An Estimation of Various Performance Parameters of CI Engine Fueled with Diesel and Biodiesel Blends

Brahma Nand Agrawal, Charan Singh, and Shailendra Sinha

Abstract A series of test experimental analyses have been performed to analyze the performance parameters of CI engine fueled with diesel and biodiesel blends. The various biodiesel blends have been prepared as K0L20D80, K5L15D80, K10L10D80, K15L5D80, and K20L0D80 with the combination of Karanja and Linseed biodiesel along with diesel. The results indicate that the performance parameters of blends have been given adjacent results to diesel. A higher concentration of Karanja oil as compared to linseed oil in diesel blends has given better results for performance parameters. The results demonstrated that K15L5D80 gives better results compared to all other blends and is close to diesel for the performance parameters of CI engine.

Keywords CI engine · Performance parameters · Karanja oil · Linseed oil · Diesel

1 Introduction

Extensive research was started to find substitute sources of conventional fuel. Biodiesel came as one of the alternatives for fossil fuels. It is formed mainly by conversion of edible oils [1]. In an experimental study, the longer ignition delay, and pressure rise have been achieved at propanol diesel blends [2]. A study done on ignition delay was studied using blends of n-pentane and DEE with regular diesel. A type of optical method is used for the measurement of ignition delay for this experimental setup. During the experiment, various different pressures and temperatures

B. N. Agrawal (✉)
Department of Mechanical Engineering, Manav Rachna International Institute of Research and Studies, Faridabad, India
e-mail: brahmaagrawal.set@mriu.edu.in

C. Singh
Department of Mechanical Engineering, Galgotias University, Greater Noida, India

S. Sinha
Department of Mechanical Engineering, Institute of Engineering and Technology, Lucknow, India

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of air coming inside the combustion chamber have been studied. The investigation was done on a diesel engine combustion system fueled with blends of n-Pentane and DEE with pure/regular diesel. The ignition delay characteristics were studied. The result reveals that by increasing the temperature and pressure of hot air, the ignition delay of diesel engine fuel spray decreases. Results also show that at low ignition temperatures, effect of methyl group is more dominant whereas at higher temperature the alkyl group is more effective. The main factors for ignition delay are temperature and the pressure of hot air inside the engine combustion chamber. The results say that the DEE reduces the ignition delay [3]. An experimental test investigation has been done under varying load conditions (0, 2, 4, 6, 8, and 10) kW, with diesel engine having blends of Karanja oil to be tested, and SVO, with diesel. Results showed that the BSFC decreases as rise in blend percentage of regular diesel while brake thermal efficiency (BTE) increases. Carbon dioxide, carbon monoxide, and some amount of hydrocarbon emission decrease but Nitric oxide shows slight increasing trend in comparison to FD. The results reveal that the emission characteristics of KB20 were discovered useful [4]. The engine can simultaneously achieve high efficiency and low emissions so that it has attracted much interest. Use of blend fuel Dimethyl ether (DME)/Natural Gas (NG) is used to investigate the effect by (SOC) timing. The experimental results are focused on to parameter variations of SOC timing, and heat flux, and revealed that the quantity of DME/NG supplied increased in blend a 2-stage heat release rate would be seen than that of quantity supplied. It was clearly noticed that changes in DME can advance SOC while having to reduce inlet temperature. Supplying 5% DME would make a change of 6.7-CAD in SOC [5]. An (HCCI) combustion is demonstrated to see the ability of lower engine emission by characteristics of even mixture and lower temperature of combustion at part loads and low speed with mode variation of CI-HCCI and vice versa in real application. Great variations in IMEP value and combustion occur during mode switch causing unfavorable performance of diesel engine. The test research deals with diesel engine HCC Reliance by early injection of fuel with negative valve overlap (NOV) have been investigated. To increase the smooth working of IMEP during switching of modes based on fuel injection strategy did with significant improvement in EGR smoothness of CA50 [6]. The results reveal that due to turbulent nature of the fuel stream I system, breakup occurs at an early stage at higher air flow rate [7]. Various blend of pine oil and additives addition was used to improve characteristics like performance of engine, emissions coming out, and combustion without any modification of a DI engine. Biofuel significantly degrades the DI engine performance values. To overcome this challenge pine oil with an additive (1,4-dioxane) was selected for study and two variant concentrations of Pine oil were utilized (P20, P40) at additive proportions of (5 ml, 10 ml). A comparison of the mixture and diesel value was conducted and an increase of 5.77 and 3.88% in fuel consumption and brake thermal efficiency was noticed respectively. A contemplative of emissions and decreases in pollutant is noted (22.41% CO, 29.19% HC, 22.81% smoke) leaving CO_2 and NO_x at peak loads is described. Change in NO_x and CO_2 value increase about 7.24 and 25.42%. Parameters like heat release rate and peak pressures of pine oil mixture gave inferior values with respect to regular diesel. P20 is the best blend when mixed with

