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Analysis of Variation of Valve Gap Size on Power and Torque of a Four-stroke Motorcycle

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Abstract

This study aims to analyze changes in valve clearance on engine power and torque. The subjects in this study were four-stroke motorcycles with a cylinder capacity of 100 cc. The stages of the research included: 1) Preparation by adjusting the size of the inlet and outlet valve gaps with the dimensions in millimeters being 0.03, 0.05, and 0.07; 2) Testing using a dyno test; 3) The conclusion is based on the results of the dyno test tool print out data. Research results: 1) The maximum engine power achieved at the valve clearance size of 0.03 mm and 0.05 mm is 4.5 hp. Maximum engine power at 0.03 mm valve clearance is achieved at 6.42 rpm, while 0.05 mm valve clearance is achieved at 6.39 rpm; 2) The highest maximum engine torque among the three variations in valve clearance size, is 0.03 mm, which is 5.92 N.m at 3.081 rpm; 3) The size of the valve gap that is not by the standard specifications will significantly affect the power and torque of the engine.

Keywords: *Valve Clearance Size, Engine Power, Torque*

Abstrak

Penelitian bertujuan menganalisis ubahan celah katup terhadap daya dan torsi mesin. Subjek dalam penelitian ini adalah sepeda motor empat langkah dengan kapasitas silinder 100 cc. Tahapan penelitian meliputi: 1) Persiapan dengan penyetelan ukuran celah katup masuk dan keluar dengan ukuran dalam milimeter adalah 0.03, 0,05, dan 0.07; 2) Pengujian menggunakan alat dynotest; 3) Kesimpulan didasarkan pada hasil data print out alat dynotest. Hasil penelitian: 1) Daya mesin maksimal yang dicapai pada ukuran celah katup 0,03 mm dan 0.05 mm sebesar 4,5 hp. Daya maksimal mesin pada ukuran celah katup 0.03 mm dicapai pada putaran 6.42 rpm, sementara ukuran celah katup 0.05 mm dicapai pada putaran 6.39 rpm; 2) Torsi mesin maksimal tertinggi diantara tiga variasi ukuran celah katup adalah pada ukuran 0.03 mm yaitu sebesar 5.92 N.m pada putaran 3.081 rpm; 3) Ukuran celah katup yang tidak sesuai dengan standar spesifikasinya akan sangat berpengaruh terhadap daya dan torsi mesin.

Kata-kata kunci: *Ukuran Celah katup, Daya, Torsi Mesin*

1. Introduction

Motorcycles are a means of transportation used to facilitate daily activities. Motorcycles are considered more practical and economical as daily transportation to meet the need for transportation facilities. Therefore, many people prefer to use motorbikes rather than cars to avoid traffic jams and practicality when used alone or with luggage that is still possible. For this reason, it is essential to maintain the condition of the motorbike at its best performance by always carrying out regular or periodic maintenance and repairs. With technology development in the automotive sector, many vehicles have undergone changes or modifications to certain parts, both engines, electricity, and frame parts.

Included in terms of optimizing engine performance is a modification or change in the adjustment of the valve clearance size on a 4-stroke combustion engine. The working principle of a 4-stroke motor is a working system that in one cycle, is completed by two crankshaft revolutions or four-piston movements to produce one effort **[1]**. One factor affecting a motorcycle engine's performance is the size of the valve clearance. Because by adjusting the valve clearance correctly, you will get better performance, in this case, the torque and power of the motorcycle engine. On the other hand, if the valve adjustment is not made properly, it will impact the motorcycle's performance, which will decrease, engine power will decrease, and the engine sound can also be found to be louder than it should be **[2]**. If the performance of the motorcycle engine decreases, of course, it will impact fuel consumption which is getting more and more wasteful. As is known, the valve is a tool that has the function of controlling and also regulating. The valve opens and closes the suction and exhaust channels through the camshaft according to the time required **[3]**. The valve greatly affects the appearance and performance of the engine because the valve is the entrance for the mixture of air and fuel into the combustion chamber. And also the exit from the combustion products. The valve itself is only on four-stroke motors, while generally, two-stroke motors do not use valves. The valve on the four-stroke engine is mounted on the cylinder head **[4]**.

