Experimental Investigations on Combination of Castor and Neem Biodiesel & its Blends with Diesel used in Diesel Engine

Rathnagiri Mahesh Goud[1], Roshan Zameer Ahamed[2], Aiman Quraishi[3], Mohammed Ashfaque Inayath[4]

[1,2]Asst.Professor, Department of Mechanical Engineering, LIET-Hyderabad,TS, 500091.
[2,3]Research Scholar, Department of Mechanical Engineering, LIET-Hyderabad, TS, 500091.

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Abstract - *In this experiment, the work is to study the performance & emission characteristics of single cylinder, 4-Stroke, and diesel engine fueled with the biodiesel made by mixture of Castor & Neem methyl esters and its blends with diesel such as B10, B20 and B30 and compare the results with pure diesel. The experiment is carried out at endless speed of 1500 rpm, at constant IOP of 200bar for various CR as 16.5, 17.5& 18.5 at dissimilar loads of percentage 50, 75 and 100. The experimental readings are taken by using lab view software, emission values are taken with the help of multi gas analyzer & smoke values are taken by smoke meter. The outcomes are showing that castor & neem blend B10 has higher performance and lower emissions than other blends and performance almost equivalent to diesel at 18.5 CR and emissions are optimum at 18.5 CR. So, without any modifications castor & neem biodiesel combination can be used as blend B10 in the diesel engine.*

Key words: Combination of Castor & Neem methyl esters, Castor & Neem blends, Diesel Engine, Performance, Emissions.

1. INTRODUCTION

In the modern years, fossil fuels are declining abruptly. Fossil fuels are non-renewable energy resources; even natural processes are molding them because they take million years to form. We almost used up the existing coal, petroleum and the other natural resources the earth has in it. Fossil fuels have wide range of applications these are the main sources of electric power and used for industries and automobiles etc. because of increment in industrialization and substantial increment in the quantity of vehicles have come about immense interest for oil based goods, with the addition request of non-renewable energy sources everywhere throughout the world its supply in the market will keep on depleting. This increasing claim for petroleum-based fuels has run to oil crisis in the modern times. Due to rapid depleting of oil reserves, it is time to search for an alternative to petroleum-based fuels, which are readily available & easily producible. Biodiesel is a promising alternate fuel, which can be used in diesel engine without any adjustment to engine. There are many sources, which can produce biodiesel like castor seeds, sunflower seeds, jatropha etc. Using of biofuel is eco-friendly & decreases the dependence on fossil fuels. So many researchers have done experiments on diesel engines by using different biodeisels. Liaquat et al.[1] examined the performance& emissions of coconut bio diesel as blends B5 and B15 and compare the results with diesel at dissimilar loads with speed variation 1500 to 2400 rpm. They concluded that torque reduction for B5 is 0.69% & 2.58% for B15. Dawody et al. [2] have done experiments on pilot engine by using soyabean biodiesel blends [B20, B40, B100] at endless speed of 1500 rpm for numerous loads and showed that all blends have less bsfc than diesel. The investigations of Senthil Kumar et al. [3] on direct injection diesel motor by using Kapok methyl ester mixes and proved that the lean blends of Kapok methyl ester is a promising alternate to diesel fuel that shows appreciate engine efficiencies and considerable decrement in CO, HC & smoke emissions where as rich blends showed increment in BSFC and cut in BTE and NOX outflows also more compare to diesel. Sivaramakrishan [4] has inspected the performance &emission features of variable compression, multifuel engine fueled with karanja biofuel mingled with diesel such as B20, B25 & B30 for various CR of 15:1, 16:1, 17:1 and 18:1. He concluded that the B25 of karjana biodiesel at 18:1 CR is optimum. Jayasri Nairt et al. [5] tested the performance of neem oil blends in 4-stroke diesel engine & results disclosed that the B10 of neem biodiesel has higher BTE & lower emissions than diesel. Kasiraman et al. [6] used the cashew but shell oil in diesel engine & concluded that 70% of cashew nut shell oil and 30% of camper oil blend gives nearly same values as diesel like BTE for blend is 29.1% where as diesel efficiency 30.1%. Dinesh et al. [7] have tested the execution and discharges of cymbopogon flexosus biofuel mixes with diesel in various extents as B10, B20, B30, B40 and B100. As per American culture for testing measures, this trial was done in diesel motor at consistent speed of 1500 rpm. The outcomes presented that the B20 has higher B.T.E. among the blends and lower HC, CO emissions contrast to diesel. The research done by Panwar et al. [8] on VCR diesel engine for various loads by using castor oil blends. The outcomes are shown that the lower proportion blends have higher BTE and lower fuel consumption.

