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# The Effect of Fuel Pump Pressure and Number of Injector Holes on 150cc Matic Motorcycle Performance

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**Abstract**

This study aims to evaluate the effects of increasing fuel pump pressure and varying the number of holes in the injector on engine performance. The fuel system in the engine has evolved from carburettor to injection system to improve the efficiency of fuel usage. In this study, the fuel pump pressure was increased to three levels, namely 2.5 bar, 3 bar, and 3.5 bar. In addition, variations in the number of holes in the injector were also tested using 3-hole, 6-hole, and 8-hole injectors. Engine performance was evaluated based on the power and torque produced. The research method used is experimental with power and torque measurements as engine performance data. The results showed that increasing fuel pump pressure and varying the number of holes in the injector had a significant effect on engine performance. Increasing the fuel pump pressure to 3.5 bar results in an increase in engine power and torque. The best power test results were obtained at a fuel pump pressure of 3 bar with a combination of 6-hole injectors, producing a maximum power of 11.63 HP at 6000 rpm engine speed. While the best torque test results were obtained at a fuel pump pressure of 3.5 bar with a combination of 3-hole injectors, producing a maximum torque of 43.10 Nm at 3000 rpm. The variation in the number of holes in the injector shows that the use of injectors with more holes tends to increase engine power and torque.

**Keywords**: Engine Performance, Fuel Pump Pressure, Fuel Efficiency Injector Holes, Injection System

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## INTRODUCTION

This motorbike is one type of motorbike that is widely used by the public because of its comfort and practicality. Apart from comfort, engine performance is also an important factor in determining user satisfaction with the motorbike. Optimal engine performance can provide a better and more efficient driving experience [1], [2]. One way to improve engine performance is to replace the

injectors and change the fuel pump pressure without changing the ECU (Electronic Control Unit). The injector functions as an actuator that sprays fuel into the combustion chamber on a fuel injection motorbike. The number of holes in the injector can affect engine performance, because the number of holes in the injector can affect the amount of fuel that enters the combustion chamber and have an impact on engine performance with different results [3]. The ECU (Electronic Control Unit) can regulate the fuel supply, so users can adjust it according to their needs. The standard ECU installed on a motorbike has the advantage of regulating injector discharge to support this capability. By changing the number of injector holes and pressure in the fuel pump, engine performance can be adjusted to the desired conditions [4]. The fuel pump is an electric fuel pump that converts electrical energy into mechanical energy. This pump is installed in the fuel tank and produces stable fuel pressure. Through this research, it is hoped that pumps with low to high pressure can increase fuel supply according to needs, especially for larger and more injector holes.

Several researchers have examined the use of injectors in motorized vehicles, one of which is Muhammad Vendy (2020), the use of 6 hole injectors in this study has higher power and torque values compared to holes 4 and 8. The maximum power is 7.3 HP and the maximum torque is 6 .3 ft-lbs. The tests were carried out without making changes to the engine settings and fuel spray pressure, so these parameters were considered the most suitable for 6 hole injector applications [5].

The engine performance value produced by automatic motorbikes is lower when compared to scooters and sports motorbikes with the same cylinder volume. Increasing motor performance can be done by increasing the compression ratio, mixing the right fuel, and improving volumetric efficiency. Increasing the compression ratio will increase the compression number and combustion pressure. The compression ratio on a petrol motorbike should not be too high to avoid detonation. Chemically, the right ratio of air and fuel is needed for complete combustion to take place [6], [7].

The injection system is a technology that can improve engine performance and fuel efficiency. The injection system on motorbikes can produce vehicles that are fuel efficient and environmentally friendly [8], [9]. Fuel injection technology (Fuel Injection System) is a technology that mixes fuel with air before entering the combustion chamber, then sprayed at a certain pressure. This system uses several sensors to measure the amount of fuel and set the correct spray time. An important component in the fuel injection system is the injector [10], [11]. The injector nozzle acts as a sprayer of fuel into the intake manifold [12], [13]. There are several small holes at the end of the nozzle, these holes are a means of injecting fuel by fogging. Fuel injection efficiency is influenced by many parameters, namely injection pressure, fuel accuracy, air pressure, and the number of injector nozzle holes [14], [15].

