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Research Article

Performance Analysis of Di-Diesel Engine at Different Injection Pressures using Jatropha Methyl Ester

V. Rambabu[a*], V.J.J.Prasad[a], P. Ramesh Babu[a]

[a]Department of Mechanical Engineering,GMR Institute of Technology, GMR Nagar, Rajam-532127, Srikakulam Dist. A.P, India.

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Abstract

In the present study the fuel used was Jatropha Methyl Ester (J.M.E). The Jatropha methyl ester was prepared in our laboratory by using transesterification process and the physical and chemical properties were determined by using standard experimental setup. J.M.E viscosity is nearer to petroleum diesel at room temperature and flash and fire points are higher than the diesel and calorific value less than the diesel. This JME was utilized for experimentation. Effect of injection pressure on performance of a single cylinder direct injection, naturally aspirated four stroke AV-1 Kirloskar diesel engine fuelled with Diesel, Diesel-J.M.E Blends and 100% Jatropha methyl ester were tested at different injection pressure 160 bar, 180 bar, 230 bar, 250bar and 300 bar. The rated brake power is 3.75Kw, Engine speed is 1500 rpm. It was concluded that at various blends of diesel-JME at 250 bar gives better performanace when compared to the other injection pressures. At this 250 bar injection pressures the Diesel and Neat JME were tested and results shows Neat JME at 250 bar gives better performance compared to diesel.

Keywords*- Oxygenated fuels, Jatropha methyl ester, viscosity, Fuel consumption per hour, Brake specific fuel consumption and specific gravity***.**

1. Introduction

The increasing industrialization & motorization of the world lead to a steep rise in the demand of diesel products and these are limited reserves. Mismatch between demand and supply of fossil fuels and fluctuating fuel prices and associated pollution problems making it difficult for the existence of fossil fuels in the long run. The above said difficulties and sustainability issues are making the researchers develop viable alternative fuels, in order to keep the automotive industry alive. If a suitable alternative is found, there would be great reduction in revenue as well as burden on petroleum derived diesel fuel. Vegetable oils are found to have its physical, thermal and chemical characteristics close to that of diesel fuel. The raw vegetable oils used in engines without any modification results in poor performance and leads to wear of engine parts (Bari *et al*, 2002). Vegetable oils cause formation of gummy substances at high temperatures and pressures. It is reported that these problems may cause engine failures such as piston ring sticking, injector chocking, formation of carbon deposits and deterioration of lubricating oil after the use of vegetable oil for long period of time (Avinash Kumar Agarwal *et al*, 2007). Hence direct utilization of vegetable oils is not advisable on the diesel engine.

However, vegetable oils cannot be used directly as it has high viscosity. It is well established that by the process of transesterification, one may obtain methyl/ ethyl esters of vegetable oils (biodiesels) and thus are the best alternate fuel for diesel engines. Biodiesel is considered a promising alternative fuel for the diesel engines as its fuel characteristics are approximately the same as those of fossil diesel fuel and thus may be directly used as a fuel for diesel engines without any prior modification of the design or equipment (Kalligeros *et al*, 2003). Many varieties of vegetable oils have been identified and found suitable for transesterification into biodiesel (Sahoo *et al*, 2007). Although biodiesel has many advantages, its use is restricted in an unmodified engine to a maximum of 20% blend because of engine life problems (Altin *et al* , 2010). Biodiesels are renewable and bio-degradable. Several attempts are made to analyse the characteristics of a compression ignition engine fuelled with biodiesel derived from different vegetable oils which are grouped in edible and non-edible oils (Nabi *et al*, 2006). Further, it is observed that with biodiesel as fuel in existing engines, there is a slight power loss. Lower thermal efficiency with higher specific fuel consumption and comparatively higher emission of nitrogen oxides (Ramadhas *et al*, 2005). For recovery of power and thermal efficiency, a little modification in the engine operating parameter have been suggested. Modification in injection process (Ueki *et al*,

* Corresponding author's email: rambabu.v@gmrit.org,

1999). These changes have some impact also on the performance from the engine.
The aim of this study is to investigate the effect of various injection pressure with Jatropha Methyl Ester(JME) as fuel on the engine performance.

