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Experimental study of motor cycle performance with exhaust manifold using torque expansion chamber

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Abstract: The Motorcycle performance can be improved by modifying the intake manifold and exhaust manifold. In this research, the exhaust manifold was modified using a Torque Expansion Chamber (TEC), namely adding a tube to the exhaust manifold with a certain geometry and dimensions so that the heat carried by the exhaust gas is retained and does not directly escape through the exhaust. This test aims to determine the performance of a motorbike with a modified exhaust manifold by adding 250 mm tubular TEC. TEC installation with placement at 40%, 50%, and 60% of the exhaust manifold length. Engine performance including torque, power and specific fuel consumption is measured using the Dyno Test. The research results show that the use of the Torque Expansion Chamber has an effect on motorbike performance. Highest torque with 50% TEC placement and 60% TEC placement at 5000 rpm. Highest power with 50% TEC placement and 60% TEC placement at 6000 rpm to 6500 rpm. Lowest specific fuel consumption with 50% TEC placement at 6000 rpm

Keywords: Exhaust manifold; TEC; engine performance; torque, power

1. INTRODUCTION

In general, the main performance of a combustion engine is torque, power and specific fuel consumption which can be measured with DynoTest. Torque is useful for starting the vehicle so that it can move which is generated from the force multiplied by the radius of the crankshaft, the force caused by combustion pressure acting on the visible area of the piston. The power generated to increase the speed of the vehicle until it reaches a certain speed, the amount of power depends on the stroke volume of the cylinder. The consumption of materials required as a benchmark for optimal combustion performance of a combustion engine at a certain speed [1].

The performance of a combustion engine has many factors that influence it, one of which is combustion, carried out by porting polish on the exhaust manifold and intake manifold so that flow resistance is reduced so that combustion is more optimal, performance will increase [2].

Other research that has been carried out to improve the performance of combustion engines, starting from making changes to three parameters of engine parts including the intake manifold, combustion chamber and piston surface, is expected to form a turbulent flow so that the mixture of fuel and incoming air is more homogeneous [3].

Adding a spacer to the intake manifold, if there is a passing flow, a rotating flow will form, causing an effect like a turbo cyclone, in conditions the incoming flow causes the movement of particles to become irregular, causing a centralized flow (swirl) [4]. High pressure air flow can reduce heat loss in the intake manifold system, while maintaining low temperatures thereby contributing to increased cylinder filling efficiency in the intake stroke [5]. The time for preparation for combustion is very short, requiring higher incoming air pressure, this will increase combustion efficiency in a limited time so that there is fuel savings and improved exhaust emissions [6].

The research uses the adaptive PID method to control the inlet fuel air flow (AFR) under ideal conditions. The stoichiometric AFR value influences the power produced and also indirectly reduces the level of exhaust emissions [7]. Changes were also made to the combustion timing because it greatly influences the combustion results. In another study, the influence of exhaust channel modifications had an effect on fuel consumption on the Suzuki Smash [8].

The objectives of this research are as follows: 1) Study the torque on a motorbike when using a modified exhaust manifold with Torque Expansion Chamber variations in placement. 2) Study the power, when using exhaust manifold modifications with Torque Expansion Chamber variations in placement. 3) Study the specific fuel consumption of motorbikes, when using an exhaust manifold with Torque Expansion Chamber variations in placement.

Experimental research into the performance of the Honda Supra X 125. Using Exhaust Manifold Modifications with Shape Variations shows that the rotation required to achieve the highest torque is faster, namely at 4750 rpm from the standard condition of 5250 rpm. However, the peak torque produced by the shape variation decreases by 0.17 Nm from the standard exhaust [9].

Research with the title: "The Effect of Varying the Diameter of the "Magic Ring" Hole in the Exhaust Manifold on the Torque and Power of the Yamaha Vega RR Motorcycle" shows the results that the use of a ring with a diameter of 16 mm can increase torque by 7.42% and power by 0.24% of initial torque at 4580 rpm and rings with a diameter of 18 mm can increase torque by 7.12% of the initial torque with the same power as standard conditions at 4580 rpm [10].

The research is entitled "Experimental Study of the Performance of the Suzuki Satria F 150 Using Modified Exhaust Manifolds with Varying Diameters in the Orifice." The results show that the smaller the inner diameter of the orifice, the lower the engine speed required to reach peak torque. The larger the inner diameter of the orifice, the higher the peak power produced. The smaller the orifice diameter, the lower the KBBS produced [11].