1.1 History of oils.

Castor Oil: The regular name is castor oil, from where the plant was, gets its introduction, perhaps originates from its use as a additional for castoreum, a perfume base done from the dried perinea glands of the beaver (castor in Latin). Castor oil is a colorless or very pale yellow fluid with a discrete taste & odor once first swallowed. Its boiling point of oil is 313 °C (595 °F) & its density was 961 kg/m3. Almost 90% of fatty-acid chains are ricinolates in a triglyceride. Oleate & linoleates are the other important components. Castor oil is used in the manufacture of soaps, coatings, inks, lubricants, hydraulic & brake fluids, paints, dyes, waxes, cold resistant plastics, & polishes, pharmaceuticals & perfumes.

Neem Oil: Neem (Azadirachta indica) is a tree in the mahogany family Meliaceae, which is richly grownup in different places of India. The Neem rises on almost all kinds of soils containing clayey, alkaline & saline conditions. Neem seed acquired from its tree is collected, sun dried, depulped & crushed for oil extraction. The seeds are having 45% of oil which was high potential for the making of biodiesel. Neem oil is usually light to dark-brown, bitter & has a slightly strong odour that is said to combine the odours of peanut & garlic. It comprises mainly of triglycerides & large amounts of triterpenoids compounds, which are answerable for the bitter taste.

Table - 1. Properties of biodiesels.

Properties	Castor	Neem	Castor& Neem	Diesel
Density(gm/cc)	0.956	0.919	0.885	0.830
Viscosity(cst)	52	34	8.0	5.0
Flash point(deg C)	320	300	140	57
Calorific value(kJ/kg)	36000	35200	39974	42000

2. EXPERIMENTAL SETUP

A vertical, 4-stroke cycle, single cylinder, water-cooled, compression ignition engine was used for the experiment. The engine is coupled to an Eddy Current Dynamometer. Air temperature, coolant temperature and throttle position are connected to open ECU which control fuel injector, fuel pump and idle air. The engine was modified and provision were provided to vary the compression ratio from 16.5:1 to 18.5:1,rated Injection opening pressure 200bar and rated crank angle. The line diagram of the engine setup is shown in the fig.1 below and the engine specifications shown in the table.2.Initially the engine was run with pure diesel and after blends of C&N[50:50] biodiesel as B10,B20 and B30 at various compression ratios for different loads varying with help of loading unit. Various engine performance parameters BTE and BSFC were measured with the help of digital lab view software and emission parameters like HC, CO and NOx were measured with Emission Gas Analyzer. Smoke opacity is measured with the help of smoke meter and the results were plotted against brake power.

Line Diagram

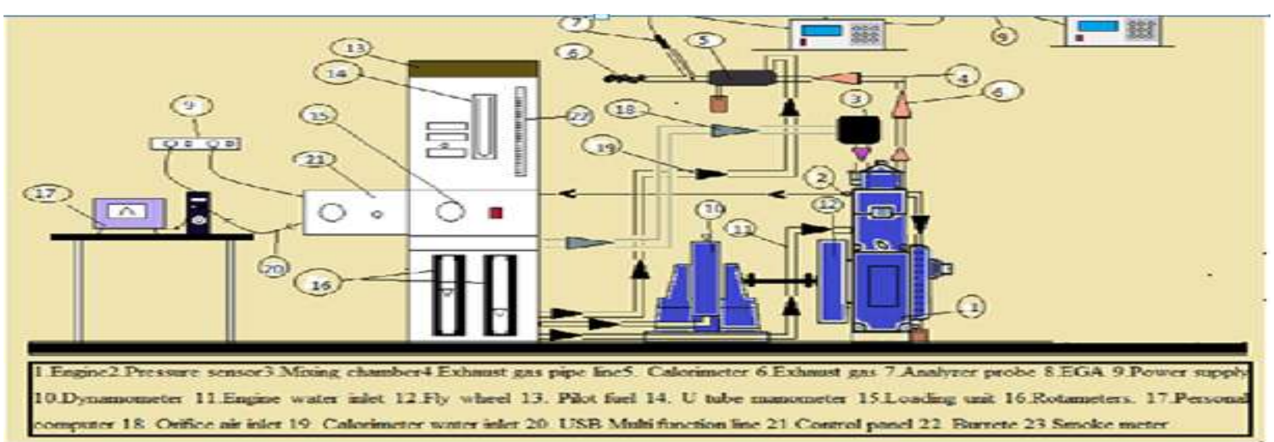


Fig-1. Line diagram of Experimental setup

Table - 2. Specifications of Test Rig.

