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Effect of Supercharging & Injection Pressure on Engine Combustion Characteristic of Jatropha Biodiesel Blend

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Abstract: *Jatrophacurcas as a non-edible methyl ester biodiesel fuel source is utilized to run single cylinder, variable compression ratio, and four-stroke diesel engine. Combustion parameters are measured for Jatropha biodiesel – diesel mixes. The properties of fuel biodiesel for example kinematic viscosity, calorific value, flash point, carbon deposit and specific gravity were found. The combustion parameters are additionally influenced by different working parameters like compression ratio, injection pressure, injection timing and inlet air pressure. The paper deals with effects on engine fueled with diesel, mix of diesel with biodiesel and simply on biodiesel with a view to give a stage to correlation of the combustion parameter on Jatrophabiodiesel fuels. In it research paper deals with the variation of cylinder pressure with different load of the engine at different injection pressure for fuel D0B100 (Jatropha bio diesel), D50B50 (Blended Jatropha) & D0B100 (Jatropha biodiesel) of the engine normal & supercharging condition is studied & concluded. In a CI engine, cylinder pressure depends on the burned fuel fraction during the premixed burning phase, i.e. initial stage of combustion. Cylinder pressure characterizes the ability of the fuel to mix well with air and burn. In it cylinder pressure vs crank angle, cylinder pressure vs cylinder volume was studied and concluded. Init result found that cylinder peak pressure increases and ignition delay period decreases with the increase in biodiesel share in the blended fuels in engine normal condition but in engine supercharging condition there is little decreasing in cylinder peak pressure. In D50B50 & D0B100 blended fuel have minimum cylinder peak pressure than mineral diesel at all injection pressure in engine supercharging condition.*

Keyword: *Diesel Engine, Jatropha Biodiesel, Biofuels, Blending, Supercharging, Combustion Characteristic, Injection Pressure, Inlet Air pressure.*

I. Introduction

The constant increment in the rate of utilization of the fossil fuels, depend upon the regularly increasing in population and the urbanization in the present day world has made the consumption of these ordinary fuel resource in the near future a very unavoidable truth. Also, the greenhouse gas outflows from these fossil fuels are continually degrading the planet and bringing about an earth wide temperature increase and other environment related issue. Thusly, the circumstance requests for a substitute alternate source of energy that can be utilized to overcome the forecasted future energy emergency [2]. Notwithstanding this, if the energy source is clean and renewable it will lessen the natural issues too. In this mission for a substitute and renewable energy sources researchers have found that biodiesel-diesel mixes as option fuels has turned into a famous alternative fuels [4]. This is because researchers have seen that the properties of biodiesel prepared from vegetable oils are near to pure diesel and in this way it has a promising future as an optional fuel for diesel engine. Biodiesel is as an optional fuel got from vegetable (green) oil or animal fats are oxygenated, bio de-gradable, non-harmful and earth safe. Biodiesel's are classified into two categories as eatable and non-eatable. Eatable oils are such that sunflower, corn, rapeseed, palm, and soybean and waste vegetable oils. The non-eatable oils are such that Jatropha, Karanja, Polanga oils and likes. Expanding sympathy toward ecological contamination alongside keeping up performance of diesel engines has prompted broad research in area of fuel. Among different choices researched for diesel fuel, biodiesel has ended up being most reasonable for diesel engines [1]. Different research works have proved that performance of biodiesel is almost like diesel engines with less discharges. Further engine parameters for example compression ratio, injection timing, injection pressure and inlet air pressure are likewise observed to be significant factors contributing on the performance, emission & combustion parameter of diesel engine fueled with biodiesel. Present paper focuses on effect of parameter viz. inlet air pressure and injection pressure.In it practical two different condition for finding the best result of C.I. Engine using Jatropha biodiesel.(1) Normal condition (2) Supercharging condition. The paper provides a platform for comparison of effect of varying load on combustion characteristics of engine fueled by (a) 100% diesel (b) blend of diesel & Biodiesel (c) 100% Biodiesel.

II. Literature Review

Jindal S et al (2011) he concentrated on with the impact of infusion timing on ignition and performance of an immediate infusion diesel engine running on Jatropha methyl ester. As the burning advances with biodiesel because of early section, hindering the infusion timing by 3° is found to expand the thermal effectiveness by 8% and lessen the particular fuel utilization by 9% when Jatropha methyl ester is utilized as fuel. Most astounding exhaust temperature and demonstrated power are acquired on 3° hindered infusion. By hindering the infusion, the fuel conveyance is additionally diminished, bringing about marginally bring down weight ascend with pinnacle moving towards outward stroke decreasing the negative work [15]. **Chaudhari et al (2016)** they researched on performance of small capacity compression ignition engine using Jatropha biodiesel blends. In their experiment engine was run at default set compression ratio of 17.5 and injection pressure of 180 bar. Performance was measured at three different loading condition for each blends used in investigation. It was found that at lower blends performance is similar to that of diesel fuel. Highest thermal efficiency was found for B20 v/v blend, which was 26.43% while other blend B30 shown similar thermal efficiency compare to diesel but was lower than B20. In this experiment B20 blend has comparatively higher performance than other [14].**Paul et al (2014)** they examined on experimental and numerical examination of the performance, combustion and emission characteristic of a diesel engine fueled with Jatropha biodiesel. The performance qualities show that brake particular fuel utilization (BSFC) increments and brake thermal efficiency diminishes with the utilization of Jatropha biodiesel. Burning characteristic show an expansion in pinnacle cylinder pressure and an abatement in start postpone period with the expansion in biodiesel partakes in the mixes; though the outflow of NOx and CO_2 expands smoke [12].

