 ©2015 IJIRCT | ISSN: 2454-5988

Effect of Injection Pressure in DI Diesel Engine using Mahua Biodiesel Blend

C. Syed Aalam
Assistant Professor
Department of Mechanical EngineeringAnnamalai University
Tamilnadu, India

Shubham Singh
Scholar UG
Department of Mechanical EngineeringAnnamalai University
Tamilnadu, India

Sanjay Jauhary
Scholar UG
Department of Mechanical EngineeringAnnamalai University
Tamilnadu, India

***Abstract*—The present study aims to evaluate the effect of injection pressure on the performance and emissions of a single cylinder, four stroke DI diesel engine, running on biodiesel blend (B25), prepared from Mahua (Madhuca longifolia) vegetable oil. The effect of varying injection pressure was evaluated in terms of brake thermal efficiency, specific fuel consumption and emissions like HC, CO, NOx and smoke. The value of diesel fuel at 220bar pressure taken as a base value and found the effect of injection pressure using mahua methyl ester blend fuel (B25) injected at different pressures (200,220,240 bar). It was found that the increasing the injection pressure enhances the thermal efficiency by about 2 percent and reduces the emissions like HC, CO and smoke. It was also found small increment in NOx emission when increases the injection pressure.**

***Keywords*— DI diesel engine, Fuel injection pressure, Performance, Emissions**

I. Introduction

From the decades, diesel engine fulfills our hunger for mechanical power and we always try to enhance engine mechanical power and other important properties either by doing an engine modification or by fuel modification [1-3]. Unluckily our sources are limited to fossil fuel and it is still heavily consumed for daily energy needs. So researches are continued in search of appropriate path regarding energy production. This forces us to think about non-conventional fuels such as biodiesel, which has many similar properties as compared to normal diesel [3,4]. Many researches carried out to make biodiesel with combination of different vegetable oils, and normal diesel and as result B25 (Mahua) came into existence with showing acceptable outcomes. But it has certain problems regarding viscosity, atomization, etc. Researchers found that these problems can be short out by injection pressure variation. Normal diesel engine pressure ranges from 170 to 200 bar depending upon engine size and combustion system employed. However, if the injection pressure is high, then this leads to longer fuel penetration distance, better air-fuel mixture and decrement in combustion duration, but also side by side, we get less production of CO due to better combustion [5-9]. But it is also seen that the fuel pressure is less than this leads to poor atomization, a higher ignition delay period, which in turn produces HC and CO due to inefficient combustion [10-13]. In this experiment, different range of pressure (200,220,240bar) has applied to DI diesel engine fueled by mahua biodiesel blend B25 to find the emissions and performance characteristics.

II. Biodiesel Production

One liter of Mahua oil is heated in an open beaker to a temperature of 100-120ºC to remove water contends present in vegetable oil followed by filtration of raw vegetable oil. The raw oil is processed under base catalyzed transesterification method where it is mixed with 200 ml of methanol and 7gms of sodium hydroxide (NaOH) pellets. The mixer is kept on a hot plate magnetic stirring arrangement for 1-1.5 hours up to 60ºC and then it is allowed to settle down for about 5-6 hours to obtain methyl ester and glycerol. The methyl ester obtained in the process is further washed with distilled water for 2-3 times for the removal of acids and heated above 100ºC to separate the moisture content present in the methyl ester. Hence, pure Mahua methyl ester is obtained. The physical and chemical properties of biodiesel were determined by standard methods and shown in Table 1.

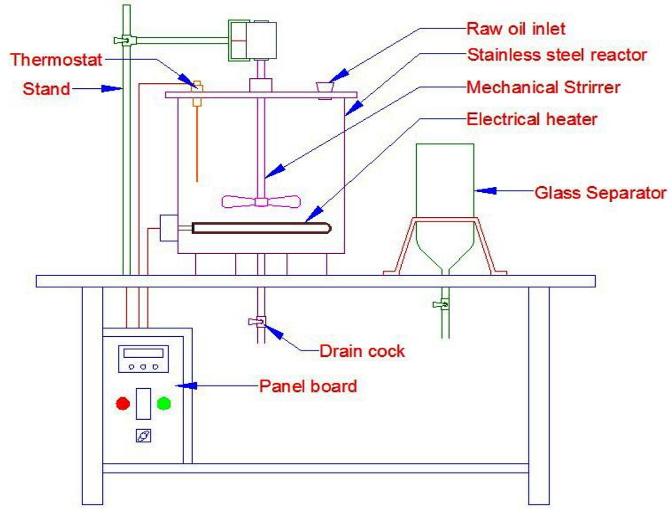

Fig. 1. Schematic diagram of Biodiesel Plant.

