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ABSTRACT

In this present paper, an experimental study is carried out on a single cylinder, four stroke VCR, direct injection diesel engine to analyze the performance characteristics of 20% karanja oil (B20) with Diethyl ether, Methanol and Ethanol as an additives by substituting 5% and 10% respectively. The engine is operated at the speed of 1500 rpm with variable compression ratios 17 and 18. Analysis of performance parameters such as brake power, indicated power, brake thermal efficiency, mechanical efficiency, specific fuel consumption (SFC) and indicated thermal efficiency are arrived by the IC Engine analysis software which has been coupled with the VCR Engine. The outcome data of these blends are to be compared with the ordinary diesel. The results are optimized by using DOE method in MINITAB 17.0 software to find out the suitable blend for the engine.

Keywords: Karanja oil, Transesterification process, Di-ethyl ether, Ethanol, Methanol, VCR Engine, Emission characteristics, Compression ratio.

INTRODUCTION

Biodiesel is renewablepetroleumcreated from vegetable andanimal fats which can be used in diesel engine with slight or noalteration. Biodiesel is naturally blended with diesel petroleumin formulations referred to as B10 (10% biodiesel and 90%diesel), B20 (20% biodiesel and 80% diesel) up to B100 (100%biodiesel). Avinash Kumar Agarwal et al. (2013) suggested that the blends of 20% biodiesel (B20) and lesser can be used in diesel apparatus without any alteration in diesel engine. Biodiesel is gaining further and additionalsignificance as an substitute fuel due to the reduction of petroleum resources and costscramble of petroleum products. Senthur et al. (2014)concluded that performance and emission tests of biodiesel petroleum on diesel engine. It is renewable, harmless andnon polluting resource of energy.

Naga Sarada et al. (2010) discussed that theelevated viscosity of vegetable oil and small calorific value affects the atomization and squirtcreation of fuel, leading to unfinished combustion, carbon authentication, injector harsh and piston ring downhill. Transesterification is normally used to decrease the viscosity of non edible vegetable oil to createfresh andenvironmental pleasant fuel. Syarifah Yunus et al.(2013) discussed that the different vegetable oil offered for invention of biodiesel such as sunflower oil, jatropha oil, karanja oil, soyabean oil, mahua oil, palm oil etc. Soyabean oil, palm oil, Sunflower oil are edible oils therefore it cannot be used for biodiesel creation. Alternatively Karanja oil are non edible oil and are smart due to easy availability and little production price.

De et al. (2014) mentioned the of performance parameters such as mechanical efficiency, brake thermal efficiency, indicated thermal efficiency, specific fuel consumption, brake power and indicated power. These performance parameters are arrived by the IC Engine analysis software which has been coupled with the VCR Engine. Nagaraja et al. (2015) analyzed thehuge number of results are achieved because of usage of three various additives (Diethyl ether, Methanol and Ethanol) with various proportions are added with B20. These blends are evaluated at compression ratio 17 and 18, where the engine is operated at 1500 rpm constant speed. The main objective of this paper is to analyze the performance characteristics of 20% karanja oil (B20) with Diethyl ether, Methanol and Ethanol as an additive by substituting 5% and 10% respectively at compression ratio 17 and 18.

EXPERIMENTAL SETUP

A load test on an engine provides information concerning the performance characteristics of the engine. The performance characteristics of such engines are obtained by changeable the load on the engine. The experiments were carried out on a single cylinder 4 stroke diesel engine of a representation manufactured by Kirloskar oil engines Ltd., the major manufacturer of convenient multi-fuel engines. The Kirloskar engine is a single cylinder, vertical and air cooled multi fuel engine. It is attached to a 3 phase loading rheostat.A fuel tank with a measuring burette enables the engine fuel consumption to be calculated. The loading rheostat is attached by means of rigid coupling carefully without any misalignment between axes. The appropriate position helps to damp-out any vibration that may occur during transmission.

