

Combustion and Emission Characteristics on Methyl Esters of Jatropha Oil in a CI Engine- an Experimental Analysis

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ABSTRACT: This paper investigates the suitability of methyl ester of jatropha oil for CI engine. The need for diesel increased has increased exponentially in this decade and at present a very promising alternative fuel to diesel is esters of jatropha which can be substituted in existing diesel engine. Combustion and emission tests were carried out in a Diesel engine with esters of jatropha. When compared to diesel, emission is generally less with slight variation in efficiency.

I. INTRODUCTION

The severe reduction of fossil fuels leads the nation to find the alternative fuels. The best way to solve the problem is by using biodiesel. In order to prove the properties of biodiesel additives can also be added. In this paper, the complex nature of combustion in biodiesel is done numerically with program in C and mapped with the actual value of experimental work. The single cylinder four stroke, constant speed, vertical water cooled and direct injection diesel engine was used. The specifications of the engine is given in Table 1.

TABLE 1

SPECIFICATIONS OF THE ENGINE

Sl.No	Item	Description
1.	Engine type	Four Stroke, Single cylinder, Diesel, Constant Speed, Water cooled
2.	Make / Model	Kirloskar TV1
3.	BHP	7.0 at 1500 rpm (5.15 kW)
4.	Bore x Stroke(mm)	87.5 x 110.0
5.	Cyclic capacity	0.6615lit (0.6615x10 ⁻³ m ³)
6.	Compression ratio	17.5:1
7.	Dynamometer type	Eddy current
8.	Speed measurement	Sensor with digital indicator
9.	Cylinder pressure measurement	Piezo sensor
10.	Analysis	Through Computer
11.	Interfacing	ADC/DAC card engine indicator -AX104

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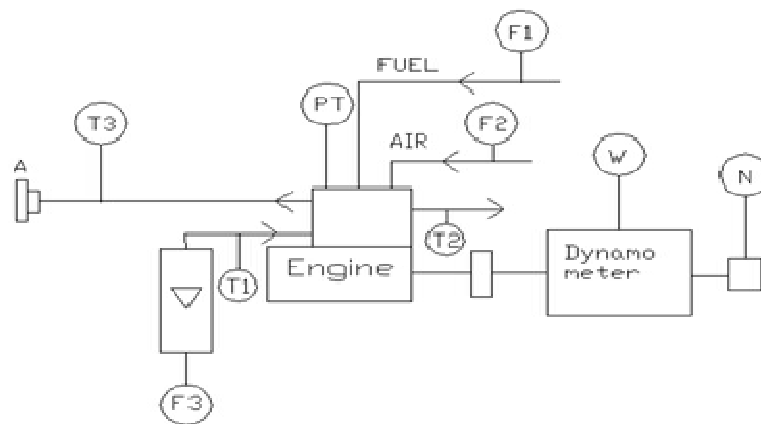
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II. EXPERIMENTAL PROCEDURE

The engine was started and warmed-up, at low idle, long enough to establish the recommend oil pressure, and was checked for any fuel, oil and water leaks. After completion of the warm-up procedure, the engine was run on no-load condition and the speed was adjusted to 1500 rpm by adjusting the fuel injection pump.

The experiments were conducted for engine torque levels viz, 0, 3, 6, 9, 12,15 and 18 Nm. The experiments were conducted for B25, B50, B75 & B100 fuel for the above said torque levels for different compression ratios at different fuel inlet temperature. The Compression ratio of the engine is varied by altering the gaskets that is present between the engine head & engine block. The fuel is preheated by means of fuel heater apparatus before fuel it is send to the engine. Experiments were conducted for both B25, B50, B76 & B100 fuel for different Compression ratios at the same time varying the fuel inlet temperature. For each load condition the engine was run for minimum 5 minutes and data were collected during the last 2-minute of operation. Simultaneously, engine exhaust emissions (NO_x, CO, HC) weremeasured.



A- Exhaust pipe.

F₁ – Fuel flow rate in kg/hr.

F₂– Air flow rate in kg/hr.

F₃ – Jacket water flow rate in kg/hr.

N – Engine speed in rpm.

T₁– Jacket water inlet temperature in K.

T₂– Jacket water outlet temperature in K.

T₃ – Exhaust gas temperature in K.

Fig. 1 Experimental Setup

A. EXPERIMENTAL SETUP FOR MEASUREMENT

1. An eddy current dynamometer has been coupled to the engine to apply the load / torque on engine.
2. The fuel flow rate was measured by timing the consumption for known quantity of fuel (10 cc) from a burette.
3. Gas Analyser is used to measure directly the exhaust gas emissions such as CO₂ in terms of % by volume, CO in terms of % by volume, HC in terms of ppm, NO_x in terms of ppm.

