# Performance Analysis on a Bosch Pf Diesel Fuel Injection Pump

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*Abstract*— The performance analysis of the BOSCH PF Diesel Fuel Injection Pump is the primary subject of the following article. The goal of the performance analysis was to improve the efficiency of the chosen pump. I concluded that the efficiency of the BOSCH PF Diesel Fuel Injection Pump can be increased by considering the following design modifications in the pump: enlarging the plunger diameter, altering the diameters of the delivery pipe, and swapping the normal valve for the adaption valve. The impact of the varied plunger diameters on the various pump efficiencies will be the main topic of the current paper. Additionally, for two chosen plunger diameters, the differences in speed with discharge are displayed.

***Keywords:*** 4-Stroke Water – Cooled Diesel Engine, PF Diesel Fuel Injection Pump, Plunger, Adaption Valve, Injectors

## I. INTRODUCTION

Cars and other devices with internal combustion engines often (but not always) require a BOSCH diesel injection pump. In contrast, fuel must be pumped into the engine from the fuel tank and delivered to the carburetor at low pressure or to the fuel injection system at high pressure. Unlike fuel-injected engines, which often use an electric fuel pump mounted inside the fuel tank, carbureted engines often use a low-pressure mechanical pump mounted outside the fuel tank. Some fuel injected engines also have two fuel pumps. A low pressure/high volume feed pump in the tank and a high pressure/low volume pump mounted on or near the engine.

### *A. Types of Diesel FuelInjection Pump*

1) Common Rail Fuel injection Pump
   - Normal
   - Electronic
2) Distributor FIP
3) In-Line FIP
4) PF Pumps
   - K-Type
   - Q-Type
   - Monotype Block Pump

"Pump with a Foreign drive" is what "PF" stands for. The piston that pushes the diesel fuel through the normal pressure valve and into the pressure tube is the external drive for this system. Single cylinder diesel fueled engines use a PF pump. The first technological diesel fuel pump, the Bosch PF, atomizes diesel and delivers it to the engine cylinders under moderate pressure. With a wide range of adjustments, many of the pump's key components can be replaced to improve fuel efficiency, including springs, pistons, valves, lubricants, housings and delivery hoses.

### *B. Working of the Pf Diesel FuelInjection Pump*

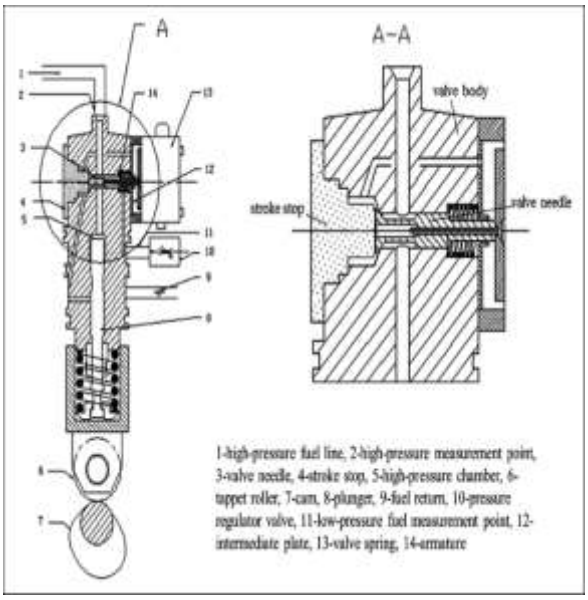



Fig. 1: Schematic figure of cross-section of a PF pump

The rotation of the camshaft cams activates the PF diesel injection pump. As the motor shaft rotates, so does the camshaft. When the cam rotates a certain amount, a spring attached to the piston activates and reciprocates the 5.5mm diameter piston attached to the cam in the opposite direction. Diesel fuel is supplied from a fuel supply port to a pump cylinder with a reciprocating piston. The reciprocating motion of the piston and the fuel inlet correspond to each other. That is, when the piston moves down, it feeds fuel into the drum, and when it moves up, it compresses the fuel and increases the pressure. Performing the compression stroke, the piston, fuel from the keg, moves from the valve to the high-pressure delivery tube, where the pressure rises to 750 bar. The fuel travels faster inside the delivery tube where it atomizes and creates pressure waves. This pressure wave forces additional fuel into the nozzles, injecting atomized fuel into the engine cylinders for combustion, reducing pump efficiency and increasing fuel consumption more than necessary. Fuel is delivered to the injector through a delivery tube and held in place by a nozzle tipped with six symmetrical holes of 0.18 mm diameter. At this point the pressure drops to 400 bar. Atomized 200 pressure gasoline is pumped into the engine cylinders for combustion.

## II. OBJECTIVES AND METHODOLOGY

By implementing the following design changes, the goal of improving the BOSCH PF Diesel Fuel Pump's efficiency can be achieved:

- Larger piston diameter. As the piston diameter increases, the pressure at the end of the pump cylinder increases. This is because the compression area remains constant while the piston head area expands. This creates a throttle valve and creates high pressure.