PARTICULARS	SPECIFICATIONS
Type	Vertical, 4-Stroke Cycle, Single Acting, Totally Enclosed, Water cooled
Type of Ignition	Compression Ignition
Rated Power	3.5 kW
Injection opening pressure	200 bar
Constant Speed	1500 RPM
Variable compression ratio	16.5:1 to 18.5:1
Fuel Injection	Direct Injection
Injection Timing	23° BTDC
Dynamometer	Eddy Current Type

3. RESULTS AND DISCUSSION

3.1. Brake Specific Fuel Consumption

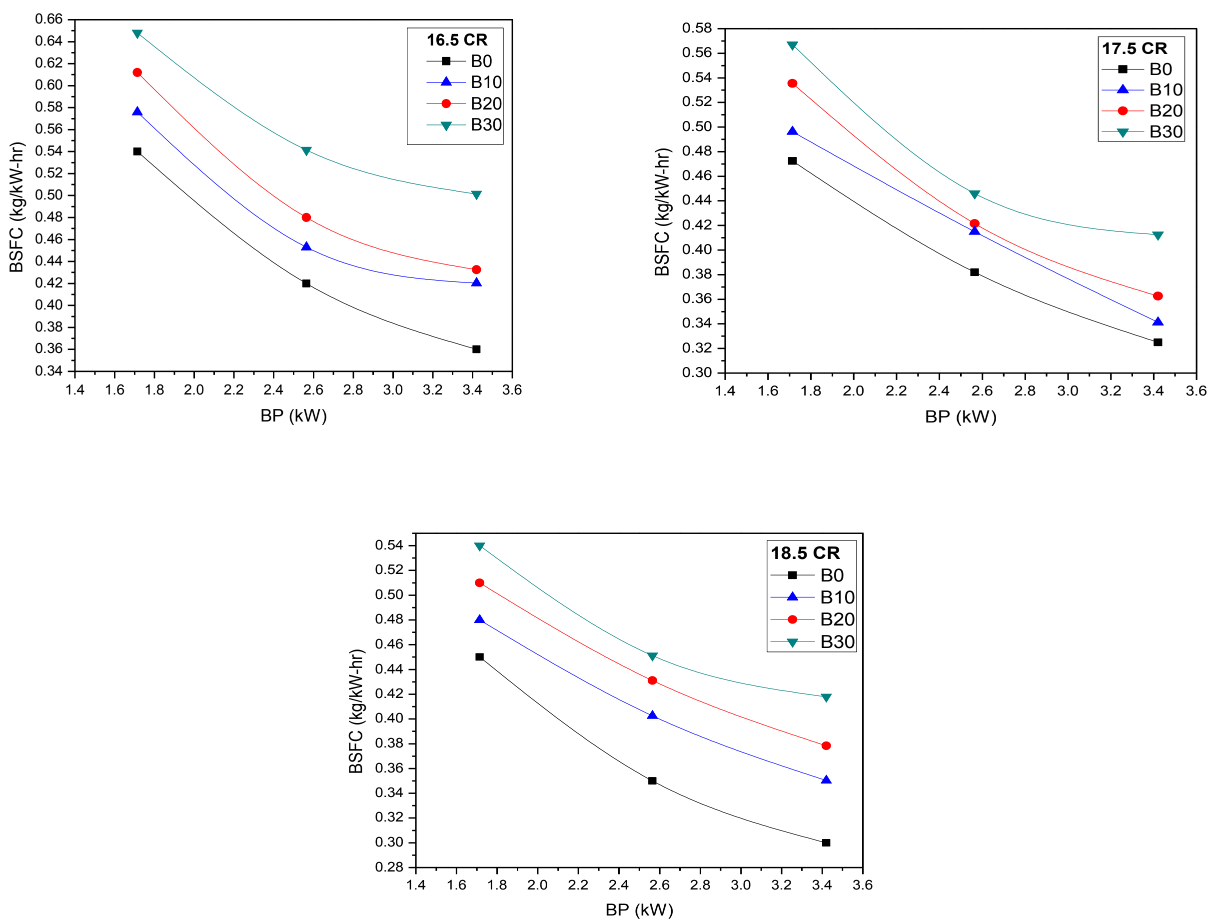


Fig-2. Variation of BSFC Vs BP for various compression ratios.