Fig.1 Experimental Setup

Engine tests were carried out at changeable compression ratio 17 and 18 for diesel, as well as biodiesel blends. The blends used in this experiment are diesel, B20, B20+5% DEE,B20+10% DEE, B20+5% Ethanol,B20+10% Ethanol, B20+5% Methanol and B20+10% Methanol. Five engine load conditionsare investigated for blend were 0%, 25%, 50%, 75% and100% of rated load.

Table 1: Specification of the VCR Engine

Make	Kirloskar
General details	4- Stroke, water cooled, variable compression ratio Engine
Rated power	3.5Kw at 1500rpm

Speed	1500rpm(constant)
No of cylinder	Single cylinder
Compression ratio	12:1 to 18:1
Bore	87.5mm
Stroke	110mm
Ignition	Compression ignition

RESULTS AND DISCUSSION

The outcomes of performance characteristics of the variable compression ratio engine fuelled with karanja oil and various additives (Diethyl ether, Ethanol, Methanol) at compression ratio 17 and 18 has been explained with graphs below. The below mentioned nomenclature is to identify the Compression Ratio, Blends and various loads in the main effect plots for the optimization of engine performance in the DOE method by using MINITAB 17.0 Software.

Table 2: Nomenclature for Minitab Graphs

CR 1	Compression Ratio 17
CR 2	Compression Ratio 18
BLEND 1	DIESEL
BLEND 2	B20
BLEND 3	B20 + 5% Diethyl ether
BLEND 4	B20 + 10% Diethyl ether
BLEND 5	B20 + 5% Ethanol
BLEND 6	B20 + 10% Ethanol
BLEND 7	B20 + 5% Methanol
BLEND 8	B20 + 10% Methanol
LOAD 1	0%
LOAD 2	25%
LOAD 3	50%
LOAD 4	75%
LOAD 5	100%

The above mentioned nomenclature is to identify the Compression Ratio, Blends and various loads in the main effect plots for the engine performance in the DOE method by using MINITAB 17.0 Software. The engine performance has been optimized with the help of DOE method by using MINITAB 17.0 Software.

Performance Parameters

Brake Power

The Fig.2 shows the effect of Brake Power with change in means of Compression Ratio (CR), Blends and Loads. Increase in compression ratio leads to decrease in Brake Power. So, lower compression ratios are preferred to achieve high brake power. The Blend 7 (B20 + 5% Methanol) attains maximum brake power (3.35kW), compared to all other blends. Then, the increase in load percentages may leads to achieve high brake power. Here, the maximum brake power (3.35kW) is achieved at full load condition.

