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Experimental Investigation of Diesel Blended With Camphor Oil for Performance and Emission Characteristics in Compression Ignition Engine

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ABSTRACT

Various organic oils are blend with high speed diesel to conserve the fossil fuel without compromising the performance. Optimum quantity of the blend plays a vital role in the functioning of an internal combustion engine and hence it is to be correctly determined. In this work a study is taken to find the performance and emission characteristics of a Compression Ignition IC engine with a variable compression ratio. The engine is supplied with the high speed diesel with predetermined quantities of Camphor oil. The blends are tested in a single cylinder direct injection diesel engine of 3.5 kW at 1500 rpm, fitted with an eddy current dynamometer. The performance, emission and combustion characteristics are observed at various loads on the engine at a constant speed of 1500 rpm. From various ratios of blends of Camphor oil with diesel and for various compression ratios, the correct proportion for which the IC engine exhibits better performance is brought out.

Keywords: bio-diesel, camphor oil**,** variable compression ratio IC engine, performance characteristics, emission characteristics

1. INTRODUCTION

In the present scenario fossil fuels are dwindling very fast. Conservation of the fossil fuels is given prime priority. Organic oils obtained from vegetation and animals are sustainable products that are regularly produced. Though any organic oil cannot be used as an alternative for fossil fuel such as diesel, yet a small amount of the organic oil is blended with diesel and used as an alternate fuel. These combinations promise to meet the ever increasing demand for the fuel. Use of the blended fuels also has the advantage of less polluting emissions compared to unblended diesel. Some of the organic oils such as camphor oil, jatropha oil, karanji oil, coconut oil, sunflower oil, rapseed oil and neem oil that are tried for the combination with diesel so as to obtain the so-called bio-diesel.

Fuel properties for identified camphor oil are examined in this work in accordance with the Bureau of Indian Standards, enabling the comparison of the results obtained from this test. The empirical correlation is given in Colin R. Fergusson. This is useful because it is cheaper to obtain the actual cetane number of any given fuel then to measure experimentally.

1.1 Objective
The objective of this work is to find out the right proportion of the fuel blend that can operate an IC engine with better
1. performance characteristics of the IC engine
2. emission characteristics of the IC engine

2. LITERATURE SURVEY
Organic oils that are obtained from vegetation that can be grown on fields. They have the potential to be used as an alternate for diesel fuel [2]. The bio-diesel from the crops behave differently in diesel engine in terms of performance emission and combustion. The properties of organic oils are comparable to that of diesel if properly blended since they have a higher cetane number. They can be used in diesel engine with small modification of the engine [4]. A number of studies have been carried out on various bio-diesel blends with respect to their combustion performance and emission characteristics [5]. Some engines give better performance with reduction in smoke [6]. The camphor oil, found on the wood of the camphor laurel readily ignites and burns without producing any residue. The viscosity of camphor oil is 1.9cST, which is very less than that of camphor and hence expected to improve the combustion of camphor oil. In the present work, efforts are carried out to identify the optimum blend for an improved performance.

3. EXPERIMENTAL SETUP
The experimental setup is show in figure 1, wherein a single-cylinder, four-stroke, water-cooled direct-injection diesel engine is employed. The fuel is directly injected in to the cylinder. The bowl portion in the crown of the piston serves as the combustion chamber. The IC engine used in this study is fitted with a piezo-electric transducer for sensing the pressure occurring inside the cylinder. A pulse is picked up when the top dead centre is reached and the crank angle is sensed to process further. An eddy current dynamometer is employed with the IC engine to measure the brake power output of the engine at various loads. The high speed data acquisition is used to record the pressure versus crank angle data, consumption of air and diesel consumption.

Figure 1. Experimental setup

The measurements are obtained from pressure transmitter interfaced instrument. Specialized software is interfaced with the help of suitable hardware so that the sensors and transducers provide the required input to the software for calculation of performance parameters. The emissions are measured by an ALV five analyzer, a Bosch smoke device, at various loads on the engine.