Fig. shows that the graphs presented variation of specific fuel consumption v/s break power of combination of neem & castor methyl ester (50:50) blends B10, B20 & B30 with diesel for compression ratios 16.5, 17.5 and 18.5. From the graph it is shown that on an average, the BSFC is reduced by 17%, when compression ratio increases from 16.5 to 18.5 for blends, which could be due to low heat losses and better combustion at higher compression ratio. The BSFC depreciates gradually with increment in load; at high load run, it shows optimum. The blend B10 shows less BSFC comparing to other blends B20 & B30 at all compression ratios but it is increased compared to that of diesel by 17%, 6% and 20% at compression ratios 16.5, 17.5 and 18.5 respectively. As the concentration of blend increase for biodiesel, showing increment in BSFC for all loads which is due to lower calorific values of B20 & B30 resulted more fuel consumption for same output energy.

3.2. Brake Thermal Efficiency

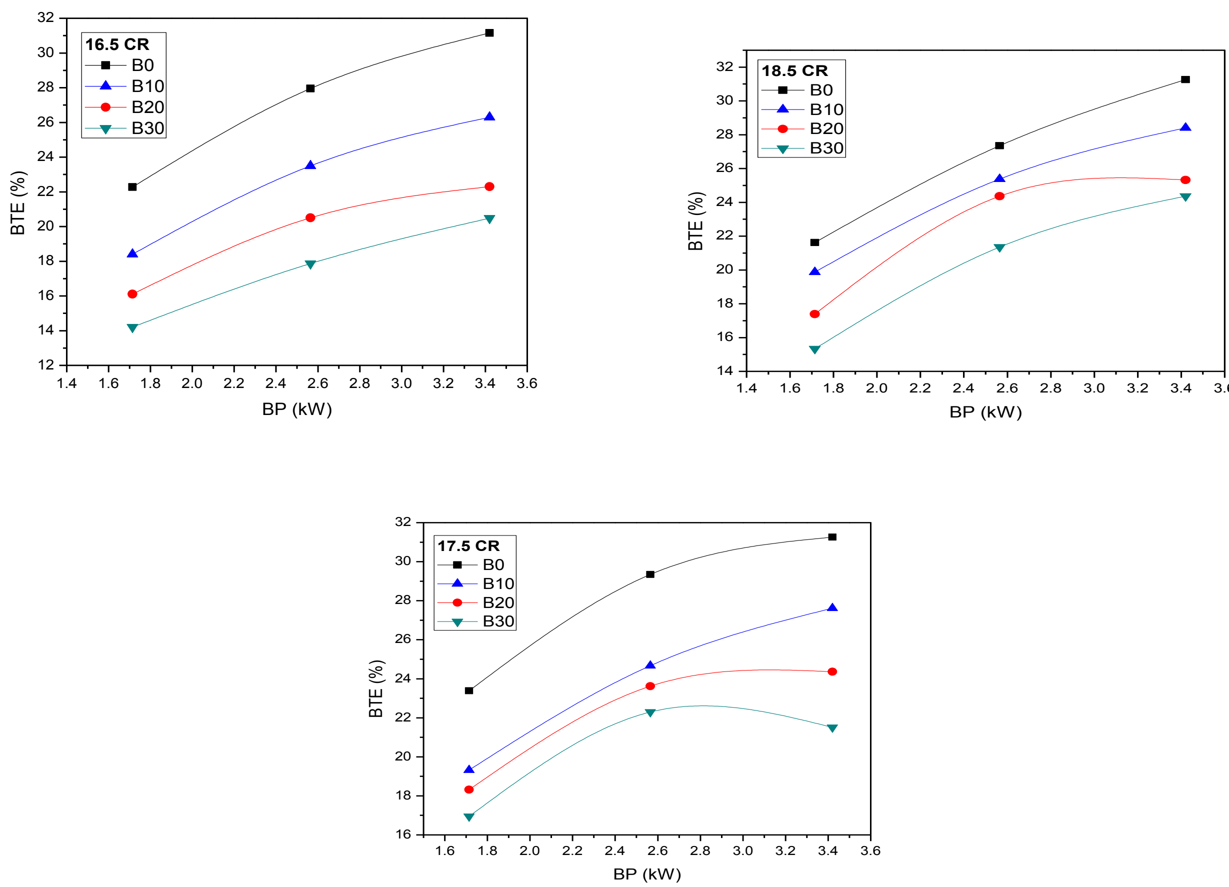


Fig-3. Variation of BTE Vs BP for various compression ratios.

