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EXPERIMENTAL INVESTIGATION OF PERFORMANCE AND EMISSION ANALYSIS ON DIESEL ENGINE FUELLED WITH KARANJA OIL METHYL ESTER

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ABSTRACT

The present research work is aimed to investigate the performance and emission characteristics of a Variable Compression Ratio (VCR) Diesel engine with karanja oil methyl ester (KOME) blend. An experimental work has been conducted on a four strokes, single cylinder water cooled diesel engine with a compression ratio of 17:1, 17.5:1 & 18:1 and 3.5 kW capacity. Blend (B) of KOME, B10 (10% KOME+ 90% Diesel), B20 (20% KOME+ 80% Diesel) and B30 (30% KOME+ 70% Diesel) biodiesel are used for conducting the test in diesel engine at different load conditions. Several parameters such as specific fuel consumption, thermal efficiency and emissions are recorded in a period of time. The noteworthy properties of KOME were related with the diesel to validate the experimental results. The experimental result shows that the fuel of B20 with the compression ratio of 18 can be used in diesel engines without any engine modifications.

Keywords: Biodiesel, Diesel engines, Karanja oil, Variable Compression Ratio.

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1. INTRODUCTION

Increase in petroleum rates, causes increasing risk to the surroundings from exhaust emissions and global warming have engendered intense in emerging alternative nonpetroleum oils for engines [1]. The developing anxiety due to ecological pollution produced by the conventional fuels and the understanding that they are non-renewable have directed to hunt for more environment methodology and renewable fuels [2]. Surrounded by numerous routes investigated for diesel fuel, biodiesel obtained from vegetable oils has been recognized world over as one of the strong contenders for drops in exhaust discharges [3]. Generally biodiesel production is mostly from edible oils such as soybean, sunflower and canola oils. Diesel engines are the supreme effective major movers. From the point of view in protecting global environment and concerns for long-term energy security, it becomes necessary to develop alternative fuels with properties comparable to petroleum fuels. India's plea for diesel fuels is approximately six times that of gasoline.

The main objective in the present research work is to find out an alternative fuel for a present diesel engine without any hardware modification. Karanja oil methyl ester (KOME) has been taken up as the alternate fuel for investigation. The exhaust gas temperatures have measured for different loads on pure diesel, and varying blends of diesel with Karanja oil in order to analyze the NOx emission levels.

2. MATERIALS AND METHODS

2.1. Karanja oil

The Pongamia Pinnata is a native of the Western Ghats and is chiefly found along the banks of streams and rivers or near the sea on beaches and tidal forests. It also grows in dry places far in the interior. It is a hardy tree that mines water for its needs from 10 meter depths without competing with other crops. It grows all over the country, from the coastline to the hill slopes. It needs very little care and cattle do not browse it. It has rich leathery evergreen foliage that can be used as green manure.

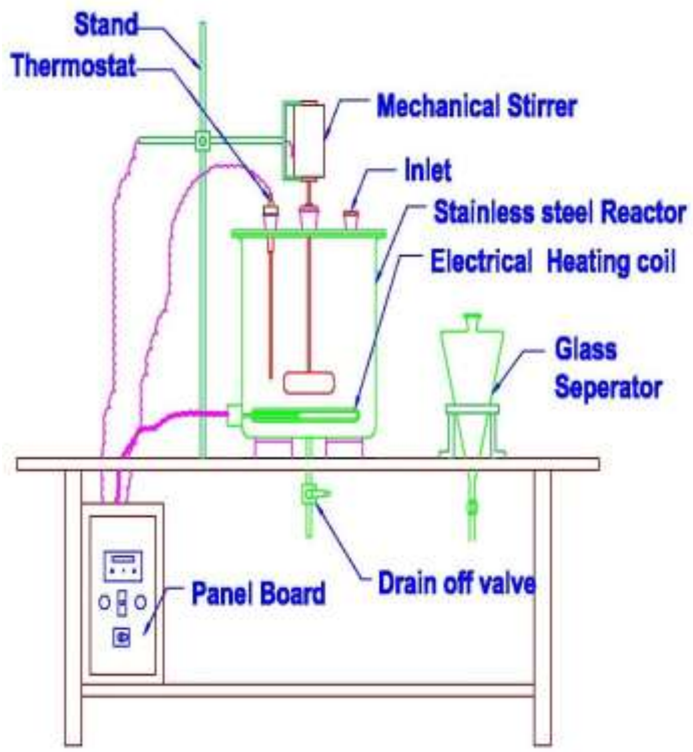
- Planting density - 200 to 250 per Acre
- Productivity - Starts yielding pods from 3 rd year onwards , but the mature average of 150 kg prods per tree per year from 10 th year onwards
- Life Span - 100 years
- Yield per hectare / year – 6 to 9 tonnes.

