ISSN 2350 - 0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 1, Issue 3, October 2014

Experimental Investigation for Optimum Fuel Injection Pressure on Diesel Engine

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ABSTRACT: Higher fuel efficiency, reliability and durability are the prime advantages of diesel engines. Out of the various parameters that influence the performance of the engine, fuel injection pressure plays a major role. An experimental study was performed on a single cylinder direct injection diesel engine at 150 N/m^2, 170 N/m^2 and 190 N/m^2 injection pressure to study the effect on performance and emission. Test results show that the brake thermal efficiency, brake specific fuel consumption and brake power are improved at 170 N/m^2 fuel injection pressure.

KEYWORDS*:* Diesel engine, Fuel injection pressure, Brake specific fuel consumption, Brake thermal efficiency.

I.INTRODUCTION

Diesel engines are gaining an increasing share of the light duty applications worldwide. Diesel engines are popular for their fuel efficiency, durability and reliability. The emission and performance characteristics of diesel engines depends on factors like amount of fuel injected, fuel injection pressure , fuel injection timing, profile of combustion chamber, injector nozzle hole, fuel spray pattern. The function of a fuel injection system in a diesel engine is to achieve a higher degree of atomization and utilize the full charge to enhance the evaporation in a very short time to achieve complete combustion.

The fuel injection pressure in a standard diesel engine ranges from 200 N/m^2 to 2000 N/m^2 depending on the size of the engine and combustion system employed which was quoted by John B Heywood et al. [1]. As the fuel injection pressure increases the combustion duration decreases as the fuel penetration becomes intense stated by Seang-wock Lee et al. [2]. If the fuel injection pressure is low, the size of fuel droplet will be more which increases the delay period. This leads to incomplete combustion in the engine and leads to the formation of more amounts of emissions. As the fuel injection pressure is increased, fuel particle size will be small. Mixing of fuel and air becomes better during ignition delay period which causes low smoke level and emissions. And, if the injection pressure is too high, ignition delay become shorter. The possibility of homogeneous mixing decreases and combustion efficiency reduces proposed by Ismet Celikten et al. [3].

In this study the performance and emission characteristics are studied on single cylinder water cooled four stroke diesel engine to obtain the optimum fuel injection pressure at which the performance of the engine is enhanced.

II. EXPERIMENTAL SETUP AND PROCEDURE

The experiments were conducted on four stroke single cylinder water cooled Kirloskar make direct injection diesel engine. The specifications of the test engine are given in Table-1. Electrical dynamometer was coupled to the engine. The engine was provided with piezo type pressure sensor, crank angle sensor, thermocouples. The schematic diagram of the engine test rig is shown in figure 1.

Table .1: Specifications of test engine

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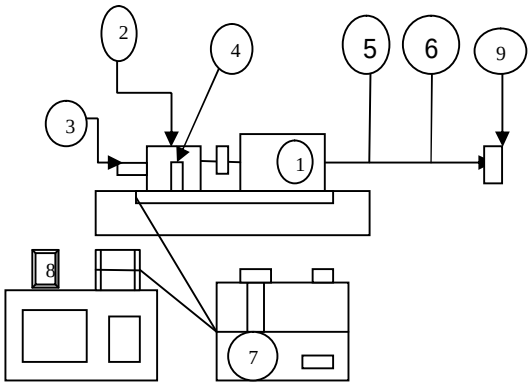
Component	Specification
Make	Kirloskar Engines Ltd, Pune
Type of engine	Four Stroke Single Cylinder Water Cooled Engine
Bore and Stroke	80 mm & 110 mm
Compression ratio	17.5 : 1
BHP and rpm	5.2kW & 1500 rpm
Fuel injection pressure	200 N/m^2
Fuel injection timing	27^0 BTDC
Specific fuel consumption	0.25175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

Figure-1: The schematic diagram of the 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

The engine was maintained at a constant speed of 1500 rpm and the fuel injection pressure was varied at levels of 150 N/m^2, 170 N/m^2 and 190 N/m^2 by adjusting the spring tension on the fuel injector.