The influence of electric fuel pump pressure variations on the power and exhaust emissions of injection motorbikes. The pressure variations given to the electric fuel pump are 2.7bar, 2.94bar, 3.5bar and 3.8bar. there is an influence of changes in the value of power, engine torque, fuel efficiency and exhaust emissions with the overall result being that the vehicle's ideal pressure for power, torque and gas emissions and meets the specified threshold for injection motorbikes is found at a pressure of 2.94 bar – 3.5 bar use at high engine speed [16], [17]. There is an influence on fuel pressure on power and torque. The highest power is produced at a pressure of 4.5 bar, namely 5.75Hp at 6000rpm. The highest torque is produced at a pressure of 1.5bar, namely 46Nm at 6000 rpm. The higher the pressure, the greater the power produced, but the increase in torque cannot be predicted, and 3bar pressure (standard) [18], [19].

Meanwhile, increasing the camshaft duration on Performance and Exhaust Gas Emissions on the Sinjai 650 cc Engine. Simulation results comparing the performance of the best SINJAI 650 cc SOHC port fuel injection engine using a 260˚ camshaft, with an increase in torque of 0.908%, power of 0.908%, bmep of 0.908%, thermal efficiency of 0.626%, volumetric efficiency of 1.003% and a decrease in bsfc of 0.252% of the camshaft standard in the rotation range of 4000-6000 rpm [20], [21]. Apart from that, variations in ignition performance affect engine performance. Where the maximum torque and power values are produced when the ignition degree is advanced 6˚ from the standard [22], [23].

This research aims to analyze the effect of using the number of injector holes and fuel pump pressure on the engine performance of a 150cc automatic motorbike. With this research, it is hoped that it can provide useful information for the public in choosing the right number of injector holes and fuel pump pressure to improve engine performance, which is measured in the form of power and torque

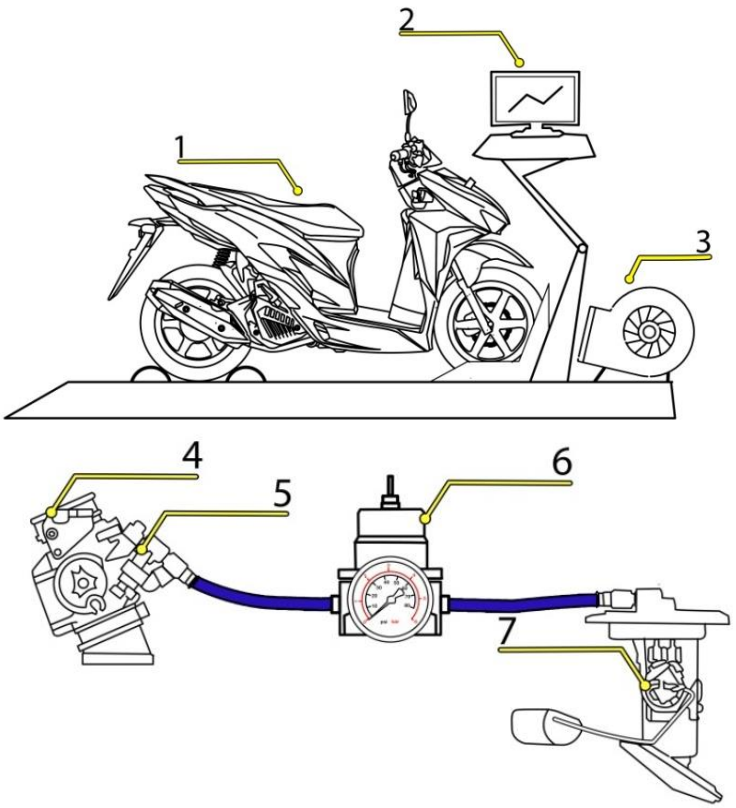
**METHOD**

Testing engine power and torque on a 150cc automatic motorbike by replacing injectors with 3, 6 and 8 holes and variable pressures of 2.5 bar, 3 bar and 3.5 bar. This test uses engine speeds between 3000, 4000, 5000, 6000, 7000, 8000, 9000 and 10000 rpm. T