Each tree can yield 40 Liters of oil, 120 Kg of fertilizer grade oil cake and 250 Kg of biomass as green manure per year. When in bloom, the Pongamia trees can be used for bee harvesting and honey production. The long term adverse impacts of mono cropping of Pongamia and even Jatropha need to be evaluated and confirmed.

Figure 1 Photograph of Karanja seed

3. TRANSESTERIFICATION

The translation of karanja oil into its methyl ester can be consummate by the transesteification process. Transesterification comprises in reaction of the karanja oil with methyl alcohol (methanol) in the existence of a catalyst like potassium hydroxide (KOH) to produce glycerol and fatty acid ester. The investigational setup for production of biodiesel by transesterification procedure is as shown in figure 2.



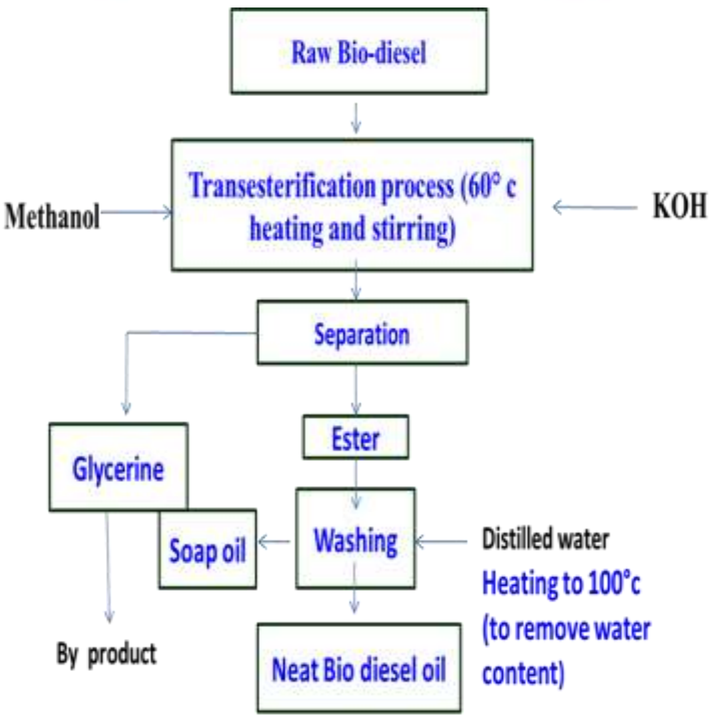


Figure 2 Experimental setup for production of biodiesel and Flow Chart of Bio-Diesel Trans-esterification Process

The measured karanja oil fuel properties have given in Table 1. The table also includes the properties of diesel to justify that karanja oil methyl ester can be a better alternative to diesel in terms of fuel properties.

