EXPERIMENTAL INVESTIGATION OF PERFORMANCE PARAMETERS OF VCR ENGINE FUELED WITH MINERAL OIL AND ITS BLENDS WITH DIESEL

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1.ABSTRACT

A 3.5 kW, constant speed diesel engine was tested on diesel, MOME-diesel blends in B15D85, B30D70, B45D55 and B60D40 ratio. The performance of the engine was found to be satisfactory on the blends.

The kinematic viscosity of raw mineral oil used to make mineral oil methyl ester (MOME) was about 4.665 times higher than the diesel and MOME was about 3.477 times higher than the diesel.

The gross heat of combustion of raw mineral oil is found to be 2.75 % higher than the diesel but MOME had the gross heat of combustion 13.45 % lesser than the diesel.

The engine performance was the best on B30 as the brake thermal efficiency was found to be highest and BSFC was found to be lowest on this blend.

Key Words-
Mineral Oil Methyl Ester (MOME); B15; B30; B45; B60; Brake power.

2.INTRODUCTION

The increase of fossil fuels and their things on environmental pollution require the seek out for another renewable energy sources in recent years. Biodiesel is a renewable and energy efficient fuel that is non-toxic, biodegradable and present higher lubricates. It can also decrease greenhouse gas effect and does not give to global warming due to lesser emissions because it does not include much impurity and its sulphur matter is also lower than the mineral diesel.

Biodiesel is an another fuel for diesel engines. Vegetable oil or fats are reacted with small chain alcohol, usually methanol and ethanol, to produce a mixture of corresponding mono-alkyl esters defined as biodiesel. This process is identified as transesterification.

A mineral oil is any of different monotonous, neutral, light mixtures of higher alkanes from a mineral source, particularly a concentrate of petroleum. This type of mineral oil is a transparent, colorless oil collected mainly of alkanes and cyclo alkanes associated to petroleum jelly. It has a density of around 0.8 gram/cm^3.

3. LITERATURE REVIEW

This chapter reviews the possibility of this fuel cause and some of the results obtained from investigation on the use of vegetable oils and their esters as fuel in CI engine.

Bueno et al 2011 studied the combustion characteristics of a turbocharged diesel engine operated with soybean oil ethyl ester and it is 10%, 20% and 30% by volume blends at full load conditions. The test results showed that the crank angle interval required to a combustion reaction progresses of 90% presented an average reduction of 1.81 for B15, 1.87 for B30 and 1.97 for B45 was obtained with relation to diesel. He was attributed that to the shorter mixing time of neat biodiesel (B100).He also indicated that the initial heat release rates of diesel and B30 were very well matched, which indicated that the biodiesel bulk modulus of compressibility, or speed of sound, does not affect the beginning of injection with the engine. Moreover, a reduction in lower in-cylinder mean temperatures was observed for B30 blend. This can be attributed to the reduction in fuel heat value and injected mass caused by biodiesel addition to diesel fuel.

Sharon et al 2012 studied the combustion characteristics of a palm oil biodiesel and its 25% ,50% and 75% by volume blends at different load conditions and constant speed in DI diesel engine. The results showed that peak pressure of B25, B75, and B100 are 1.08bar ,8.124bar and 7.347bar higher than diesel. He has also been observed that biodiesel and their blends showed shorter ignition delay of 2.11, 1.91, 1.71 and 11 for B100, B75, B50 and B25 respectively compared to diesel fuel. This is because of higher cetane number and the presence of some fatty acid sin biodiesel which stimulates easy vaporization hence it would reduce the ignition delay. Maximum heat release rate for B25, B50, B75 and B100 were 1.343 kJ/m3deg, 2.192 kJ/m3deg, 13.884 kJ/m3deg and 21.149 kJ/m3deg, respectively, lower than diesel fuel. This is attributed to the lower ignition delay of biodiesel blended fuel.

M.R. Jakeria et al 2013 find out the gradual depletion of fossil fuel has greatly enhanced the necessity to look for alternative fuel for automotive engine. In response to this, biodiesel is being considered as a promising solution with a number of technical advantages over conventional petroleum diesel. On the other hand, commercial use of biodiesel has been limited because of some drawbacks including corrosivity, instability of fuel properties, higher viscosity, etc.