III. RESULTS AND DISCUSSIONS

A piezo type transducer was used to measure the cylinder pressure. It was found that the indicated power was found decreasing as the injection pressure was increased at all loads. The decrease in indicated power

ISSN 2350 - 0328

International Journal of Advanced Research in Science, Engineering and Technology

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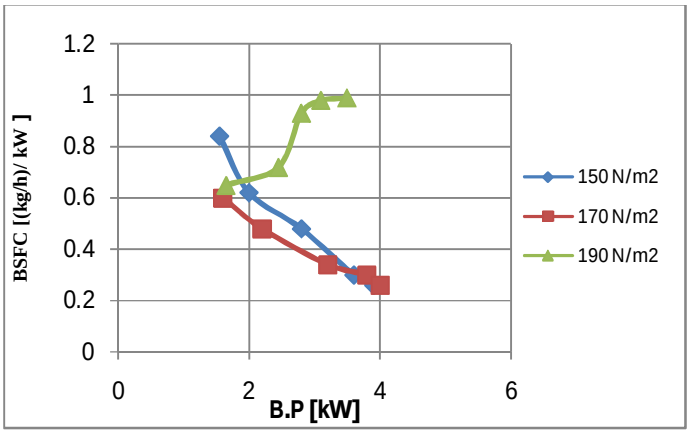
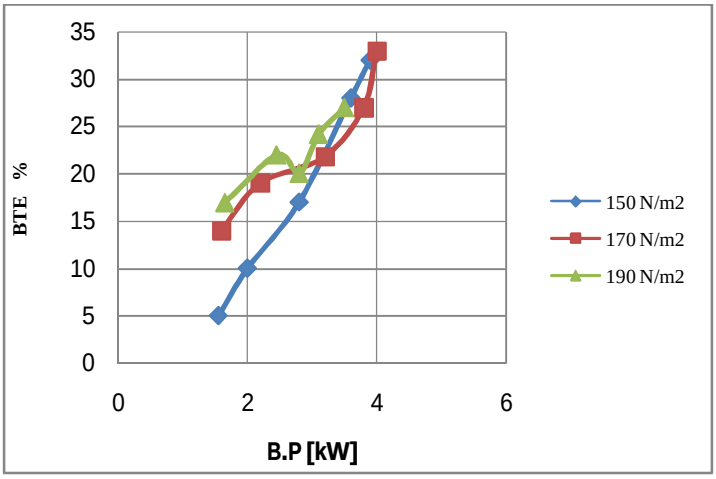
was 1.4% and 2.8% when the injection pressure was increased from 150 N/m^2 to 170 N/m^2 and 170 N/m^2 to 190 N/m^2 , respectively.

Figure-2. Effect on brake specific fuel consumption



The brake specific fuel consumption at different loads at injection pressure 150, 170, and 190 N/m^2 are shown in Figure-2. As the fuel injection pressure increases , the brake specific fuel consumption decreases at injection pressures of 150 N/m^2 and 170 N/m2. The brake specific fuel consumption deteriorates at fuel injection pressure of 190 N/m^2

Figure-3. Effect on brake thermal efficiency



It was found that the highest brake thermal efficiency was at 170 N/m^2 . At 190 N/m^2 brake thermal efficiency got reduced. The variation of brake thermal efficiency at all loads at injection pressure 150, 170 and 190 N/m^2 are shown in Figure-3.

