:

- Cylinder pressure per crank angle, bar
- Injection pressure per crank angle, bar
- Brake power, kW
- Indicated power, kW
- Fuel flow, kg/h
- Air flow, kg/h

Table 1 Engine specification

Maker	Kirloskar
Model	TV1
Details	Single cylinder, DI, Four stroke
Bore and Stroke	87.5 mm × 110 mm
Compression ratio	17.5:1
Cubic capacity	661
Rated power	5.2 kW @ 1500rpm

The same experiment procedure was performed for all blends like KB100, KB20, RB50 and RB20. And after getting all the required parameters the combustion and performance characteristics are evaluated.

3 Result and Discussion

3.1 Brake Thermal Efficiency

From the result we are analyzed that the biodiesel blends have higher Brake thermal efficiency than diesel at all load condition. KB20 was recorded with maximum brake thermal efficiency of 31.072% at full load, which is primarily due to 10 to 12% excess of oxygen and high lubing property.

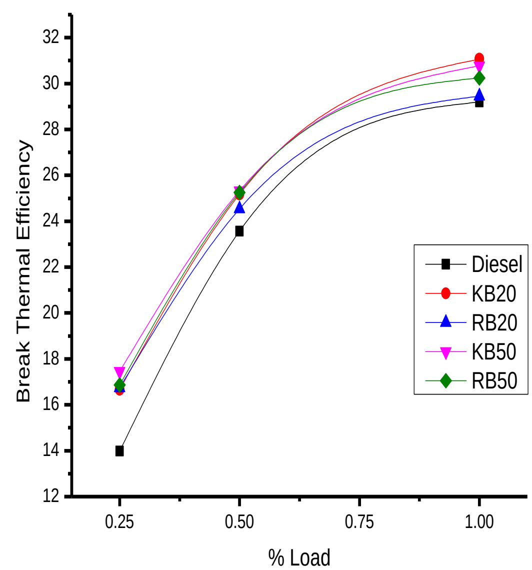

Figure 2

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International Journal of Scientific & Engineering Research, Volume 6, Issue 1, January-2015
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3.2 Fuel-Air Ratio

Fuel air ratio is much more important performance parameters than other performance parameters. From the result we have analyzed that fuel air ratio increase as loading increases with

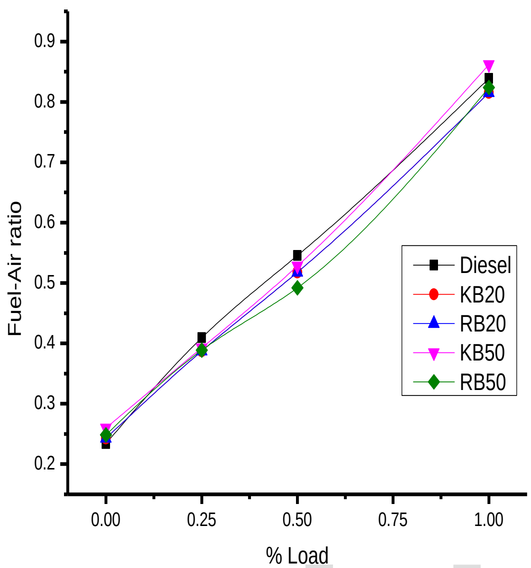

Figure 3

KB50 recorded to have maximum fuel air ratio of all the bio-diesel blends due to its lower calorific value than diesel and rapeseed biodiesel.