3.1 IC ENGINE SPECIFICATION

Table 2. The IC engines specification

Parameter	Value
Engine power	3.5 kW @ 1500 rpm
Cylinder bore	87.5 mm
Stroke length	110 mm
Compression ratio	18
Stroke	4
Number of cylinders	1
Speed type	Constant
Cooling type	Water
Dynamometer	Eddy Current

The Detailed specification of the fuels used in this study is given in Table No. 2.

Table 2. Properties of diesel and camphor

Properties	Diesel	Camphor oil
Calorific value kJ/kg	42,500	38,200
Sp.Gravity @25°C	0.85	0.923
Viscosity(CP)@20°c	4. 2	12.
Density, g/cm^3	0.856	0.8942
Flash point	64°C	64°C
Cetane No.	50	5
Auto ignition temperature	250°C	466°C
Boiling point	175°C -200°C	232°C-250°C
Water solubility(g/dm^3)	Negligible	1.2
Vapor pressure at 70°C	15	4 mm

3. TEST PROCEDURE

The engine is started and run for some time in order to reach steady state condition. The engine outlet water temperature is maintained constant by controlling the cooling water flow rate. The brake thermal efficiency, brake specific energy consumption and volumetric efficiency are calculated for each load. The heat release rate is calculated from the data retrieved by the software installed in the set up. Ignition delay, maximum rate of pressure rise and combustion are calculated from pressure-crank angle data in the direct injection diesel engine with variable load conditions at a constant engine speed of 1500 rpm. For each operating condition, power output measurements are recorded. Many trials are taken and an average is calculated to have higher accuracy and dependability.

4. RESULTS AND DISCUSSION

4.1 Performance Characteristics

The variation of brake thermal efficiency is show in figure 2. At rated output, the brake thermal efficiency of the camphor blends with diesel (B-10, B-20, B-30, B-40) increases with the load. These in turn render high brake thermal efficiency at peak load. Due to the higher cetane value of Camphor oil, even the blend B-40 gives better brake thermal efficiency.

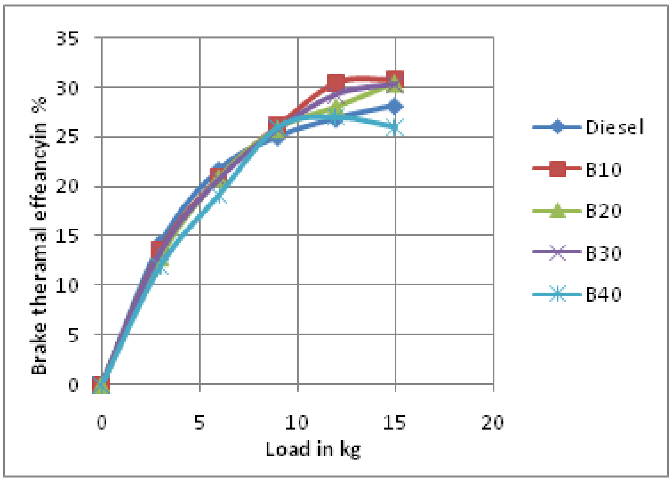

Figure.2 Brake thermal efficiency CR=18

4.2 Brake specific fuel consumption

Brake Specific Fuel Consumption (BSFC), the ratio between mass fuel consumption and brake power, inversely varies to the brake thermal efficiency. The variation in BSFC vis-à-vis load for different fuel samples is shown in Figure 3. The specific fuel consumption when using biodiesel fuel is expected to increase as compared to the consumption of diesel fuel. BSFC decreases sharply with increase in load for all fuel samples. The main reason for this may be due to the increase in fuel required to operate the engine is less than the increase in brake power due to relatively less portion of the heat losses at higher loads. As the BSFC is calculated on weight basis, higher densities resulted in higher values of BSFC. But unexpectedly BSFC of B10 is slightly lesser than that of unblended diesel. From the graph it is clear that the B30 shows the maximum BSFC followed by camphor B20 and B30 blends.