Flash position, density, pour position, cetane amount, calorific number of biodiesel comes in very similar range to that of mineral diesel.

4.MATERIALS AND METHODS

This chapter briefly describes the methodology used for the experimental procedure adopted to evaluate performance of a **VCR diesel engine** on the blends.

4.1 Selection of Fuel Constituents

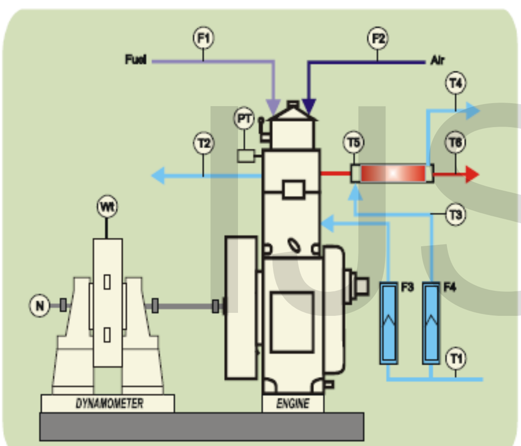
The experiments were carried out using diesel as reference fuel and Mineral oil methyl ester (MOME) and their blends with diesel in various proportions as engine fuel.

4.2 Preperation of Fuel Blends

High viscosity of mineral oil makes it unsuitable as whole substitution of diesel for the CI engine. The mineral oil methyl ester (MOME)-diesel blends were arranged by blending mineral oil methyl ester (MOME) with diesel.

4.3 Test Engine

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio)Diesel engine connected to eddy current type dynamometer for loading. The setup enables study of VCR engine performance for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio and heat balance. EnginesoftLV" is provided for on line performance evaluation.



Schematic arrangement

Figure:1

Table:1 Engine Specification

Rated Brake Power (kW)	3.5
Rated Speed (rpm)	1500
Number of Cylinder	1
Bore (mm)	87.5
Stroke (mm)	110
Displacement volume (cc)	661 cc
Compression Ratio	17.5:1

Table:2 Mineral Oil Methyl Ester – Diesel Blends selected for Experiments

S.No.	Fuel Types	Nomenclature
1.	Diesel	-
2.	Raw mineral oil	-
3.	15% Mineral Oil Methyl Ester + 85% Diesel	B15
4.	30% Mineral Oil Methyl Ester + 70% Diesel	B30
5.	45%	B45

	Mineral Oil Methyl Ester + 55% Diesel	
6.	60% Mineral Oil Methyl Ester + 40% Diesel	B60

4.4 Fuel consumption test

The fuel consumption test was carried out on fuels . The performance of the engine on selected fuels was evaluated at the following load condition.

- No load
- 3 kg load
- 6 kg load
- 9 kg load
- 12 kg load

The following parameters were measured during the test:

- Indicated power,KW
- Brake power, KW
- Friction power, KW
- Indicted mean effective pressure, bar
- Brake mean effective pressure, bar
- Frictional mean effective pressure,bar
- Specific fuel consumption
- Fuel consumption, l/h
- Air flow
- Fuel flow
- Indicated thermal efficiency
- Brake thermal efficiency
- Torque
- Mechanical efficiency
- Volumetric efficiency

4.5 Measurement of Engine Parameters

Brake power

The brake power developed by the engine under different test condition was measured. In order to make the measurement the engine was initially run on no load condition and its speed was adjusted constant.

The corresponding torque to be applied to the engine when delivering rated power (3.5 kW) at rated speed of 1500 rpm was calculated using the equation given below:

$$BP = \frac{2\pi \times N \times T}{60000}$$

Where,

T= Torque, N-m

N= Engine speed, rpm

Fuel consumption

The fuel consumption was measured with the help of fuel consumption unit as shown in the engine set up. The hourly fuel consumption was calculated using equation as given below:

$$f_c = \frac{V_{cc} \times 3.6}{T}$$

Where,

f_c = Fuel consumption, l/hr

V_{cc} = Volume of fuel consumed,

T = Time, hr

3.6 = Unit constant

The brake specific fuel consumption was calculated using the following relationship:

$$BFSC = \frac{Fuel\ consumption\ rate}{Brake\ power} = \frac{V_{cc} \times \rho \times 3.6}{BP \times t}$$