The research entitled "Experimental Study of the Performance of the Suzuki Satria F 150 Using Exhaust Manifold Modifications with Diffuser Angle Variations of 40°, 50°, and 60°" shows that Exhaust Manifold modifications with variations in Diffuser angles influence the Torque, Power and Kbbs values on the bicycle. motorcycle. The smaller the Diffuser angle, the lower the engine speed required to produce high Torque, Power and KBBS. The highest increase in performance is obtained when the motorbike uses a modified Exhaust Manifold with a 40° Diffuser angle variation [12].

Back pressure is the gas pressure that comes out of the combustion chamber after passing through the outlet, sound dampening filter and other supporting components. This pressure is still able to return to the combustion chamber if the pressure is higher than the environmental pressure. Combustion waste gas that re-enters the combustion chamber occurs during the over-lap timing. The used gas is mixed with the fresh mixture so that it will disrupt the combustion process. If this phenomenon occurs, it will affect the combustion process, causing the performance of the combustion engine to decrease [13].

The Torque Expansion Chamber (TEC) is shown in Figure 1. It is a chamber in the form of a tube with a certain location and size on the exhaust manifold or exhaust neck. In 2009, this technology was patented by Bajaj, this technology is able to increase bottom-end torque in motorized vehicles.

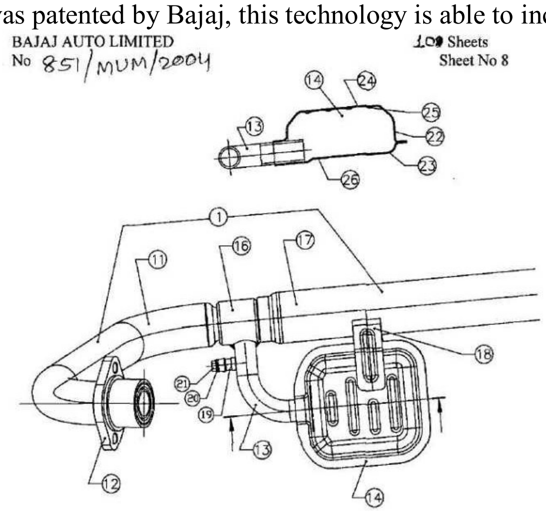

Figure 1. TEC on a Bajaj auto limited motorbike

The mechanism of this TEC technology is to connect the header pipe with a space or in the form of a small tube with a predetermined volume and distance, the distance usually used is 40-60% of the header, either directly or through a connecting pipe. In one study, it was stated that peak torque occurs

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at engine speed between 4500 rpm and 6000 rpm. The two torque peaks are produced by a combination of reflected pressure waves at the end of the header pipe and in the exhaust manifold [14].

Thermal efficiency is the ratio of useful power to fuel energy, the amount is influenced by many factors, one of which is the combustion process. The amount of this efficiency can be determined by using the following formula [15].

$$n_{th} = \frac{w_{net}}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}} \quad (1)$$

With:

η_{th} = Thermal Efficiency
Q_{in} = The amount of heat entered
Q_{out} = The amount of heat released

2. METHOD

The research was carried out following the research flow diagram in Figure 2. The initial stage is preparing the test equipment, followed by testing the engine performance. The next stage is testing performance using a standard exhaust manifold as comparative data. Next, test the exhaust manifold by adding 40% TEC, 40% TEC and 40% TEC. Engine performance testing including torque, power and specific fuel consumption is carried out using the Dyno Test.