3.3 Brake specific fuel consumption

BSFC decreases with increase in load due to higher percentage

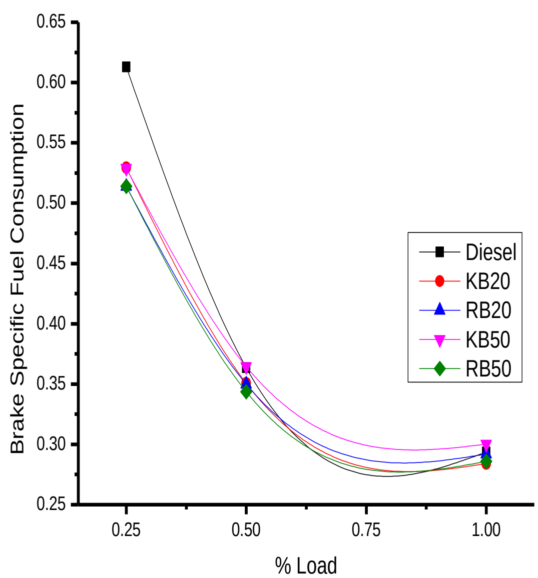

Figure 4

of increase in brake power with load as compared to fuel consumption. KB50 has recorded highest BSFC at full load. KB20 has lowest recorded BSFC as compared to all other blends of biodiesel for all loading condition even than diesel. This is because biodiesel having 10-12 % more oxygen contain which help in complete burning of fuel

3.4 Brake mean effective pressure

The variation of brake mean effective pressure was recorded as shown in result, BMEP increase with increased loading condition because at higher load the loss in term of friction power is reduced. At no load BMEP is almost having zero value for all blends and as well as diesel. The RB20 recorded maximum BMEP at full load. The BMEP value is almost same for different fuels at every load condition.

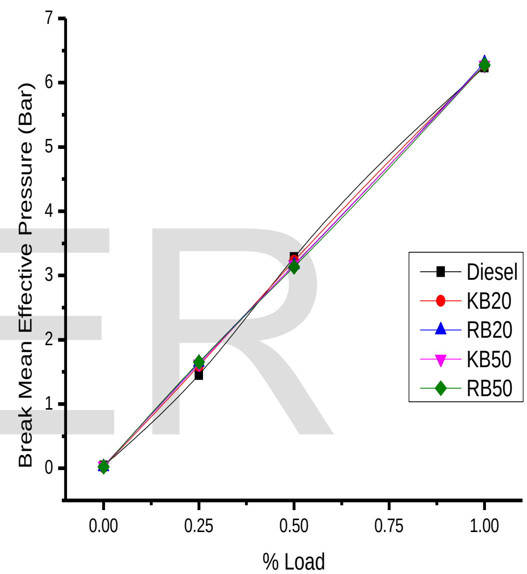

Figure 5

3.5 Rate of pressure rise

The engine combustion characteristics are greatly influenced by rate of pressure rise as it affects the smoothness of combustion process. So high rate of pressure rise is obnoxious and figure 3 gives its variation with load. The increase in load increases rate of pressure rise due to higher amount of fuel injected which leads to reduction in engine life and increased noise. From results diesel as shown in figure 6 is observed to have higher value of rate of pressure rise compared to all other blends. At full load KB50 has been recorded lowest rate of pressure rise of 5.5 bar/degCA.

3.6 Heat release rate

Biodiesel blends have low heat release rate than diesel due to lower calorific value, higher viscosity and higher density resulting in inferior atomization and vaporization which reduces fuel- air mixing. But from figure 4 it is observes that RB20

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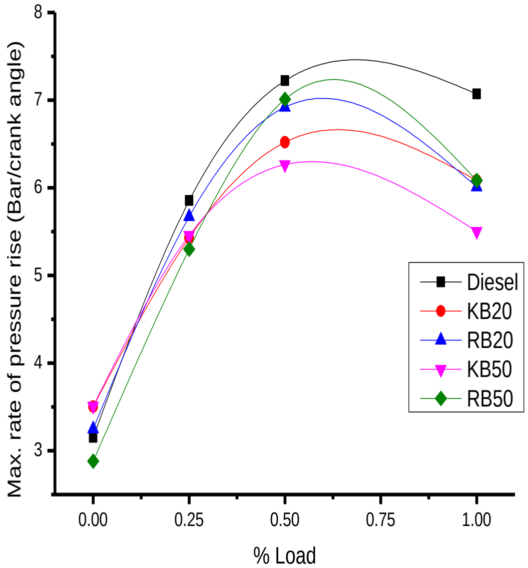

Figure 6

and RB50 having heat release rate (104.23J/CA for RB20 and 102.6 for RB 50 J/CA) almost equivalent to diesel (107.84 J/CA). This is because rapeseed biodiesel having higher calorific value which is almost equivalent to diesel.