Where,

BFSC = Brake specific fuel consumption, kg/kW-h

Vcc = Volume of fuel consumed, 25 cc

ρ = Density of fuel, g/cc

BP = Brake power, kW

T = Time taken to consume 25 cc fuel, s

Brake thermal efficiency

The brake thermal efficiency of the engine at the different loads was determined using the equation as given below:

$$\eta_{th} = \frac{Brake\ power}{Fuel\ power} = \frac{Ks}{HV \times BSFC}$$

Where,

η_{th} = Brake thermal efficiency, percent

Ks = Unit constant, 3600

HV = Gross heat combustion, kJ/kg

$BFSC$ = Brake specific fuel consumption

$$ss - jjF$$

5.RESULT AND DISCUSSION

A 3.5 kW, stationary, constant speed, single cylinder diesel engine was tested on diesel and selected MOME-diesel blends. The break power, specific fuel consumption, brake thermal efficiency were calculated.

5.1 Engine Performance On Selected Fuels

The performance of the engine was evaluated on diesel, B15, B30, B45, B60 under the fuel consumption test at different load condition in terms of brake power, fuel consumption, specific fuel consumption, brake thermal efficiency.

5.2 Indicated Power, Brake Power and Friction Power

The Indicated power, brake power and Friction power corresponding brake load when operating on diesel, B15, B30, B45, B60 at no load, load of 3kg,load of 6kg,load of 9kg,load of 12kg. is shown in Fig.2 to 4.

