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Performance Test On VCR Engine Working with Mustard Bio Diesel Blended with Diesel

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ABSTRACT

The performance of the engine is considered to be as one of the most important factor for any automobile. Biodiesel as a renewable source of fuel for diesel engine application. In this work, biodiesel is fumigated and diesel fuel will be used as an ignition source. The comparable study of emission and performance characteristics of biodiesel and diesel fuel is carried out in this project. The performance characteristics like BMEP, IP, IMEP, BSFC, BTE, ITE, Mechanical Efficiency and Heat in exhaust are compared. In our project we use mustard oil to blend with diesel to produce biodiesel. Fuel properties of biodiesel obtained from mustard oil were determined in the laboratory using standard procedure and an experimental setup was constructed to study the performance of a diesel engine. We used different lower blends of biodiesel such as B20, B40, and B60.

1. INTRODUCTION

The resources of petroleum as fuel are dwindling day by day and increasing demand of fuels, as well as increasingly stringent regulations, pose a challenge to science and technology. With the commercialization of biology, it has provided an effective way to fight against the problem of petroleum scarce and the influences on environment. Biodiesel is a renewable, clean burning diesel replacement that is reducing. Made from a diverse mix of feedstock including recycled cooking oil, soybean oil, and animal fats, it is the first and only EPA-designated Advanced Biofuel in commercial-scale production across the country and the first to reach 1 billion gallons of annual production. Meeting strict technical fuel quality and engine performance specifications, it can be used in existing diesel engines without modification and is covered by all major engine manufacturers' warranties, most often in blends of up to 5 percent or 20 percent biodiesel. It is produced at plants in nearly every state in the country. Bio-diesel is the most valuable form of renewable energy that can be used directly in any existing, unmodified diesel engine. Biofuels are diversified as alcohols, ethers, esters, carbonates and acetate compounds, containing inbuilt oxygen, and are emerging as potential substitute for diesel. Significantly, these less viscous biofuel which are deemed to be synthesized from plants parts, unlike the triglycerides (vegetable oils), have one phenomenon in unison, which relates to their lower cetane number and viscosity. Despite their lower ignition quality, these fuels could be used in diesel engine by blending it with diesel, which is regarded as the simplest way to use alcohol or other less viscous fuels. The above discussion on fuels with lower viscosity and cetane number identifies three new research scopes: (1) Though a variety of vegetable oil based fuels have been conceived, lesser attention or interest has been paid to conceive less viscous biofuel

in the likes of ethanol and methanol (2) There seems to be a lack in sufficient data on fumigation studies for fuels with lower viscosity and cetane 2
Number, whereas a lot of data have been made available for the operation of these fuels in blend fuel mode. (3) Absence of contributions to examine the fundamental study on vaporization of the fuels being fumigated and couple it with engine fumigation study.

With the above stated shortcoming, it is decided to embark on a research work that would address the limitations of previous research works. A new renewable fuel derived from as a potential candidate for diesel engine. Rather than using it in blends with diesel, it was inducted into the engine cylinder through inlet manifold, while diesel was supplied through main injection system. Further, the inlet air was also preheated to evaporate the injected fuel, whereby, hot vaporized biodiesel/air mixture was inducted into the cylinder. The preheat temperature was decided based on the outcome of suspended droplet evaporation study, conducted prior to engine study. Biodiesels have calorific values close to diesel fuel which makes it a potent candidate for replacement of diesel. However, it has very high viscosity but that can be reduced by transesterification. There are different methods available to reduce viscosity of the vegetable oils such as Preheating, Transesterification, pyrolysis etc. A lot of researchers and scientists are already working on developing new and efficient methods of synthesizing biodiesel from biofuel. This biodiesel can be used as an alternate fuel. It can be directly fuelled in CI engine without much engine modifications.

Advantages of Vegetable Oils as Diesel Fuel

The advantages of vegetable oils as diesel fuel are

- Liquid nature-portability
- Ready availability
- Renewability
- Higher heat content (about 88% of no. 2 diesel fuel)
- Lower sulfur content
- Lower aromatic content
- Biodegradability

Bio-fuels contain carbon that was taken out of the atmosphere by plants and trees as they grew. The fossil fuels are adding huge amounts of stored carbon dioxide (CO_2) to the atmosphere, where it traps the Earth's heat like a heavy blanket and causes the world to warm. Studies show that bio-diesel reduces CO_2 emissions to a considerable extent and in some cases all most nearly to zero.