2. Experimental set up and experimentation

Experimental setup consists of a single cylinder, four stroke, and naturally aspirated water cooled diesel engine. The schematic outline of the experimental setup is shown in Fig.1 (Engine photograph). The specification of the test engine is given in Table 1. The test bed contains instruments for measuring various parameters such as engine torque, fuel consumption, air flow rate and inlet & exhaust temperatures.

Fig.1 Photo graph of experimental setup

Experiments were initially carried out on the engine at all loads using diesel to provide base line data. The engine was stabilized before talking all measurements. Various blends of different proportions of JME and diesel (B20, B40, B60, B80, B100) were used to run a single cylinder CI engine at different injection pressures such as 160bar, 180bar, 230bar, 250bar and 300bar.

Table 1 Experimental Setup Specifications

Engine	Four-stroke, single cylinder, constant speed, watercooled Diesel engine
Maximum Power	5 hp (3.75 kW)@1500 RPM
Bore × Stroke	80 × 110 mm
Compression Ratio	16.5:1
Dynamometer	Eddy current dynamometer with loading unit
Injection Pressure	200 bar

An electrical eddy current dynamometer is employed for measuring the engine torque. The fuel consumption is measured using a burette and stop watch. A damping tank and an orifice plate along with manometer are used to measure the air flow rate. The exhaust gas temperature measured with thermocouple and each reading was taken after stabilization of exhaust gas temperature. The engine was run at 1500 rpm and readings were taken from no load to full load.

3. Results & discussions

To conduct the experiments with Jatropha methyl ester, it was prepared using transesterification process from the raw Jatropha oil. The comparison of physical properties of JME and Diesel oil are shown in Table 2.

Table 2 Physical properties of JME and Diesel

Property	**Unit**	**Biodiesel BIS Std**	**Diesel**	**JME**
Density	gm/cm^3	0.87-0.90	0.8394	0.884
Calorific value	MJ/kg	--	44.13	39.5
Kinematic Viscosity at 60^0C	cSt	3.5-5.0	2.77	5.81
Cloud Point	^0C	-	< 3	0
Pour Point	^0C	-	< -5	-3
Flash Point	^0C	>100	56	120
Iodine value		< 115	-	100

3.1 Performance analysis

The injection pressure increases fuel droplet size decreases. So that each particle of the fuel surrounded with air and causes for decreasing of physical delay resulting in increasing combustion efficiency. If injection pressure goes on increases it leads to poor combustion and causes for increasing the specific fuel consumption. Diesel, Diesel-J.M.E Blends and 100% Jatropha methyl ester were tested at different injection pressures 160 bar, 180 bar, 230 bar, 250bar and 300 bar. The rated brake power is 3.75Kw, Engine speed is 1500 rpm**.**

3.1.1 B20 at different injection pressures

B20 (80% Diesel and 20%JME) were tested at different injection pressures.