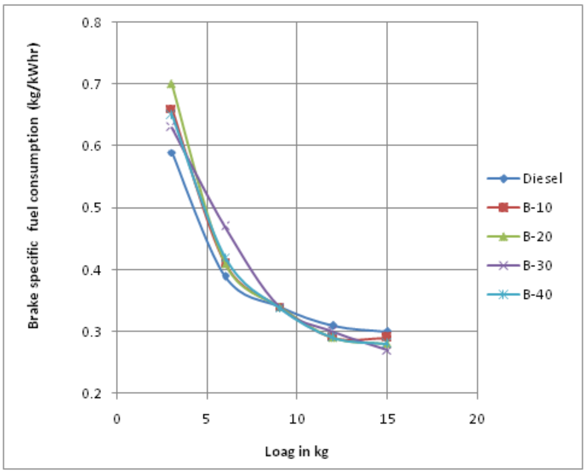

Figure 3. Brake specific field consumption Vs Load (CR=18)

4.3 Volumetric efficiency

The variation of volumetric efficiency with load is shown in figure 4 the load increases then volumetric efficiency is decreases. The volumetric efficiency of B40 blend is higher to that of Diesel. However there is a dip in the volumetric efficiency when the load is increased. Still B30 has a better volumetric efficiency compared to that of diesel in higher loads.

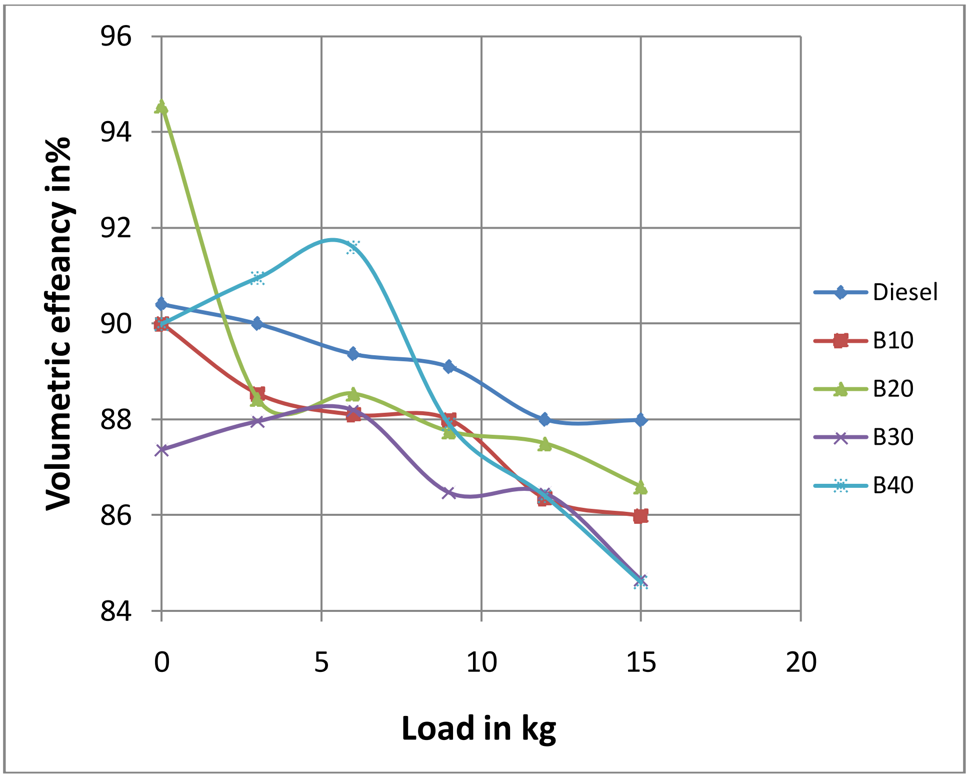

Figure 4. Volumetric efficiency Vs Load

The effect of B-10 volumetric efficiency is reaches 80% to the diesel fuel volumetric efficiency. B-20 the fresh air mixes with higher temperature of residual exhaust gas inside the cylinder and expands, which result is lower volumetric efficiency.

4.4 Emission Analysis

4.4.1 Hydrocarbon Emission

The variation of hydrocarbon emission with load for different blends is plotted in figure 5.