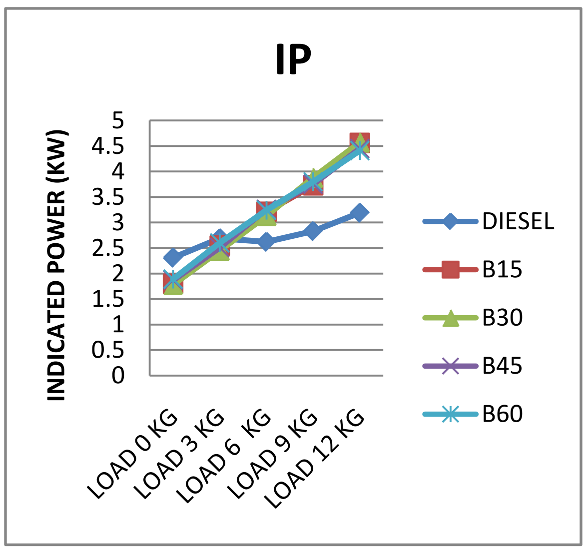


Figure:2 Indicated Power Produced by Diesel and its Blend with MOME

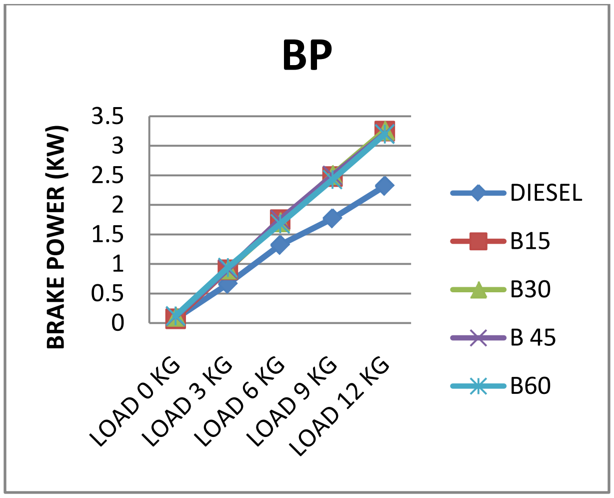


Figure:3 Brake Power Produced by Diesel and its Blend with MOME

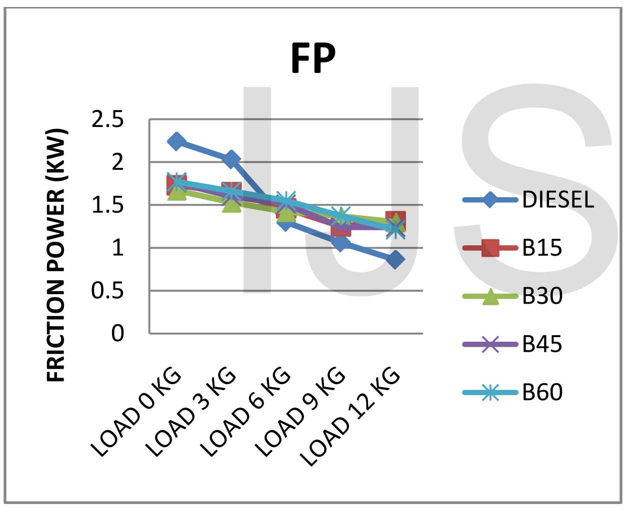


Figure:4 Friction Power Produced by Diesel and its Blend with MOME

The figures indicate an increase in Indicated and brake power with increase in brake load of the engine under all fuel types. The figures also reveal that with increase in brake load there was an increase in brake power and decrease in engine speed on all the MOME-diesel blends.

It is observed from the figure that the fuel consumption of the engine gradually increased with increase in brake load and was found to maximum on all selected fuel types. The fuel consumption of the engine on B60 was found higher than that of diesel.

5.4 Specific fuel consumption

The relationship between the specific fuel consumption of the engine and brake load on different fuel types is presented in Fig:5.

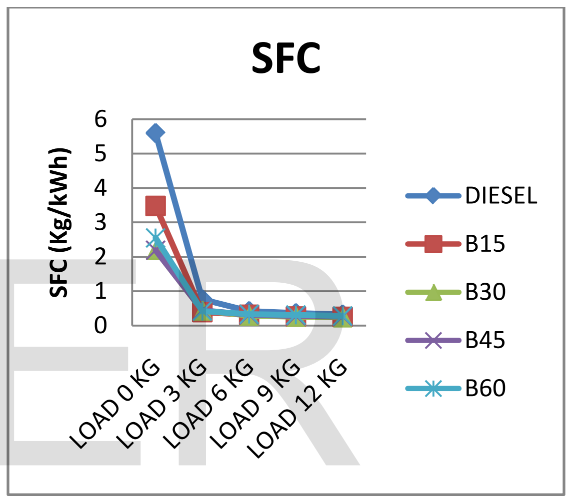


Figure:5 SFC Produced by Diesel and its Blend with MOME

5.5 Indicated and Brake Thermal Efficiency

The Indicated and brake thermal efficiency corresponding brake load is shown in Fig:6 and Fig:7