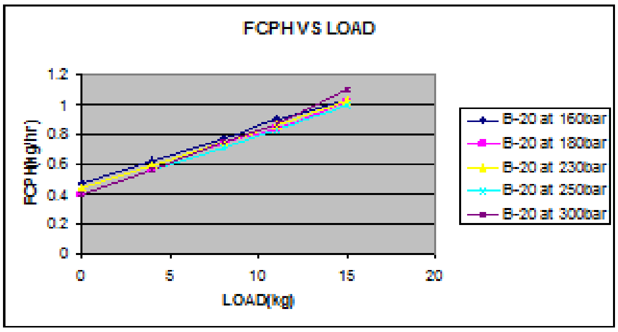

Fig 2 FCH Vs Load at different pressures

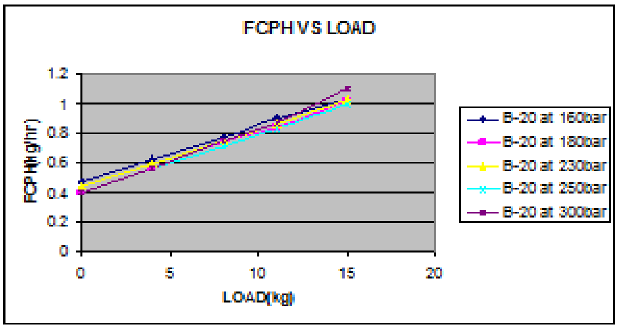

Fig 3 BTh efficiency Vs Load at different pressures

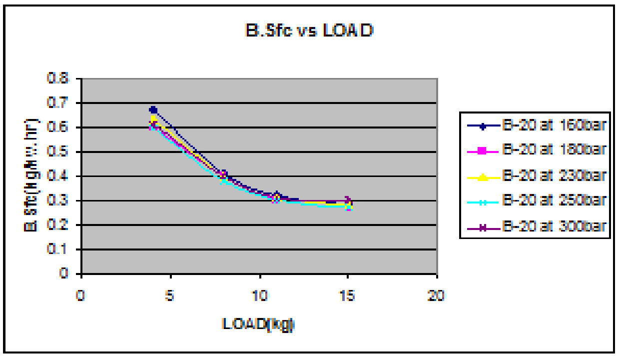

Fig 4 BSFC Vs Load at different pressures

3.1.2 B40 at different injection pressures

B40 (60% Diesel and 40%JME) were tested at different injection pressures

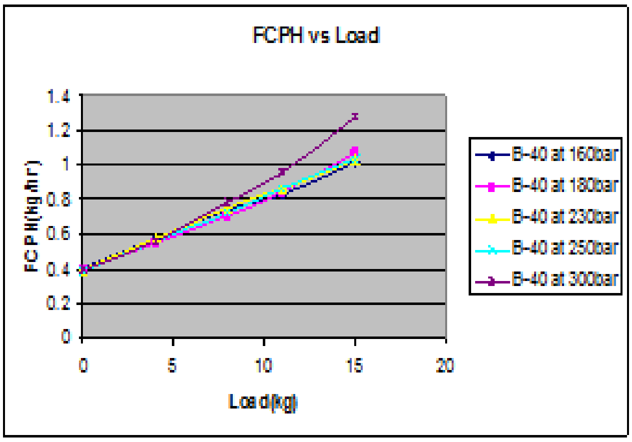

Fig 5 FCH Vs Load at different pressures

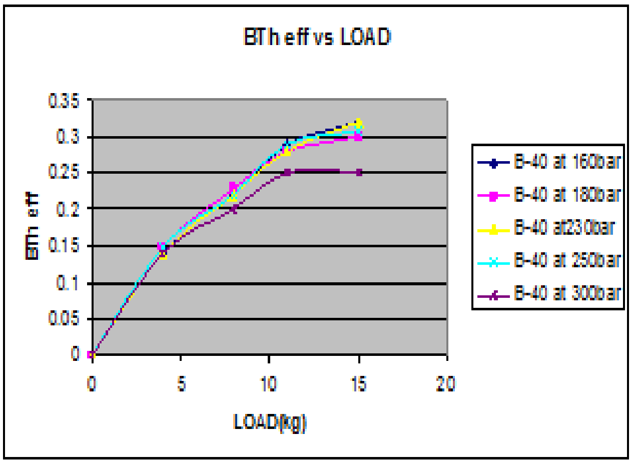

Fig 6 BTh efficiency Vs Load at different pressures

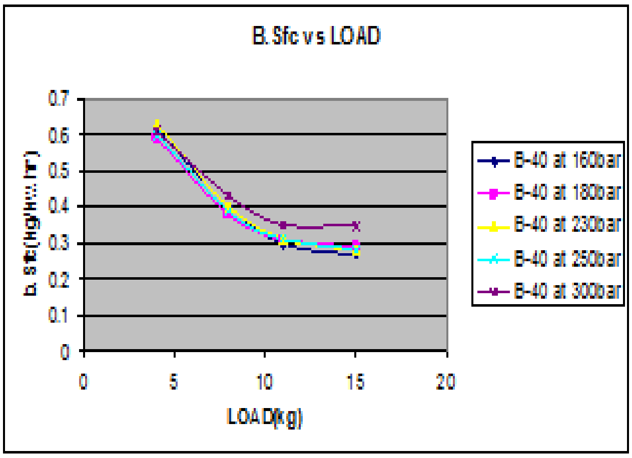

Fig 7 BSFC Vs Load at different pressures

3.1.3 B60 at different injection pressures