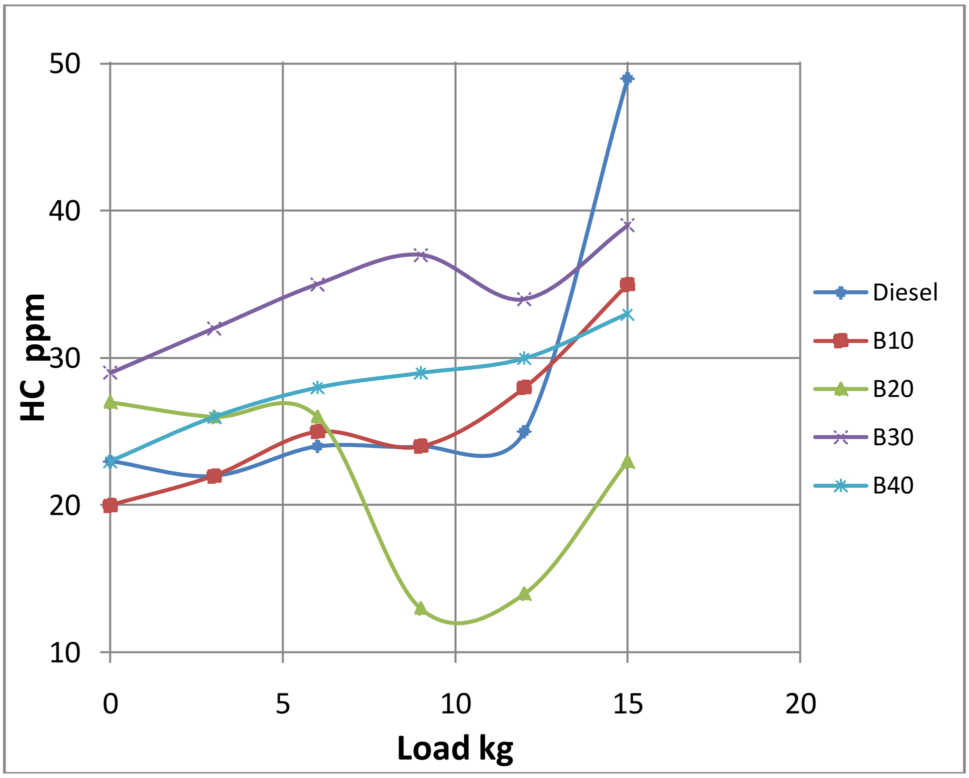

Figure 5. Hydrocarbon emission vs. Load

The hydrocarbon emissions of various blends are higher at higher loads. The effect of fuel viscosity and the fuel spray quality might be the causes that produced some hydrocarbon emissions. Increase in the blends of camphor oil increases the hydrocarbon emission hydrocarbon emission than the standard diesel due to the longer ignition delay, accumulation of fuel in the combustion chamber. The loading capacity increases slightly for the blend B-40 where the hydrocarbon emission is comparatively higher then diesel.

4.4.2 Carbon Monoxide

The emissions of CO for various blends are shown in figure 6. It may be observed that the emissions of blends are less than that of pure diesel fuel.