- Conveyor tube diameter changed from 2mm to 1.5mm. Smaller diameter delivery pipes increase the speed of diesel fuel. This finely atomizes the diesel fuel and also contributes to optimal fuel combustion in the engine.
- Adaptive valves are used instead of standard valves. Even after the intake process in the combustion chamber of the engine, additional fuel losses occur in the engine due to pressure waves generated in the pressure valve under high pressure. Regulating valves reduce fuel consumption by sucking excess fuel through pressure valves.

With all of the aforementioned goals, pressure and velocity greatly rise, which causes the diesel fuel to be finely atomized. A complete combustion of the fuel is made possible by effective atomization, which also improves pump performance. The creation of the gaseous pollutants that are expelled from the engine cylinder is reduced thanks to the complete combustion of the fuel.

### *A. Experimental Procedure*

A water-cooled, single-cylinder, four-stroke diesel engine rated at 5 hp/1500 rpm was used for performance work. For charging, the engine was connected to an electric dynamometer. Engine speed was determined using a photosensor and a digital speed display. The fuel volumetric flow rate was determined on the test bench. Fig. 2 shows the experimental configuration of the engine.

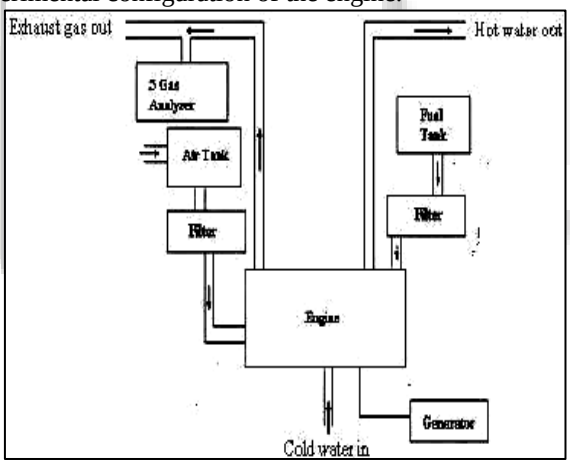



Fig. 2: The experimental set-up of the engine


Fig. 3: The actual pictures of BOSCH Inline PF Diesel Fuel Injection Pump

The study was carried out in the following stages

1) The decompression lever is activated after carefully completing the preliminary steps in order to prevent air from being trapped between the cylinder head and piston.
2) Next, the engine is started by turning the crank with the aid of a hand crank lever while swiftly decompressing the engine.
3) The engine is permitted and set to select the speed and operate at rated speed for a brief period of time. The tachometer was used to check the rated speed.
4) On the panel board, note the manometer reading and the amount of time it took to consume 5cc of fuel with no load.
5) The engine is then electrically loaded, given 5cc of fuel to burn, and the manometer reading is recorded.
6) Repeat the experiment with various loads and 160, 180, and 200 bar fuel injection pressures.
7) Repeat step 1 again, replacing the manifold with a different inclination.

Two pumps, one with a 5.5 mm diameter plunger and the other with an 8.0 mm diameter plunger, are compared in the accompanying table.

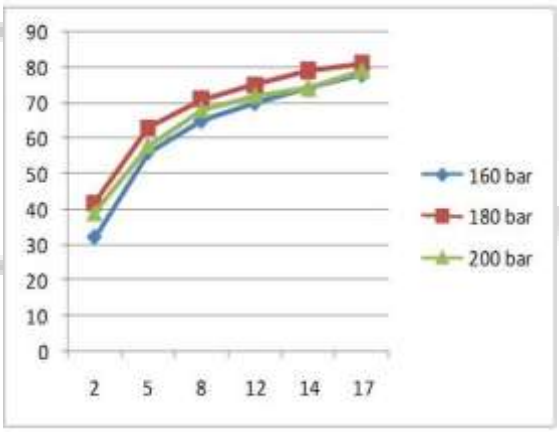
| Parameters | Pump having 5.5 mm diameter Plunger | Pump having 8.0 mmdiameter Plunger |
|---|---|---|
| Engine Power | 6.5kW | 8kW |
| Bore | 83mm | 86mm |
| Stroke | 77mm | 80mm |
| Swept Volume | 0.416 liters | 0.611 liters |
| Compression ratio | 24:1 | 18:1 |
| RPM | 3000 | 3000 |

| | | |
|---|---|---|
| Discharge Tube Dimensions | 6 X 2X 469mm | 6 X 1.5 X 395mm |
| Valve Used | Simple Delivery Valve | Adaption Flat Valve |
| Plunger Diameter | 5.5mm | 8mm |
| Injection Pressure | 150-180 bar | 200-250 bar |
| Lubricant Used | SAE 40 | Synthetic |
| Injector Nozzle Diameter | 0.18mm | 0.16mm |
| Specific Fuel Consumption | 222.62 gm/BHP hr | 201.75 gm/BHP hr |
| IndicatedThermal Efficiency | 26% | 34% |