In a four-stroke engine, there is a system of inlet and exhaust valve mechanisms, the purpose of which is to regulate the intake of the fuel-air mixture and regulate the release of burnt gases. This valve mechanism aims to prevent expansion at the end of the inlet valve stem and exhaust valve to prevent expansion when the engine is running **[5]**. Giving this gap will affect the engine if the components of the valve mechanism are disturbed, and it will impact engine performance, where engine performance will decrease. The valve gap must be at a standard condition to obtain timeliness when opening and closing the valve to obtain optimal power **[6]** . If the valve gap is made smaller than standard, the valve opens quickly and closes longer, which causes compression to leak because when the compression stroke occurs, the valve has not closed **[7]**.

This entry and exit process will have an overlapping angle on the valve. This angle helps exhaust the remaining gas. When the fresh gas mixture enters the exhaust completely, and fresh gas intake is affected also produces good power. This valve gap adjustment influences the valve overlapping angle. If the valve gap is too tight, the overlapping angle of the formed valve will be greater. Still, if the valve gap is too wide, then the overlapping angle is too small for injecting fuel; removing residual combustion gas and rinsing is not optimal. Based on the problems above, the background is for researchers to conduct research by analyzing the influence of valve clearance on the power and torque of a four-stroke motorcycle engine **[8]**.

Torque (torque) is the machine's ability to drive or move the motor from rest to running. Torque is related to acceleration. For example, when we feel our bodies crashing backward during acceleration, it shows the amount of torque on the machine. According to jama **[9]**, torque is a movement in the form of a push that occurs between the piston and the crankshaft. If there is a push on the two parts, it will produce a rotational movement or torque. Torque is also the multiplication of the force resulting from the pressure of the combustion products on the piston multiplied by the radius of the crankshaft circumference. When the piston moves from TDC to TMB on an automatic motorcycle, a force is applied to the connecting rod that connects the piston to the crankshaft bearing so that the crankshaft rotates. This rotating force that is applied to the crankshaft is called torque. According to Philip Kristanto **[10]**, torque is the ability of the motor to do work; the unit of measurement for torque is the Newton meter. Large torque will make it easier to rotate the load.

According to Mallev **[11]**, power is the energy a vehicle generates to reach its maximum speed (top speed). The greater the power of a vehicle, the higher the maximum speed of a vehicle. Power or power is the power that can be measured from the wheel rotation. Shaft power is generated by the engine, which is reduced by friction. This power is used to drive the wheel axle. When the wheel rotates quickly, the piston will automatically work fast, producing maximum power. So that the resulting engine rotation is high, the shaft power will be high too.

2. Method

The method used in this study is an experimental research method. According to Sugiyono [12], the experimental research method is a research method used to look for the effect of certain treatments on others under controlled conditions. According to Arikunto [13], the experimental research method is a way to look for a causal relationship (causal relationship) between two factors that are deliberately generated by researchers by eliminating or reducing or setting aside other disturbing factors. An experimental research method was designed in which variables can be selected, and other variables that can affect the experimental process can be controlled carefully.

The research was conducted at the Mototech workshop, which is located at Jl. South Ringroad, Singosaren III, Singosaren, Banguntapan District, Bantul Regency, Special Region of Yogyakarta. Mototech is a workshop in Yogyakarta that has a dyno test tool. The implementation time will be held in May 2023. This research was conducted on a four-stroke motorcycle engine with a cylinder capacity of 100 ccs, which had been changed to the settings or size of the intake (in) and exhaust (ex) valve gaps. The variation in the change in the size of the valve gap adjustment that was analyzed was 0.03 mm (less than the standard), 0.05mm (standard), and 0.07 mm (more than standard).

The research was conducted in three stages: preparation, testing (data collection) and conclusions. The data collection technique in this study was carried out using documentation from laboratory test results in the form of printouts from the dyno test tool. The data analysis technique used in this study is descriptive analysis. The stages of conducting the research are shown in Figure 1.