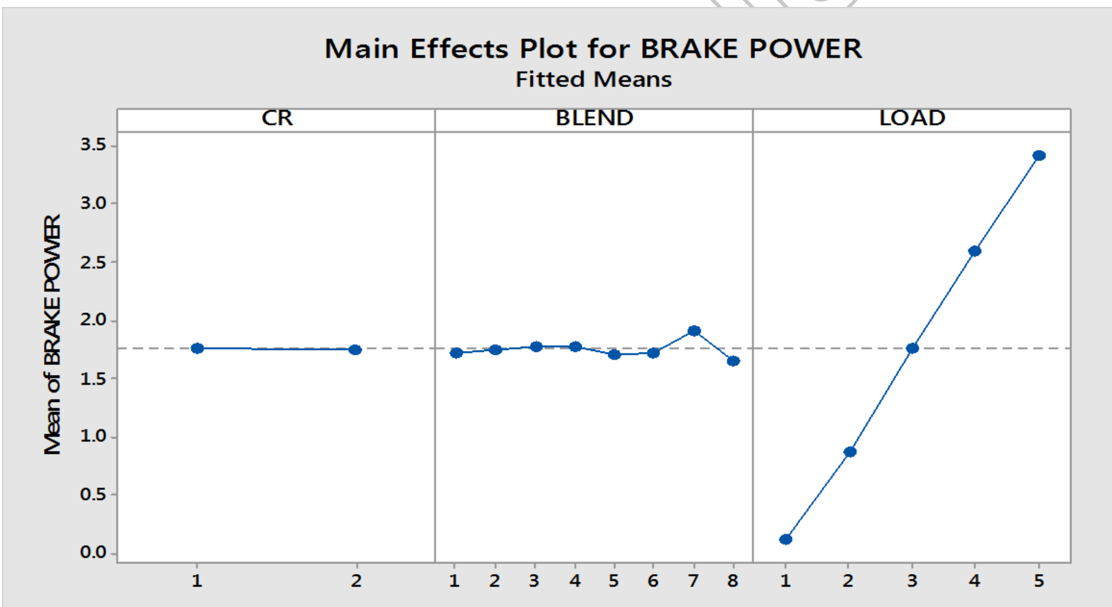

Fig.2 Main Effects Plot for Brake Power

Indicated Power

The Fig.3 shows the effect of Indicated Power with change in means of Compression Ratio (CR), Blends and Loads. Increase in compression ratio leads to decrease in indicated power. So, lower compression ratios are preferred to achieve high indicated power. The Blend 7 (B20 + 5% Methanol) attains maximum indicated power (2.64kW), compared to all other blends.

Then, the increase in load percentages may leads to achieve high indicated power. Here, the maximum indicated power (2.64kW) is achieved at full load condition.

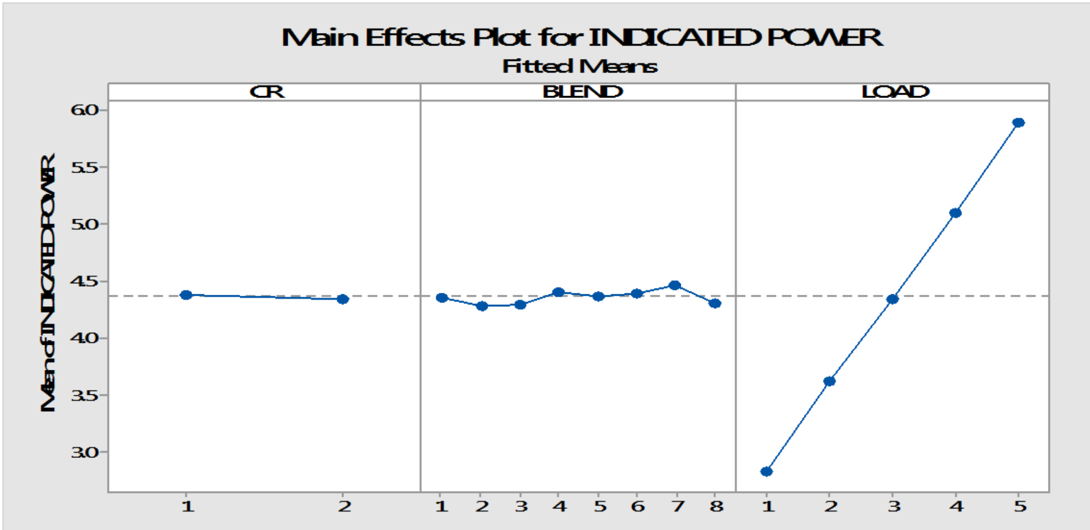

Fig.3 Main Effects Plot for Indicated Power

Brake Thermal Efficiency

The Fig.4 shows the effect of brake thermal efficiency with change in means of Compression Ratio (CR), Blends and Loads. Increase in compression ratio leads to increase in brake thermal efficiency. So, higher compression ratios are preferred to achieve high brake thermal efficiency. The Blend 7 (B20 + 5% Methanol) attains maximum brake thermal efficiency (33.3%), compared to all other blends. Then, the increase in load percentages may leads to achieve high brake thermal efficiency. Here, the maximum brake thermal efficiency (33.4%) is achieved at full load condition.

