Performance of Single Cylinder Diesel Engine by Varying In Fuel Injection Pressure and Fuel Nozzle

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Abstract— Injection spray pressure in diesel engines play an important role for engine performance and emissions. For a diesel engine, fuel injection pressure and fuel nozzle are very important parameters which influence the engine performance and emissions. With increasing in fuel injection pressure performance parameter like break thermal efficiency increased. Fuel injection pressure is decreasing break specific fuel consumption decreased. The main objective of this study is to find IP and nozzle which give good performance for diesel engine. The test shows that good results for BTE,BSFC and B.P with IP is 160 using 3HN.
Keywords:- Fuel injection pressure, BSFC, BTE, Fuel nozzle.

I. INTRODUCTION

Compression ignition (CI) engines, due to their excellent fuel efficiency and durability, have become popular power plants for automotive applications. This is globally the most accepted type of internal combustion engine used for powering agricultural implements and industrial applications[1]. Diesel engine plays a dominant role in the field of power, propulsion and energy. The engine performance, power output, economy etc is greatly dependent on the effectiveness of the fuel injection system. The injection system has to perform the important duty of initiating and controlling the combustion process[2].

There are several factors that the engine designer varies to provide low emission levels with high performance and good fuel economy, like fuel quantity injected, fuel injection timing, fuel injection pressure, shape of combustion chamber, position and size of injection nozzle hole, fuel spray pattern, air swirl etc. But fuel injection pressure is most important parameter because ,when fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase. When injection pressure is increased fuel particle diameters will become small. Since formation of mixing of fuel to air becomes better during ignition period, but, if injection pressure is too higher ignition delay period becomes shorter. So, possibilities of homogeneous mixing decrease and combustion efficiency falls down[3].

Also influence of number of holes on engine performance and emission characteristics. Nozzle with single hole give simple construction and operation. The velocity of injection required is high and therefore, very high injection pressure is needed which is not achieved by nozzle with single hole. Nozzle with multi hole give better fuel distribution and mix with air properly so complete combustion is achieved at high injection pressure. Nozzle with multi hole give good performance and lower emission compare to nozzle with single hole.[4] So, performance of single cylinder diesel engine is achieved by varying in fuel injection pressure and fuel nozzle. Show in figure 1.1 location of fuel injector in which different types of nozzles are fitted.

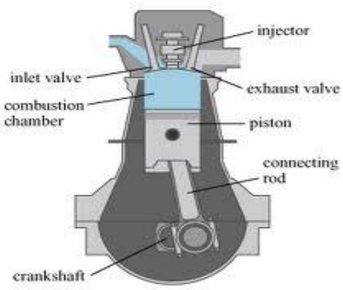

Fig. 1: Diagram of single cylinder diesel engine.[5]

II. VARIATION IN INJECTION PRESSURE AND DETAILS OF FUEL INJECTION NOZZLES.

The injection pressure of the injector can be varied by tightening or loosening the screw of the injector as shown in the figure 2.1. The injector pressure can be determined by a fuel injector pressure tester as shown in the figure 2.2 given below.

Fig. 2: Fuel injector

Fig. 3: Pressure Tester Gauge [6]

Table 2.1 Details of Fuel Injection Nozzles. [6]

Sr No.	No. of hole.	Diameter of hole.
1	3	0.25mm
2	4	0.25mm
3	5	0.23mm

III. EXPERIMENTAL SETUP AND PROCEDURE

The experimental set up consists of a single cylinder diesel engine, fuel measuring equipment and RTD gun which indicate temperature. The schematic diagram of test setup is shown in figure 3.1

Table .1 Specifications of Test Engine

Maker's Name	Sensitive Industries,Rajkot,Gujarat,India
Type of Engine	Four Stroke Single Cylinder Vertical,Water Cooled Engine
Bore and Stroke	80 mm and 110 mm respectively
Displacement Volume	553 cc.
Compression ratio	16.5:1
Brake Power and RPM	3.7 kw (5.0 hp) and 1500 rpm
Fuel Injection Pressure	180 kgf/cm^2
Number of hole.	3
Fuel Injection Timing	Injection starts 27°before tdc
Fuel Oil	High Speed Diesel Oil
Lubricating Oil	SAE 30
Specific Fuel Consumption	251.75 g/kwh
Lubricating System	Sump Type Lubrication System
Dynamometer	Eddy Current Dynamometer