TABLE I. PROPERTIES OF BIODIESEL SAMPLE

Description	**Viscosity @40°C (cSt)**	**Density @ 15°C (kg/m3)**	**Flash Point (°C)**	**Calorific value, (kJ/kg)**	**Cetane number**
Diesel fuel	3	815	56	42,000	47
Biodiesel standards (ASTM)	1.9-6	850-900	>130	≥36000	47 to 65
Mahua methyl ester (MME)	4.9	869.8	136	39950	58

III. USING THE TEMPLATE

For the experiment, single cylinder, four stroke, Kirloskar TV-1 engine was used. Details of the engine specification are given in Table 2. The fuel flow rate is obtained on the gravimetric basis and the airflow rate is obtained on the volumetric basis. NOx emission is measured with the help of an exhaust gas analyzer. The AVL smoke meter is used to measure the smoke density. AVL five-gas analyzer is used to measure the rest of the pollutants. A burette is used to measure the fuel consumption for a specified time interval. During this interval of time, how much fuel the engine consumes is measured, with the help of the stopwatch. The experimental setup is indicated in the Fig. 2.

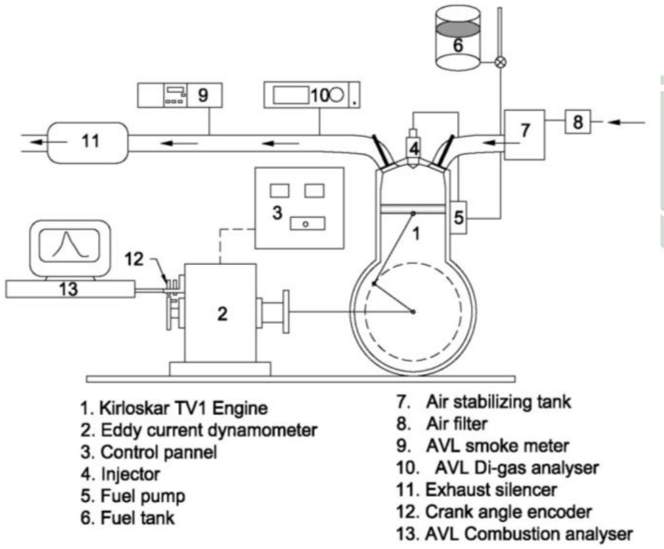

Fig. 2. Experimental setup (Kirloskar TV-I Engine).

TABLE II. ENGINE SPECIFICATION

Type	:	Vertical, Water cooled, Four stroke
Number of cylinders	:	One
Bore	:	87.5 mm
Stroke	:	110 mm
Compression ratio	:	17.5:1
Maximum power	:	5.2 kW
Speed	:	1500 rev/min
Dynamometer	:	Eddy current
Injection timing	:	23° before TDC
Injection pressure	:	220 kgf/cm^2

IV. RESULTS AND DISCUSSION

The results were obtained by varying different fuel injection pressures at 200, 220 and 240 bar respectively, for the Mahua biodiesel blend fuel (B25). Thus the results obtained are compared with that of neat diesel fuel at standard injection pressure (220bar). According to the output, the discussions and conclusions are conferred.

A. Specific Fuel Consumption (SFC)

The specific fuel consumption at all loads at different fuel injection pressures 200, 220, and 240 bar are shown in Fig. 3. Increasing the fuel injection pressure resulting in reduced SFC and this could be due to more efficient utilization of fuel resulting in better atomization. Specific fuel consumption of diesel fuel at standard injection pressure was 0.34 kg/kW-hr. When using the biodiesel blend (B25) at 220 bar, SFC was reduced to 0.32 kg/kW-hr. From the figure it is clear that the increasing the injection pressure, specific fuel consumption was reduced. When fuel injection pressure was 240 bar, SFC reduced to 0.31 kg/kW-hr.

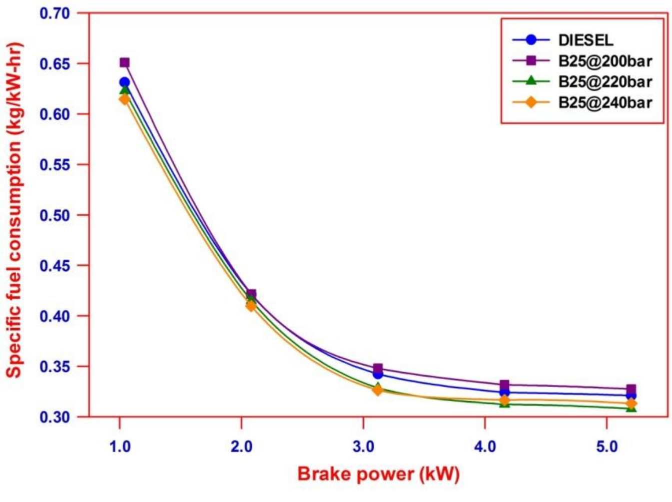

Fig. 3. Specific Fuel Consumption against Brake Power.