10 ml additive and gives a close value than that of regular diesel [8]. The estimated performance analysis for engine is conducted. The result shows that highly reactive fuel changes the operation condition and optimum combustion significantly. A great influence of unburned hydrocarbon, nitrogen oxide and carbon monoxide is seen on addition of n-heptane. Simulation shows pure biogas and n-heptane operation generates greater results with practical HCCI engine solutions [9]. A diesel engine powered by fish oils and waste palm cooking oil is conducted to see the characteristics change in performance and emission with other parameters. During experiment modified engine with different parameters is used with advanced compression ratio of (17.9:1), injection timing (23.9° bTDC), injections pressure (231 bar), modified Pistons head geometry and speed at 1500 rpm. In experiment PMBD20% shows close resemblance to regular diesel fuel [10]. A review on combustion, emission with performance of CI, CRDI, and HCCI engine operating on different fuels is discussed. The use of mechanical governor fuel injection system to be changed to and Micro-controller controlled system to control injections of fuel at any injection pressure and current angle with improved BTE of Compressed ignition engine with change in emissions levels is reviewed [11]. The earliest start of combustion covers more area in the CP-time diagram while using regular diesel–biodiesels–DEE blends [12]. The ignition sources of dual-fuel combustion were biodiesel derived from soybeans oil [13]. Effects of blends on the cylinder pressure, heat release rates, and emissions were measured. For all the blends of SMEs, NO_x emissions were increased. The experimental test results are validated with Diesel-RK software [14]. Characteristics of performance and emission were studied on the effects of thermal barriers coated pistons fueled with mahua-biodiesel on regular diesel engine and compared with those results of neat diesel fuel. Coating of 0.25 mm thickness of Al_2O_3 material is used on pistons, cylinder walls and the valves of the engine with same compression ratio of the engine. A series of experiments were performed while engine was fueled with regular diesel and B20 and results were compared with and without coating [15].

Many performance parameters should be added to attention. In this study, major base parameters were investigated at CR 18, when it is fueled with 0% Karanja oil, 20% linseed oil, and 80% regular diesel by volume and mixed properly, named as K0L20D80, 5% Karanja oil, 15% linseed oil, and 80% regular diesel, named as K5L15D80, 10% Karanja oil, 10% linseed(flax) oil and 80% regular diesel, named as K10L10D80, and 15% Karanja oil, 5% linseed oil and 80% regular diesel, named as K15L5D80, 20% Karanja oil, 0% linseed oil and 80% regular diesel, named as K20L0D80. This test study has been done to analyze and find optimum blends for performance parameters of the CI engine.

2 Materials and Methods

There are two types of biodiesels used in this study which are obtained from Karanja and Linseed oil.

Table 1 Physical properties of fuel

S. No.	Name of property	Unit	Karanja oil	Linseed oil	Pure diesel
1	Viscosity	cS	27.9	29.3	2.79
2	Density	kg/m^3	911.5	925.7	848.7
3	Calorific value	MJ/kg	34.1	30.7	43.8
4	Cloud point	°C	13	−3.9	−10.2
5	Pour point	°C	4.1	1.01	−14.98
6	Flash point	°C	206	240	76.5

Karanja Oil

Karanja oil is extracted from millettia pinnate tree which is a native of South and Southeast Asia. The seeds on the plant can be extracted from fifth year of plant life and increase each year until it stabilizes in tenth year. The harvest season is spring usually and each seed weighs around 1.101–1.79 g with an oil content of 27.1–38.99% according to season. A single tree can supply around 10–50 kg of seeds on different conditions. The method of oil extraction may change according to the person extracting the oil by generally expeller pressing, solvent extraction, and cold pressing are preferred.

