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Fuel Injection Pressure Effect on Performance of Direct Injection Diesel Engines Based on Experiment

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Abstract: Fuel injection pressures in diesel engine plays an important role for engine performance obtaining treatment of combustion. The present diesel engines such as fuel direct injection, the pressures can be increased about 100 – 200 Mpa bar in fuel pump injection system. The experimental investigated effects of fuel injection pressure on engine performance. Experiments have been performed on a diesel engine with four-cylinder, two-stroke, direct injection. Engine performance values such as indicated pressure, indicated horse power, shaft horse power, brake horse power, break mean effective pressure and fuel consumption have been investigated both of variation engine speeds - fixed load and fixed engine speed – variation loads by changing the fuel injection pressure from 180 to 220 bar. According to the results, the best performance of the pressure injection has been obtained at 220 bar, specific fuel consumption has been obtained at 200 bar for fixed load – variation speeds and at 180 bar for variation loads – fixed speed. The results of the experiment have given as graphics in this paper.

Keywords: Diesel engines, performance, fuel injection pressure

INTRODUCTION

The diesel engine is a type of internal combustion engine; more specifically, it is a compression ignition engine, in which the fuel ignited solely by the high temperature created by compression of the air-fuel mixture[1, 14, 15]. The engine operates using the diesel cycle. The diesel engine is more efficient than the petrol engine, since the spark-ignition engine consumes more fuel than the compression-ignition engine[1, 10, 14]. The used of diesel engines have extended in the last years to vehicles area due to their high efficiency also by economic fuel cost [2, 3]. In present diesel engines, fuel injection systems have designed to obtain higher injection pressure. So, it is aimed to decrease the exhaust emissions by increasing efficiency of diesel engines. When fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase[2 - 9]. This situation leads to increase pressure. Engine performance will be decrease since combustion process goes to a bad condition. When injection pressure increased of fuel particle diameters will become small. Since formation of mixing of fuel to air becomes better during ignition period, engine performance will be increase. If injection pressure is too higher, ignition delay period becomes shorter. Possibilities of homogeneous mixing decrease and combustion efficiency falls down [2, 9].

The fuel injection system in a direct injection diesel engine is to achieve a high degree of atomization in order to enable sufficient evaporation in a very short time and to achieve sufficient spray penetration in order to utilize the full air charge. The fuel injection system must be able to meter the desired amount of fuel, depending on engine speed and load, and to inject that fuel at the correct time and with the desired rate. Further on, depending on the particular combustion chamber, the appropriate spray shape and structure must be produced. Usually, a supply pump draws the fuel from the fuel tank and carries its through a filter to the high-pressure injection pump, see Fig. 1.

Dependent on the area of application and engine size, pressures between 100 and 200 MPa generated. The high pressures injection pump carries the fuel through high-pressure pipes to the injection nozzles in the cylinder head [12]. Excess fuel transported back into the fuel tank. The functionality of the so-called unit pump system is practically identical to that of the unit injector system and offers the same advantages and disadvantages. However, the pump and nozzle not

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combined into one unit. The camshaft driven a high-pressure pump and thus directly coupled with the engine speed. The injection nozzle is located inside a so-called nozzle holder in the cylinder head and connected via a high-pressure pipe with the pump. An advantage of this system is that the pump and nozzle not installed at the same place. This reduces the size of the components that have integrated into the cylinder head and simplifies the assembly of the injection system[12].

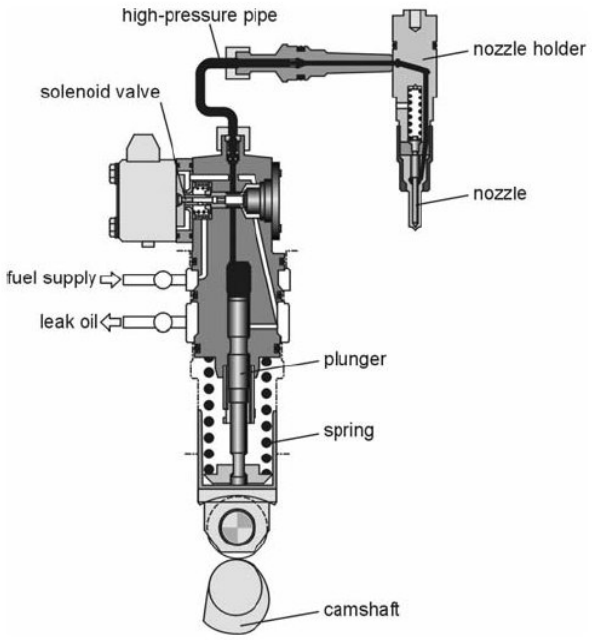

Fig. 1: Unit pump system [12]