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B. NUMERICAL ANALYSIS

For heat release, temperature, pressure and volume coding with selected model is used.

III. RESULTS OF NUMERICAL ANALYSIS

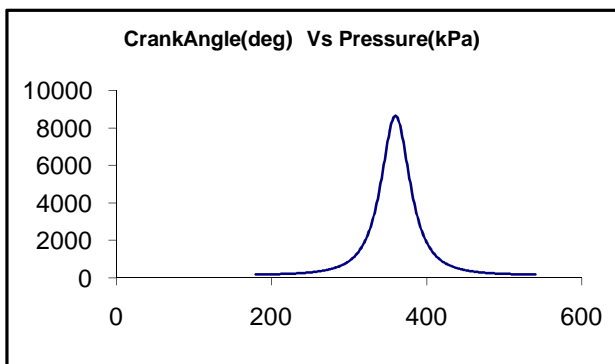


Fig.2a Crank angle (deg) Vs Pressure(kPa)

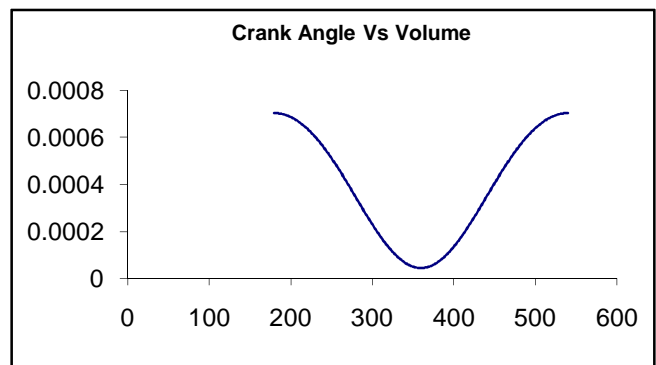


Fig. 2b Crank angle(deg) Vs Volume(m³)

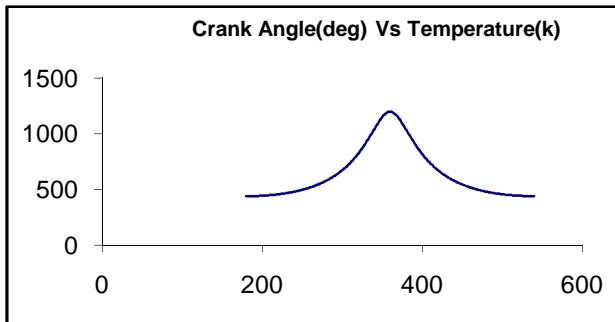


Fig. 2c Crank angle(deg) Vs Temperature(k)

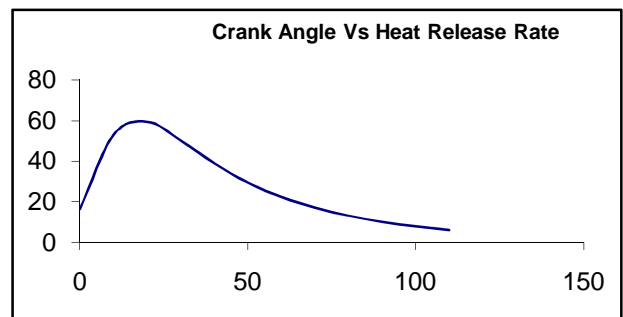


Fig.2d Crank angle(J/deg) Vs Heat release rate(J/deg)