- Biodiesel can be used in the existing engines without any modifications.
- Biodiesel obtained from vegetable sources does not contain any sulfur, aromatic hydrocarbons, metals or crude oil residues.
- Biodiesel is an oxygenated fuel; emission of carbon monoxide and soot tend to reduce.

Unlike fossil fuels, use of Biodiesel does not contribute to global warming as the CO_2 so produced absorbed by the plants. Thus CO_2 is balanced

2. PRODUCTION OF BIODIESEL AND TESTING

Production:

Biodiesel is typically produced by the reaction of a vegetable oil or animal fats with an alcohol such as methanol or ethanol in the presence of catalyst to yield mono-alkyl esters (biodiesel) and glycerin. This reaction is called transesterification. Raw or refined vegetable oil or recycled greases that have not been processed into biodiesel are not biodiesel. Care must be taken to then separate the finished biodiesel from the glycerin, catalyst, soaps and any excess alcohol that may remain.

Different methodologies used for production of biodiesel are:

- Direct Use and Blending
- Transesterification Process III Thermal Cracking (Pyrolysis) IV Micro-emulsion.

Direct Use and Blending:

The animal fat or vegetable oil can be used as a fuel in direct injection engines; it has a good heating value and could give a sufficient power. But it has some problems due to its unacceptable properties, so it cannot be used in DI engine without any modification. To avoid such problems, the alternative fuel sources are directly blended with conventional fossil fuels. This kind of blending will improve the fuel quality, reduces the fossil fuel consumption, etc., so it is also preferable as a most convenient way to use an alternative fuels such as biofuel. The bio oil and diesel blends will be in different ratio like 10:1,10:2, 10:3, etc.,

Transesterification:

The transesterification process is a reaction between triglycerides in the vegetable and alcohol which produces the biodiesel (mono alkali ester) and glycerol. In this process some catalyst also used to increase the speed of the reaction and quality of the outcome product. The amount and types of catalyst are decided by the amount of free fatty acid present in the feed stock oil. The higher amount of free fatty acid is unfavourable for biodiesel production which leads to formation of soap and biodiesel yield efficiency.

3. EXPERIMENTAL SETUP

Experimental setup

The experiment was conducted at single cylinder four stroke VCR Engine. The compression ratio can be changed without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Research engine connected to eddy current dynamometer. It is provided with necessary instruments for combustion pressure, crank-angle, airflow, fuel flow, temperatures and load measurements. These signals are interfaced to computer through high speed data acquisition device. The setup has stand-alone panel box consisting of air box, twin fuel tank, manometer, fuel measuring unit, transmitters for air and fuel flow measurements, process indicator and piezo powering unit. Rotameters are provided for cooling water and calorimeter water flow measurement. The Engine performance study includes brake power, indicated power, frictional power, brake means effective pressure, indicated means effective pressure, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, Air fuel ratio, heat balance and combustion analysis.

S.NO	FEATURE	SPECIFICATION
1.	Engine make	Kirloskar diesel engine
2.	Engine type	TV1
3.	No of cylinder	One
4.	Loading device	Eddy current dynamometer
5.	Cylinder bore diameter	87.5 mm
6.	Stroke length	110 mm
7.	Engine speed	1500 rpm
8.	Combustion principle	Compression ignition

9.	Engine capacity	3.5KW
10.	Orifice diameter	20 mm
11.	Brake horse power	4.69
12.	Compression ratio	Variable from 12 to 18
13.	Orifice diameter	20 mm
14.	Brake horse power	4.69

Brake Mean Effective Pressure (BMEP)

It is defined as the average pressure the engine can exert on the piston through one complete operating cycle. If N is the number of revolutions per second, and c the number of revolutions per cycle, the number of cycles per second is just their ratio (W) which can be expressed by

$$W = \frac{P n_c}{N}$$

Brake Horsepower (BHP)

It is the measure of an engine's horsepower before the loss in power caused by the gearbox, alternator, water pump, and other auxiliary components like power steering pump, muffled exhaust system, etc

BHP = IHP-FP

Where,
FP is frictional power
IHP is indicated horse power

Mechanical Efficiency

The work output is also defined as brake power and input is indicated power and the ratio of BP to IP is defined as mechanical efficiency.