his research uses experimental laboratory methods, namely research by comparing test groups against standards using laboratory facilities as a reference in searching for data.

Figure 1. Equipment settings

**Research Equipment Setup**




Where,

1. 150 CC automatic motorbike

2. Monitor Dynamometer

3.Cooling Fan

4. Throttle Body

Research procedure

1. Prepare the tools or materials to be used
2. Install the injector that will be used (hole 3, 6, or 8)
3. Install the fuel pump regulator between the fuel pump line and the injector then remove the pressure regulator
4. Adjust the fuel pump regulator to adjust the fuel pressure that comes out
5. Check the pressure on the fuel pump regulator, make sure it matches the variable used (2.5 bar, 3bar, and 3.5 bar)
6. Carry out a test using a dynamometer according to the specified engine speed.

## RESULT AND DISCUSSION

### 1. Power Test Results

Results from research conducted using a Dynamometer test equipment on a 150cc engine.

Figure 2 Effect of engine speed on engine power

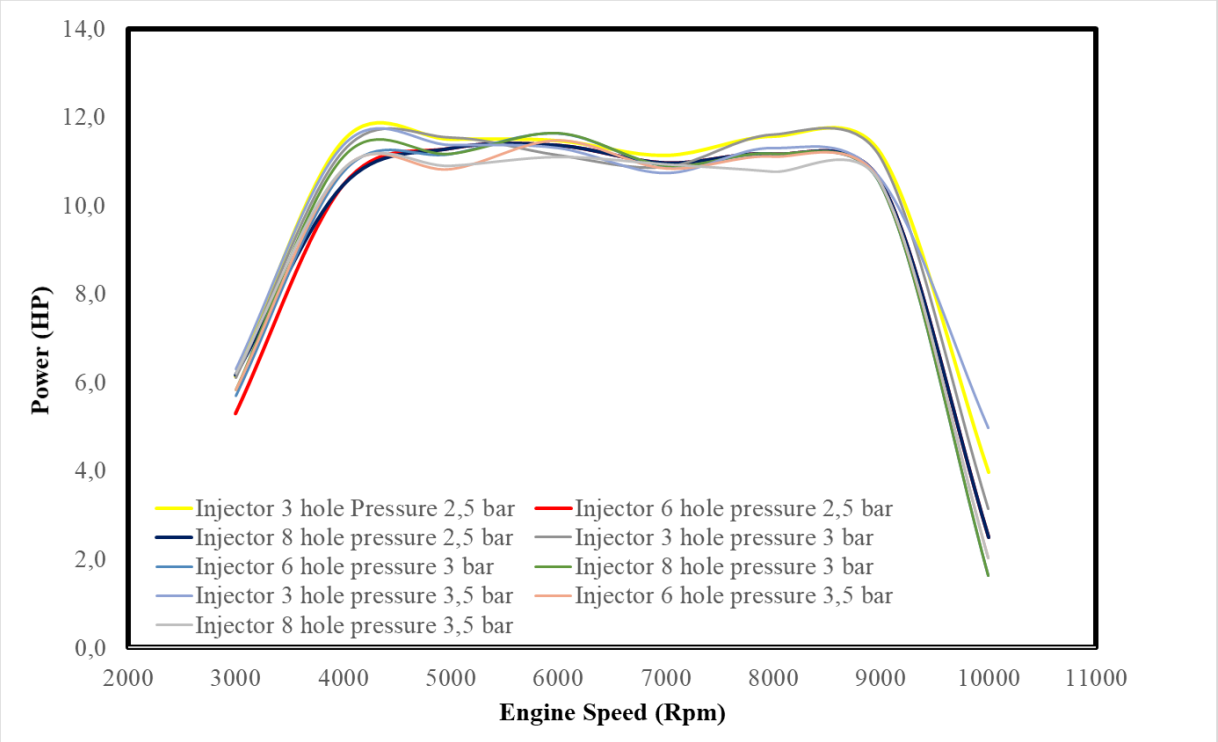



Figure 2 shows that the 2.5 bar fuel pump pressure for the 3-hole injector has the highest power, namely 11.57 HP at an engine speed of 8000 rpm, while the 6-hole injector and 8-hole injector reach the highest power of 11.37 HP at an engine speed of 6000 rpm. Meanwhile, the fuel pump pressure is 3 bar, the injector with more holes, namely the 6 and 8 hole injector, has a superior