After observing literature review we concluded that, to find out the other option like alternative fuel that can be used and get energy from it. For higher performance, engine must be modified. When alternative fuel is used as a blend with diesel than there must have to do optimization of parameter which one directly or indirectly effect on the emission of the engine. From above survey, researcher took Jatropha fuel as a blend and optimize one parameter which affect the performance of the engine. The combustion characteristics have been analyzed and compared to baseline diesel fuel.

III. Jatropha Oil

The performance, emission& combustion characteristics of biodiesel fueled engine depend purely upon the thermo physical properties of the biodiesel [3]. Since Jatropha oil can be grown in wastelands, its cultivation to biodiesel production can also generate a large scale employment in a country like India. Basically the biodiesels are derived from vegetable oils via a popular process, transesterification in the presence of a catalyst and alcohol as a reactant [5]. Due to the availability and cost factor methyl alcohol is commonly used and the derived biodiesel is also known as fatty acid methyl ester. The purpose of the transesterification process is to lower the viscosity of the oil.

Table 3.1 Comparison of property Jatropha biodiesel vs Diesel [8]

Sr. no.	Properties	Jatropha biodiesel	Diesel
1	Colour	Golden yellow	Orange
2	Mass fraction (%)		
	Carbon	0.766	0.87
	Hydrogen	0.121	0.126
	Oxygen	0.113	0.004
3	Density at 323 K (kg/m^3)	862	830
4	Specific gravity at 30 ^{0}C	0.886	0.84 to 0.88
5	Gross calorific value(Mj/Kg)	41	42
6	Kinematic viscosity, Cst@40 ^{0}C	4.20	2
7	Cetane number	57-62	55
8	Boiling point ^{0}C	286	248
9	Solidifying point ^{o}C	-10	-14
10	Molecular mass	282	190

Experimental Setup And Method

4.1 Experimental Setup

The setup consists of single cylinder, four stroke, multi-fuel, research engine connected to eddy type dynamometer for loading. The operation mode of the engine can be changed from diesel to Petrol and from Petrol to Diesel with some necessary changes. In both modes the compression ration can be varied without stopping the engine and without altering the combustion chamber geometry by specially designed tilting cylinder block arrangement. The injection point and spark point can be changed for research tests. Setup is provided with necessary instruments for combustion pressure, Diesel line pressure and crank-angle measurements [16]. These signals are interfaced with computer for pressure crank-angle diagrams. Instruments are provided to interface airflow, fuel flow, temperatures and load measurements. The setup has stand-alone panel box consisting of air box, two fuel flow measurements, process indicator and hardware interface. Rota meters are provided for cooling water and calorimeter water flow measurement. A battery, starter and battery charger is provided for engine electric start arrangement [17]. 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, heat balance and combustion analysis. Lab view based Engine Performance Analysis software package “Engine soft” is provided for on line performance evaluation [18].

Fig 4.1 Front view of experimental setup

Fig 4.2 Side view of experimental setup

Table 4.1 Technical specifications [19]

Engine manufacturer	Apex Innovations (Research Engine test set up)
Software	Engine soft Engine performance analysis software
Engine type	Single cylinder four stroke multi fuel research engine
No. of cylinder	1
Type of cooling	Water cooled
Rated Power	3.5 kW @ 1500 rpm
Cylinder diameter	87.5 mm
Orifice diameter	20 mm
Stroke length	110 mm
Connecting rod length	234 mm
Dynamometer	Type: eddy current, water cooled, with loading unit

4.2 Experimental Methodology

In this experiment, diesel engine is used and connected with the rope break dynamometer, with the help of dynamometer, vary the load on the engine or remain constant .Gas analyzer is used to find the emission characteristic of exhaust gas. The reading takes by constant load or by varying the load on the engine using the dynamometer. Engine performance such as break power, indicated power, break specific fuel consumption etc. are found from the experiments [20].

First of all experimental set up is developed to fulfil the objective and it contains single cylinder diesel engine. Inlet air pressure & injection pressure are taken for the optimization for same compression ratio at different load. We used two different condition for finding the best result of C.I. Engine using Jatropha biodiesel. (1) Normal condition- In its first condition engine take atmospheric air as an inlet air. (2) Supercharging condition- In it engine take continuous flow of air with the use of air compressor as an external device. Take the Measurement using pure diesel, blended diesel & bio-diesel fuel at different load condition, different injection pressure for the two condition & measure the combustion characteristics of C.I. Engine. Emission reading is also taken by gas analyser equipment for emission analysis purpose.

Fig 4.2.1 Air compressor

Fig 4.2.2 Diesel, Blended Fuel &Jatropha bio oil

IV. Result & Discussion

An alternative fuel used in engines is always evaluated on the basis of both engine performances and its environmental impacts. As such, various parameters defining the performance and emissions of diesel engine which have been evaluated both experimentally and numerically in this work and have been discussed and analyzed in this section.Energy sources being considered diesel, biodiesel for the purpose of present work. After the engine reached the stabilized working condition fuel consumption, air consumption, engine load and exhaust emissions were measured. Engine power for diesel was 5.2 kW when engine speed was at 1500 rpm. In this section, the simulated results are verified with experimental results at the same operating conditions. The validation is done with three extreme fuels, namely pure Jatropha biodiesel (D0B100) Blended Jatropha biodiesel (D50B50) and mineral Diesel (D100B0).In this paper mainly emission parameters are considered at different injection pressure and different load condition with different blends.

