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STUDY ON THE EFFECTS OF VARIATION OF FUEL INJECTION PRESSURE ON SINGLE CYLINDER DIESEL ENGINE

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ABSTRACT

Various parameters influence the performance of the compression ignition engine. The parameter like fuel injection pressure plays an important role. If the fuel injection pressure is increased, performance parameters like brake thermal efficiency and brake power increased. When the fuel injection pressure decreases, brake specific fuel consumption increased. This work is carried out to find the optimum fuel injection pressure, which gives good performance of the compression ignition engine .Test results shows that the brake thermal efficiency, brake specific fuel consumption and brake power are improved at 160 N/m^2 fuel injection pressure.

Keywords: Fuel injection pressure, Specific fuel consumption, Brake power, Diesel engine

Nomenclature

DI	Direct Injection
BSFC	Brake Specific Fuel Consumption
BTE	Brake Thermal Efficiency
A	Ampere

1. INTRODUCTION

The diesel engine is the most versatile power plant in the transportation sector. Its traditional strengths are economy, reliability and high-torque output. That is why it became established as the engine of choice for commercial vehicles a long time ago. The continuing development of the direct injection diesel engine coupled with the rapid advances made in high-pressure fuel-injection systems have consistently brought about further improvements in performance and consumption.

The introduction and consequent application of a series of strict regulations concerning performance, combustion phenomenon and emissions from diesel engine have forced engine manufacturers to focus their research into a series of innovative technologies. It is widely recognized that the basic mechanism involved in the performance and formation of pollutants inside the direct injection diesel engine combustion chamber is the mixing and combustion of injected fuel [12]. Some of these measures that have already been under extensive research and discussion include advanced injection strategies, increased injection pressure [16].

More research is required so that they can be adopted as mainstream approaches in today's commercial heavy-duty diesel engines. The injection system has to perform the important duty of initiating and controlling the combustion process [6]. 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, shape of combustion chamber, fuel injection pressure, fuel injection timing, fuel injector nozzle hole size, fuel injector position, fuel spray pattern, air swirl. But fuel injection pressure is most important parameter [1] because, at low fuel injection pressures, the size of fuel particles is large and ignition delay period during the combustion will increase. As fuel injection pressure is increased the size of fuel particles becomes small. During the ignition period, mixing of fuel with air becomes better, but, if injection pressure is too high, ignition delay period becomes shorter, combustion efficiency falls down and the possibility of homogeneous mixing decreases [7].

The optimum fuel injection pressure is found by conducting the performance test on four stroke single cylinder naturally aspirated water cooled compression ignition engine.

2. EXPERIMENTAL SETUP AND PROCEDURE

A. Experimental setup

The engine used for this experimental investigation was a single cylinder four stroke naturally aspirated water-cooled research diesel engine having 5.2kW as rated power at 1500 rpm.

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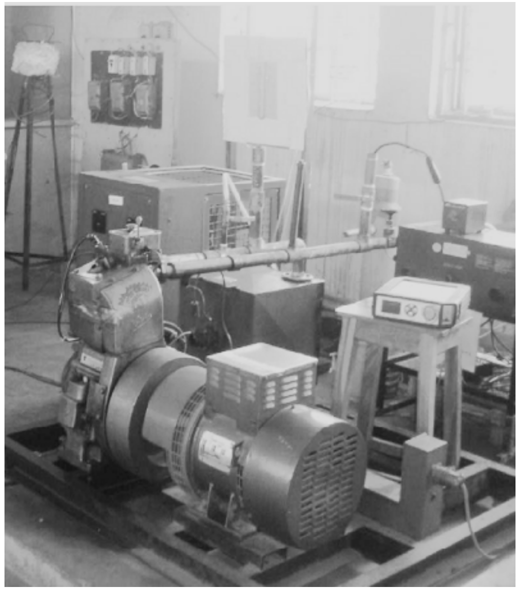

Figure-1. Experimental setup.

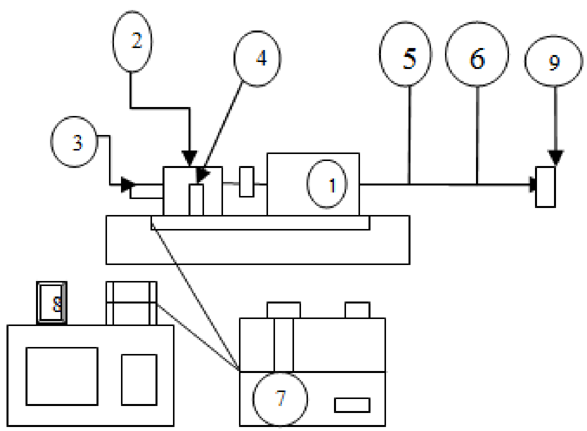

Figure-2. Schematic diagram of experimental setup.

1. Engine 2. Dynamometer 3. Crank angle encoder 4. Load cell 5. Exhaust gas analyzer 6. Smoke meter 7. Control panel 8. Computer 9. Silencer

Table-1. Specifications of test engine.