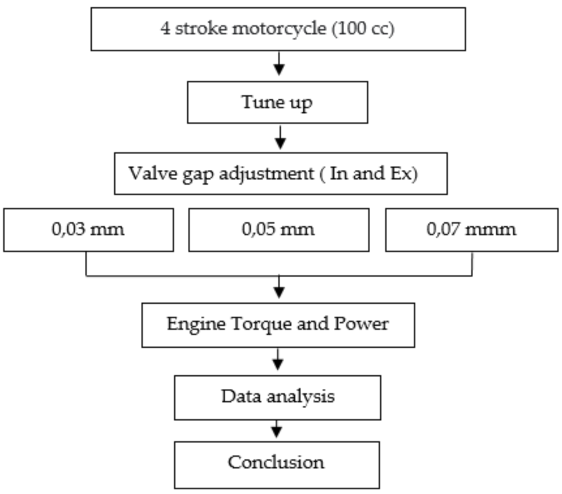

Figure 1. Stages of Research Implementation

3. Results and Discussion

3.1 Data from Test Results for Changes in Valve Gap to Engine Power

The results of testing engine power for each valve clearance size are presented in **Table 1.**

Table 1. Engine Power Test Data Results

Testing	Valve Gap (mm)	Max power/rpm
1	0.03	4.5 hp / 6.42 rpm
2	0.05	4.5 hp / 6.39 rpm
3	0.07	4.4 hp / 6.64 rpm

Engine power testing chart is presented on **Figure 2**.

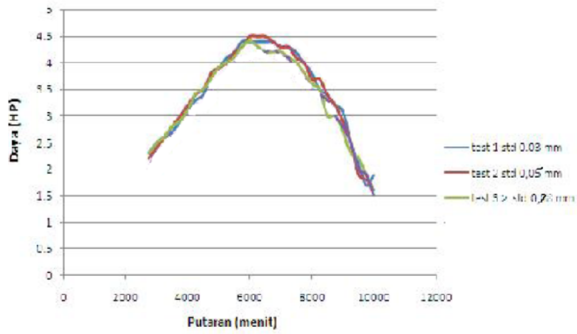

Figure 2. Engine Power Testing Chart

Based on the results of the engine power test data above, the results of testing the engine power on each size of the valve clearance change found that the order of magnitude of the engine power generated from the largest to the smallest is: valve clearance size of 0.05 mm produces the highest engine power, which is 4.5 hp at 6.39 rpm (lowest rpm); followed by a valve clearance of 0.03 mm (4.5 hp / 6.42 rpm); and the last with the lowest engine power, namely the valve clearance size of 0.07 (4.4 hp / 6.65 rpm).

Based on the results of tests carried out on changing the valve clearance with three variations of the valve clearance size of 0.03 mm, 0.05 mm and 0.07 mm, it is known that the valve clearance with a size of 0.05 mm produces more engine power compared to a valve clearance of 0.08. The amount of engine power produced with a valve clearance size of 0.03 mm is the same as a valve clearance size of 0.005, which is 4.5 hp. However, the valve clearance size of 0.05 mm shows a lower rotation of 6.39 rpm than the valve clearance size of 0.03. Thus the valve clearance of 0.05 mm is more appropriate for increasing engine power.

Providing a valve gap functions so that the valve can close appropriately in all temperature conditions. When the engine is running, the components on the engine will move and rub against each other, including the valve mechanism components [14]. When the engine is running, this valve mechanism will get forces from all directions and heat loads, so over time, the parts of this valve mechanism will experience wear on the valve/rocker arm components and on the valves and their seats, so that the valve gap will change in width. The distance. As a result of this wear and tear, the valve clearance will become large, reducing the engine's performance **[15]**.