A. *Experimental Setup*

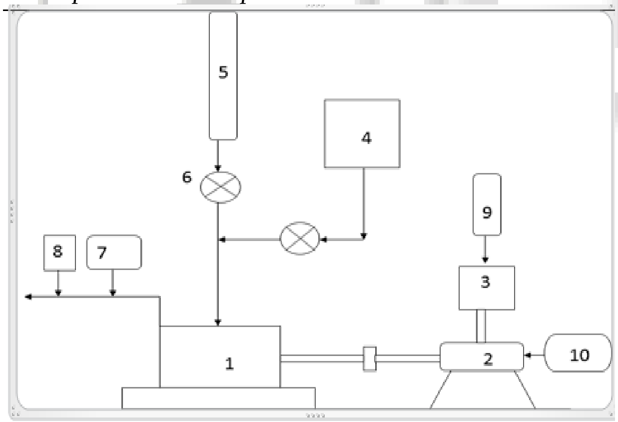

Fig. 4: Schematic diagram of experimental setup (1) Engine (2) Alternator (3) Electrical Load Bank (4) Fuel tank (5) Burette (6) Two way control valve (7) Gas Analyzer (8) RTD gun (9) Volt meter (10) Tachometer

B. *Methodology*

1) *Testing Procedure:*

With the help of experimental setup by necessary equipment calculation of following parameters break thermal efficiency, brake specific fuel consumption and brake power.

2) *Steps for Measurement:*

- The diesel engine was mounted rigidly on a test bed and test was conducted with the help of eddy current dynamometer. The engine is coupled with 440 V three phase alternator and balance load.
- The fuel to the engine is supplied by an fuel tank through a burette having capacity of 50 CC by means of which the fuel consumption could be measured with a stopwatch.
- Exhaust gas temperature is measured by means of RTD gun of the range of -50 °C to 550 °C.
- Speed is measured by using tachometer.
- The performance parameters, break thermal efficiency and brake specific fuel consumption.

IV. RESULT AND DISCUSSION.

A. *Break Specific Fuel Consumption (Bsfc)*

BSFC decreased in all experimental conditions with increasing engine load. This reduction in BSFC can be explained by the fact that as the engine load increases, there was continuous improvement in combustion quality and efficiency. With increasing engine load and increasing injected fuel quantity, which burned more efficiently therefore fuel consumption per unit brake power produced i.e. BSFC decreased. Air–fuel ratio decreased with increasing engine load in CI engines due to injection of higher fuel quantities in every engine cycle. [1]

Show in figure 4.1 and figure 4.2 for 3HN and 4HN BSFC decreased with increasing in IP in order 140-160-180 because with increasing in fuel injection pressure fuel particle diameters will become small and homogeneous mixture in combustion chamber also delay period becomes short with increasing in IP. For 5HN BSFC decreased with increasing in IP in order 140-180-160 in Figure 4.3. From graphs it is clearer that at 160 bar IP with 3HN BSFC is 0.300 kg/kWhr at 3.77kW B.P which is best.

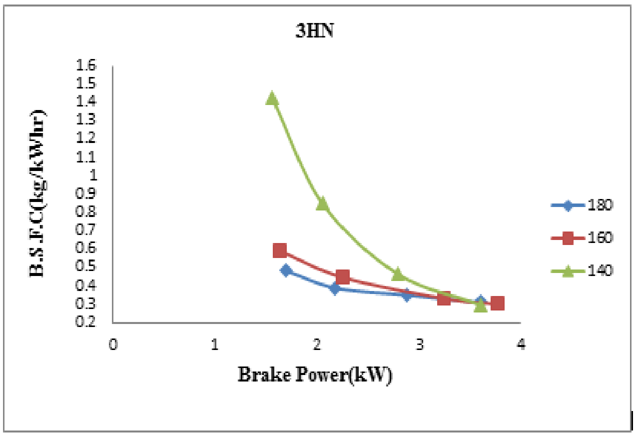

Fig. 5: BSFC v/s Brake Power.