B60 (40% Diesel and 60%JME) were tested at different injection pressures

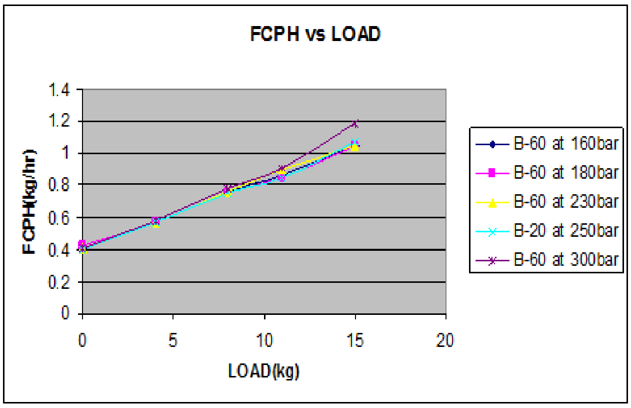

Fig 8 FCH Vs Load at different pressures

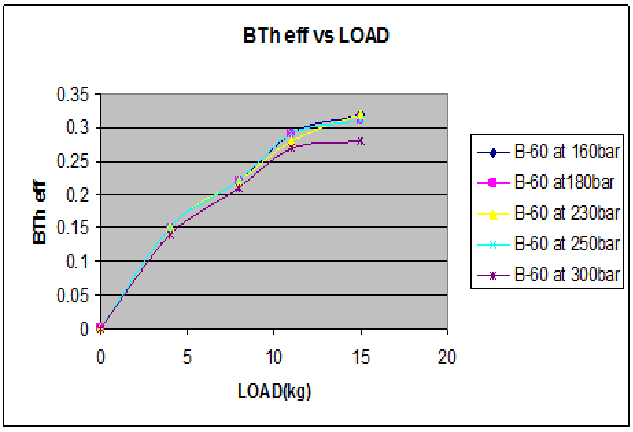

Fig 9 BTh efficiency Vs Load at different Pressures

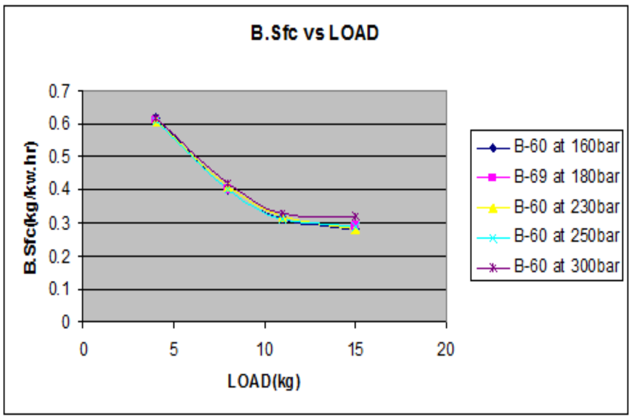

Fig 10 BSFC Vs Load at different pressures

3.1.4 B80 at different injection pressures

B80 (20% Diesel and 80%JME) were tested at different injection pressures

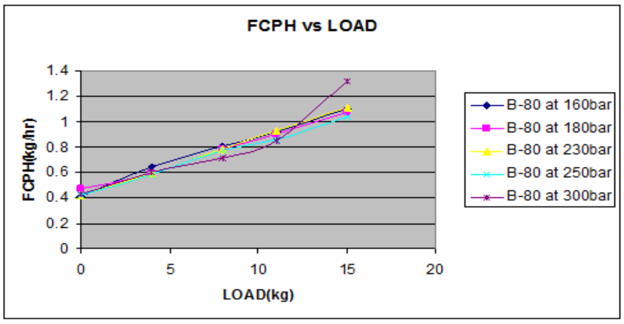

Fig 11 FCH Vs Load at different pressures

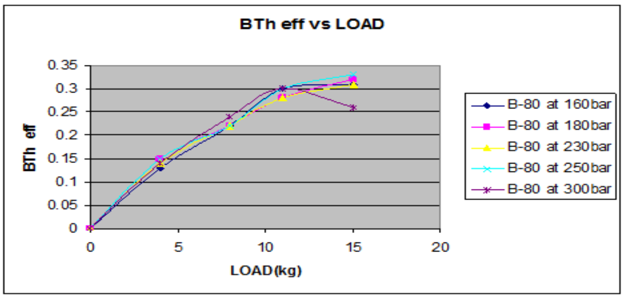

Fig 12 BTh efficiency Vs Load at different Pressures

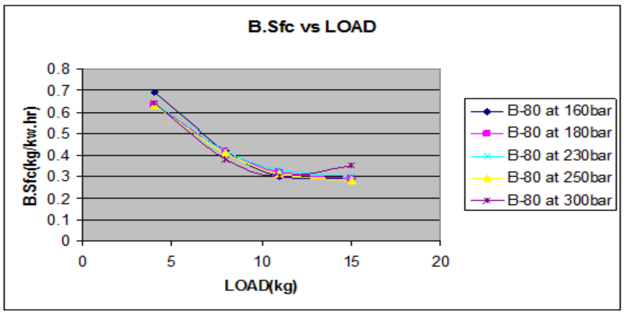