This paper included the comparative analysis of various experimental data for various test conditions. An alternative fuel used in engines is always evaluated on the basis of both engine performances and its environmental impacts. As such, various parameters defining the combustion characteristics of diesel engine which have been evaluated graphically in this work and have been discussed and analyzed in this section.

Effect on Combustion Parameters

In a CI engine, cylinder pressure depends on the burned fuel fraction during the premixed burning phase, i.e., initial stage of combustion. Cylinder pressure characterizes the ability of the fuel to mix well with air and burn. In it cylinder pressure vs crank angle, cylinder pressure vs cylinder volume was studied and concluded.

5.1 Effect of Blends on Cylinder Pressure Vs Crank Angle

High peak pressure and maximum rate of pressure rise correspond to large amount of fuel burned in premixed combustion stage. The cylinder pressure crank angle history is obtained at different injection pressure & different engine condition (normal & supercharging) for diesel and Jatropha oil biodiesel blends

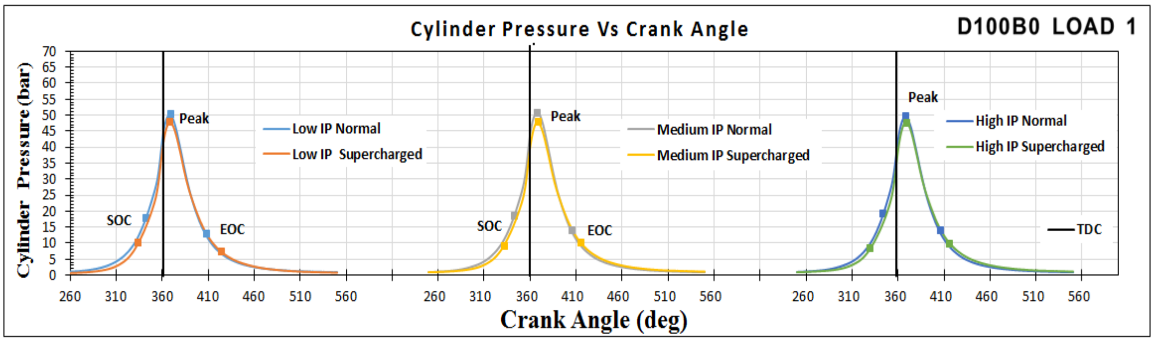

Fig 5.1.1 Cylinder Pressure Vs Crank Angle of D100B0 at load 1 kg

- ✓ Figure 5.1.1 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D100B0 (pure diesel) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 1 kg.
- ✓ From graph 5.1.1 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 50 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 47 bar. Not so much difference between both conditions.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 1 cylinder peak pressure is low compared to normal condition of engine.

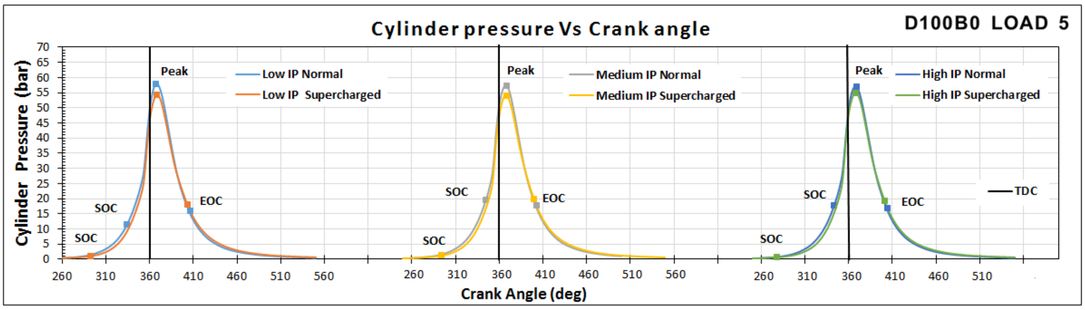

Fig 5.1.2 Cylinder Pressure Vs Crank Angle of D100B0 at load 5 kg

- ✓ Figure 5.1.2 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D100B0 (pure diesel) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 5kg.
- ✓ From graph 5.1.2 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 58 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 55 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 5 cylinder peak pressure is low compared to normal condition of engine.

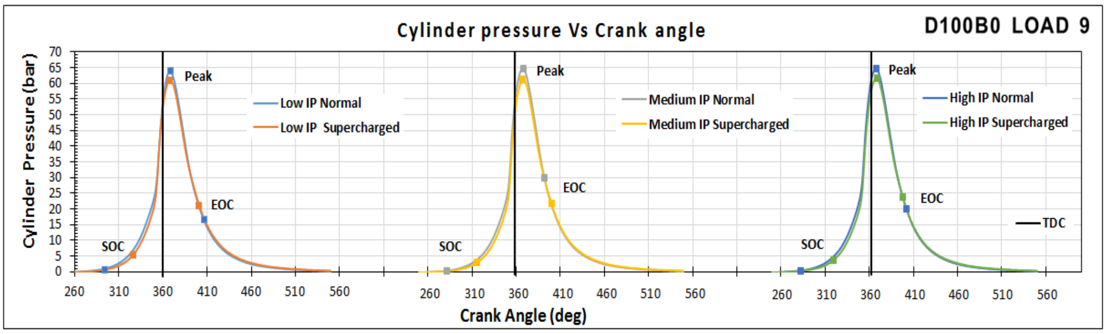

Fig 5.1.3 Cylinder Pressure Vs Crank Angle of D100B0 at load 9 kg

- ✓ Figure 5.1.3 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D100B0 (pure diesel) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 9 kg.
- ✓ From graph 5.1.3 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 65 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 60 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 9 kg cylinder peak pressure is low compared to normal condition of engine.