Effects of injection pressure on engine performance have investigated on a unit pump system direct injection diesel engine. The diesel engine performance and fuel consumption have been measured both of variation engine speeds - fixed load and fixed engine speed – variation loads by changing the fuel injection pressure. In the investigation is the effect of injection pressure in fixed load – variation engine speeds and fixed engine speed – variation engine loads in the fuel injection pressures are setting from 180 - 220 bar.

MATERIALS AND METHODS

The specification of the selected diesel engine shows in Table 1. An electrical dynamometer assembled on four-cylinder and two-stroke direct injection diesel engine used in the research. As shows in Fig. 2, there are different thermocouples and electrical units on the dynamometer and the engine. Engine was tested in range of 600 - 1600 rpm with the interval of 200 rpm and the fuel injection pressure setting from 180 – 220 bar with the interval of 10 bar. In the second experiment the diesel engine loads were tested in 55% - 80% in interval of 5%, engine speed is fixed on 1600 rpm and the fuel injection pressure setting from 180 – 220 bar with the interval of 10 bar.

Table 1: Specification of the engine

Engine Parameters	Value
Bore (mm)	108.0
Stroke (mm)	127.0
Number of cylinder	4
Max. cont. net power (HP)	112
Fuel nozzle injection pressure (bar)	200
Max. engine speed (rpm)	1800

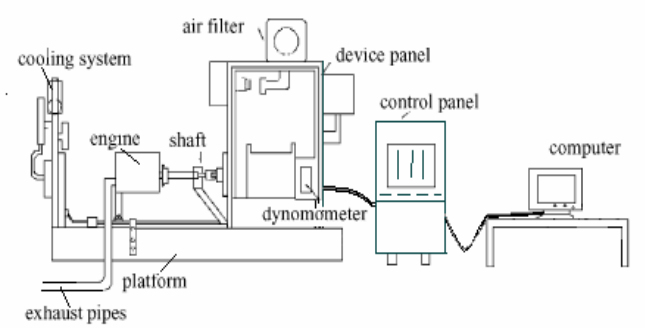

Fig.2: Schematics of engine test bed

In this research, no maximum speed and no maximum load reached. In the experiments, shaft horse power, brake horse power, indicated pressure and fuel consumption were recorded by computer. In addition, indicated horse power, break mean effective pressure and specific fuel consumption calculated from the experiments data.

RESULTS AND DISCUSSION

The experiment result on fixed load of 67 kW, in interval engine speeds 600 until 1600 rpm and the fuel injection pressure setting from 180 – 220 bar. The variations for engine performance have given in Fig. 3 – Fig. 8. Then, the experiment result on fixed engine speed on 1600 rpm, in interval engine loads were tested in 55% - 80% in interval of 5% and the fuel injection pressure setting from 180 – 220 bar. The variations for engine performance have given in Fig.9 – Fig.14.