Brake Specific Fuel Consumption (BSFC)

The BSFC is defined as the ratio between fuel flow rate and power output. It is a measure of the efficiency of the engine in using the fuel supplied to produce work.
It can be calculated by
BSFC =Wf/BP
where
Wf = fuel consumed (g/h)
BP = Brake power (kW)

Brake Thermal Efficiency (BTE)

It is the ratio of the thermal energy in the fuel to the energy delivered by the engine at the crankshaft
BTE (b) = BP/(mf x NCV)
where
BP= Brake Power (kW)
mf = fuel consumption (kg/sec)
NCV = net calorific value (kJ/kg)

IC ENGINE SOFT TEST REPORT PERFORMANCE CR-16-B60 DIESEL WITH DIFFERENT LOADS

Engine Details:

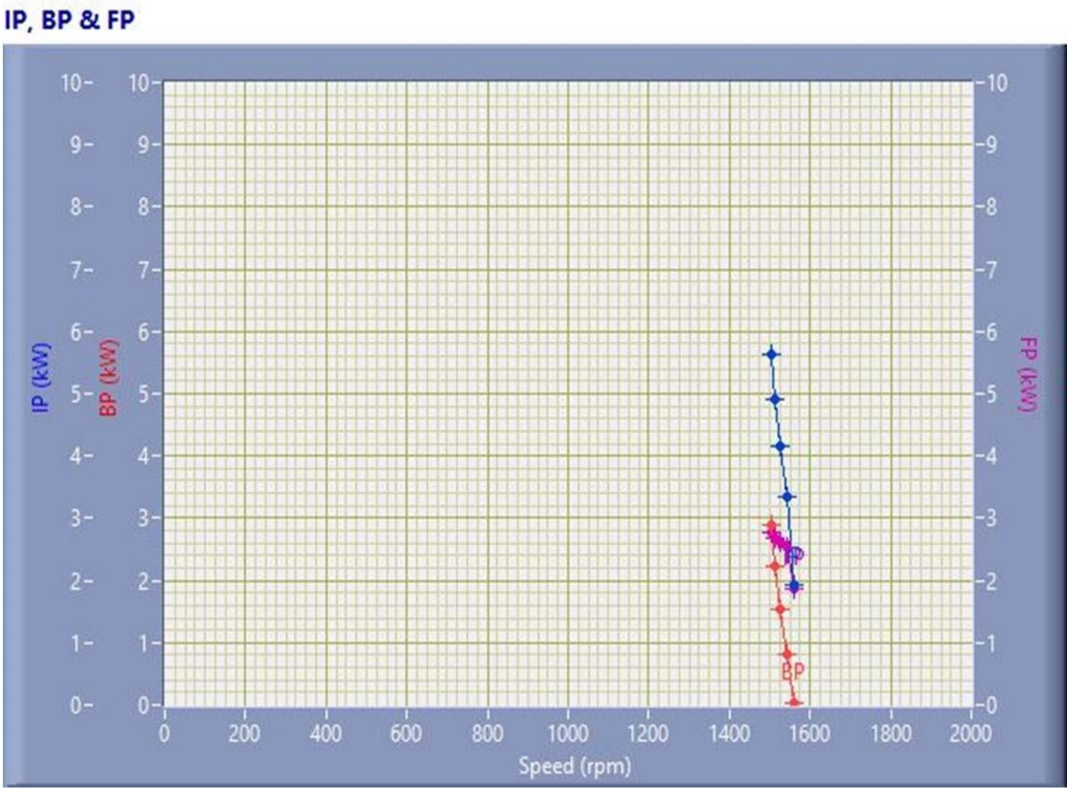
IC Engine set up under test is Kirloskar TV1 having power 5.30 kW @
1500 rpm which is 1 Cylinder, Four stroke, Constant Speed, Water Cooled, Diesel Engine, with Cylinder Bore 87.50(mm), Stroke Length 110.00(mm), Connecting Rod length 234.00(mm), Compression Ratio 16.00, Swept volume 661.45 (cc)

Combustion Parameters:

Specific Gas Const (kJ/kgK): 1.00, Air Density (kg/m^3) : 1.17, Adiabatic
Index: 1.41, Polytrophic Index: 1.26, Number Of Cycles: 10, Cylinder Pressure Reference: 7, Smoothing 2, TDC Reference: 0

Performance Parameters:

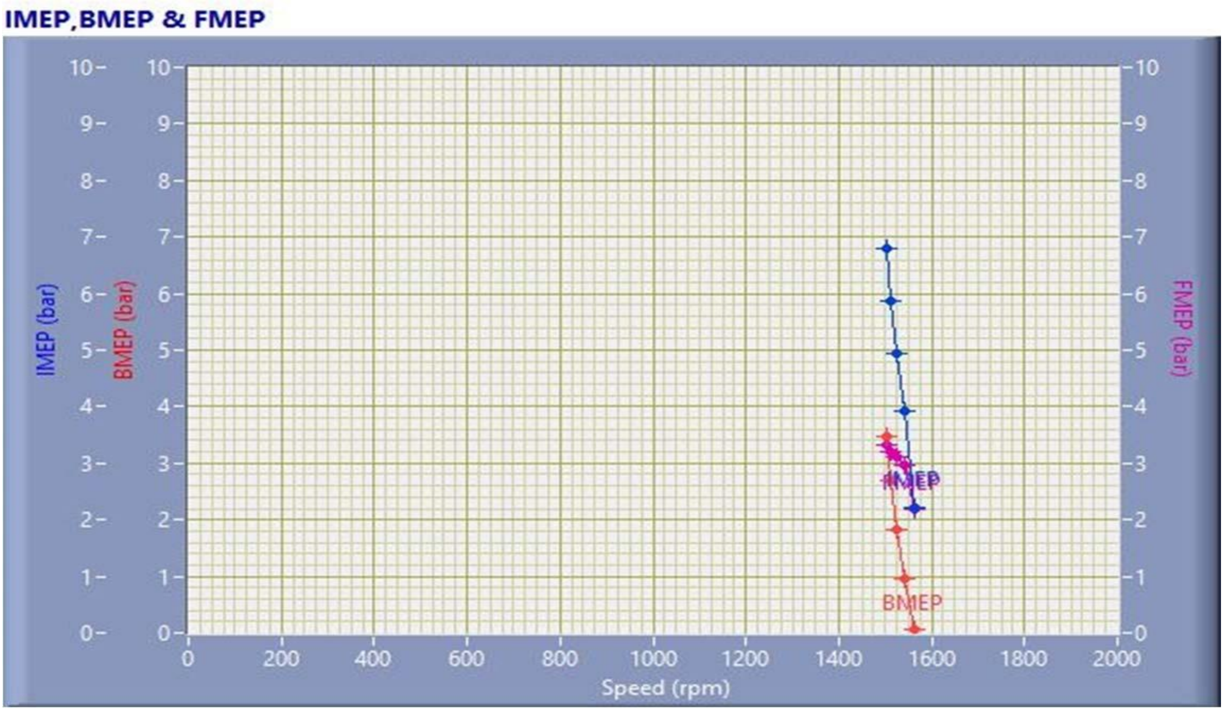
Orifice Diameter (mm): 20.00, Orifice Coeff. Of Discharge: 0.60, Dynamometer Arm Legnth (mm) : 185, Fuel Pipe dia (mm) : 12.40, Ambient Temp. (Deg C): 27, Pulses Per revolution: 360, Fuel Type: Diesel, Fuel Density (Kg/m^3) : 899, Calorific Value Of Fuel (kj/kg) : 49200



Graph no 14.1 IP, BP & FP

Table 14.1 IP, BP & FP

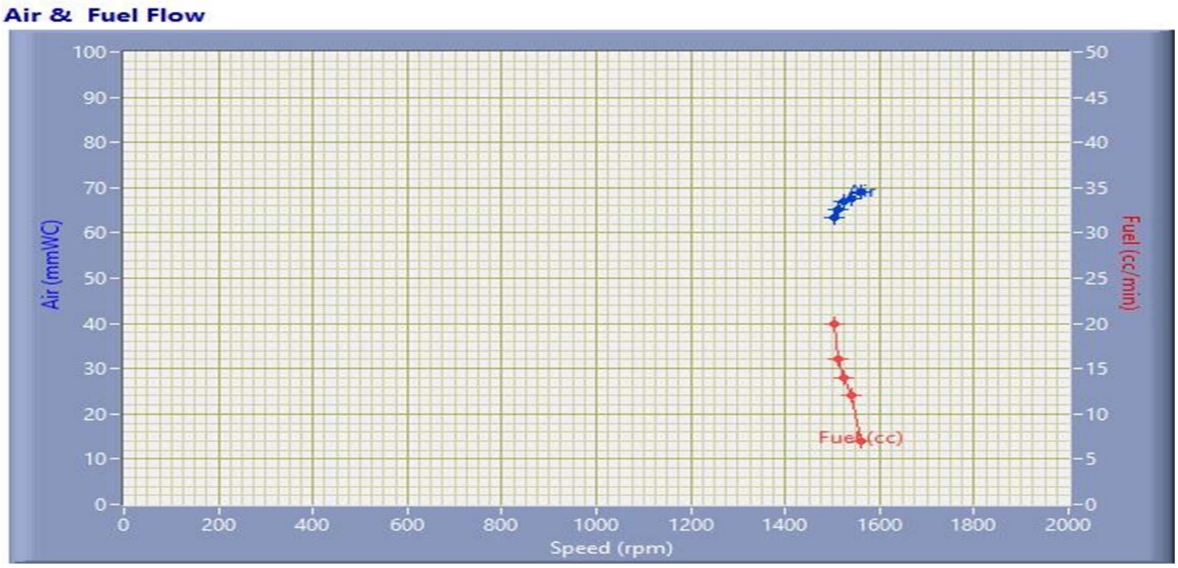
Speed (rpm)	Load (kg)	IP (kW)	BP (kW)	FP (kW)
1562.00	0.14	1.91	0.04	1.87
1542.00	2.78	3.35	0.81	2.53
1525.00	5.33	4.16	1.55	2.62
1513.00	7.79	4.91	2.24	2.67
1504.00	10.09	5.64	2.89	2.76