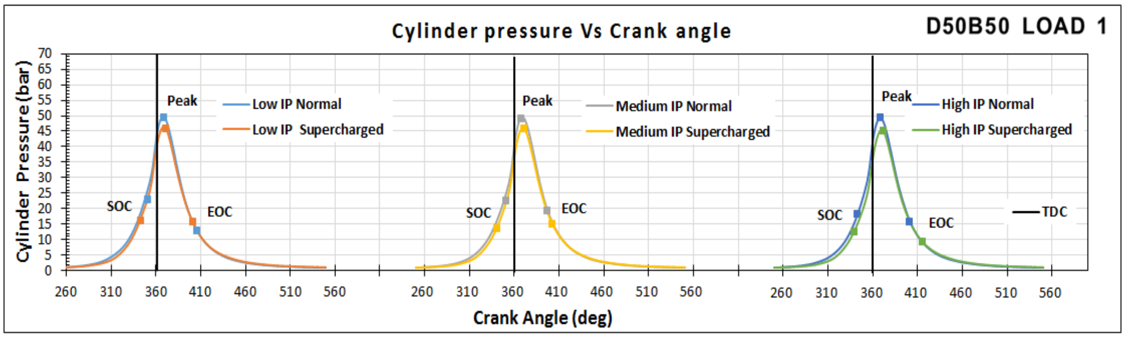

Fig 5.1.4 Cylinder Pressure Vs Crank Angle of D50B50 at load 1 kg

- ✓ Figure 5.1.4 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D50B50 (Jatropha blend) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 1 kg.
- ✓ From graph 5.1.4 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 50 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 45 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 1 kg cylinder peak pressure is low compared to normal condition of engine**.**

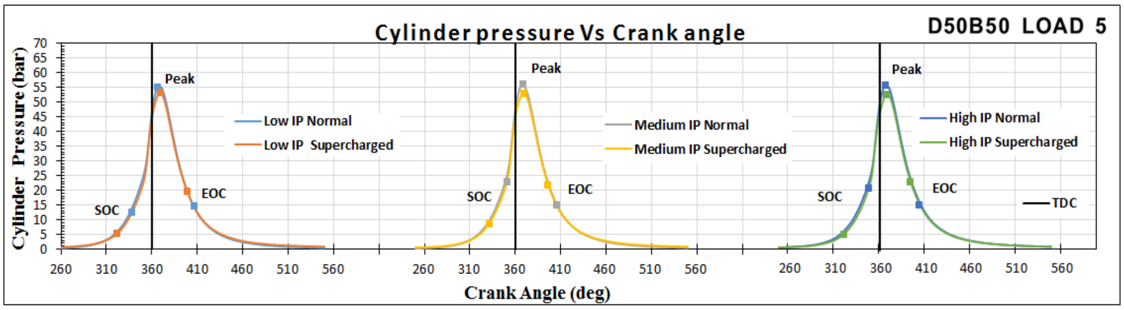

Fig 5.1.5 Cylinder Pressure Vs Crank Angle of D50B50 at load 5 kg

- ✓ Figure 5.1.5 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D50B50 (Jatropha blend) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 5 kg.
- ✓ From graph 5.1.5 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 55 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 52 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 5 kg cylinder peak pressure is low compared to normal condition of engine.

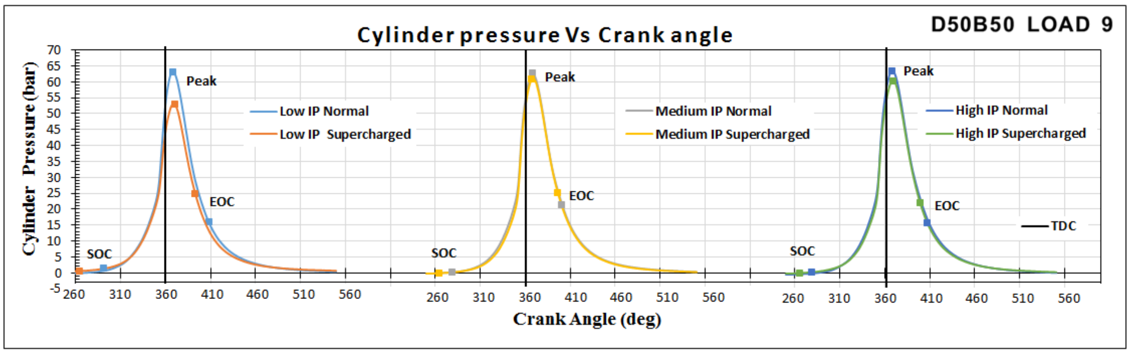

Fig 5.1.6 Cylinder Pressure Vs Crank Angle of D50B50 at load 9 kg

- ✓ Figure 5.1.6 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D50B50 (Jatropha blend) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 9 kg.
- ✓ From graph 5.1.6 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 65 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 61 bar except of low injection pressure peak pressure is 53 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 9 kg cylinder peak pressure is low compared to normal condition of engine.