B. Brake Thermal Efficiency (BTE)

Performance characteristic curve for brake thermal efficiency against brake power is shown in Fig. 4. From the figure, it was observed that the B25 blend at lower injection pressure having low brake thermal efficiency, because of poor atomization and coarse spray formation. By increasing injection pressure to 240bar BTE increased, which may be due to better atomization and fine spray formation, which lowers physical delay period and results better combustion. BTE for standard diesel fuel at 220 bar was 25.2% and for B25 at 200 bar was 24.8%. When the fuel injection pressure increase, it increases the BTE up to 1-2%.

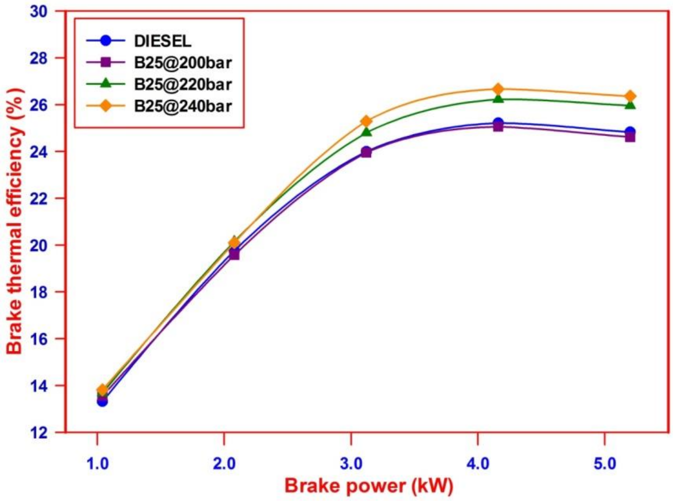

Fig. 4. Brake Thermal Efficiency against Brake Power.

C. Carbon monoxide Emission (CO)

Emission characteristic curve for carbon monoxide emission against brake power is shown in Fig. 5. From the figure, it can be concluded that the load increases the amount of carbon monoxide also goes on increasing but the blend which is injected at the highest injection pressure shows the lesser amount of CO as compared to standard diesel fuel and the blends at lower IP.Awful performance of other blends may be happened because of irregular mixing of fuel particles with air, and feeble combustion of the blend at lower injection pressure. So it can be assured that B25 at 240 bar pressure is the best one to reduce the CO emission.

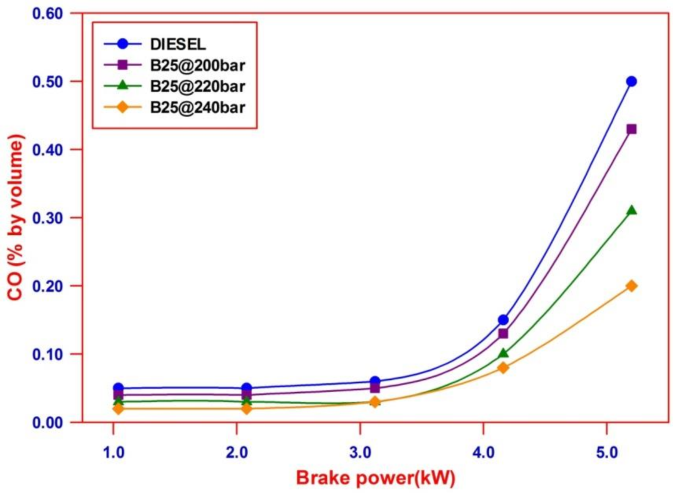

Fig. 5. Carbon Monoxide Emission against Brake Power.

D. Hydrocarbon Emission (HC)

Emission characteristic curve for hydrocarbon emission against brake power is shown in Fig. 6. The reason for unburned hydrocarbons is incomplete combustion of fuel. At higher pressures the HC emission was decreases, this may be due to finer fuel spray which results a momentum of better combustion. From the figure, it is seen that neat diesel fuel emits more hydrocarbon emission compared with B25, because biodiesel blend having higher oxygen content which tends complete combustion of fuel. The HC emission for standard diesel fuel was 108 ppm and for B25 at 200 bar injection pressure was 102 ppm. The HC emission reduced up to 86ppm in the case of B25 injected in 240 bar injection pressure.