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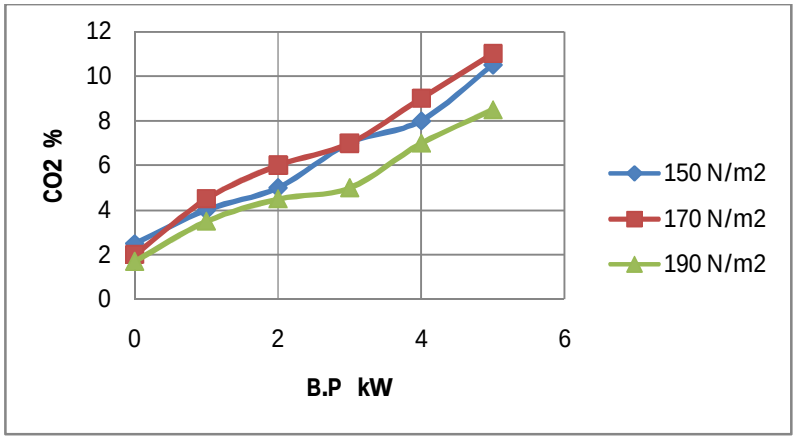
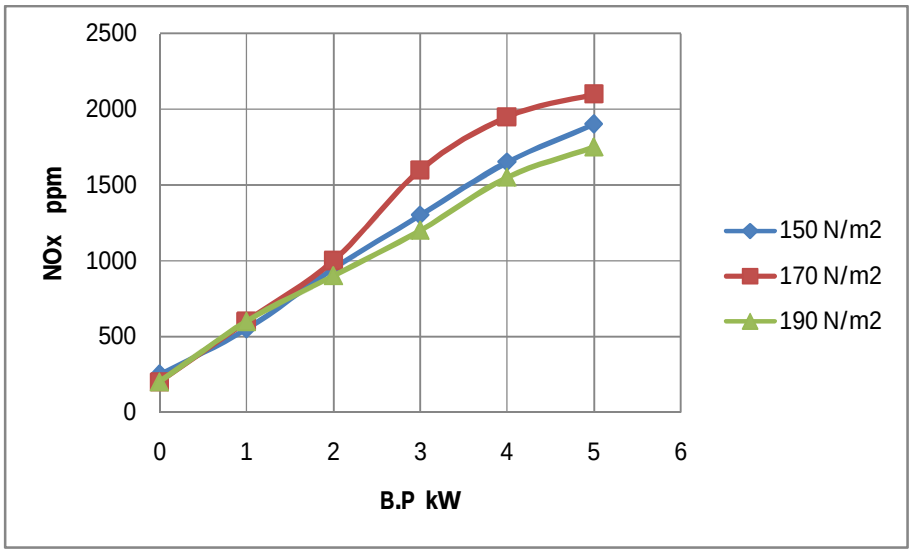
Figure-4. Effect on CO_2 emissions.



The CO2 emissions are lower at fuel injection pressure of 190 N/m^2.

Figure-5. Effect on NOx emissions.



The NOx emission was found lowest at 190 N/m^2 fuel injection pressure.

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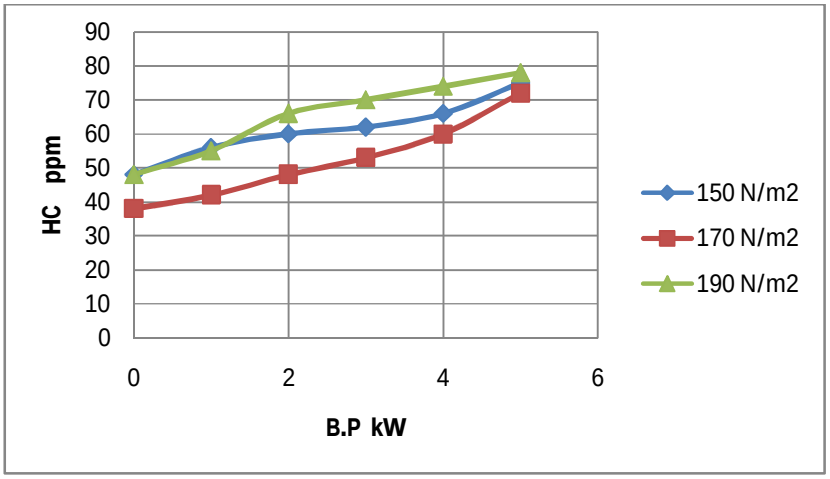
Figure-6. Effect on HC emissions.



It was found that the lowest HC emissions were found at fuel injection pressure of 170 N/m2.

IV. CONCLUSIONS

In the current study, experiments were conducted to evaluate the effect of fuel injection pressure on the performance and emissions of a single cylinder diesel engine. The result shows that by increasing the fuel injection pressure, brake specific fuel consumption was reduced and brake thermal efficiency was enhanced. CO2 emissions were decreased at the fuel injection pressure was increased. NOx emission was found to be increased and then decreased. HC emission was found to be decreased and then increased.

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