The above standard valve adjustment, which is 0.07 mm for the intake and exhaust valves, produces a maximum engine power of 4.4 hp at 6.65 rpm, smaller than the valve settings of 0.005 mm (standard) and 0.003 mm. Valve adjustments that are looser or looser than expected result in the slower opening of the inlet valve and conversely closing it faster so that the intake period for the fuel and air mixture is reduced, so that fuel and air enter the combustion chamber. Hence, this is a bit one that affects the output engine power. Conversely, suppose the adjustment or change in the valve gap is too small. In that case, it will result in opening the inlet valve faster and vice versa, closing it slower so that the intake period is longer and the fuel-air mixture is more, but the valve position is not tight in its seat so that the compression leaks. The valve overlapping process greatly influences it,**[16]**.

3.2 Data from Test Results for Changes in Valve Gap to Engine Torque

The results of the engine torque test for each valve clearance size are presented in **Table 2**.

Table 2. Engine Torque Test Data Results

Testing	Valve Gap (mm)	Max Toque/rpm
1	0.03	5.92 N.m / 3.081 rpm
2	0.05	5.75 N.m / 3.125 rpm
3	0.07	5.90 N.m / 3.155 rpm

Engine torque testing chart is presented on **Figure 3.**

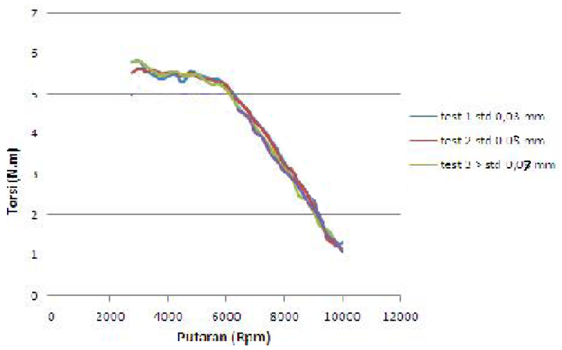

Figure 3. Engine Torque Testing Chart

Based on the engine torque test data above, the results of testing the engine torque on each size of the valve clearance change found that the order of magnitude of the engine torque generated from the largest to the smallest is: valve clearance size of 0.03 mm produces the highest engine torque, namely 5.92 N.m at 3,081 rpm (lowest rpm); followed by a valve clearance of 0.07 mm (5.75 N.m / 3.125 rpm); and the last with the lowest engine power, namely the valve clearance size of 0.05 (5.75 N.m / 3.125 rpm).

Based on the results of tests carried out on changing the valve clearance with three variations of the valve clearance size of 0.03 mm, 0.05 mm and 0.07 mm, it is known that the valve clearance with a size of 0.05 mm produces the highest engine torque compared to the other 2 size variations. The amount of engine torque produced is 5.92 N.m at 3,081 rpm. This is very possible because with valve adjustments that tend to be small (medium), it will allow the inlet valve to open faster and, conversely, to close slower so that the intake period is longer and the fuel-air mixture is more **[17]**.

When making adjustments to the valve or valve clearance, it must be done correctly, and the valve clearance must be in accordance with the standard specifications (see the vehicle or motorcycle repair manual). Improper adjustment of the valve clearance will, of course, cause problems, whether the valve clearance is too large or the valve clearance is too small. Therefore the size set by the manufacturer is the ideal valve clearance size for motorcycle use that has been adjusted to the engine specifications **[18]**.

4. Conclusion

Based on the results of research, analysis and discussion, the research can be concluded as follows:

a. The maximum engine power that can be achieved at the valve clearance setting of 0.03 mm and 0.05 mm is the same, which is 4.5 hp. The maximum engine power at a valve clearance of 0.03 mm is achieved at 6.42 rpm, while a valve clearance of 0.05 mm is achieved at 6.39 rpm.

b. The highest maximum engine torque among the three variations in valve clearance size (0.03, 0.05, 0.07 mm) is achieved at a valve clearance size of 0.003, 5.92 N.m at 3.081 rpm.

c. In accordance with the purpose of this study, namely, if the change in the size of the valve gap is too large or too small, it does not comply with the specifications, it will greatly affect the compression pressure in the combustion chamber so that it will affect the power and torque of an engine.

d. The size of the valve gap that is too small will result in the valve opening being longer than it should be. As a result, a longer valve opening will cause new gas losses (new gas will be wasted into the exhaust channel because the exhaust valve opening takes longer), so the idle rotation becomes unstable.

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