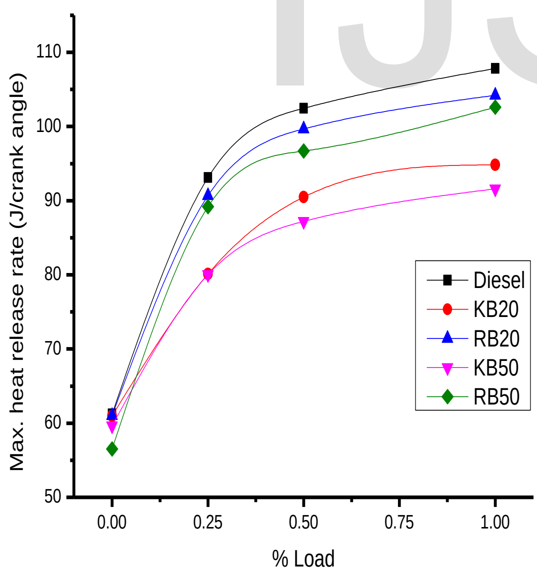

Figure 7

3.7 Mean gas temperature

The variation mean gas temperature calculated from thermodynamic model based on cylinder pressure data with engine speed is given in figure 5. From the result that mean gas temperature increases with increasing load because at higher load high amount is fuel is burned and this high mean gas temperature promote high NOX emission, so for low NOX emission it should be minimum. At lower load RB20 and KB50 are having lower mean gas temperature as compare to other fuel blends even than diesel but at high load KB20 and RB20 having higher mean gas temperature.

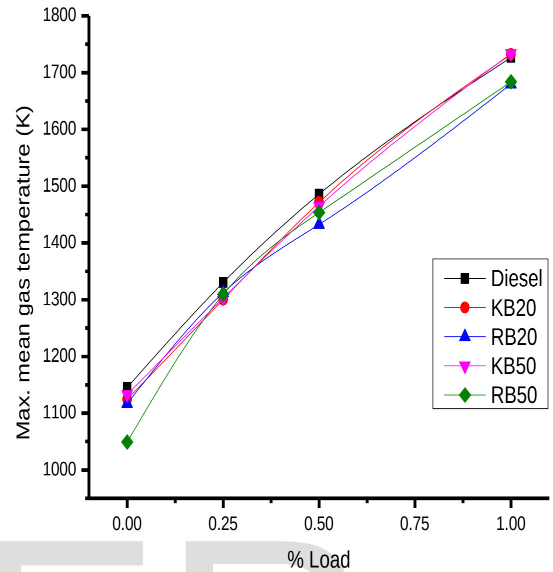

Figure 8

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4 Conclusions

The following conclusions have been made in this research work:

1. KB20 was recorded with maximum brake thermal efficiency of 31.072% at full load, which is primarily due to 10 to 12% excess of oxygen and high lubing property.
2. KB50 recorded to have maximum fuel air ratio of all the biodiesel blends due to its lower calorific value than diesel and rapeseed biodiesel.
3. KB20 has lowest recorded BSFC as compared to all other blends of biodiesel for all loading condition even than diesel. This is because biodiesel having 10-12 % more oxygen contain which help in complete burning of fuel.
4. At full load KB50 has been recorded lowest rate of pressure rise of 5.5 bar/degCA.

At lower load RB20 and KB50 are having lower mean gas temperature as compare to other fuel blends even than diesel but at high load KB20 and RB20 having higher mean gas temperature.

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International Journal of Scientific & Engineering Research, Volume 6, Issue 1, January-2015
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