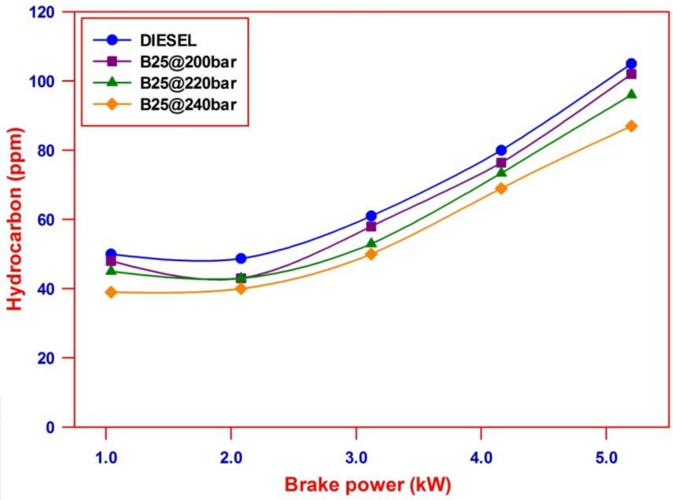

Fig. 6. Hydrocarbon Emission against Brake Power.

E. Oxides of Nitrogen (NOx)

Emission characteristic curve for oxides of nitrogen emission against brake power is shown in Fig. 7. The main reason for formation of NOx is lean mixture and higher temperature. When the fuel injection pressure increase, it tends to complete combustion of fuel and increase the heat release rate. From the graph it is very clear that the injection pressure increases, the amount of NOx emission increases. NOx emission for standard diesel fuel at 220 bar was 845 ppm, where as it was 930 ppm for B25 fuel blend at same fuel injection pressure. When increase the fuel injection pressure from 220 bar to 240 bar NOx emission dramatically increased from 930 ppm to 980 ppm.

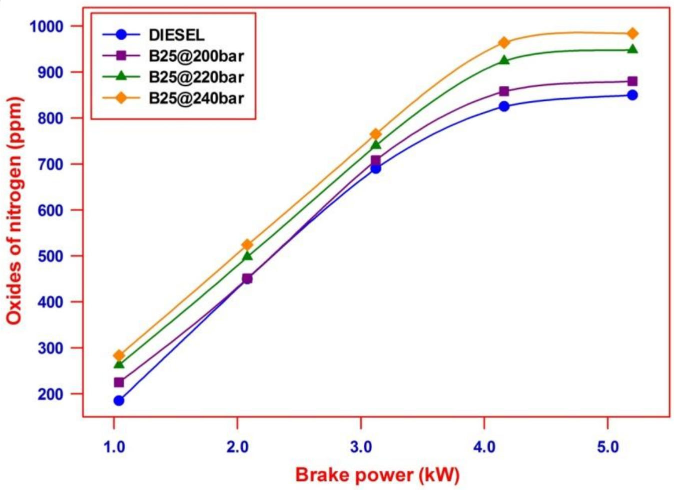

Fig. 7. Oxides of Nitrogen against Brake Power.

F. Smoke Emission

Emission characteristic curve for smoke emission against brake power is shown in Fig. 8. From the figure, it is found that the mahua biodiesel blend (B25) which is injected at high pressure releasing lower smoke emission than that of standard diesel fuel. It may happen because of some amount of oxygen is present in biodiesel blends, which causes lean mixture of fuel at higher pressure. When fuel injected at high injection pressure, it tends the better atomization and better combustion of fuel, and results reduced the smoke opacity. From the figure, it is clear that the smoke emission was reduced when biodiesel blend (B25) used as fuel. Smoke emission further reduced when the fuel injection pressure was increased. Smoke emission for neat diesel fuel at 220 bar fuel injection pressure was 67 HSU, where as it was 63 HSU for B25 fuel blend at 200 bar injection pressure. Fuel injection pressure was increased to 220 bar, the smoke emission reduced to 56 HSU and for 240 bar 55HSU.