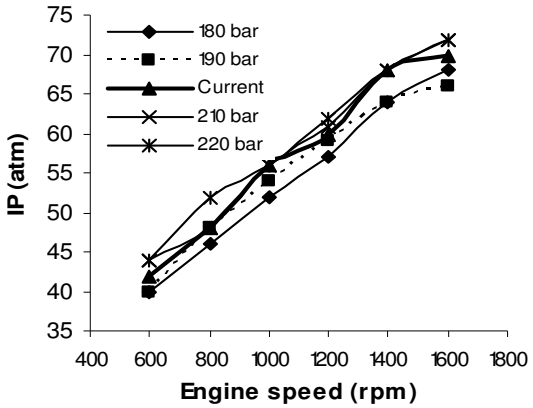

Fig. 3: Injection pressures effect for IP

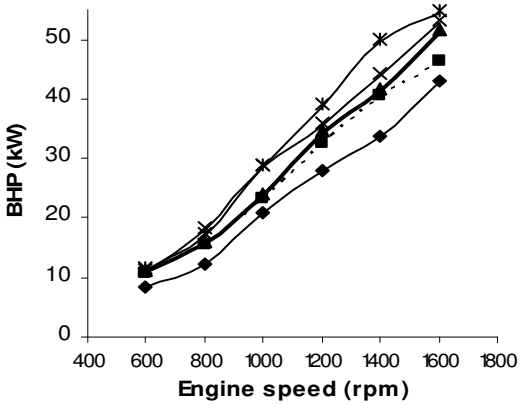

Fig. 6: Injection pressures effect for BHP

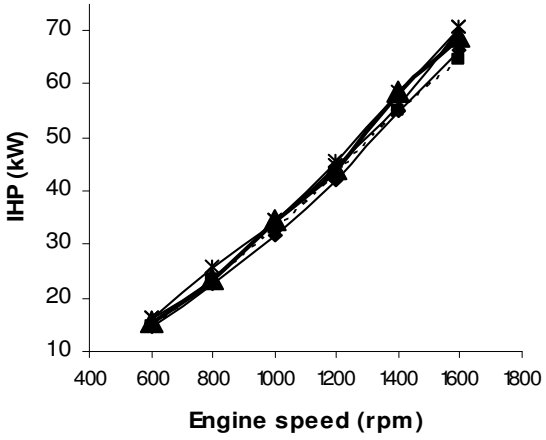

Fig. 4: Injection pressures effect for IHP

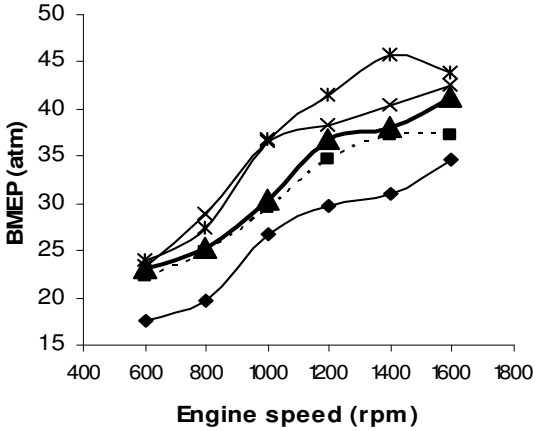

Fig. 7: Injection pressures effect for BMEP

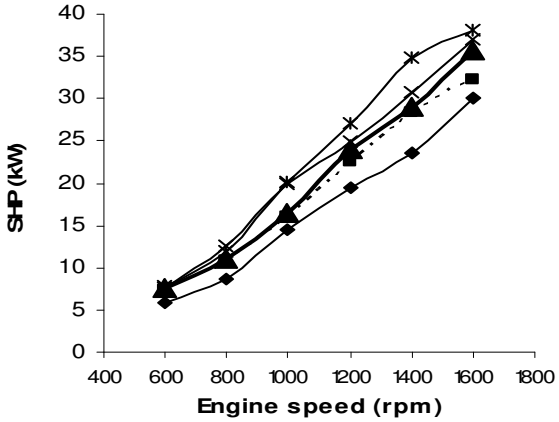

Fig. 5: Injection pressures effect for SHP

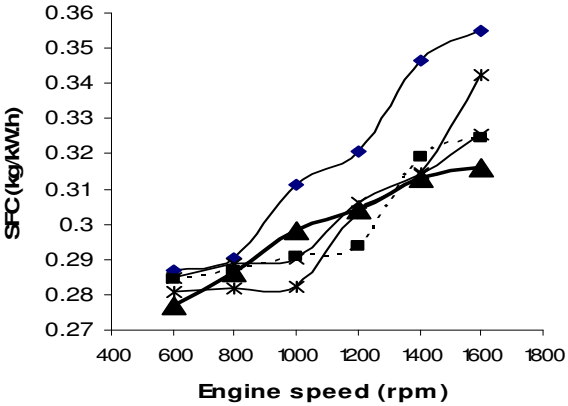

Fig. 8: Injection pressures effect for SFC

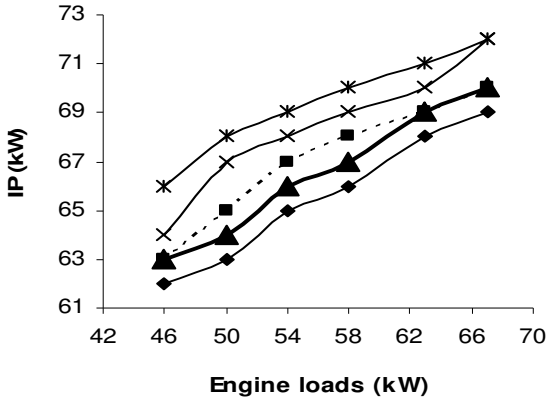

Fig.9: Injection pressures effect for IP

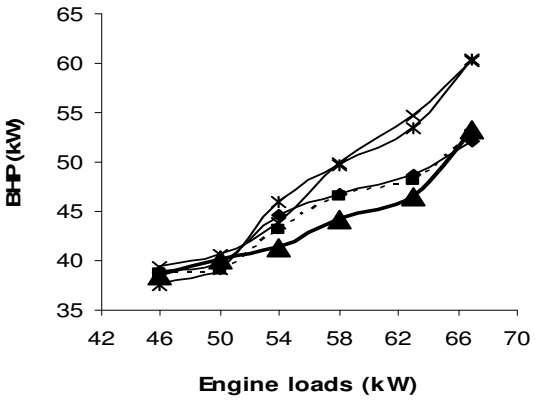

Fig.12: Injection pressures effect for BHP

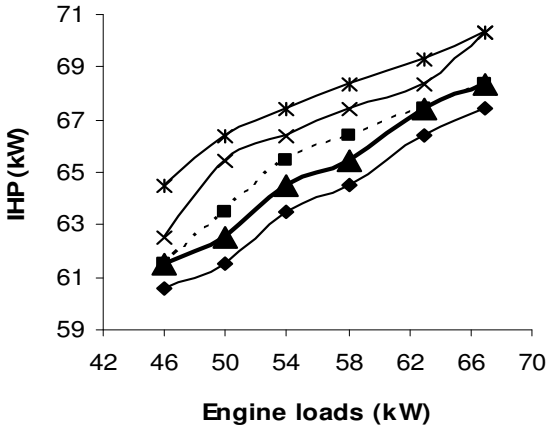

Fig.10: Injection pressures effect for IHP

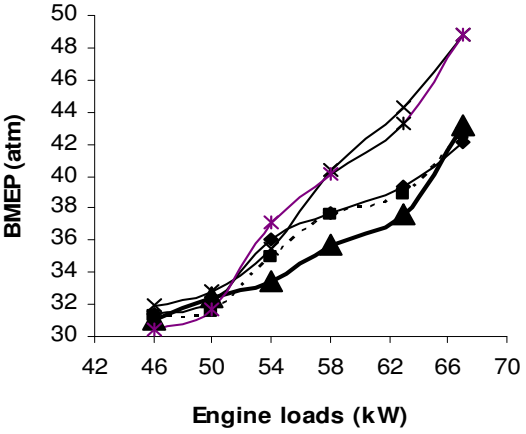

Fig.13: Injection pressures effect for BMEP

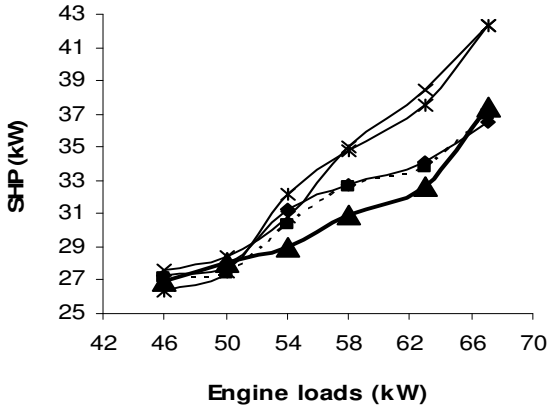

Fig.11: Injection pressures effect for SHP

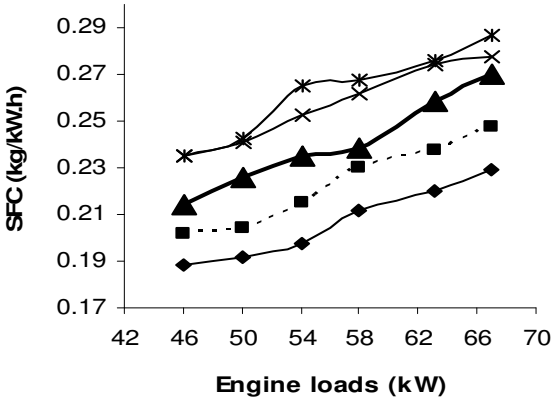

Fig.14: Injection pressures effect for SFC

The first experiment on fixed engine load and variations engine speeds the result shows that in the averages performance. The best engine performance for indicated pressure (IP), indicated horse power (IHP), shaft horse power (SHP), break horse power (BHP) and break mean effective pressure (BMEP) obtained at 220 bar and the best engine SFC obtained at 200 bar or in current fuel injection pressure. The experiment result shown that the effect of the increasing of the fuel injection pressure was made increasing for the engine performance in IP, IHP, SHP, BHP and BMEP, more high of injection pressure have been given more power in engine performance. The increasing injection pressure have been given the fuel-air mixing in the combustion chamber was more excellent, so the un-burnt fuel is less than the lower injection pressure. Increasing the injection pressure offer the possibility better to include the complete air charge in the mixture formation and combustion process.