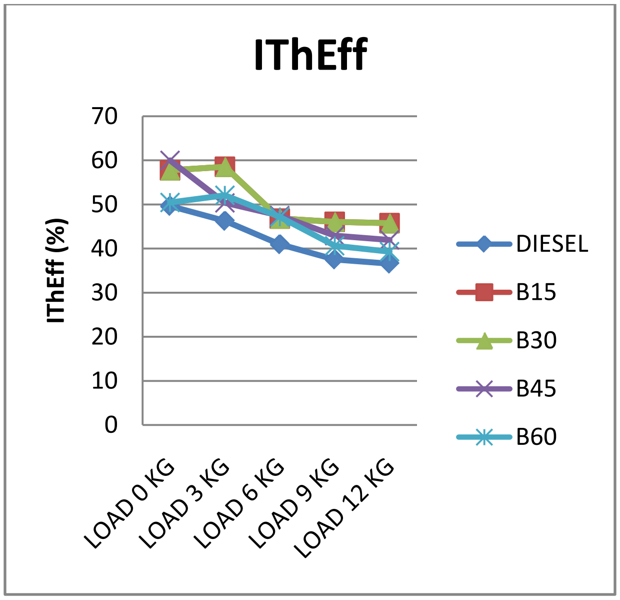


Figure:6 IThEff Produced by Diesel and its Blend with MOME

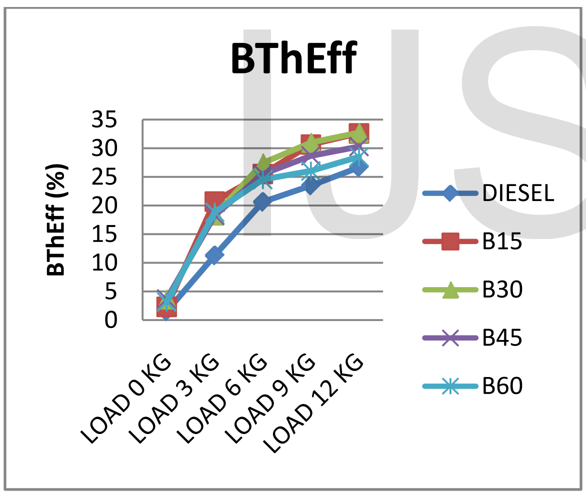


Figure:7 BThEff Produced by Diesel and its Blend with MOME

Indicated Thermal Efficiency is decreasing with the increase in load. It is clear from the figure that the MOME-diesel blends mostly are having higher brake thermal efficiency than diesel.

5.6 Torque and Mechanical Efficiency

The Torque and mechanical efficiency corresponding brake load is shown in Fig:8 and Fig:9.

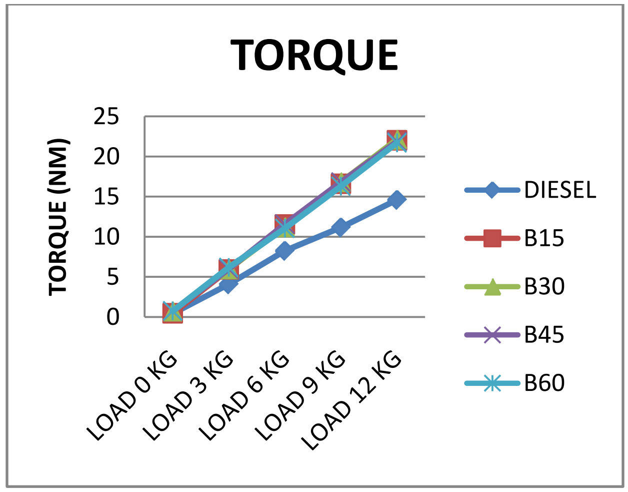


Figure:8 Torque Produced by Diesel and its Blend with MOME

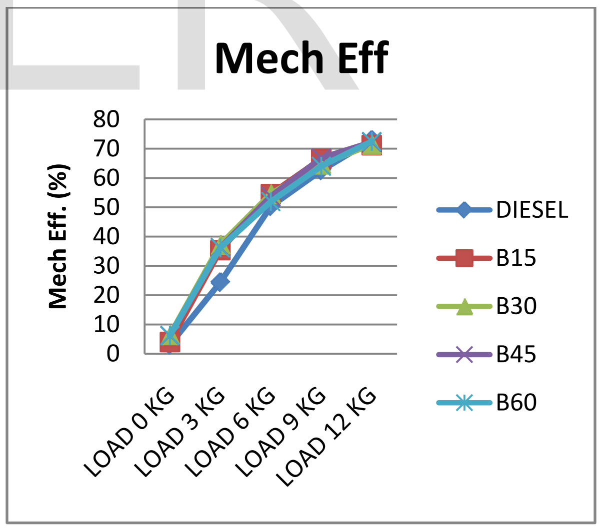


Figure:9 MechEff Produced by Diesel and its Blend with MOME

6. SUMMARY AND CONCLUSION

A 3.5 kW, constant speed diesel engine was tested on diesel, MOME-diesel blends in B15D85, B30D70, B45D55 and B60D40 ratio. The performance of the engine was found to be satisfactory on the blends. On the basis of the results obtained from the whole experiment the following conclusion can be drawn:

1) The performance evaluation of 3.5 kW diesel engine under the fuel consumption test on blends of MOME and diesel was found satisfactory on the basis of brake power, brake specific fuel consumption and brake thermal efficiency.
2) The engine was able to develop power similar to diesel on all the MOME-diesel blends.
3) The brake thermal efficiency of the engine on MOME-diesel blends was found higher than diesel but BSFC of the engine on MOME-diesel was also found higher than the diesel.
4) The engine performance was the best on B30 as the brake thermal efficiency was found to be highest and BSFC was found to be lowest on this blend.

The above discussion indicate that mineral oil methyl ester (MOME) may be recommended as CI engine fuel. However for the better performance of the engine B30 may also be recommended.

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