Fig 13 BSFC Vs Load at different pressures

3.1.5 B100 at different injection pressures

Neat Jatropha methyl ester were tested at different injection pressures

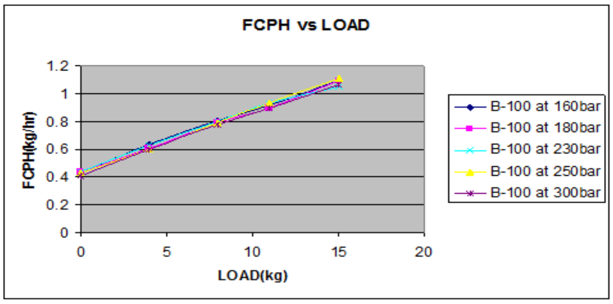

Fig 14 FCH Vs Load at different pressures

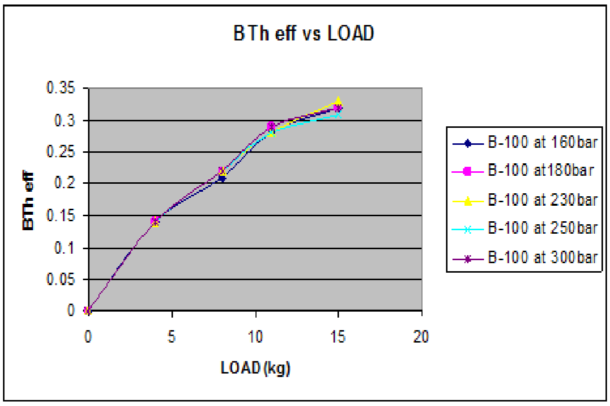

Fig 15 BTh efficiency Vs Load at different pressures

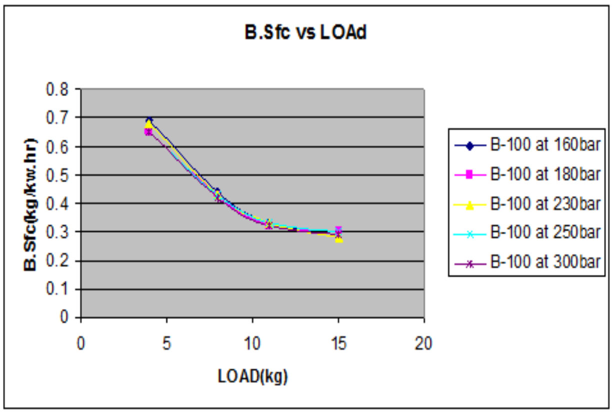

Fig 16 BSFC Vs Load at different pressures

From Fig.2, Fig.5, Fig.8, Fig.11 and Fig.14 it is observed that fuel consumption increases with increasing of load for all injection pressures. At 250bar injection pressure the FCH is lower for B20 at full load compared to remaining injection pressures and blends.