In the second experiment on fixed engine speed and variation engine loads, the result shown that increasing injection pressure have given that in engine performance was increased for indicated pressure(IP), indicated horse power (IHP), shaft horse power (SHP), break horse power (BHP) and break mean effective pressure (BMEP). Higher injection pressure given increased higher engine performance power and the highest engine performance was obtained at injection pressure 220 bar.

The fuel injection pressure effects for specific fuel consumption performance of the first experiment have given in Fig. 8. The result shown, that the effect of increasing the engine speeds can be increasing the specific fuel consumption for the engine. The highest specific fuel consumption on180 bar of the fuel injection pressure and the economic specific fuel consumption at 200 bar or the injection pressure was used until current. The fuel injection pressure at 200 bar have used for the engine more stabiles in specific fuel consumption in the different engine speeds. In engine speed is 800 rpm, the specific fuel consumption is higher than the injection pressure at 220 bar. In engine speed is 1000 rpm the specific fuel consumption is higher than the injection pressure at 190 bar, 210 bar, 220 bar and in engine speed is 1200 rpm the specific fuel consumption is higher than the injection pressure at 190 bar. Based on the engine speeds, the result experiment trend of the specific fuel consumption at injection pressure 200 bar is more economics than the other injection pressure.

The effect of injection pressure for fuel consumption in second experiment results have been given that the increasing injection pressure was increased the engine performance and increased specific fuel consumption. The best engine SFC was obtained at injection pressure of 180 bar. The Fig. 14 shows that the current fuel injection pressure