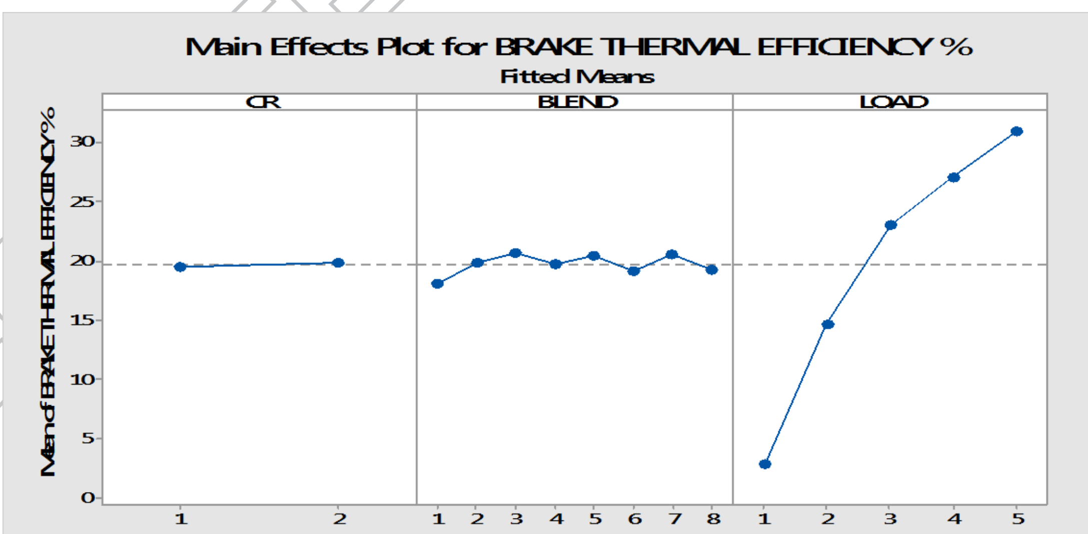

Fig.4 Main Effects Plot for Brake Thermal Efficiency%

Indicated Thermal Efficiency

The Fig.5 shows the effect of Indicated thermal efficiency with change in means of Compression Ratio (CR), Blends and Loads. Increase in compression ratio leads to increase in Indicated thermal efficiency. So, higher compression ratios are preferred to achieve high Indicated thermal efficiency. The Blend 8 (B20 + 10% Methanol) attains maximum Indicated thermal efficiency (85.11%), compared to all other blends. Then, the increase in load percentages may leads to decrease in Indicated thermal efficiency. Here, the maximum brake thermal efficiency (85.11%) is achieved at initial load condition.