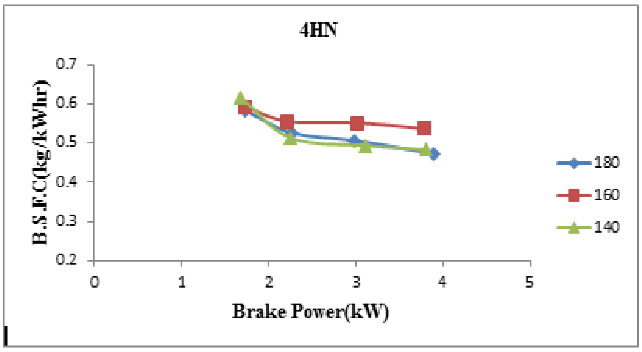

Fig. 6: BSFC v/s Brake Power

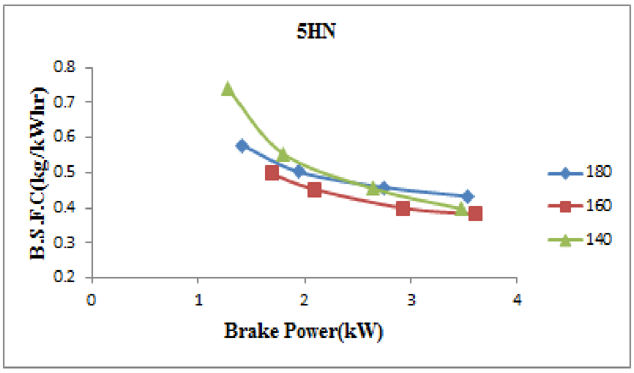

Fig. 7: BSFC v/s Brake Power.

B. Break Thermal Efficiency (BTE)

Show in figure 4.4 and figure 4.5 for 3HN and 4HN BTE increased with increasing in IP in order 140-160-180 because with increasing in fuel injection pressure fuel particle diameters will become small. Since formation of mixing of fuel to air becomes better during ignition period and possibility of complete combustion. For 5HN BTE increased with increasing in IP in order 140-180-160 in Figure 4.6. For 5HN at 140 bar pressure fuel droplet size is larger so possibility of homogeneous mixture decreasing so BTE is not good. For 5HN at 180 bar pressure fuel droplet size is very small so possibility of homogeneous mixture but delay period is very short so complete combustion is not achieved.160 bar pressure is good with 5HN at which homogeneous mixture and delay period for complete combustion available. From graphs it is clearer that at 160 bar IP with 3HN BTE is 28.49% at 3.77kW B.P which is best.

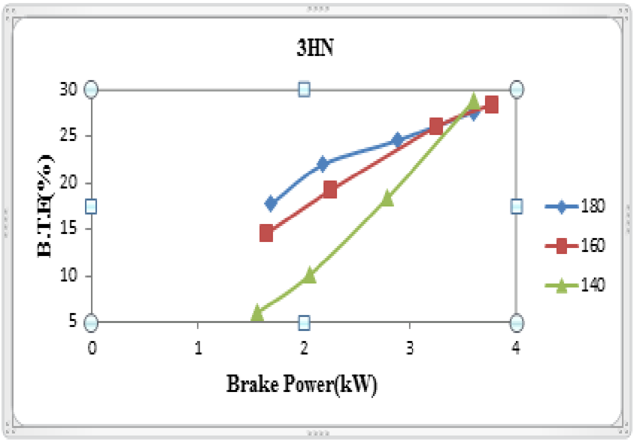

Fig. 8: BTE v/s Brake Power.

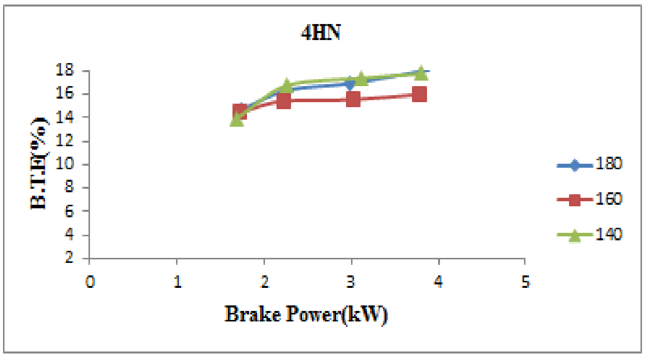

Fig. 9: BTE v/s Brake Power.