Table 1 Fuel properties

Properties	Diesel	Karanja oil	KOME	B10	B20	B30
Calorific value (KJ/Kg)	42000	35614	36914	41472	40948	40428
Fuel Density @40^{o}C (Kg/m3)	830	891	863	833.3	836.6	839.9
Viscosity@40^{o}C (cst)	2.68	37.63	5.10	4.51	3.82	3.12
Flash point (^{o}C)	56	212	129	82	96	110
Fire point (^{o}C)	63	223	141	89	104	118

4. EXPERIMENTAL SETUP

The methodological expressions of the used engine for the current research work is a single cylinder DI diesel engine, water cooled, output of 3.5 kW at 1500 rpm. The experimental and schematic setup used in this study is shown in Figure 3.

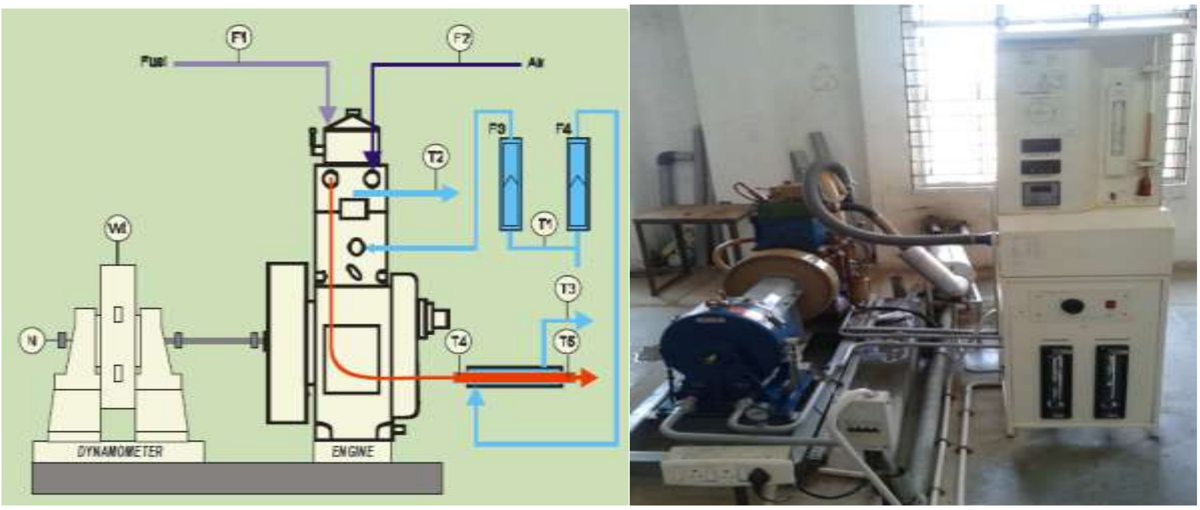


Figure 3 Schematic of the experimental setup and Experimental setup

The experimental setup comprises of VCR four stroke, single cylinder diesel engine, connected to eddy current dynaKOMEter for engine supplying. Without discontinuing the engine and altering the compartment combustion the compression ratios can be altered by specifically designed tilting cylinder block arrangement. The arrangement has detached type self-governing rectangular box containing air box, fuel tank and manometer, fuel measuring unit, digital speed indicator and temperature meter. Engine coolant inlet, outlet and calorimeter value are displayed on temperature indicator. Calorimeter and rota meters are on condition that for cooling water flow measurement. The arrangement permits to study the VCR engine management for brake thermal efficiency, BSFC, brake power, heat balance, volumetric efficiency, air fuel ratio and fuel specific consumption

5. RESULTS AND DISCUSSION

The performance analysis and emission release physical characteristics of the engine detected during the present work are detailed. All the results are obtained with a contrast between the conventional diesels, karanja oil methyl ester with the compression ratio of 17:1, 17.5:1 and18:1in conventional mode with blend of B10, B20 and B30 are discussed.

Brake Thermal Efficiency

The influences of brake thermal efficiency for different loads are shown in Figure. 4. There is a steady rise in brake thermal efficiency as the load increases. In general, increasing the compression ratio improved the efficiency of the engine. The mean brake thermal efficiency augmented higher than the diesel at greater loads may due to the reduced ignition delay. The compression ratio 18:1 was establish the best for all mixtures tested. This might be due to the fact that bio-diesel mixtures has lesser instability and as a result the improvement in their combustion characteristics might have been relatively more at higher temperatures resulted from higher compression ratio with the same rise in compression ratio.