IV. RESULTS OF PERFORMANCE TEST (COMPRESSION RATIO 13)

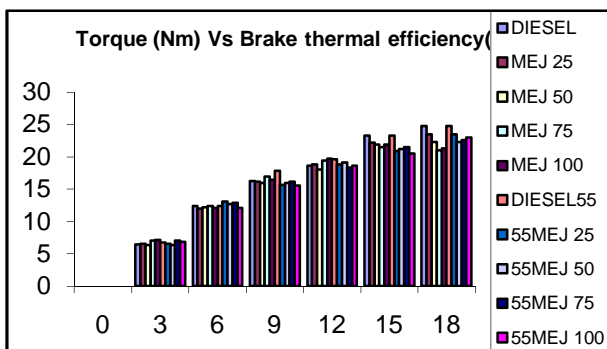


Fig.3a Brake Thermal Efficiency Vs Torque

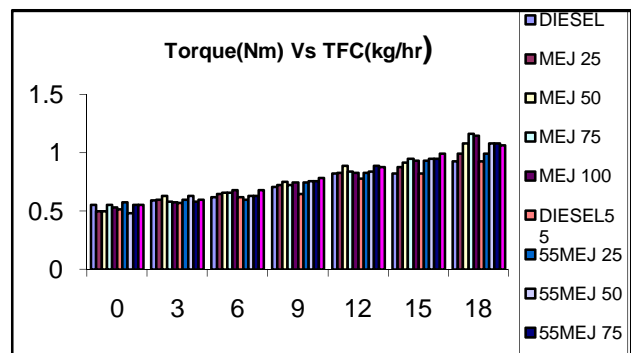


Fig.3b TFC Vs Torque

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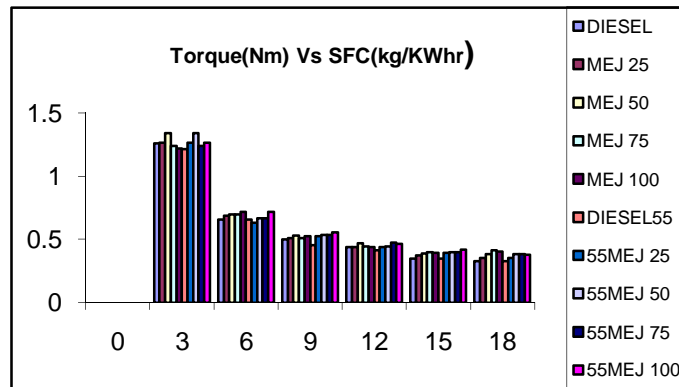


Fig.3cSFC Vs Torque

V. RESULT OF PERFORMANCE TEST (COMPRESSION RATIO 16)

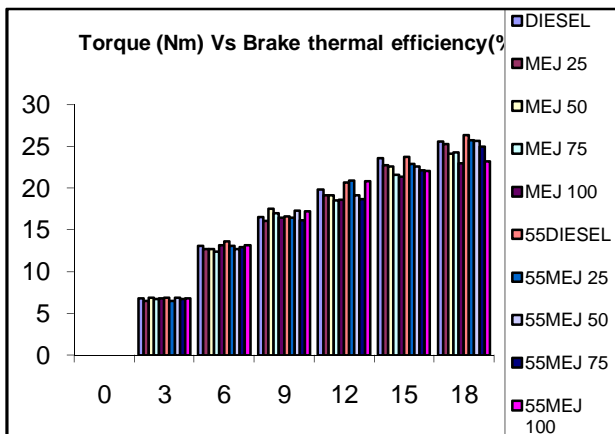


Fig.4a Brake Thermal Efficiency Vs Torque

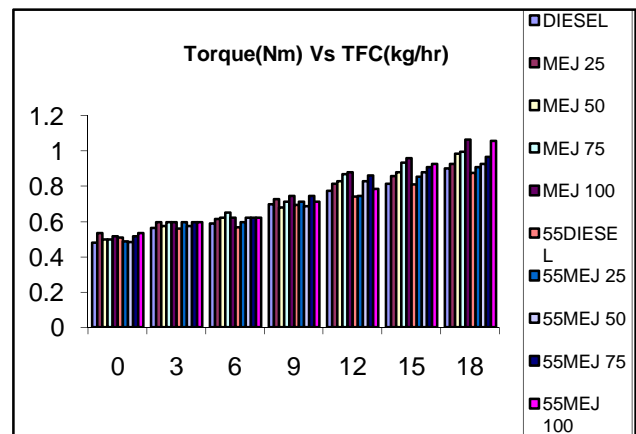


Fig.4bTFC VsTorque

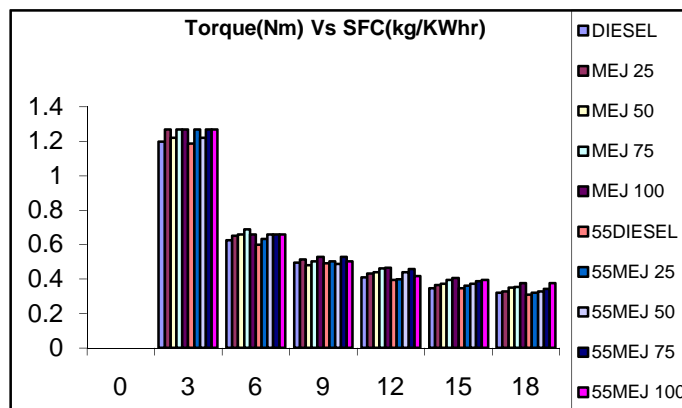


Fig.4cSFC Vs Torque

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VI. INVESTIGATION ON EMISSION (COMPRESSION RATIO 13)