Linseed Oil

Linseed oil or flax seed oil is used widely for many things from paint binder, making of varnish for wood finishing, edible oil for dietary supplement, and various chemical manufacturing. The oil is obtained from linseed seeds by the process of expeller pressing and solvent extraction. Within eight weeks of seed sowing plant can attain a height of 10–15 cm and around 35–45% oil can be extracted from a kg of dry linseed seeds (Table 1) [16, 17, 18].

3 Experimental Arrangement and Method

3.1 Experimental Setup

The present study covers the investigation of performance characteristics of the CI engine. The diesel and blended with linseed and Karanja biodiesel was used as a fuel for investigation. Figure 1 shows the schematic diagram of experimental setup. The computer is connected to the engine. Engine-soft-LV has been commissioned to analyze various characteristics of engine. Different load conditions were applied to the engine connected with the dynamometer. The engine specification is given in Table 2.

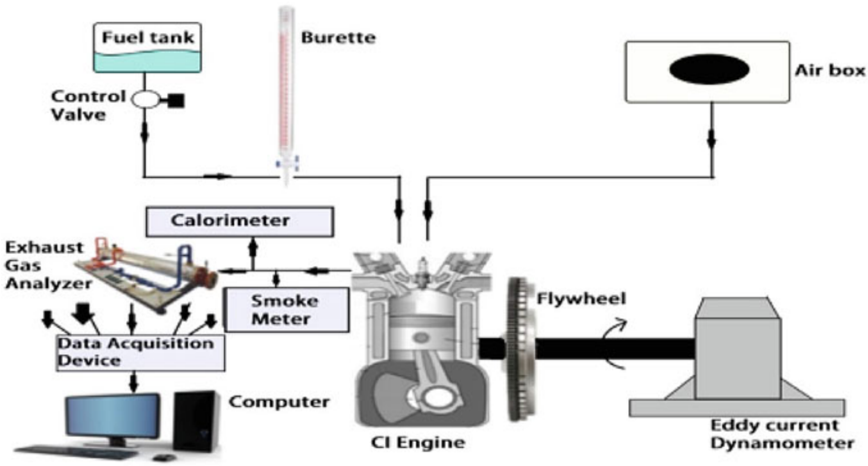

Fig. 1 Experimental setup

Table 2 Engine specifications

Engine specifications	
Engine type	Four stroke
Rated power capacity	3.5 kW @ 1500 rpm
Compression ratio available	18
CR ranging	13–18

3.2 Experimental Procedure

The procedure adopted during test investigation is as follows.

a. First, all the blends of Karanja oil and linseed oil were prepared.
b. To test and investigate of performance parameters of the CI engine, engine needs to run for fifty minutes to become stable in its conditions while fueled with diesel. The data acquisition devices collect all data at constant speed of engine and various loads.
c. All previous steps repeat for blends K0L20D80, K5L15D80, K10L10D80, and K15L5D80, K20L0D80.
d. Evaluated data were analyzed and from the observed values, the various graphs show the performance parameters.