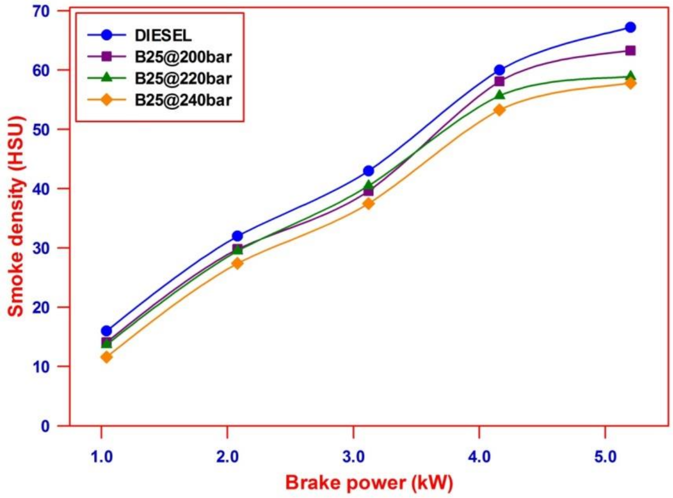

Fig. 8. Smoke Emission against Brake Power.

CONCLUSION

The performance and emission characteristics of single-cylinder, constant speed, common rail system assisted direct-injection diesel engine was investigated at different fuel injection pressures. Based on the experimental data, the following conclusions have been drawn.

The brake thermal efficiency of biodiesel blended fuel (B25) was relatively better as compared to that of neat diesel and the BTE dramatically increase, when the fuel injection pressure was increased.

B25 operation at 240 bar fuel injection pressure resulted in better performance in terms of reduced smoke, HC, CO emissions as compared to neat diesel operation.

The NOx emissions were relatively high for B25 at 240 bar injection pressure as compared to that of B25 at 200 bar injection pressure operation.

REFERENCES

[1] Celikten, Ismet. An experimental investigation of the effect of the injection pressure on engine performance and exhaust emission in indirect injection diesel engines, Applied Thermal Engineering 23, pp: 2051–2060.

[2] Gimenez B, Tinaut. F, Melgar A, Payri R. Effects of the Operating Variables and Atomization Parameters on Diesel Spray Characteristics by Means of a Transient Evaporative Spray Atomization Model, SAE Technical Paper, 2004- 01-2013.

[3] S. Jindal, B.P. Nandwana, N.S. Rathore and V. Vashistha. Experimental investigation of the effect of compression ratio and injection pressure in a direct injection diesel engine running on Jatropha methyl ester. Applied Thermal Engineering, 30 (2010), pp 442-448.

[4] Rosli Abu Baker, Semin, Abdul Rahim Ismail. Fuel injection pressure effect on performance of direct injection diesel engines based on experiments. American Journal of Applied Sciences. 5 (3): pp 197-202, 2008.

[5] IsmetCelıkten. An experimental investigation of the effect of the injection pressure on engine performance and exhaust emission in indirect injection diesel engines. Applied Thermal Engineering. 23: pp 2051–2060, 2003.

[6] K. Kannan and M. Udayakumar. Experimental study of the effect of fuel injection pressure on diesel engine performance and emission, ARPN Journal of Engineering and Applied Sciences, Vol. 5, No. 5: pp 42-45, 2010.

[7] Can Cinar, TolgaTopgul, Murat Ciniviz, Can Hasimoglu. Effects of injection pressure and intake CO2 concentration of performance and emission parameters on an IDI turbocharged diesel engine. Applied Thermal Engineering. 25, 2005: pp 1854-1862.

[8] C. Syed Aalam, C.G. Saravanan, M. Kannan. Experimental investigations on a CRDI system assisted diesel engine fuelled with aluminium oxide nanoparticles blended biodiesel, Alexandria Engineering Journal, Volume 54, Issue 3, 2015, Pages 351–358.

[9] Seang-wock Lee, Daisuke Tanaka, Jin Kusaka, Yasuhira Daisho. Effects of diesel fuel characteristics on spray and combustion in a diesel engine. JSAE Review. 23, 2002: 407-414.

[10] Prakash Maran, J, Sivakumar, V, Sridhar, R., Prince Immanuel, V. 2013. Development of model for mechanical properties of tapioca starch based edible films. Ind. Crop. Prod. 42, pp 159–168.

[11] John B Heywood. 1988. Internal Combustion Engine Fundamentals. McGraw Hill Book Company.

[12] Yakup Icingur, Duran Altiparmak. Experimental analysis of the effect of fuel injection pressure and fuel cetane number on direct injection diesel engine emissions. Turkish Journal of Engineering Environment Science. 27, 2003: pp 291-297.

[13] Seang-wock Lee, Daisuke Tanaka, Jin Kusaka, Yasuhira Daisho. Effects of diesel fuel characteristics on spray and combustion in a diesel engine. JSAE Review. 23, 2002: pp 407-414.