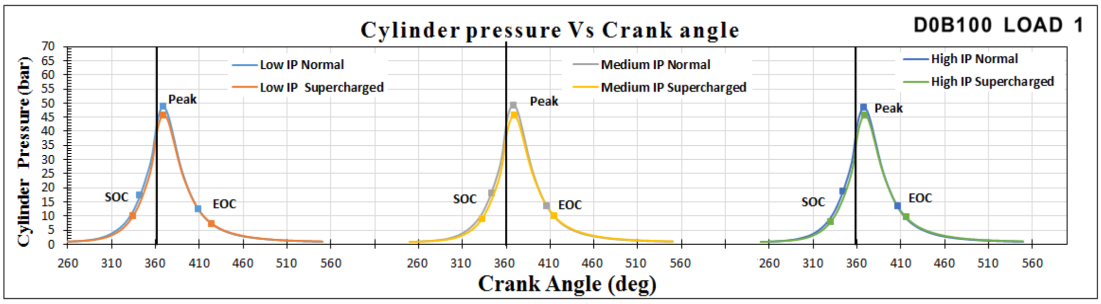

Fig 5.1.7 Cylinder Pressure Vs Crank Angle of D0B100 at load 1 kg

- ✓ Figure 5.1.7 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D0B100 (pure Jatropha bio oil) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 1 kg.
- ✓ From graph 5.1.7 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 50 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 45 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 1 kg cylinder peak pressure is low compared to normal condition of engine.

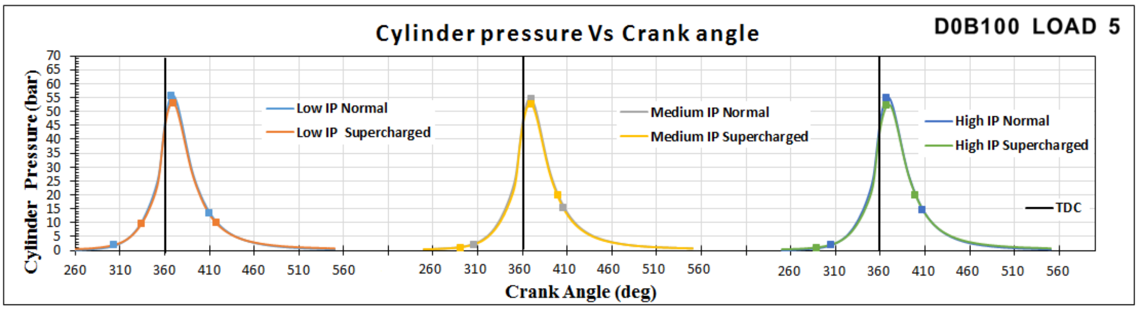

Fig 5.1.8 Cylinder Pressure Vs Crank Angle of D0B100 at load 5 kg

- ✓ Figure 5.1.8 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D0B100 (pure Jatropha bio oil) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 5 kg.
- ✓ From graph 5.1.8 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 55 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 53 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 5 kg cylinder peak pressure is low compared to normal condition of engine.

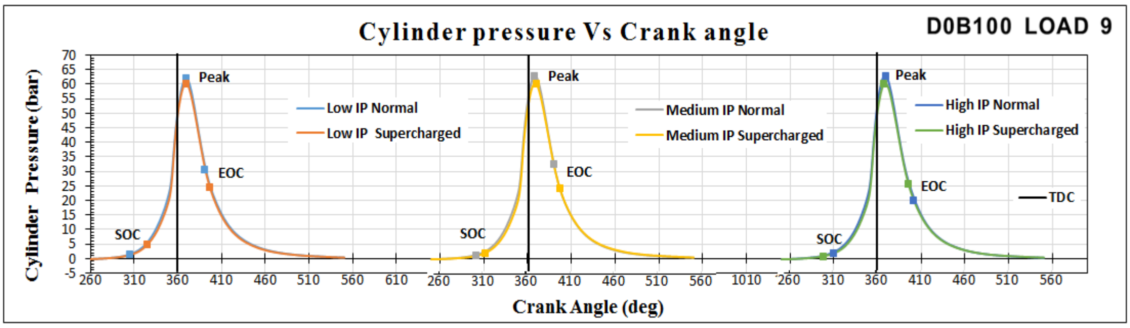

Fig 5.1.9 Cylinder Pressure Vs Crank Angle of D0B100 at load 9 kg

- ✓ Figure 5.1.9 shows the graph of cylinder pressure Vs crank angle. In it shows that effect of cylinder pressure with the use of D0B100 (pure Jatropha bio oil) at low, medium & high injection pressure and engine normal & supercharged condition at the load of 9 kg.
- ✓ From graph 5.1.9 we can conclude that the cylinder pressure is same for all injection pressure engine running at normal condition is nearly 63 bar. Where as in engine running at supercharged condition at all injection pressure cylinder peak pressure is nearly 60 bar.
- ✓ Also, in supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging. From graph it shows that in supercharging condition for pure diesel of load 9 kg cylinder peak pressure is low compared to normal condition of engine.

5.2 Effect of Blends on Cylinder Pressure Vs Cylinder Volume

Cylinder Pressure is the pressure in the engine cylinder during the 4 strokes of engine operation (intake, compression, combustion and expansion, and exhaust). You could argue that pressure during expansion is the most important, because that is the cylinder pressure pushing on the piston to produce power.

In it studied about the variations in cylinder pressure with cylinder volume for diesel & biodiesel at different injection pressure & different engine condition for all load.