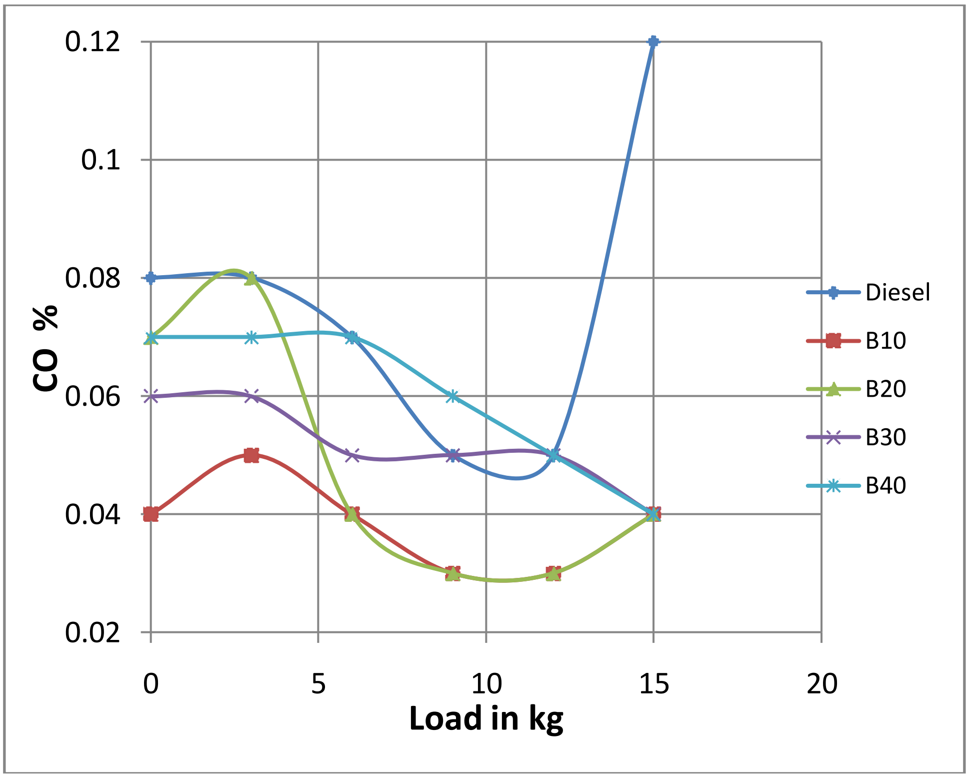

Figure 6. Emission of carbon monoxide vs. Load

For various loads, the CO emissions of the blend B-10 is close to that of standard diesel and it is found to be higher for light and medium load than the other blends.

The proportion of CO increases due to rising temperature in the combustion chamber. Physical and chemical properties of the air-fuel ratio, the effects of fuel viscosity on fuel spray quality are expected to produce an impact on emission of CO.

4.4.3 Carbon di-oxide Emission

The variation of carbon dioxide emission with different loads is shown in figure 7.