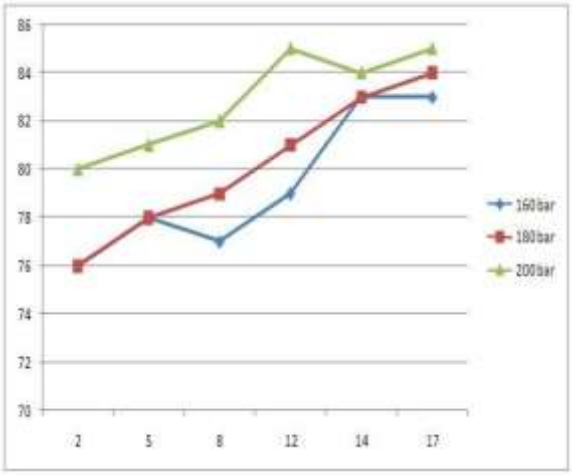
Table 1: Comparison of pumps having 5.5mm and8mm diameter plungers

## III. RESULTS AND DISCUSSION

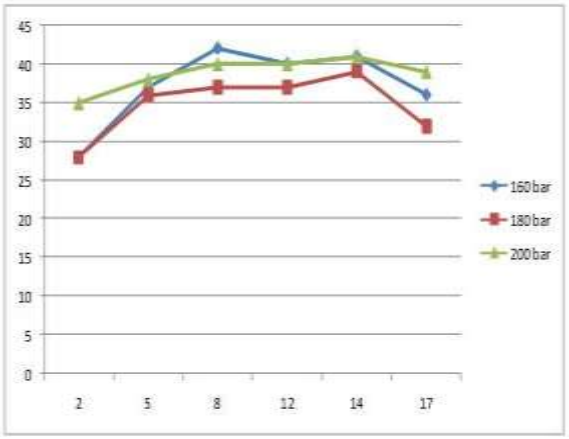
By changing the pressures at the end of the nozzle, several tests were conducted on the pump. Below is a graphical interpretation of the outcomes. 160, 180, and 200 bars, respectively, are the various pressures that were considered for the performance study. Additionally, the loads vary between 2 and 17 amps.



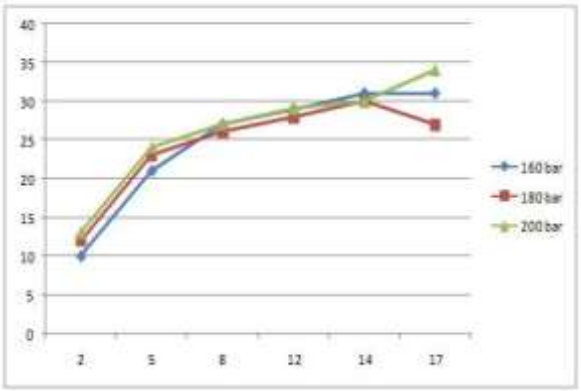

Graph 1: Load (on X-axis) V/S Mechanical Efficiency (on Y- axis) at different pressures




Graph 2: Load (on X-axis) V/S Volumetric Efficiency (on Y- axis) at different pressures




Graph 3: Load (on X-axis) V/S Indicated thermal Efficiency (on Y-axis) at different pressures




Graph 4: Load (on X-axis) V/S Brake thermal Efficiency (on Y- axis) at different pressures

Following load estimates, fuel discharge was determined on the TEST BENCH MACHINE with varied camshaft rpm.

Fig. 4: The actual photograph of Test Bench for calculating the fuel discharge

For 8mm diameter of plunger

| Speed(RPM) | Discharge Quantity(cc/500strokes) |
|---|---|
| 1500 | 19.5 |
| 900 | 18 |
| 600 | 3.5 |

Table 2: Results of speed v/s discharge of fuelfor 8mm diameter plunger

For 5.5mm diameter of plunger

| Speed(rpm) | Discharge Quantity (cc/500strokes) |
|---|---|
| 1500 | 13.3 |
| 900 | 17.3 |
| 600 | 3.2 |

Table 3: Results of speed v/s discharge of fuel for5.5mm diameter plunger

## IV. CONCLUSIONS

The paper's conclusion is that the pressure of the diesel fuel increases as the plunger's diameter grows. This aids in the fine atomization of the diesel fuel, which in turn aids in full combustion. Even after the combustion process, extra fuel leaks from the nozzle into the engine cylinder's combustion chamber due to the high pressure in the delivery pipe's pressure wave.

The adaption flat valve, which has a groove around its perimeter, is used to replace the regular valve at the end of the pump barrel in order to prevent this problem. From the graphs, it can be observed that changing the plunger dimensions results in a modest percentage improvement in the various sorts of efficiency.

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