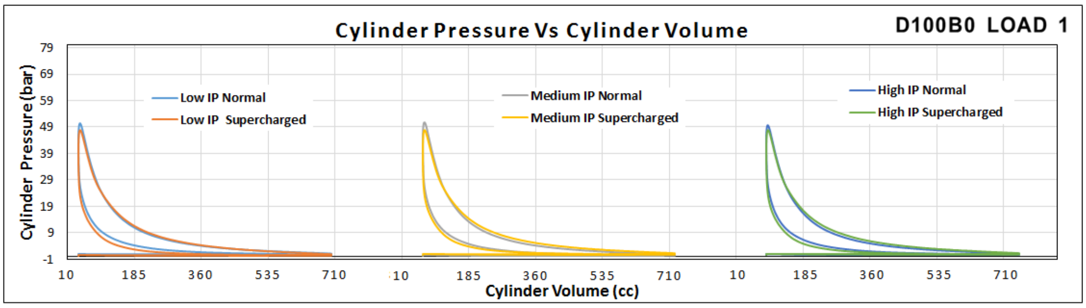

Fig 5.2.1 Cylinder Pressure Vs Cylinder Volume of D100B0 at load 1 kg

- ✓ Figure 5.2.1 shows cylinder pressure Vs cylinder volume graph for load 1 kg with the use of D100B0 with different injection pressure at the engine condition of normal & supercharging.
- ✓ From graph 5.2.1 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the small percentage of pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 1 kg condition.

- ✓ The volume at various pressure created by the combustion is at peak level of nearly 50 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 48 bar for all injection pressure for load of 1 kg.

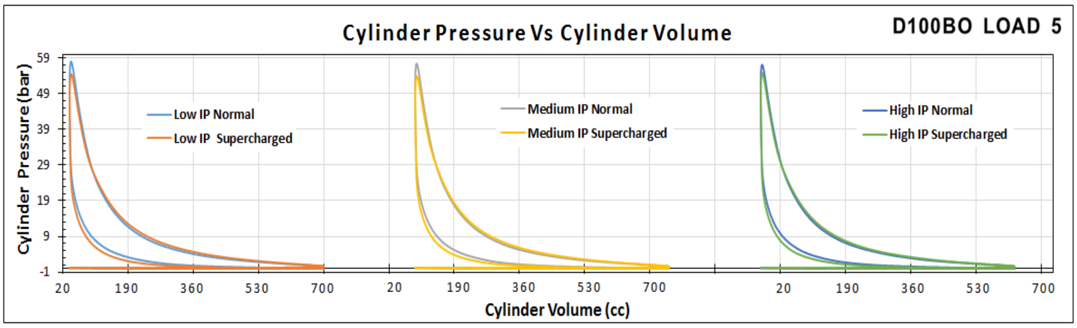

Fig 5.2.2 Cylinder Pressure Vs Cylinder volume of D100B0 at load 5 kg

- ✓ Figure 5.2.2 shows cylinder pressure Vs cylinder volume graph for load 5 with the use of D100B0 with different injection pressure at the engine condition of normal &supercharging.
- ✓ From graph 5.2.2 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 5kg condition.
- ✓ The volume at various pressure created by the combustion is at peak level of 58 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is 55 bar for all injection pressure & for load of 5 kg.

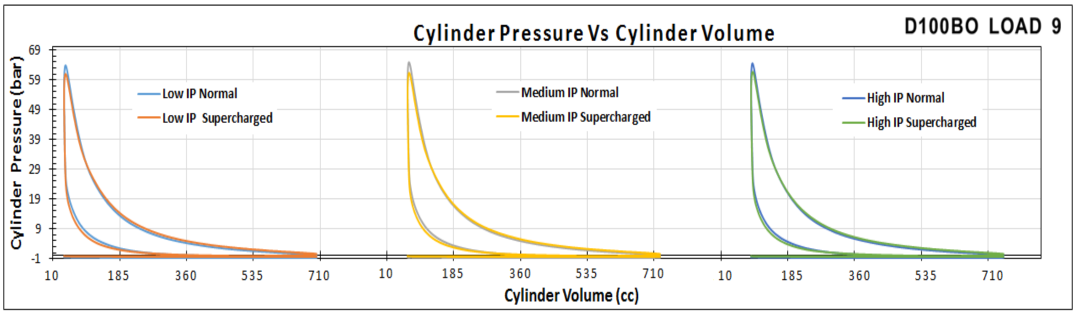

Fig 5.2.3 Cylinder Pressure Vs Cylinder volume of D100B0 at load 9 kg

- ✓ Figure 5.2.3 shows cylinder pressure Vs cylinder volume graph for load 9 with the use of D100B0 with different injection pressure at the engine condition of normal & supercharging.
- ✓ From graph 5.2.3 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 9kg condition.
- ✓ The volume at various pressure created by the combustion is at peak level of 64 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is 60 bar for all injection pressure & for load of 9 kg.