Graph no 14.2 IMEP,BMEP & FMEP

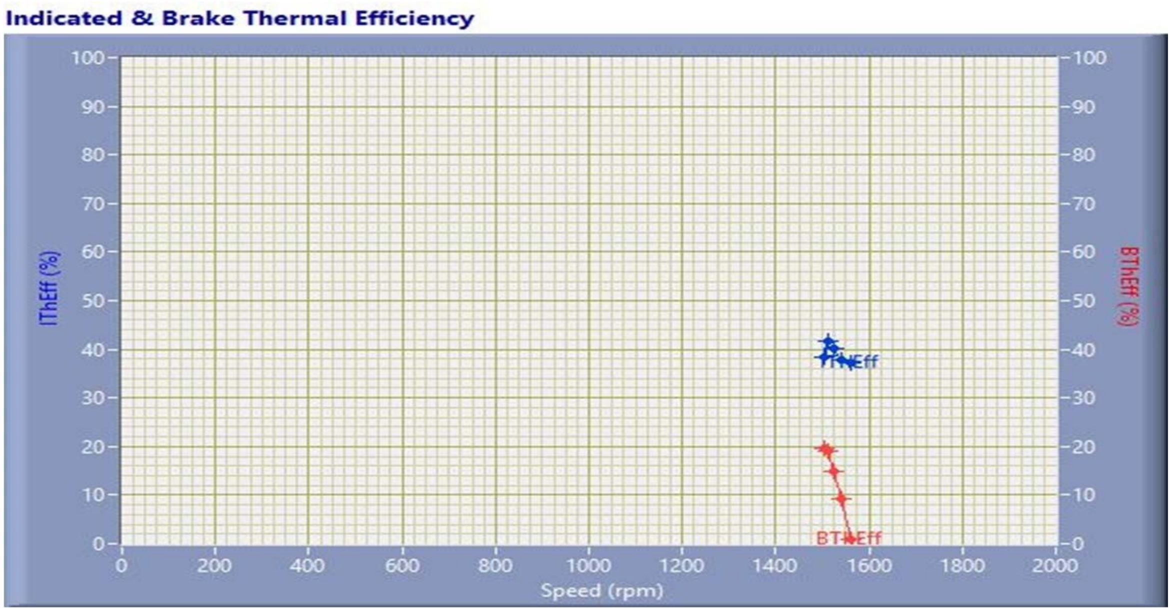
Table no 14.2 IMEP,BMEP & FMEP

Speed(rpm)	Load (kg)	IMEP (bar)	BMEP (bar)	FMEP (bar)
1562.00	0.14	2.22	0.05	2.18
1542.00	2.78	3.94	0.96	2.98
1525.00	5.33	4.95	1.84	3.11
1513.00	7.79	5.88	2.69	3.20
1504.00	10.09	6.81	3.48	3.33