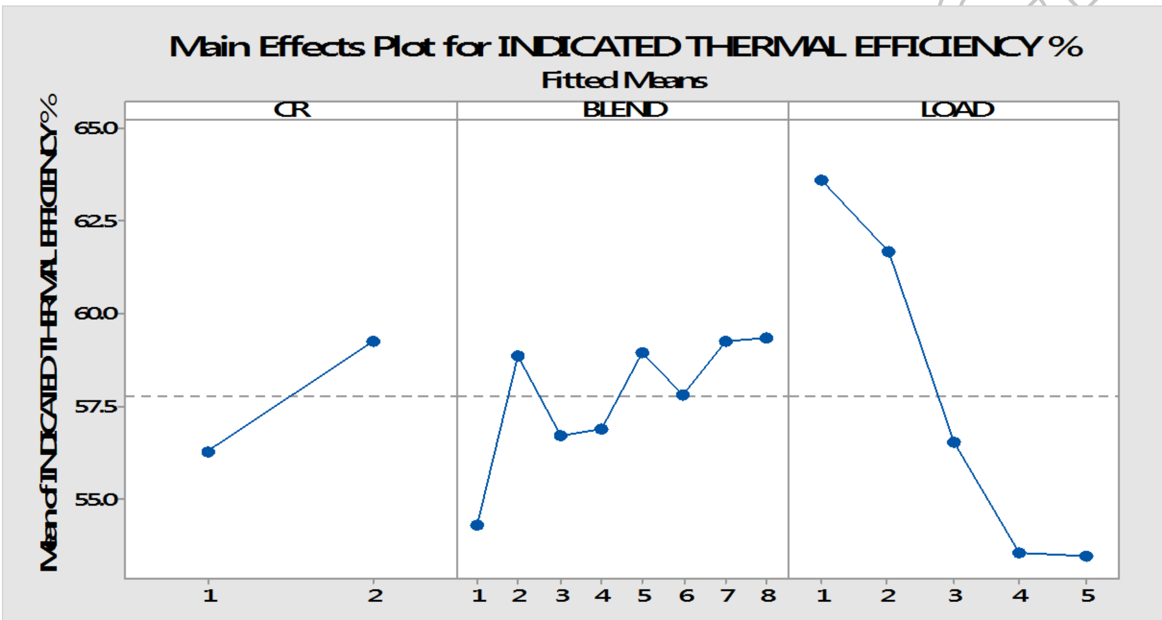

Fig.5 Main Effects Plot for Indicated Thermal Efficiency%

Mechanical Efficiency

The Fig.6 shows the effect of mechanical efficiency with change in means of Compression Ratio (CR), Blends and Loads. Increase in compression ratio leads to increase in mechanical efficiency. So, lower compression ratios are preferred to achieve high Mechanical efficiency. The Blend 7 (B20 + 5% Methanol) attains maximum mechanical efficiency (59 %), compared to all other blends. Then, the increase in load percentages may leads to achieve high mechanical efficiency. Here, the maximum mechanical efficiency (59%) is achieved at full load condition.

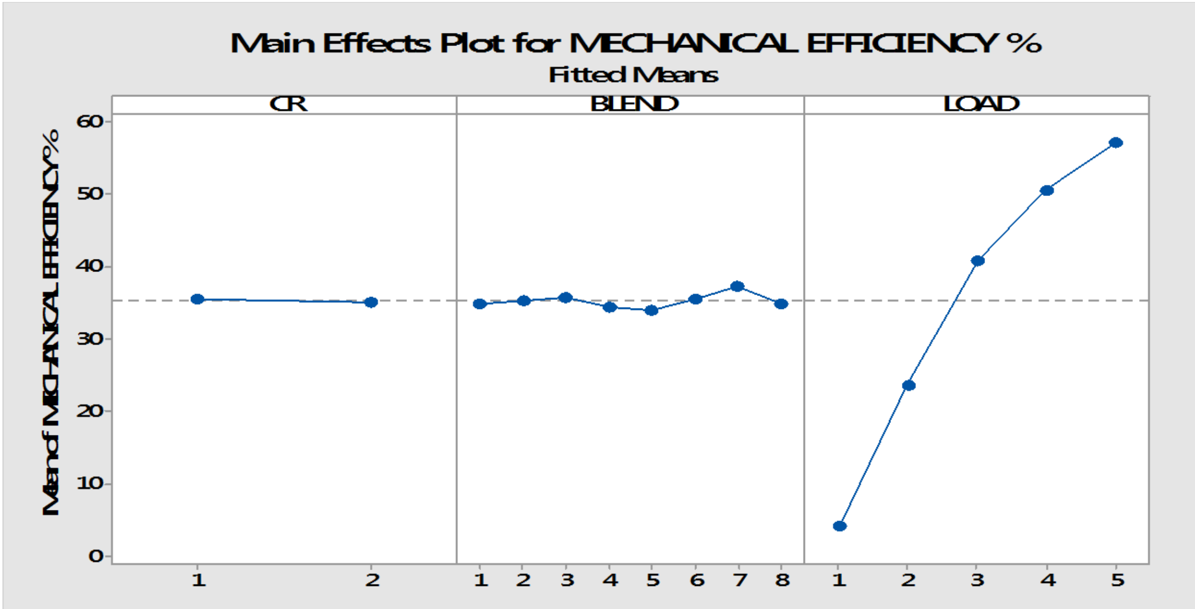

Fig.6 Main Effects Plot for Mechanical Efficiency%

Specific Fuel Consumption

The Fig.7 shows the effect of Specific fuel consumption with change in means of Compression Ratio (CR), Blends and Loads. Increase in compression ratio leads to decrease in specific fuel consumption. So, higher compression ratios are preferred to achieve low specific fuel consumption. The Blend 8 (B20 + 10% Methanol) attains minimum specific fuel consumption (0.26 kg/kWh), compared to all other blends and it is almost equal to Blend 1 (diesel). Then, the increase in load percentages may leads to high specific fuel consumption.