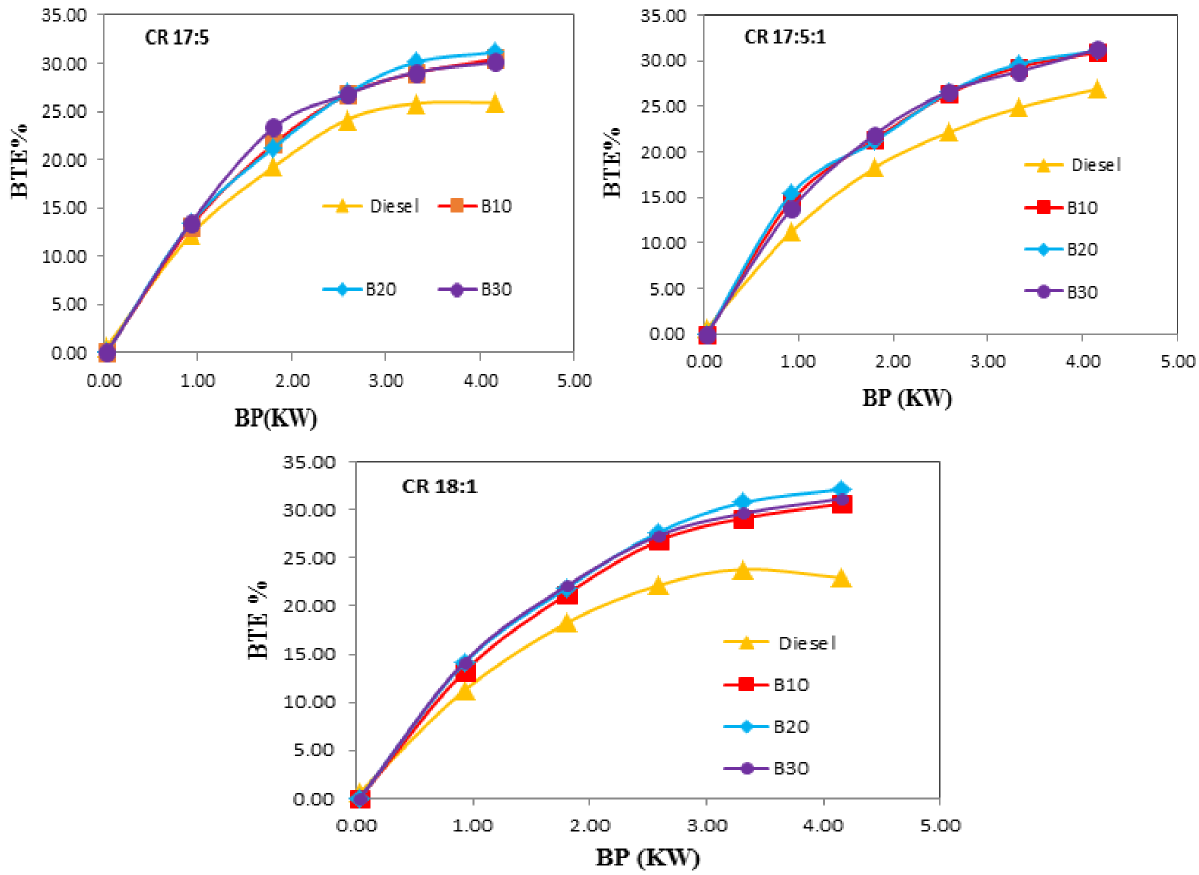


Figure 4 Brake power Vs Brake thermal efficiency

Carbon Monoxide Emissions

The influence of carbon monoxide (CO) in additional of different loads is shown in Figure. There is a gradual decrease in carbon monoxide as the load increases. The compression ratio

18 is slightly reducing carbon monoxide compared with others. The CO emissions are increases with increase of each blend. Here the CO emission increase because of the oxygen content of the biodiesel is low. Among this various blends the blend B20 is effective compared to others.