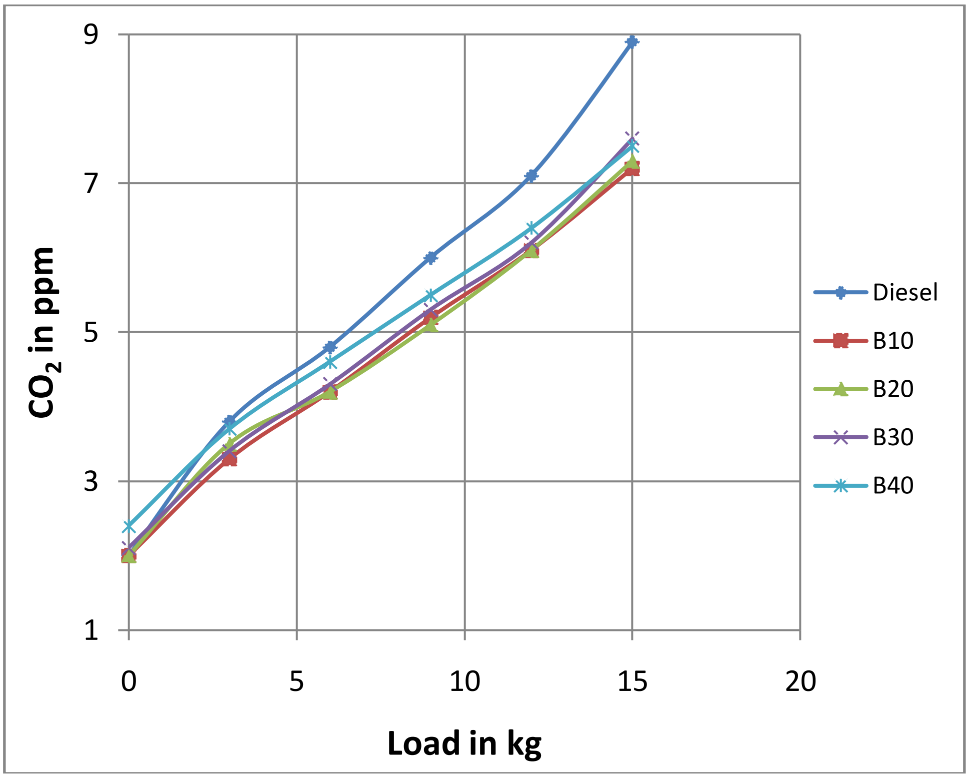

Figure 7. Emision of carbon di-oxide vs. Load

CO_2 emission of the blend B40 for higher load is less due to complete combustion and adequate supply of oxygen. The level of emission is only next to that of the pure diesel.

4.4.4 Nitrogen Oxide

Figure 8 shows that the variations of Nitrogen oxides (NOx) emission with load for different blends.

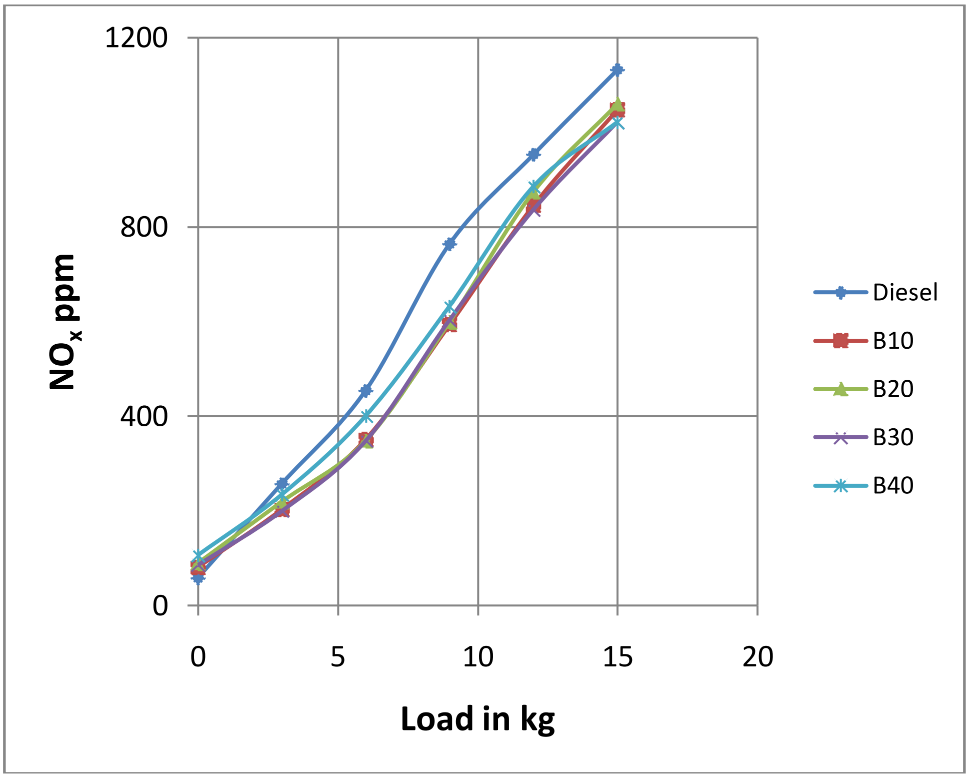

Figure 8. Emission of Nitrogen oxide vs. Load

The NOx emissions for biodiesel and its blends are higher than that of standard diesel except for B40. It is well known that the vegetable based fuel contains a small amount of nitrogen. This contributes towards lesser NOx. It is obvious that for 50% load, NOx emission from the blend B40 is lesser than that of diesel. But for full load the NOx emission from the blend B40 is higher than that of diesel. The other blends closely follow standard diesel. The reason for higher NOx emission for blends might be due to the higher peak temperature. The NOx emission for diesel and blend B40 for 50% load is 621 ppm and 432 ppm respectively which makes B40 a desirable blend.

4.4.5 Smoke emissions

The variation of smoke emission with load is show in figure 9.