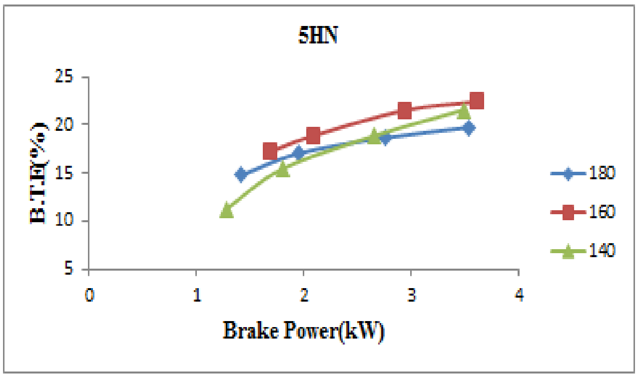

Fig. 10: BTE v/s Brake Power.

V. CONCLUSIONS.

From present investigation the following conclusions are drawn.

- It is observed that 140 bar IP with 3HN BTE 28.86% at 3.6kW B.P and BSFC is 0.296kg/kWhr but only 6% BTE and BSFC is very high which is 1.429 kg/kWhr.
- It is observed that 160 bar IP with 3HN BTE 28.49% and BSFC 0.300kg/kWhr at 3.77kW B.P. For 180 bar IP with 3HN BTE 27.69% and BSFC 0.3097kg/kWhr at 3.6kW B.P.
- It is observed that 5HN 160 bar IP is good but results of BTE and BSFC not effective compare to 3HN with 160 bar IP.
- Improvement in BTE and reduction in BSFC using 3HN with IP 160 bar.
- It is observed that highest temperature is 278 °C for 160 bar pressure with 3HN.

REFERENCES

[1] Kumar Agarwal, Dhananjay Kumar Srivastava, Atul Dhar, Rakesh Kumar Maurya, Pravesh Chandra Shukla, Akhilendra Pratap Singh. "Effect of fuel injection timing and pressure on combustion, emissions and performance characteristics of a single cylinder diesel engine". Fuel 111(2013) 374-383.

[2] M.L.S Deva Kumar, S.Drakshayani, K.Vijaya Kumar Reddy. "Effect of fuel injection pressure on performance of single cylinder diesel engine at different intake manifold inclinations". ISSN: 2277-3754.

[3] Ismet Celıkten. "An experimental investigation of the effect of the injection pressure on engine performance and exhaust emission in indirect injection diesel engine". Applied Thermal Engineering 23 (2003) 2051–2060.

[4] V.M.Domkundwar, First Edition, Dhanpat Rai & Co.New Delhi - 110009 pp. 10.14-10.15.

[5] https://www.google.co.in.

[6] Amar Diesel Service. Bareja, Ahmedabad.

[7] V.M.Domkundwar, First Edition, Dhanpat Rai & Co.New Delhi - 110009 pp. 1.23,1.24,19.13,19.27.

[8] S.Jaichandar, K.Annamalai. "Combined impact of injection pressure and combustion chamber geometry on the performance of a biodiesel fueled diesel engine". Energy 55(2013) 330-339.

[9] Yakup Iicıngeur, Duran Altiparmak. "Effect of fuel cetane number and injection pressure on a DI diesel

engine performance and emissions". Energy Conversion and Management 44 (2003) 389–397.

[10] Cenk Sayin, Metin Gumus. "Impact of compression ratio and injection parameters on the performance and emissions of a DI diesel engine fueled with biodiesel-blended diesel fuel". Applied Thermal Engineering 31 (2011) 3182-3188.

[11] Cenk Sayin, Ahmet Necati Ozsezen, Mustafa Canakci. "The influence of operating parameters on the performance and emissions of a DI diesel engine using methanol-blended-diesel fuel". Fuel 89 (2010) 1407–1414.

[12] 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.

[13] Can Cinar, Tolga Topgul, Murat Ciniviz, Can Hasimoglu. "Effects of injection pressure and intake CO_2 concentration on performance and emission parameters of an IDI turbocharged diesel engine". Applied Thermal Engineering 25 (2005) 1854–1862.

[14] K.M.Gupta, Automobile Engineering (Volume 2), First Edition, Umesh Publication,New Delhi-110006 pp. 419.

[15] Sibendu Som, Anita I. Ramirez , Douglas E. Longman , Suresh K. Aggarwal. "Effect of nozzle orifice geometry on spray, combustion, and emission characteristics under diesel engine conditions". Fuel 90 (2011) 1267-1276.

[16] R.Payri, F.J.Salvador, J. Gimeno, J. de la Morena. "Effects of nozzle geometry on direct injection diesel engine combustion process". Applied Thermal Engineering 29 (2009) 2051–2060.

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