Fig. shows the BTE of combination of neem & castor methyl ester blends and diesel against BP (break power) at compression ratios 16.5, 17.5 and 18.5. The graph clears that on an average, the break thermal efficiency is increased by 8%, when compression ratio increases from 16.5 to 18.5 for all the blends. Because of increment in compression ratio cause to complete combustion, and this may increase the efficiency. The BTE increases steadily with increment in load due to higher power produced at high load run. The blend B10 shows more BTE compared to other blends B20 & B30 at all compression ratios but it is still reduced by an average 17% compared to that of diesel at various compression ratios.

3.3. Carbon Monoxide

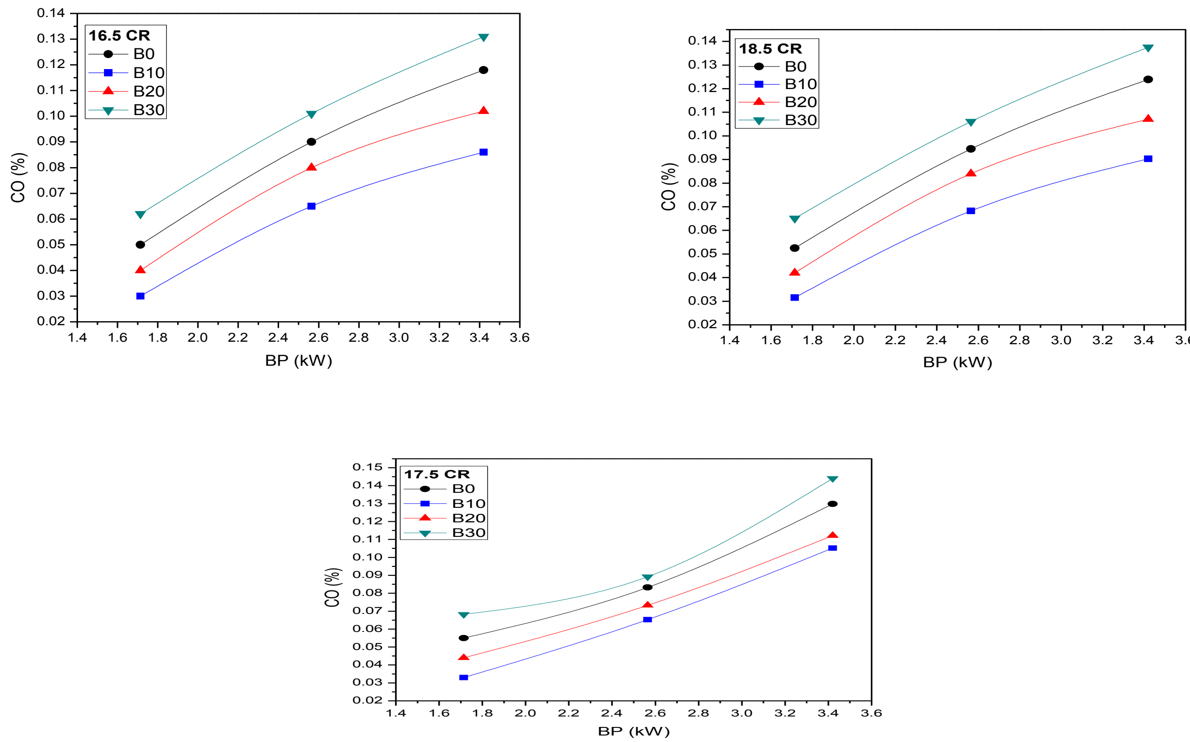
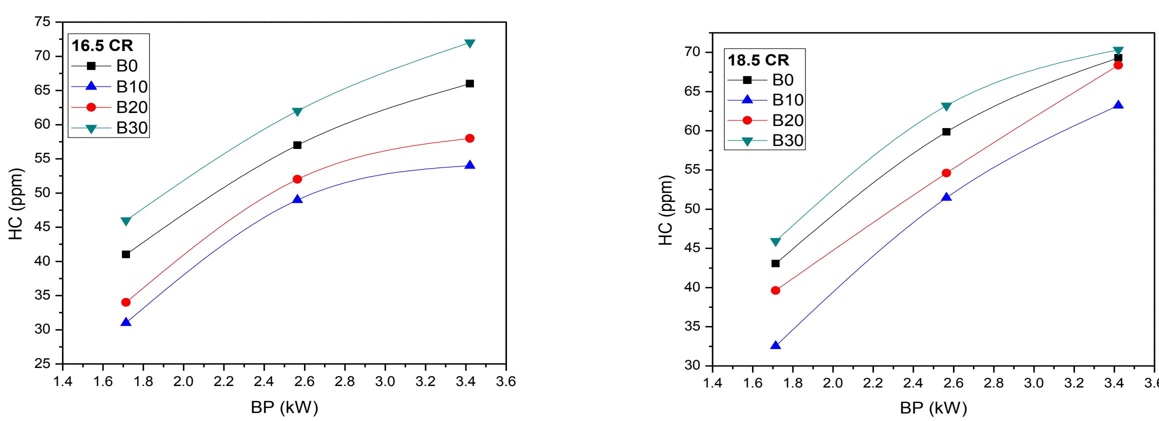