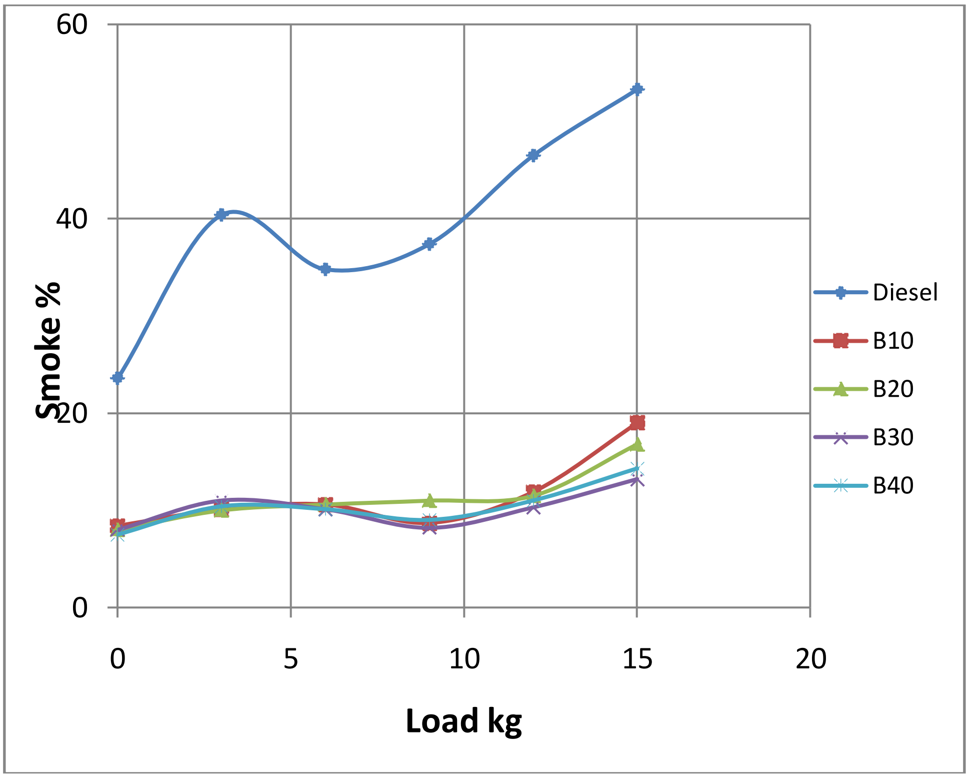

Figure 9. Smoke emission vs. Load

The long chain aromatics of the camphor oils blend create low level of smoke due to complete combustion. However, the smoke emission reduces with the blends of the camphor oil. At peak output, smoke level intensifies for blend operation is 2.22 BUS where as it is 5.28 BUS for diesel fuel operation. Smoke emission reduces to 3.06 BSU for camphor blend. This may be due to improved better fuel properties of blend such as low viscosity and better ignitability.

5. CONCLUSIONS

The work has been conducted on diesel engine using blends of camphor oil with diesel to examine the impact of the same on engine performance characteristics. Experiments have been conducted under various load conditions.

- It is observed that the blends used in this work can be used as alternative fuels in the existing diesel engine without any major modification.
- Camphor oil blends B10, B20, B30, B40 show a 4% increase in brake thermal efficiency than usage of diesel.
- The BSFC decreases with increase in load for all the blends. Camphor B10 has the brake specific fuel consumption nearly equal to that of diesel.
- For the various blends of camphor, the volumetric efficiency is 74.1% at maximum output. In lower loads the volumetric efficiency 92.3%.

- The NOx emissions for the blends are low, 920 ppm compared to 1050 ppm for diesel.
- Emission of CO depends on the air fuel ratio and incomplete combustion produces higher CO emission and increase nearly linearly with the brake mean effective pressure.
- The presence of camphor oils in the blend enhances the combustion process which is reflected in the reduction of CO emission.
- The experiment has shown that a maximum of 2.87% CO_2 emission is produced for the blends which is on higher side than that of diesel.
- Smoke emission is relatively less in the bio-diesel blends compared to diesel both at peak load and normal load.

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