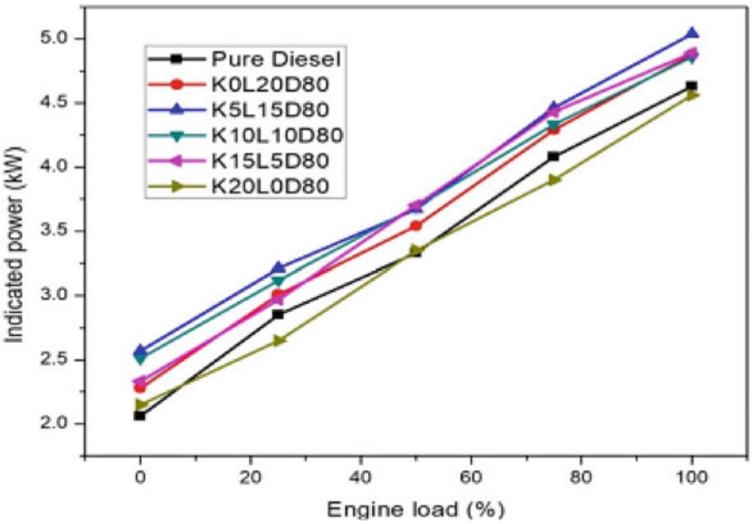

Fig. 2 Indicated power versus engine load

4 Results and Discussion

4.1 Performance Parameters

This section deals with various performance parameters of engine fueled with various biodiesel blends and diesel, and discussed below.

4.1.1 Indicated Power

It is been detected from Fig. 2, that all blends except K20L0D80 give larger indicated power than that of regular diesel for all loads. At full loads, the blend K5L15D80 gives more indicated power by amount of 500 W to regular diesel. At 75% of engine load both blends K5L15D80 and K15L5D80 give nearly same results but greater than pure diesel by amount of 410 W.

4.1.2 Mechanical Efficiency

This study reveals that from Fig. 3, blend K20L0D80 give higher mechanical efficiency while comparing other blends and diesel at entire ranges of engine loads. Nevertheless, at no load conditions, all blends of Karanja and linseed oil give very similar result for mechanical efficiency to that of pure diesel. The blend K20L0D80 gives 3% more mechanical efficiency compared to diesel at full loads.

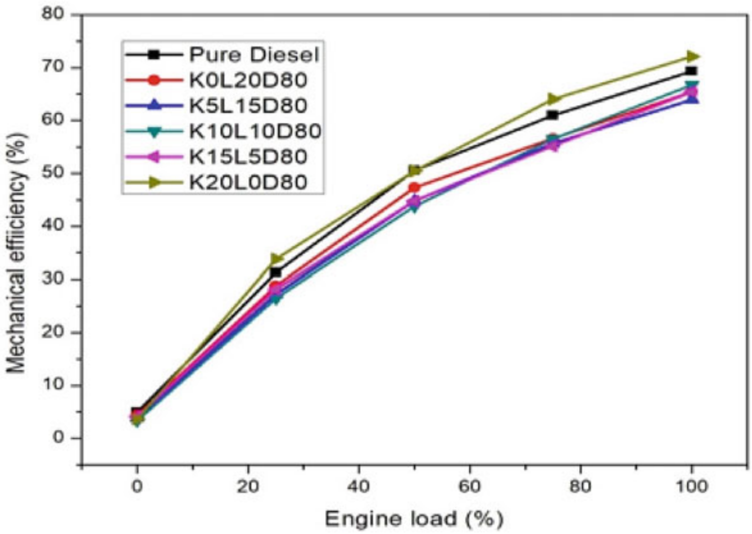

Fig. 3 Mechanical efficiency versus engine load

4.1.3 Brake Thermal Efficiency

It was clear that K15L5D80 has more BTE than that of other blends and pure/regular diesel from 35 to 70% of engine loads as Fig. 4. However, except 35 to 70% of load, pure diesel has greater brake thermal efficiency than any other blend except K15L5D80. At 50% load condition, 6% higher brake thermal efficiency was achieved by blend K15L5D80 than that of pure/regular diesel.

4.1.4 Brake-Specific Fuel Consumption

Brake-specific fuel consumption is a sign of effective fuel combustion. Figure 5 displays the BSFC of diesel, Karanja, and linseed oil mixtures for various loads. From 0 to 22% of load blend K20L0D80 has higher BSFC than other blends along with diesel. Due to improved combustion, the BSFC of blends and pure/regular diesel drops as loads rise.