Fig-4. Variation of CO Vs BP for various compression ratios.

Fig. shows the variation in emissions of carbon monoxide v/s break power for blends B10, B20 & B30 of castor & neem biodiesel and diesel at CR 16.5, 17.5 and 18.5. From the figure, it is clear that CO emissions are low at higher compression ratio due to adequate heat of compression boosts ignition; therefore, on an average, the CO emissions are decreased by 14% with increase in compression ratio from 16.5 to 18.5 for all the blends. Blends B10 & B20 have fewer emissions than B30 and diesel. On an average, B10 & B20 CO emissions are reduced compared to that of diesel by 25% and 17% respectively for compression ratios 16.5, 17.5 and 18.5.

3.4. Hydrocarbon



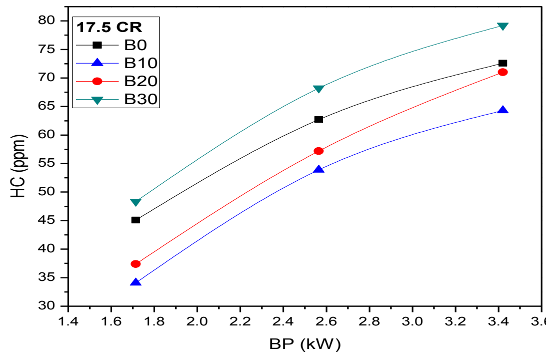


Fig-5. Variation of HC Vs BP for various compression ratios

Fig. shows the variation of unburnt hydrocarbons for different blends of neem &castor combination biodiesel and diesel at compression ratios 16.5, 17.5 and 18.5. From the graph, it is clear that the HC emissions are increasing with load increases for all the blends and diesel. On an average, the HC emissions were diminished by 8% for all the blends along with unadulterated diesel as compression ratio increases from 16.5 to 18.5.this increment prompts increase in temperature and pressure, that high temperature and high pressure ensure complete combustion, because of this complete combustion HC emissions were low. In addition, from the graphs it is cleared that B10 and B20 have less unburnt HC emissions than B30 & diesel. On an average, the HC emissions of B10 & B20 were reduced by 20% and 13% respectively, compared to that of diesel at compression ratios 16.5, 17.5 and 18.5.