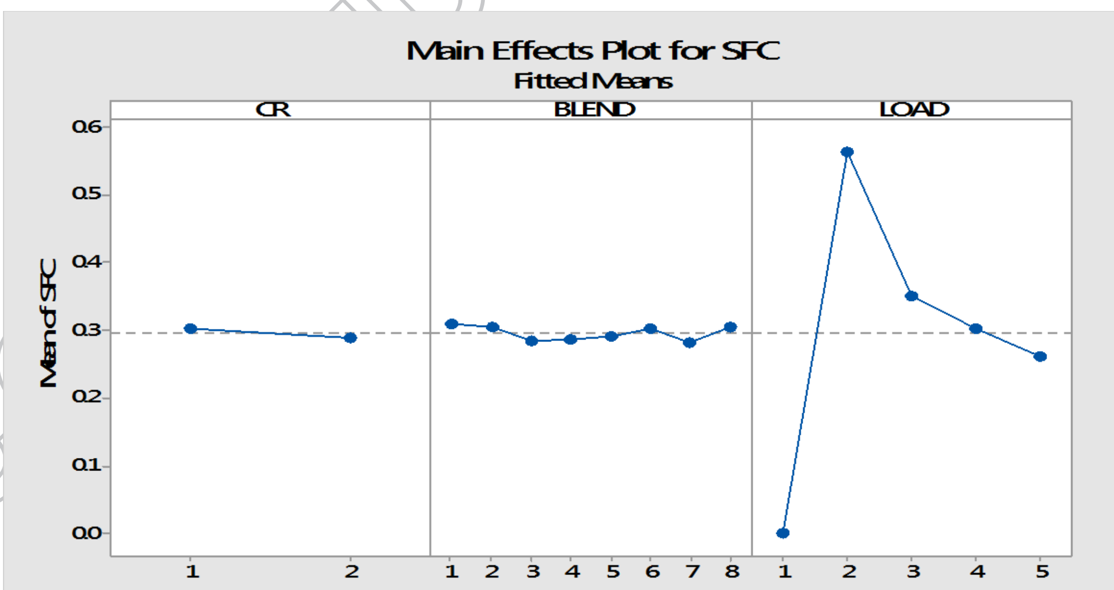

Fig.7 Main Effects Plot for Specific Fuel Consumption

CONCLUSION

The performance characteristics of single cylinder, four stroke VCR, direct injection diesel engine with 20% karanja oil (B20) with Diethyl ether, Methanol and Ethanol as an additive by substituting 5% and 10% at compression ratio 17 and 18 were optimized by using DOE method in MINITAB 17.0 software.

- The Blend 7 (B20 + 5% Methanol) attains maximum brake power (3.35kW), compared to all other blends. Then, the increase in load percentages may leads to achieve high brake power. Here, the maximum brake power (3.35kW) is achieved at full load condition.
- The Blend 7 (B20 + 5% Methanol) attains maximum indicated power (2.64kW), compared to all other blends. Then, the increase in load percentages may leads to achieve high indicated power. Here, the maximum indicated power (2.64kW) is achieved at full load condition.
- The Blend 7 (B20 + 5% Methanol) attains maximum brake thermal efficiency (33.3%), compared to all other blends. Then, the increase in load percentages may leads to achieve high brake thermal efficiency. Here, the maximum brake thermal efficiency (33.4%) is achieved at full load condition.
- The Blend 8 (B20 + 10% Methanol) attains maximum Indicated thermal efficiency (85.11%), compared to all other blends. Then, the increase in load percentages may leads to decrease in Indicated thermal efficiency. Here, the maximum brake thermal efficiency (85.11%) is achieved at initial load condition.
- The Blend 7 (B20 + 5% Methanol) attains maximum mechanical efficiency (59 %), compared to all other blends. Then, the increase in load percentages may leads to achieve high mechanical efficiency. Here, the maximum mechanical efficiency (59%) is achieved at full load condition.
- The Blend 8 (B20 + 10% Methanol) attains minimum specific fuel consumption (0.26 kg/kWh), compared to all other blends and it is almost equal to Blend 1 (diesel). Then, the increase in load percentages may leads to high specific fuel consumption.

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