Graph 14.4 Indicated & Brake Thermal Efficiency

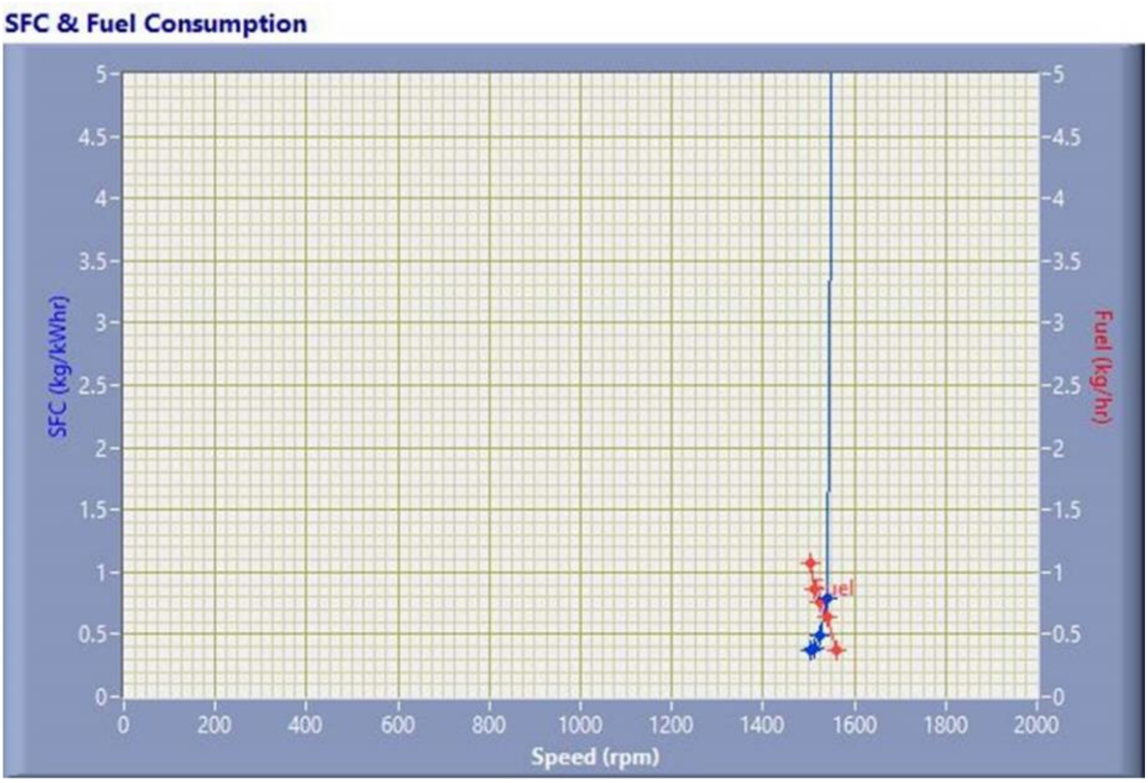
Speed (rpm)	Load (kg)	Air (mmWC)	Fuel (cc/min)
1562.00	0.14	68.93	7.00
1542.00	2.78	67.51	12.00
1525.00	5.33	66.96	14.00
1513.00	7.79	65.19	16.00
1504.00	10.09	63.30	20.00



Graph no 14.3 Air & Fuel Flow Table no 14.3 Air & Fuel Flow

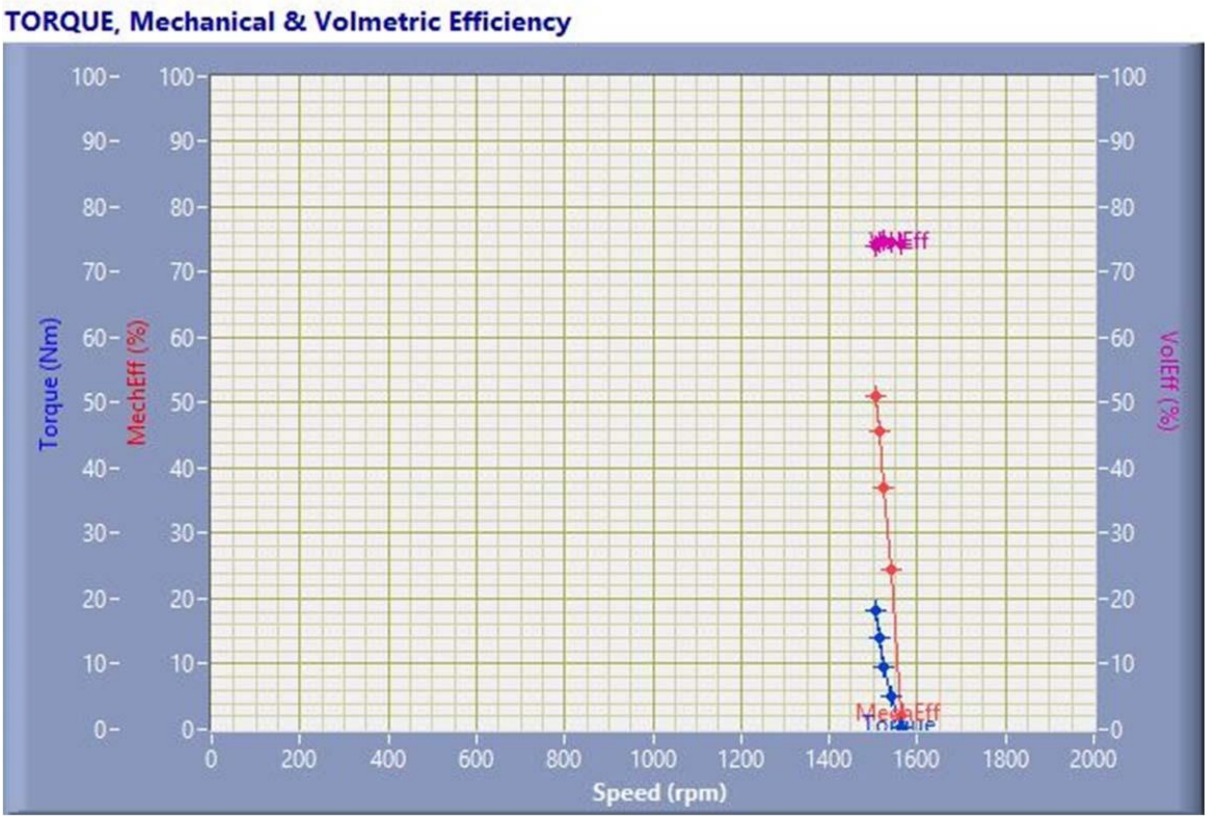
Table no 14.4 Indicated & Brake Thermal Efficiency