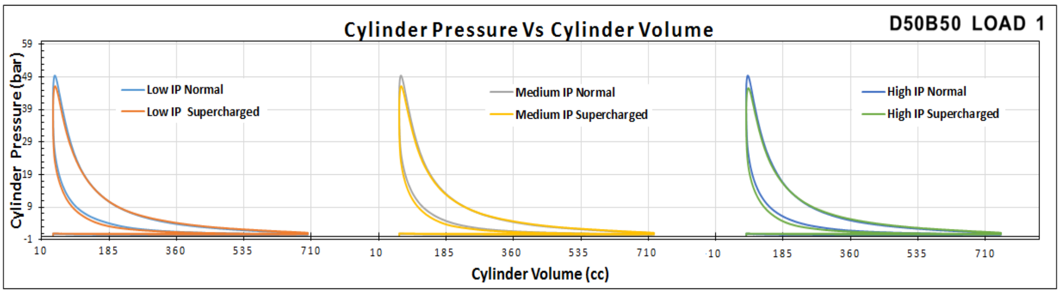

Fig 5.2.4 Cylinder Pressure Vs Cylinder Volume of D50B50 at load 1kg

- Figure 5.2.4 shows cylinder pressure Vs cylinder volume graph for load 1 with the use of D50B50 with different injection pressure at the engine condition of normal & supercharging.
- From graph 5.2.4 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 1kg condition.
- The volume at various pressure created by the combustion is at peak level of nearly 49 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 46 bar for all injection pressure & for load of 1 kg.

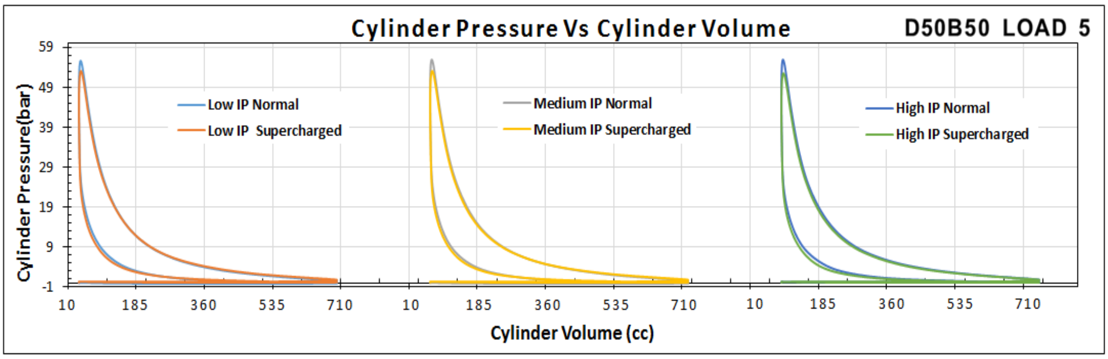

Fig 5.2.5 Cylinder Pressure Vs Cylinder Volume of D50B50 at load 5 kg

- Figure 5.2.5 shows cylinder pressure Vs cylinder volume graph for load 5 with the use of D50B50 with different injection pressure at the engine condition of normal & supercharging.
- From graph 5.2.5 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 5kg condition.
- The volume at various pressure created by the combustion is at peak level of nearly 55 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 53 bar for all injection pressure & for load of 5 kg.

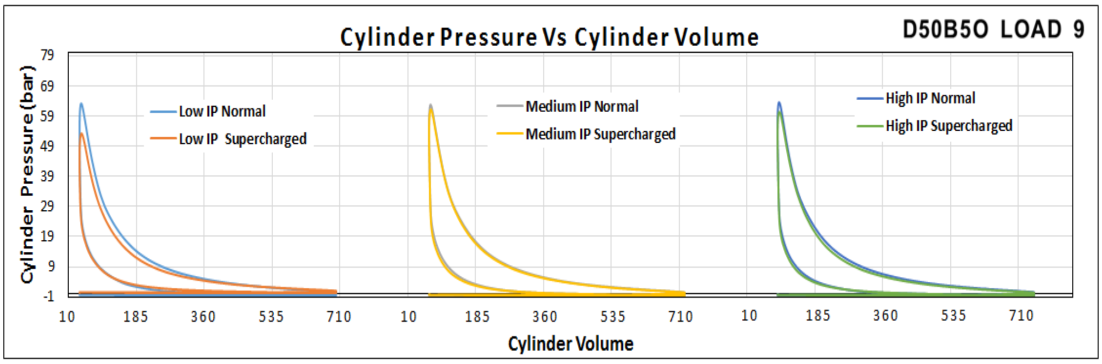

Fig 5.2.6 Cylinder Pressure Vs Cylinder Volume of D50B50 at load 9 kg

- Figure 5.2.6 shows cylinder pressure Vs cylinder volume graph for load 9 kg with the use of D50B50 with different injection pressure at the engine condition of normal & supercharging.
- From graph 5.2.6 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 9kg condition.
- The volume at various pressure created by the combustion is at peak level of nearly 62 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 59 bar for high & low injection pressure and for low injection pressure peak value is low as nearly 53 bar &for load of 9 kg.

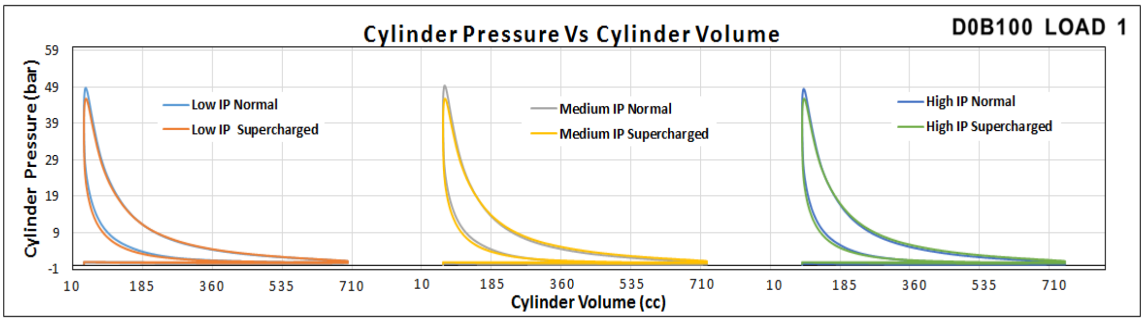

Fig 5.2.7 Cylinder Pressure Vs Cylinder Volume of D0B100 at load 1 kg

- ✓ Figure 5.2.7 shows cylinder pressure Vs cylinder volume graph for load 1 kg with the use of D0B100 with different injection pressure at the engine condition of normal & supercharging.
- ✓ From graph 5.2.7 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 1kg condition.
- ✓ The volume at various pressure created by the combustion is at peak level of nearly 49 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 45 bar for all injection pressure for load of 1 kg.