engine rotation of 6000 rpm with a power of 11.63 HP. Meanwhile, the 3 hole injector is capable of producing 11.60 HP of power at an engine speed of 8000 rpm. Apart from that, Figure 2 also shows the results of power testing using a fuel pump pressure of 3.5bar. The highest power of 11.47 HP was achieved by a 6-hole injector, while a 3-hole injector was able to reach a power of 11.37 HP at 5000 rpm and an 8-hole injector was able to reach the highest power of 11.10 HP. at 6000 rpm.

Based on Figure 2, the results of the power test with a combination of fuel pump pressure and injector hole, the highest was obtained by a 6 hole injector with a fuel pump pressure of 3 bar with a maximum power of 11.63 HP at an engine speed of 6000 rpm, and the second highest was obtained by a fuel pump pressure of 2.5 bar with a combination of 3 hole injectors reaches a maximum power of 11.57 HP at an engine speed of 8000 rpm, for third place it is achieved by

a pressure of 3.5 bar using a 6 hole injector with a maximum power of 11.47 HP at an engine speed of 6000 rpm.

Engine performance (power and torque) is influenced by fuel pump pressure and the number of holes in the injector. At higher fuel pump pressures, injectors with more holes tend to provide better performance at certain engine speeds. Because more injector holes will produce more fuel discharge, the fuel is classified as rich which results in a good supply of fuel but the fuel tends to be wasteful.