Speed (rpm)	Load (kg)	IThEff (%)	BThEff (%)
1562.00	0.14	37.08	0.79
1542.00	2.78	37.83	9.21
1525.00	5.33	40.32	14.98
1513.00	7.79	41.59	18.99
1504.00	10.09	38.28	19.57



Graph no 14.5 SFC & Fuel Consumption Table no 14.5 SFC & Fuel Consumption

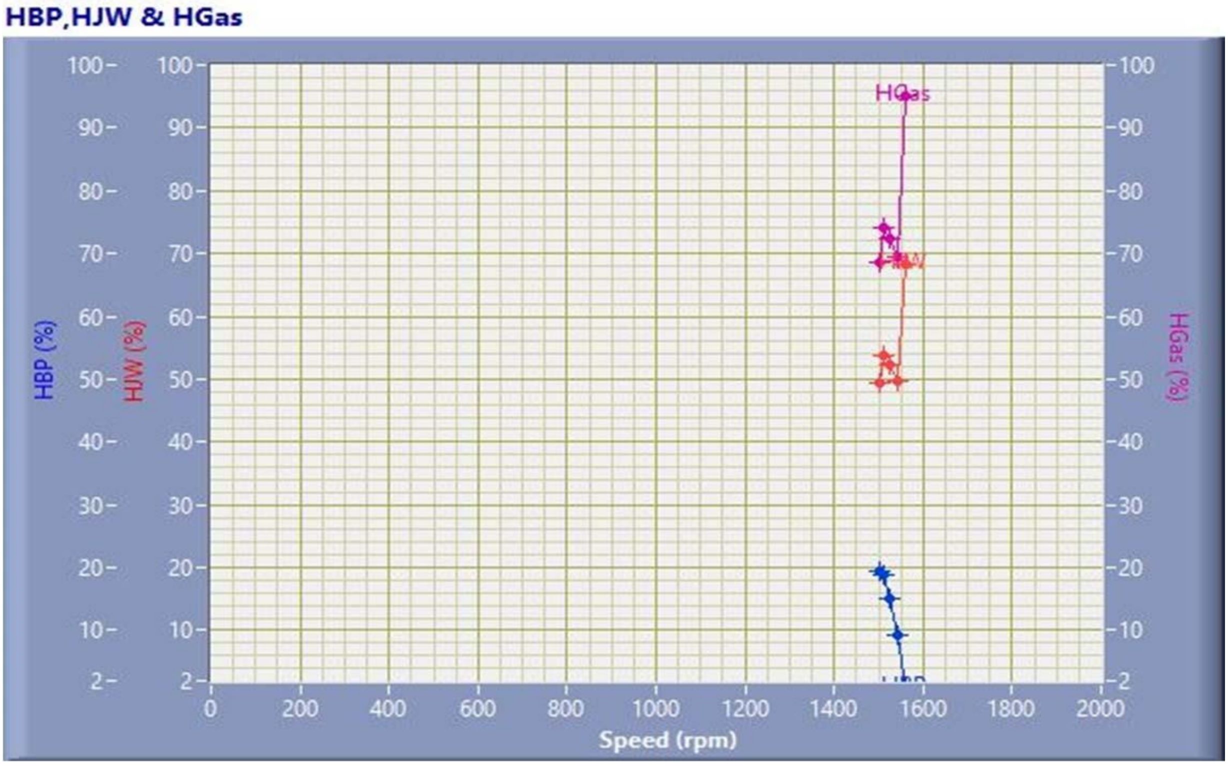
Speed (rpm)	Load (kg)	SFC (kg/kWh)	Fuel (kg/h)
1562.00	0.14	9.30	0.38
1542.00	2.78	0.79	0.65
1525.00	5.33	0.49	0.76
1513.00	7.79	0.39	0.86
1504.00	10.09	0.37	1.08