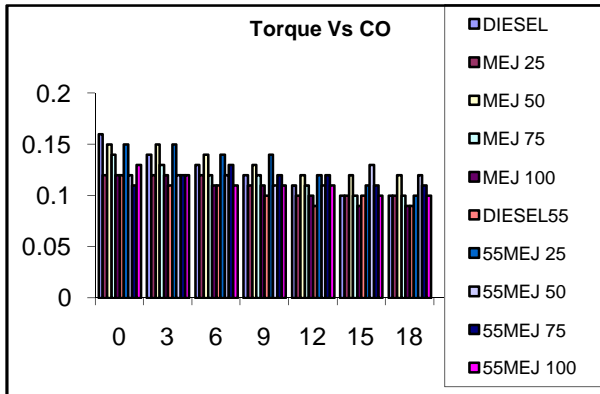


Fig. 5aCO(%)VsTorque(Nm)

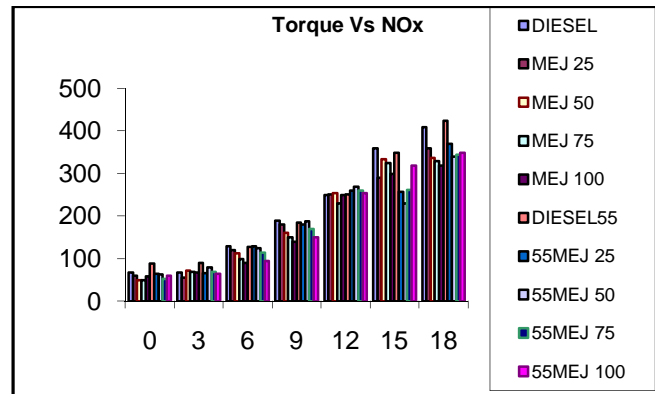


Fig. 5b NOx (ppm) Vs Torque(Nm)

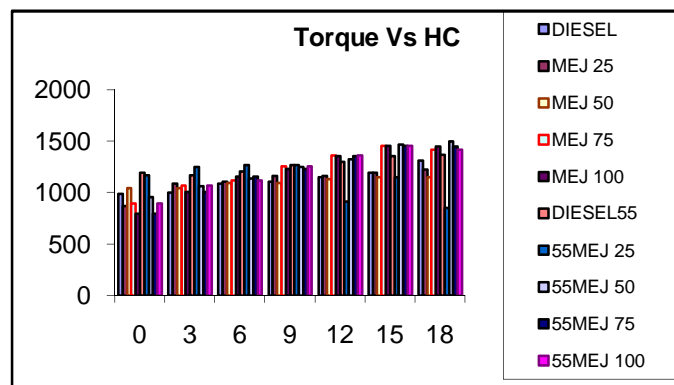


Fig.5cHC (ppm) Vs Torque(Nm)

VII. INVESTIGATION ON EMISSION1 (COMPRESSION RATIO 16)

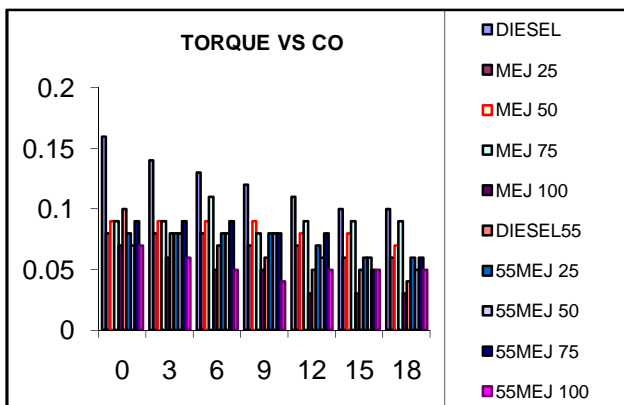


Fig. 6aCO(%)VsTorque(Nm)