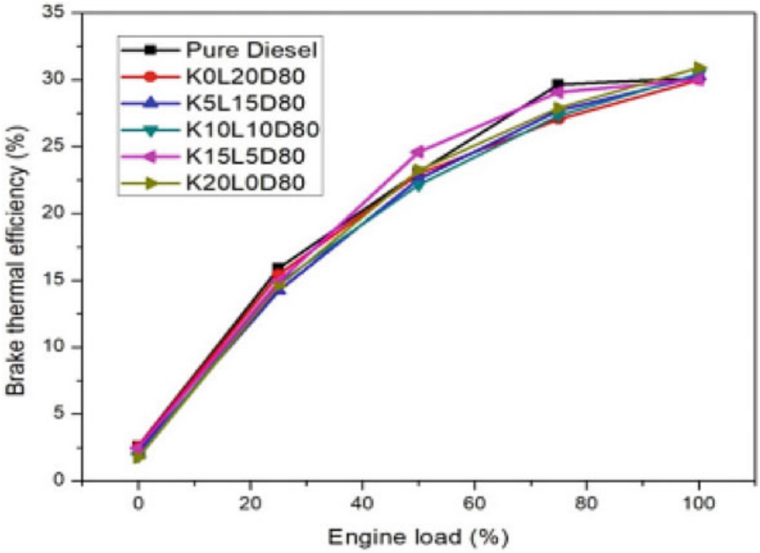

Fig. 4 BTE versus engine load

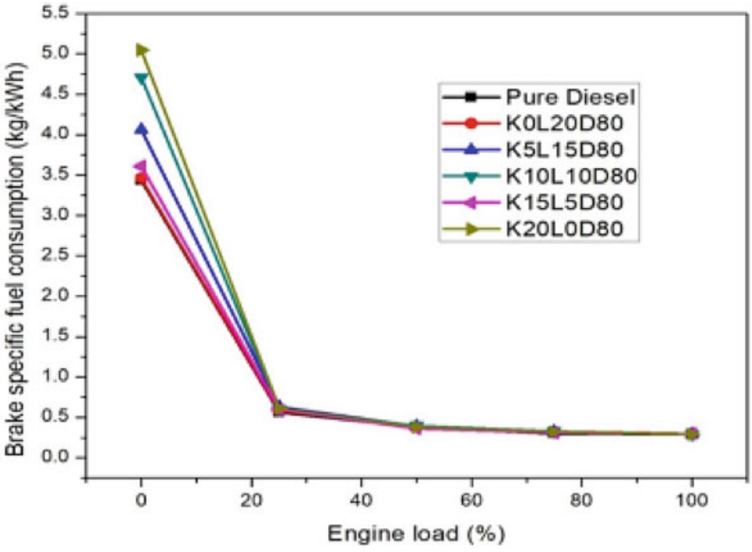

Fig. 5 BSFC versus engine load

5 Conclusion

The concluding remarks can be drawn from the study as follows.

- The blend K15L5D80 gives close result to pure diesel for cylinder pressure and mass fraction burned as comparable to pure diesel.
- The heat releasing rate of blend K20L0D80 is greater than that of all other blends of linseed oil and diesel also.
- The mean gas temperature is also close to pure diesel at blend K15L5D80.
- The rate of pressure rise is comparable to pure/regular diesel at blend K20L0D80.
- It has been shown in the test research that at all blends K5L15D80, noticed highest indicated power and indicated mean effective pressure than pure diesel and all blends except blend K20L0D80 at no load condition to full loads.
- Pure diesel has 3% more mechanical efficiency than that of blend K20L0D80 at full loads.
- At blend K15L5D80 higher the brake thermal efficiency has been achieved from 35 to 70% of engine load than that of diesel. However, on other engine load conditions brake thermal efficiency is comparable to diesel.
- Brake-specific fuel consumption is more at blends K20L0D80 from 0 to 22% of engine loads.
- Its analysis forces us to assume that there should be an optimal ratio of the combination of Karanja oil, linseed oil, and diesel. The present investigation noticed better combustion attributes and performance parameters at blend K15L5D80. This study concludes that higher concentration of Karanja oil can be used as partial substitution for the diesel.

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