Graph no 14.6 TORQUE, Mechanical & Volmertic Efficiency

Table no 14.6 TORQUE, Mechanical & Volmertic Efficiency

Speed (rpm)	Load (Kg)	Torque (Nm)	Mech Eff. (%)	Vol Eff. (%)
1562.00	0.14	0.25	2.12	74.31
1542.00	2.78	5.04	24.34	74.49
1525.00	5.33	9.68	37.15	75.01
1513.00	7.79	14.14	45.66	74.60
1504.00	10.09	18.32	51.13	73.96



Graph no 14.7 HBP,HJW & HGas

Speed (rpm)	Load (kg)	HBP (%)	HJW (%)	HGas (%)
1562.00	0.14	0.79	67.53	26.83
1542.00	2.78	9.21	40.41	19.78
1525.00	5.33	14.98	37.25	20.12
1513.00	7.79	18.99	34.73	20.38
1504.00	10.09	19.57	29.84	19.06

Speed (rpm)	Load (kg)	Comp Ratio	T1 (deg C)	T2 (deg C)	T3 (deg C)	T4 (deg C)	T5 (deg C)	T6 (deg C)
1562	0.14	16.00	19.55	39.46	19.55	29.46	178.48	135.9 9
1542	2.78	16.00	19.57	40.00	19.57	29.83	218.57	145.0 7
1525	5.33	16.00	19.58	41.55	19.58	30.56	254.37	163.5 9
1513	7.79	16.00	19.58	42.99	19.60	31.14	292.60	182.3 8
1504	10.09	16.00	19.59	44.72	19.59	32.28	339.39	206.1 3

Air (mmWC)	Fuel (cc/min)	Water Flow Engine (lph)	WaterFlow Cal (lph)
68.93	7.00	150	125
67.51	12.00	150	125
66.96	14.00	150	125
65.19	16.00	150	125
63.30	20.00	150	125

Torque (Nm)	BP (kW)	FP (kW)	IP (kW)	BME (bar)	IMEP (bar)	BTHE (%)	ITHE (%)	Mech Eff. (%)
0.25	0.04	1.87	1.91	0.05	2.22	0.79	37.08	2.12
5.04	0.81	2.53	3.35	0.96	3.94	9.21	37.83	24.34
9.68	1.55	2.62	4.16	1.84	4.95	14.98	40.32	37.15
14.14	2.24	2.67	4.91	2.69	5.88	18.99	41.59	45.66
18.32	2.89	2.76	5.64	3.48	6.81	19.57	38.28	51.13

Air Flow (kg/h)	Fuel flow (kg/h)	SFC (kg/kWh)	Vol Eff . (%)	A/F Ratio	HBP (%)	HJW (%)	HGas (%)	HRad (%)
27.04	0.38	9.30	74.31	71.61	0.79	67.53	26.83	4.86
26.76	0.65	0.79	74.49	41.34	9.21	40.41	19.78	30.60
26.65	0.76	0.49	75.01	35.29	14.98	37.25	20.12	27.64

26.92	0.86	0.39	74.60	30.47	18.99	34.73	20.38	25.90
25.91	1.08	0.37	73.96	24.02	19.57	29.84	19.06	31.53

CONCLUSION

To overcome the need of alternate fuels in the field of automobile in upcoming years due to over population and less availability of field like diesel, we tried out various proportion of MUSTARD OIL along with desired quantity of Diesel considering various engine and environmental facts. The fuel properties of MUSTARD were found to be similar to the diesel fuel and DEE has high volatility and high cetane number hence used for a alternative fuel for diesel. The experiments were conducted on a VCR engine with different blends like D, B20, B40, B60 .The engine performance characteristics and emission characteristics were compared

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