3.5. NOx Emissions

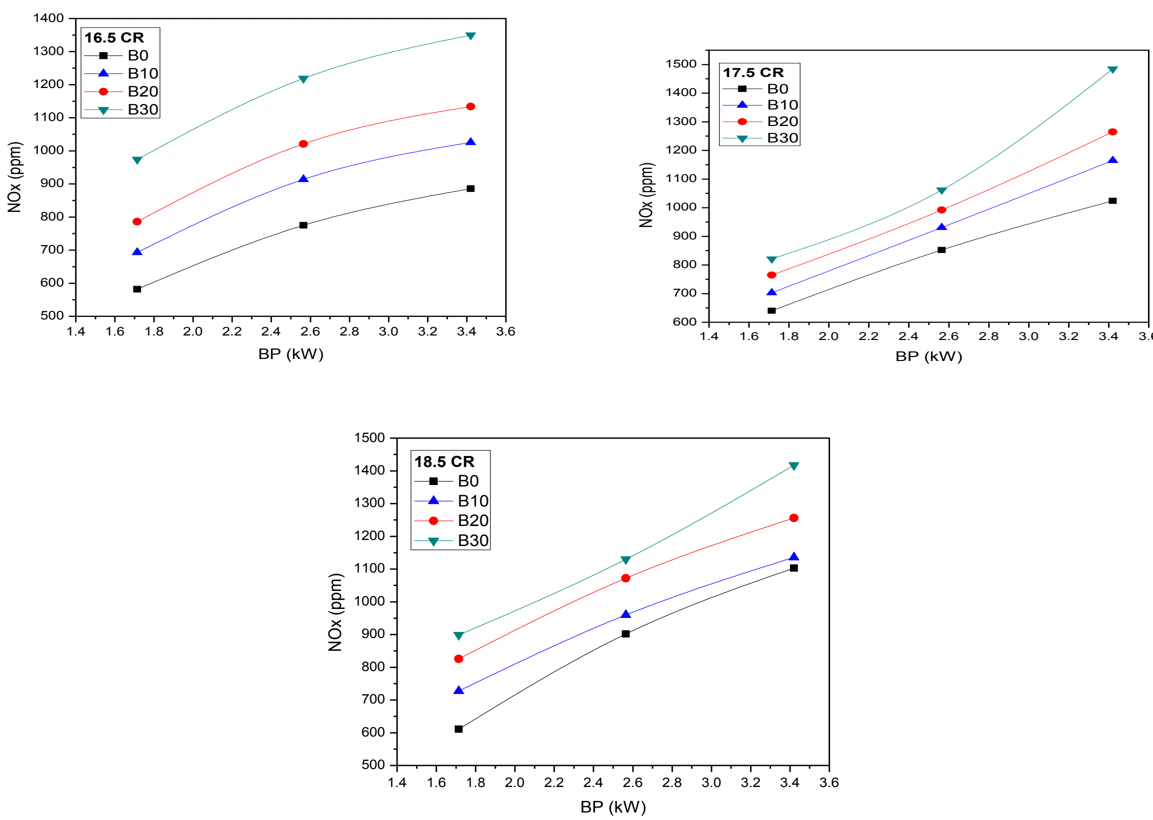


Fig-6. Variation of NOx Vs BP for various compression ratios

Fig. shows the variation of NOx emissions as a function of break power of diesel and C&N (50:50) blends as B10, B20 and B30 for various compression ratios 16.5, 17.5 and 18.5. From the figure, it is noticed that NOx outflows are increased on an average by 10% for all the blends and diesel, when compression ratio was increased from 16.5 to 18.5. This is due to higher combustion temperature makes nitrogen to react with oxygen in high proportion. In addition, B10 and diesel are having fewer NOx emissions as compared to that of B20 & B30. On an average, NOx discharges of B10, B20 and B30 were enhanced by 9%, 23% and 32% respectively, for various compression ratios 16.5, 17.5 and 18.5.