## 2. Torque Test Results

Figure 3 Effect of engine speed on torque

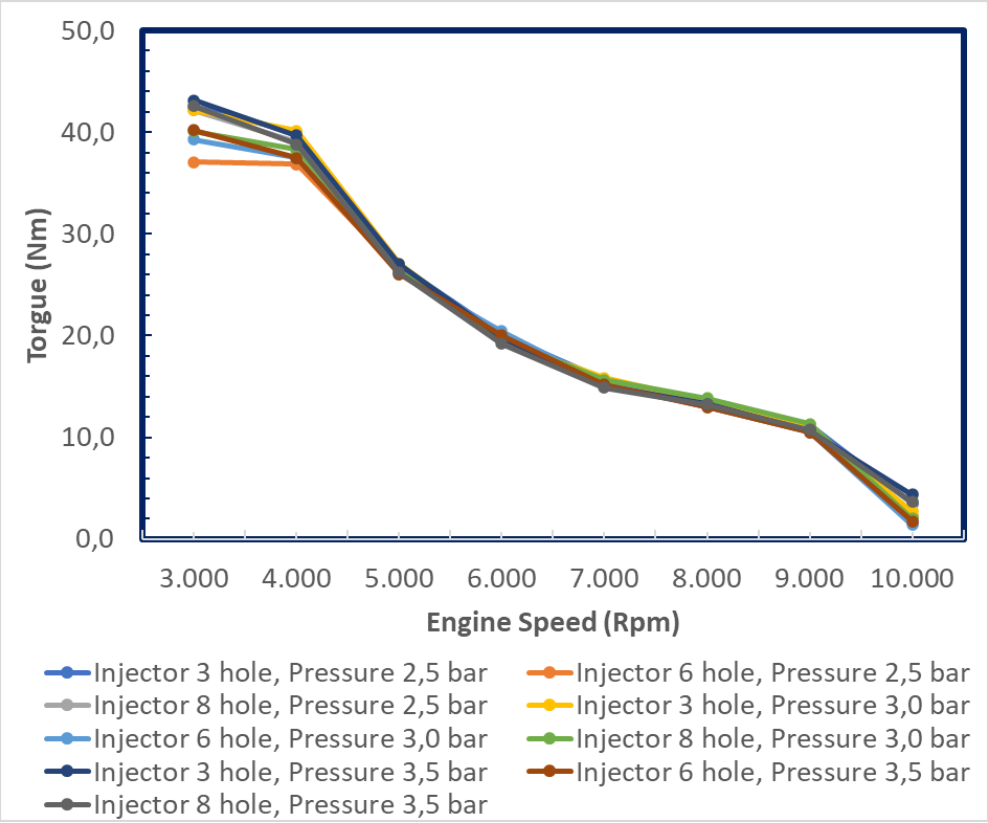



Figure 3 shows the results of the torque test with a fuel pump pressure of 2.5 bar capable of producing 42.50 Nm of torque at 3000 rpm using a 3 hole injector, followed by an 8 hole injector capable of producing 42.17 Nm of torque at 3000 rpm engine rotation, while the 6 hole injector is capable of producing highest torque of 37.07 Nm at the same engine speed. Meanwhile, for the 3 bar fuel pump pressure, the highest torque is obtained by the 3 hole injector with torque reaching 42.14 Nm at 3000 rpm engine speed, the 8 hole injector can reach 40.10 Nm at 3000 engine speed, and the 6 hole injector can produce 39.25 Nm torque at 3000 rpm. 3000 rpm engine. and for the torque test results with a fuel pump pressure of 3.5 bar, the highest was obtained by a 3 hole injector at 3000 engine speed producing a torque of 43.10 Nm, while for a 6 hole injector it produced a torque of

40.20 Nm at the same engine speed and for an 8 hole injector it was able to produce 42.56 Nm at 3000 rpm engine speed.

Fuel pump pressure of 3 bar, injectors with 3, 6 and 8 holes provide the highest power at certain engine speeds. However, when the fuel pump pressure changes, the injector performance can also change, and this change can affect the power and torque produced. At some engine speeds, injectors with different numbers of holes can produce the highest power and torque. Therefore, the choice of fuel pump pressure and injector type must be adjusted to the needs and characteristics of the desired engine.

In power testing, the combination of 3 bar fuel pump pressure with a 6 hole injector gave the best power performance, while in torque testing, the combination of 3.5 bar fuel pump pressure with a 3 hole injector gave the best torque performance. This shows that engine performance depends on the combination of fuel pump pressure and the number of holes in the injector, and can be different for power and torque tests. The choice of the combination of fuel pump pressure and injector hole must be considered appropriately according to the needs and characteristics of the desired engine. A combination of a good injector with the appropriate pressure will produce fuel with maximum discharge and ignition. Atomization will have an effect on the combustion process.

## CONCLUSION

The number of injector holes and fuel pump pressure affect the power and torque of a motorbike. The 6-hole injector reaches a maximum power of 11.63 HP at 6000 rpm, while the 3-hole injector produces 43.10 Nm of torque at 3000 rpm. 3 bar fuel pump pressure provides maximum power of 11.63 HP at 6000 rpm, and 3.5 bar fuel pump pressure produces the highest torque of 43.10 Nm at 3000 rpm. The combination of 3 bar fuel pump pressure with a 6 hole injector provides the highest power, while the combination of 3.5 bar fuel pump pressure with a 3 hole injector provides the highest torque.

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