From Fig.3, Fig.6, Fig.9, Fig.12 and Fig.15 shows that the brake thermal efficiency is high at 250 bar injection pressure for B20 at full load compared to all injection pressures and blends because the injection pressures goes on increases it leads to poor combustion

From Fig.4, Fig.7, Fig.10, Fig.13 and Fig.16 it is observed that load increases BSFC decreases for all injection pressures. At 250bar injection pressure the BSFC is lower for B20 at full load compared to all injection pressures and blends. From the above graphs it is concluded that at 250bar injection pressure and B20 gives better performance.

4. Comparison of diesel and neat jatropha methyl ester at250b

It was observed that at various blends of diesel-JME at 250 bar and B20 gives better performance when compared to the other injection pressures. At this 250 bar injection pressures the Diesel and Neat JME were tested.

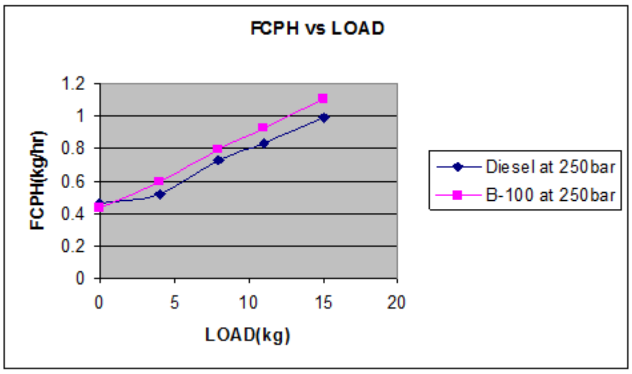

Fig 17 FCH Vs Load at different pressures

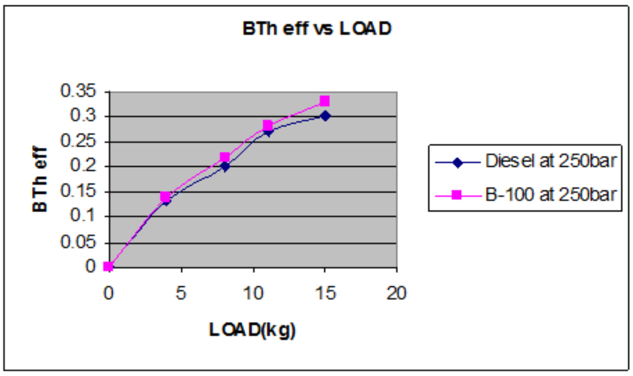

Fig 18 BTh efficiency V Load at different pressures

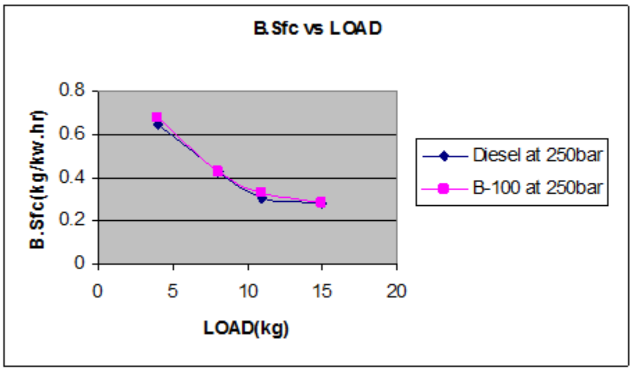

Fig 19 BSFC Vs Load at different pressures

From Fig.17 it is observed that fuel consumption increases with increasing of load. The FCH of Jatropha methyl ester is higher than diesel because JME having high viscosity compared to diesel. Similar reflections are observed from the brake specific fuel consumption versus load (Fig.19).

Fig.18 shows that brake thermal efficiency of JME is higher than diesel. On increasing of injection pressure the rate of reaction in between air and fuel particles have improved as a result efficient combustion is obtained. Finally JME at 250 bar injection pressure gives better performance compared to diesel.

Conclusions

The performance characteristics are analysed and compared with conventional fuel. The results are discussed based on the experimental investigations carried out with the use jatropha methyl ester in DI diesel engine. The following coclusions are arrived.

- With increase in the injection pressure of fuel it influences the physical delay period of combustion of the fuel i.e., the physical delay period is decreased on increasing of injection pressure.
- Injection pressure at 250bar and B20 gives better performance when compared to the other injection pressures and blends.
- Neat JME at 250 bar injection pressure gives better performance compared to diesel.

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