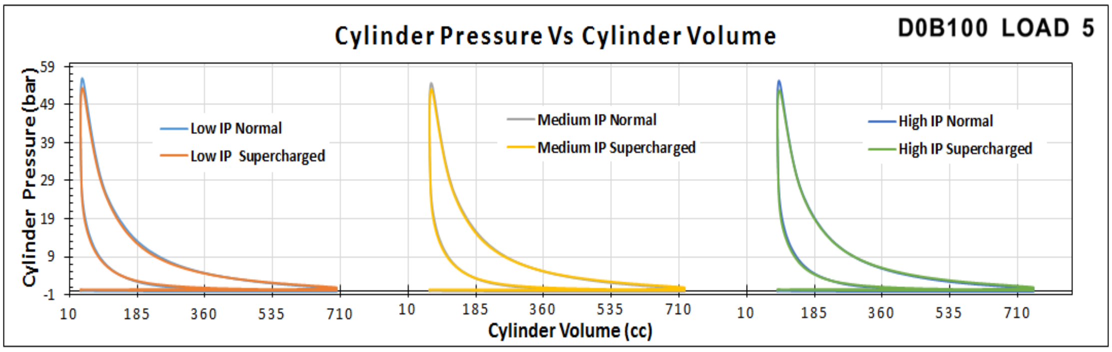

Fig 5.2.8 Cylinder Pressure Vs Cylinder Volume of D0B100 at load 5 kg

- ✓ Figure 5.2.8 shows cylinder pressure Vs cylinder volume graph for load 5 kg with the use of D0B100 with different injection pressure at the engine condition of normal & supercharging.
- ✓ From graph 5.2.8 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 5kg condition.
- ✓ The volume at various pressure created by the combustion is at peak level of nearly 57 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 53 bar for all injection pressure for load of 5 kg.

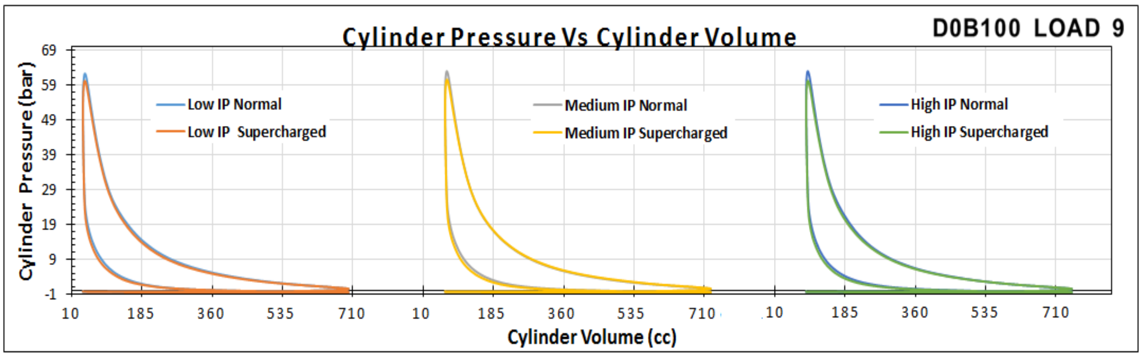

Fig 5.2.9 Cylinder Pressure Vs Cylinder Volume of D0B100 at load 9 kg

- ✓ Figure 5.2.9 shows cylinder pressure Vs cylinder volume graph for load 9 kg with the use of D0B100 with different injection pressure at the engine condition of normal & supercharging.
- ✓ From graph 5.2.9 we can conclude the changes in pressure & volume in the system by the combustion for all the injection pressure is same for engine both condition (normal & supercharging). It can be seen that the small percentage of pressure decrease with the use of engine supercharging condition for all injection pressure & for load of 9kg condition.
- ✓ The volume at various pressure created by the combustion is at peak level of nearly 62 bar for all injection pressure in engine normal condition. While for engine supercharged condition peak pressure is nearly 60 bar for all injection pressure for load of 9 kg.

V. Conclusion

From the engine combustion characteristics was studied, it can be concluded that

- Cylinder peak pressure increases and ignition delay period decreases with the increase in biodiesel share in the blended fuels in engine normal condition but in engine supercharging condition there is little decreasing in cylinder peak pressure.
- In supercharging condition the point of start of combustion shifts towards left compared to engine normal condition. As such it can be said that the combustion starts earlier and the ignition delay period decreases with the use of supercharging.
- In D50B50 & D0B100 blended fuel have minimum cylinder peak pressure than mineral diesel at all injection pressure in engine supercharging condition.
- Cylinder peak pressure increase with the increasing in load & with increasing in blend proportion of Jatropha in engine both condition.
- In cylinder pressure with respect to cylinder volume there is also in D0B100 & D50B50 have low peak pressure than mineral diesel.

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