3.6. Smoke Opacity

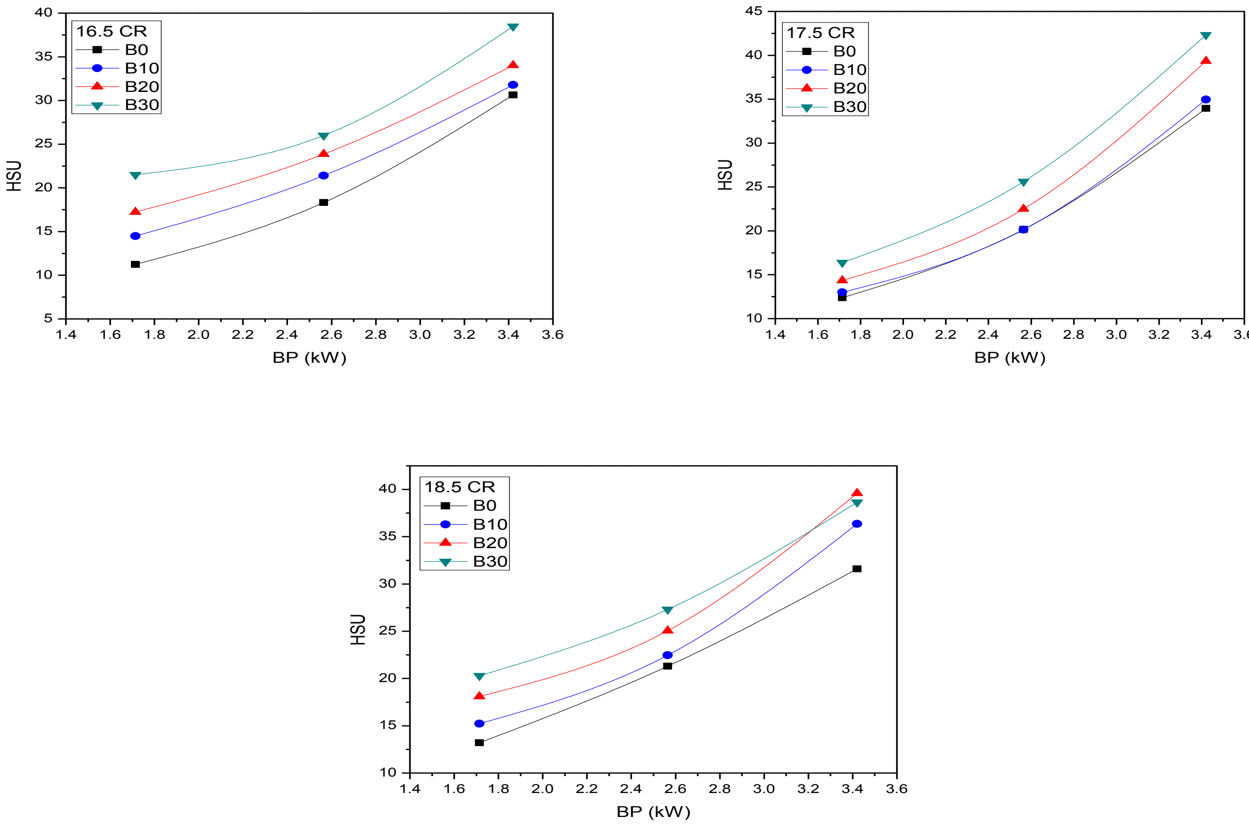


Fig-7. Variation of HSU Vs BP for various compression ratios

Fig. shows the smoke opacity graphs of castor & neem combination(50:50) biodiesel blends along with diesel were plotted against break power for various compression ratios 16.5,17 .5 and 18.5. From the graph it is cleared that smoke emissions of different blends of C&N[50:50] in form of B10,B20 & B30 were reduced on an average by 14%, when compression ratio was increased from 16.5 to 18.5. On an average, the smoke emissions were increased compared to that of diesel by 7%, 19% and 19% for B10, B20 and B30 respectively. This is due to higher viscosity results in slow combustion increasing smoke emissions.

Conclusions

From the exploratory examination on performance and emission test on diesel engine with blends of castor & neem biodiesel, we can infer that:

- Castor & neem biodiesel combination blend B10 is showing more brake thermal efficiency and less BSFC than remaining blends B20 and B30 at all compression ratios. However, it shows less brake thermal efficiency and more BSFC than pure diesel by an average 17% and 15% respectively.

- CO & HC outflows of B10 were less compared to other blends and those were reduced compared to diesel by an average 25% and 20% respectively, but NOX discharges and smoke discharges were enhanced compared to diesel by an average 9% and 7% respectively.
- For all the blends, BSFC is lowered and BTE is enhanced by an average 17% and 8% respectively, when compression ratio was increased from 16.5 to 18.5. In addition, CO, HC and smoke emissions were reduced by an average 14%, 8% and 14% respectively, where as NOx emissions were increased by an average 10%.
- Finally, the blend B10 is showing good performance and optimum emissions at compression ratio 18.5:1. Therefore, we can replace diesel with B10 in diesel engine without any modification.

Table-3. Nomenclature

B10	10% Caser & neem +90% Diesel
B20	20% Caser & neem +80% Diesel
B30	30% Caser & neem +70% Diesel
BSFC	Brake Specific Fuel Consumption
BTE	Brake Thermal Efficiency
C &N	Caster & Neem
CO	Carbon monoxide
CR	Compression Ratio
HC	Hydrocarbons
HSU	Hat ridge Smoke Unit
IOP	Injection opening pressure

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