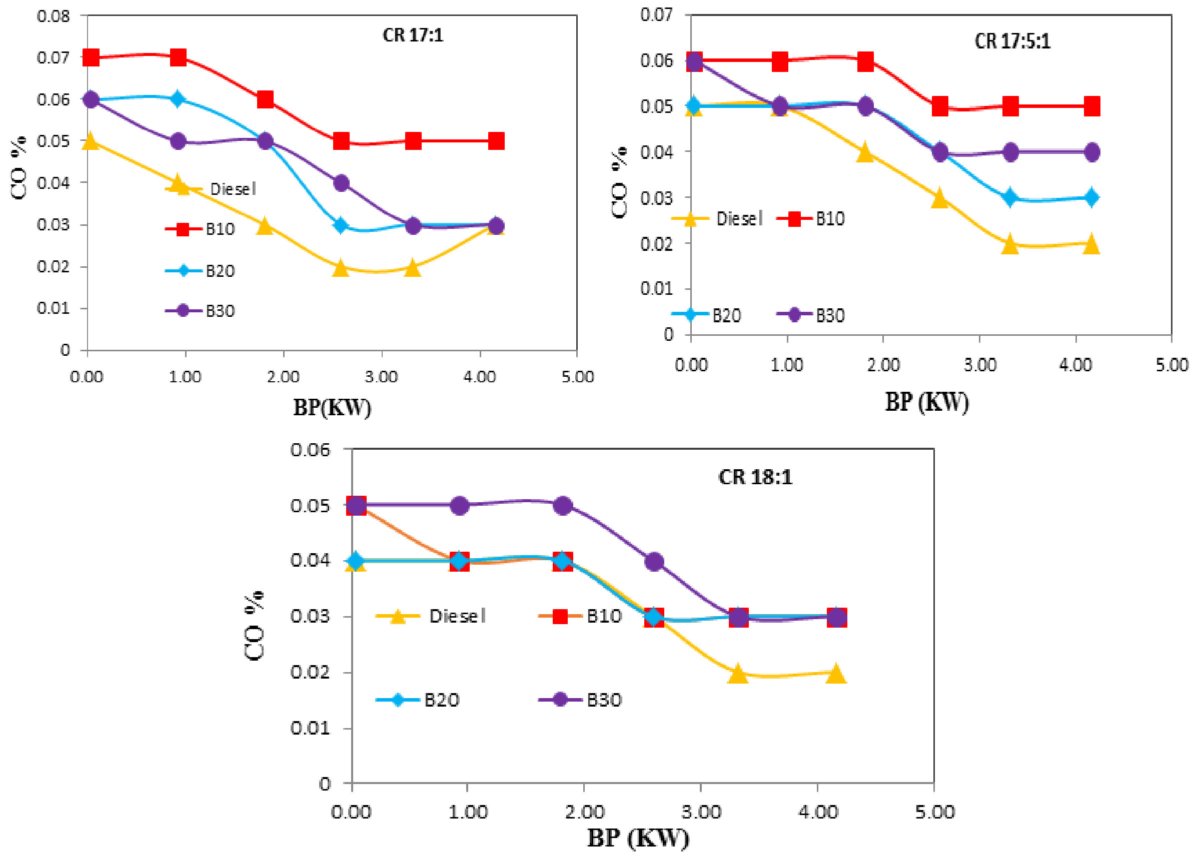
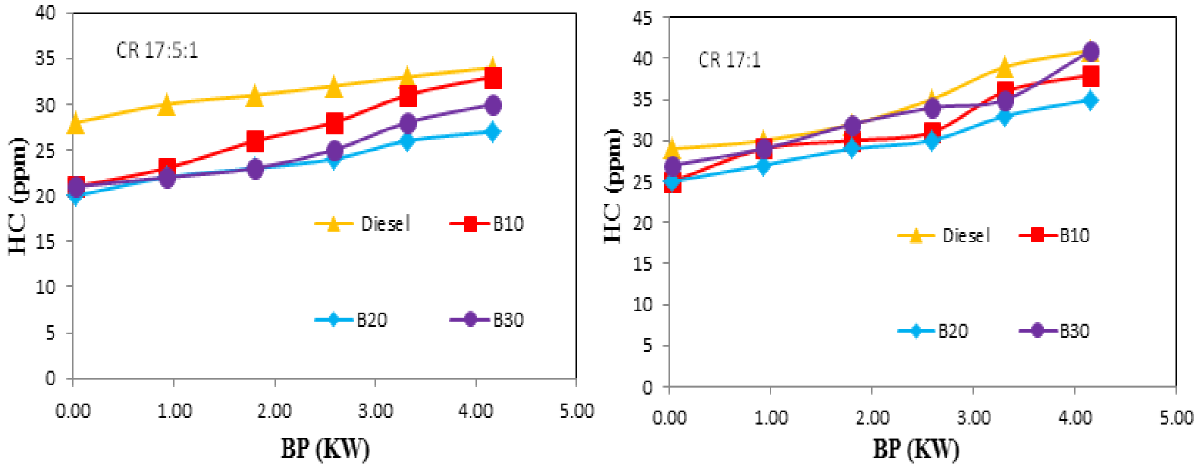