at 200 bar is not economic than at 180 bar and 190 bar. More load in engine was needed more engine power, and more engine power was needed specific fuel consumption to produced the power to take the loads were given. So, the fixed engine speed and variations on engine loads shown, that increasing the injection pressure have given increased engine performance power.

When the fuel injection pressure is low, fuel particle diameters will enlarge and ignition delay period during the combustion will increase. This situation leads to increase pressure. Engine performance will be decrease since combustion process goes to a bad condition. When injection pressure increased the fuel particle diameters will become small. Since formation of mixing of fuel to air becomes better during ignition period, engine performance will be increase. But, if the fuel injection pressure is too higher, ignition delay period becomes shorter. So, possibilities of homogeneous mixing decrease and combustion efficiency falls down.

Hence, the more injection pressure is increased, the more energy needed to drive the injection system by reducing the leak flow and by dynamically adjusting the maximum pressure to the actual needs of the engine, depending on the operating point. So, the effect of increasing injection pressure is increases fuel consumption both in fixed load - variations engine speeds and fixed engine speed – variation engine loads.

CONCLUSION

The experiment results shows that, the fixed load-variation speeds and fixed speed-variation loads have been given that the higher engine speed (rpm) given higher engine power. The increasing injection pressure is inline with increasing power. The fuel consumptions experiment result for fixed load-variation speeds and fixed speed-variation loads have been given that increasing injection pressure given increased of fuel consumption for the diesel engine.

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