Component	Specification
Make	Kirloskar Engines Ltd, Pune
Type of engine	Four Stroke Single Cylinder Water Cooled Engine
Bore and Stroke	80 mm & 110 mm
Compression ratio	17.5 : 1
BHP and rpm	5.2kW & 1500 rpm
Fuel injection pressure	200 N/m^2
Fuel injection timing	27^0 BTDC
Specific fuel consumption	0.25175 (kg/h)/kW
Dynamometer	Eddy Current Dynamometer

B. Experimental Procedure

The experiments were conducted on a single cylinder Kirloskar make direct injection four stroke cycle diesel engine. The general specifications of the engine are given in Table-1. Eddy current dynamometer was used for the tests. The engine is equipped with crank angle sensor, piezo-type cylinder pressure sensor, thermocouples to measure the temperature of water, air and gas and the complete set-up is connected to data acquisition system.

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The injection pressure of the injector can be varied by the following steps:

Bolt the tester to the work bench. Fill the tester reservoir with diesel fuel. Attach a fuel injector to the hard line fitting included. Bleed the air out at the injector fitting. Pump the handle a few times up to the point injector fires. Note the consistency of spray patterns.

Read the release pressure. Hold pressure with handle just before release point and check for injector leaks. Select thicker or thinner shim washer to change pressure. Measure shims with dial calipers to confirm correct size. Clean oil and re-assemble injector to proper torque. Install back into the engine using crush washers and fix the injector return hose.

Experiments were carried out on the engine to calculate the performance parameters of the engine at varying fuel injection pressure i.e. 140 N/m^2, 160 N/m^2 and 180 N/m^2.

3. RESULT AND DISCUSSIONS

Experiments were conducted on single cylinder diesel engine and the results are tabulated as follows:

Table-2. Results at 140 n/m^2.

B.P (kW)	**BSFC** [(kg/h)/kW]	**BTE** (%)
1.55	0.84	5
2.0	0.62	10
2.8	0.48	17
3.6	0.3	28

Table-3. Results at 160 n/m^2.

B.P (kW)	BSFC [(kg/h)/kW]	BTE (%)
1.6	0.6	14
2.2	0.48	19
3.2	0.34	21.8
3.8	0.3	27

Table-4. Results at 180 n/m^2.

B.P (kW)	**BSFC** [(kg/h)/kW]	**BTE** (%)
1.65	0.65	17
2.45	0.72	22
2.8	0.93	20.1
3.1	0.98	24.2

BRAKE THERMAL EFFICIENCY

It was found that the brake thermal efficiency at fuel injection pressure of 140N/m^2 and 160N/m^2 increased as the load was increased from 0A to 18 A. At 180N/m^2 there was increase in brake thermal efficiency at 0A to 9A load and there was decrease in brake thermal efficiency at 13A and 18A load.

The maximum brake thermal efficiency was found to be 28% at 18A load and 140 N/m^2. The minimum brake thermal efficiency was found to be 24.2% at 18A (full load) load at 180N/m^2. The variation of brake thermal efficiency at various injection pressures are shown in Figure-3.

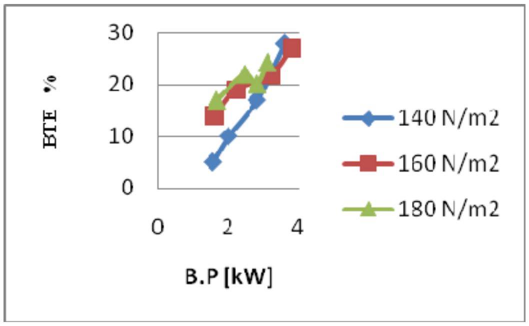

Figure-3. Brake thermal efficiency Vs Brake power.

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It is evident from the Figure-3 that the brake thermal efficiency increases with increase in fuel injection pressure. At 160N/m^2, 18A load, brake thermal efficiency was found to be 27% and brake power was found to be 3.8kW.

Brake specific fuel consumption

It was found that the brake specific fuel consumption at fuel injection pressure of 140N/m^2 and 160N/m^2 decreased as the load was increased from 0A to 18 A. At 180N/m^2 there was increase in brake specific fuel consumption at 0A to 18A load.

The minimum brake specific fuel consumption was found to be 0.3[(kg/hr)/kW] at 140N/m^2 and 160N/m^2 at 18A load. The maximum brake specific fuel consumption was found to be 0.98[(kg/hr)/kW] at 180N/m^2 at 18A load. The variation of brake specific fuel consumption at various fuel injection pressures are shown in Figure 4.

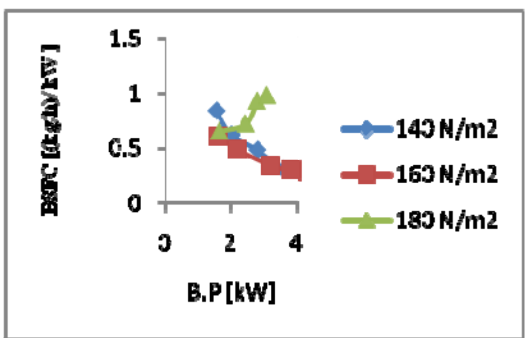

Figure-4. Brake specific fuel consumption Vs brake power.

It is evident from the Figure-4 that the brake specific fuel consumption decreases with increase in fuel injection pressure. At 160N/m^2, 18A load, brake specific fuel consumption was found to be 0.3 [(kg/h)/kW] and brake power was found to be 3.8kW.

4. CONCLUSIONS

As fuel injection pressure increases, fuel particle size will become small and the mixing of fuel and air becomes better to enhance the possibility of complete combustion. The fuel injection pressure of 160N/m^2 is found to be optimum by conducting the performance test on four stroke single cylinder naturally aspirated water cooled compression ignition engine.

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