Figure 5 Brake power Vs CO

Hydrocarbon Emissions

The effect of hydro carbon over various load is as shown in Figure 6. There has a gradual increase in hydro carbon as the load increases. Normally in C.I engine UHC (Unburned hydro carbon) produces due to fresh fuel mixture directly exhaust at engine exhaust. In VCR engine while compression ratio increases the HC emission also increase. But the hydro carbon of biodiesel is low as compared to diesel fuel. Among the three blends B20 is more effective and the compression ratio 18 is best one.



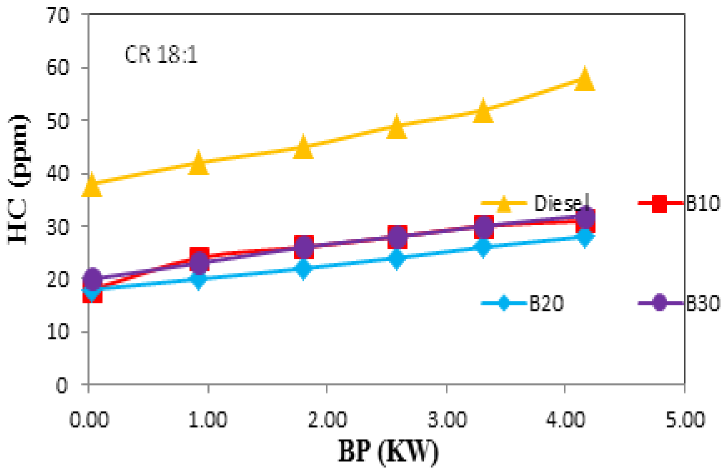


Figure 6 Brake power Vs HC

Smoke Emissions

The effect of smoke over various load is as shown in Figure 7. There has a gradual increase in smoke as the load increases. Smoke discharge from a diesel engine is exhibited as observable black smoke. Smoke discharge increases with increase in load of the engine due to complete more affluent of fuel- air ratios, longer duration of diffusion combustion phase and reduced oxygen concentration. The smoke emission for biodiesel is low compared to diesel fuel. Compared to three blends the B20 is more effective.