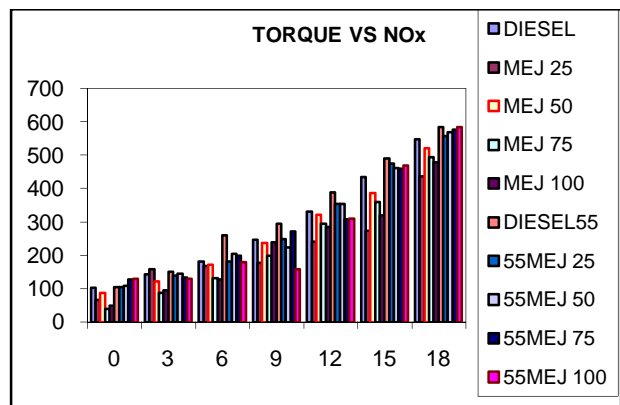


Fig.6bNOx (ppm) Vs Torque(Nm)

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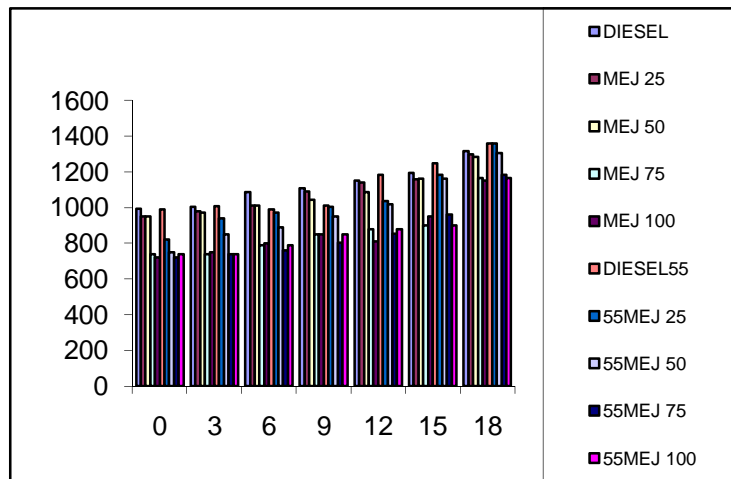


Fig.6cHC (ppm) Vs Torque(Nm)

VIII. EMISSION TEST

The engine was first run with diesel under steady state conditions, the fuel consumption rate and exhaust emission such as CO, HC and NO_x were measured for five different torque conditions. The performance characteristics are noted by running the engine with B25, B50, B75 & B100 for different compression ratios. At the same time by varying the fuel inlet temperature for different loads and the experimental results were taken. The compression ratio is varied by altering the gaskets present in between the cylinder head and cylinder block and the fuel inlet temperature is varied by means of fuel preheater. Here the compression ratios and temperature are altered for different values. The exhaust emissions are also recorded for each and every Compression ratio and fuel inlet temperature.

IX. RESULTS AND DISCUSSION

A. BRAKE THERMAL EFFICIENCY

Fig 3 and Fig.4 show the variation of Brake Thermal Efficiency as the brake power for different compression ratios at different fuel inlet temperature. The Brake Thermal Efficiency goes on increasing as brake power increases. Comparing the Brake Thermal Efficiency of diesel with B25, B50, B75 & B100 for different compression ratio and at different fuel inlet temperature, it is seen that Brake Thermal Efficiency is approximately same as that of diesel for B25, whose compression is decreased slightly at all fuel inlet temperature. If the Compression ratio is further reduced the Brake Thermal Efficiency is decreased than that of diesel at all inlet temperature. Even though if the compression ratio is unaltered, the Brake Thermal Efficiency is slightly equal to that of diesel.

B. CARBON MONOXIDE (CO)

Fig 5 and Fig.6 show the variation of emission of Carbon monoxide (CO) in terms of % by volume as the brake power is varied by increasing the torque. The emission of Carbon monoxide (CO) goes on decreasing as brake power increases or torque increases. If the compression ratio is decreased further, the emission of carbon monoxide is increased. From the Fig. it is seen that emission of carbon monoxide is increased as the compression ratio is reduced.

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C. HYDROCARBON (HC)

Fig.5 and Fig.6 show the variation of Emission of Hydrocarbon (HC) in terms of ppm as the brake power is varied by increasing the torque. The Emission of Hydrocarbon (HC) goes on increases as brake power increases or torque increases. If the Compression ratio is unaltered, the emission of Hydrocarbon is increased than that of diesel at all fuel inlet temperature.

D. OXIDES OF NITROGEN (NO_x)

Fig. 5 and Fig.6 show the variation of Emission of Oxides of Nitrogen (NO_x) in terms of ppm as the brake power is varied by increasing the torque. The emission of Oxides of Nitrogen (NO_x) goes on increasing with torque. When the compression ratio is decreased NO_x also decreases.

X. CONCLUSION

An experimental analysis on combustion and emission characteristics on methyl esters of jatropha oil in CI engine has been carried out and emission is found to be less with slight variation in efficiency.

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