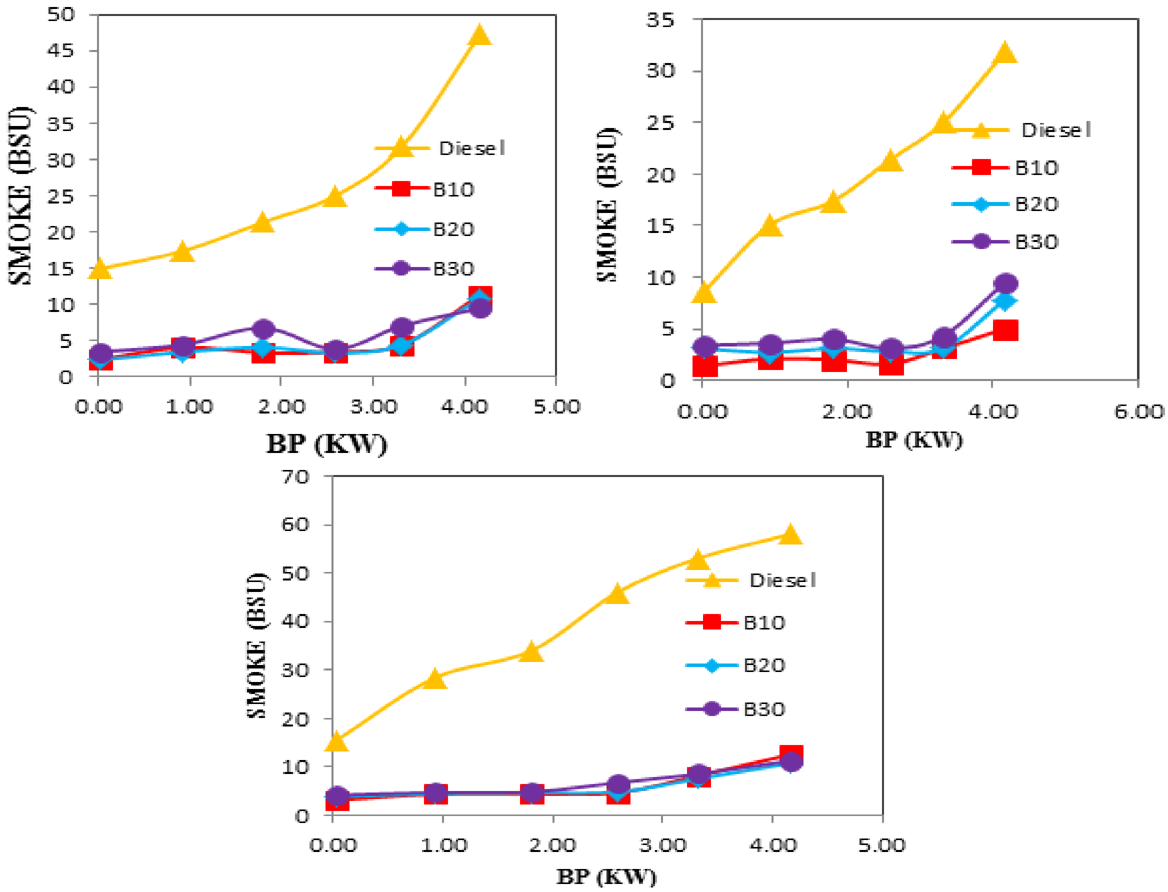


Figure 7 Brake power Vs Smoke

6. CONCLUSION

An experimental investigation was carried out on karanja oil methyl ester blends of B10, B20 and B30 in a VCR engine with the compression ratios of 17:1, 17.5:1 and 18:1. The karanja oil characteristics, performance and emission were compared with conventional fuel.

- There is a decrease in specific brake fuel consumption and slow increase in brake thermal efficiency.
- There is a gradual increase in exhaust gas temperature.
- The emission of CO has high and the other emissions HC, NOx and Smoke are reduced by using KOME biodiesel.

Hence based on the investigation B20 (20% KOME+80%diesel) can be a better substitute fuel and CR18 is better compression ratio for VCR diesel engine without any modification.

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