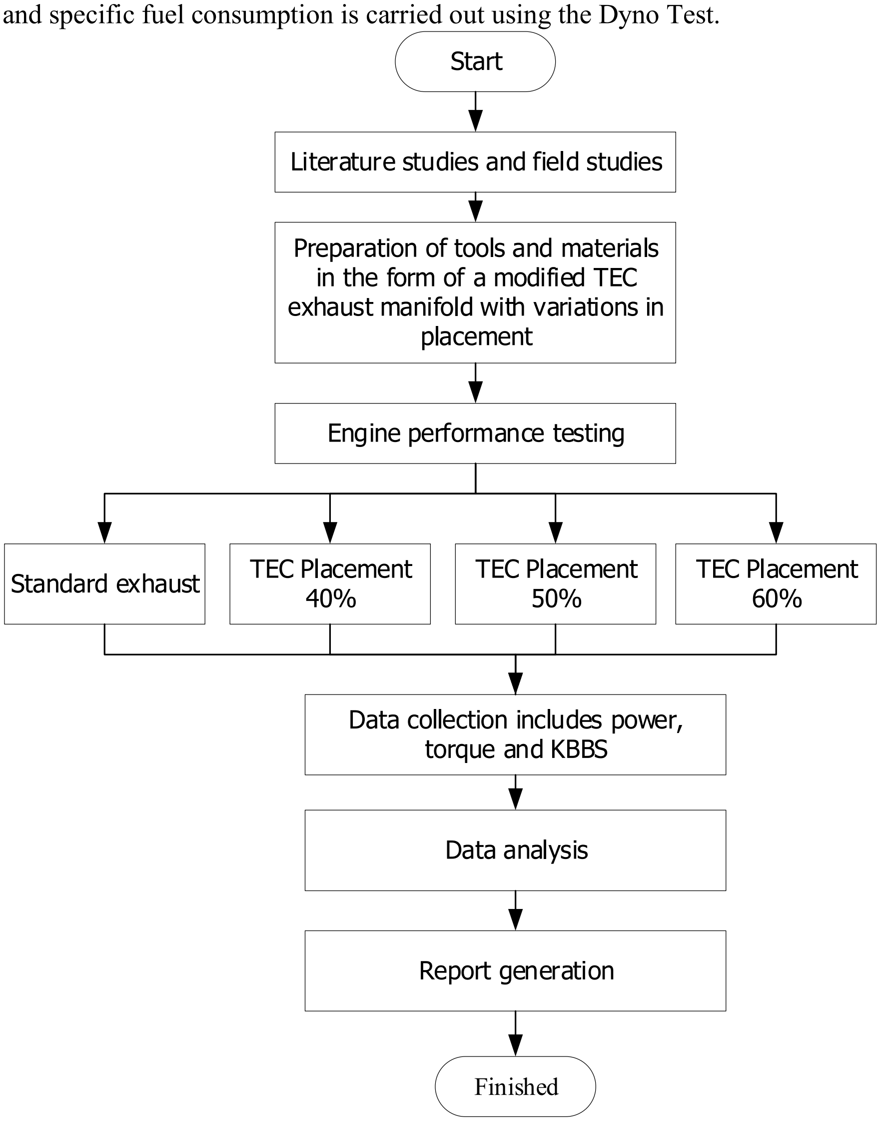

Figure 2. Research flow diagram

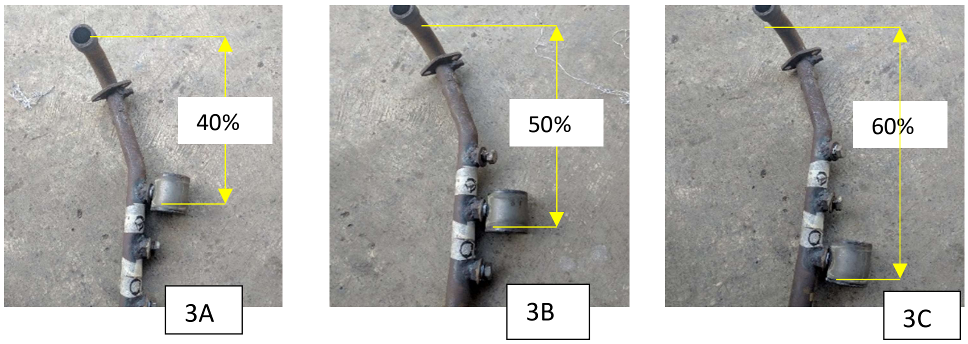

Figure 3. Exhaust Manifold TEC Placement A.40%, B.50%, C.60%

In Figure 3, it is shown that at 3A the position of the exhaust manifold has a TEC visibility of 40%, at 3B the position of the exhaust manifold has a TEC visibility of 50% and at 3C the position of the exhaust manifold has a TEC visibility of 60%. with the volume of the TEC tube for the three placement variations being the same.

3. RESULTS AND DISCUSSION

Torque test results

The torque test is shown in Figure 4. It has the same character at 4250 rpm to 5000 rpm rotation, the torque will increase, then the rotation is increased until the rotation is 7500 rpm, the torque will decrease. The highest torque is achieved at 5000 rpm for standard exhaust manifolds and exhaust manifolds with TEC.

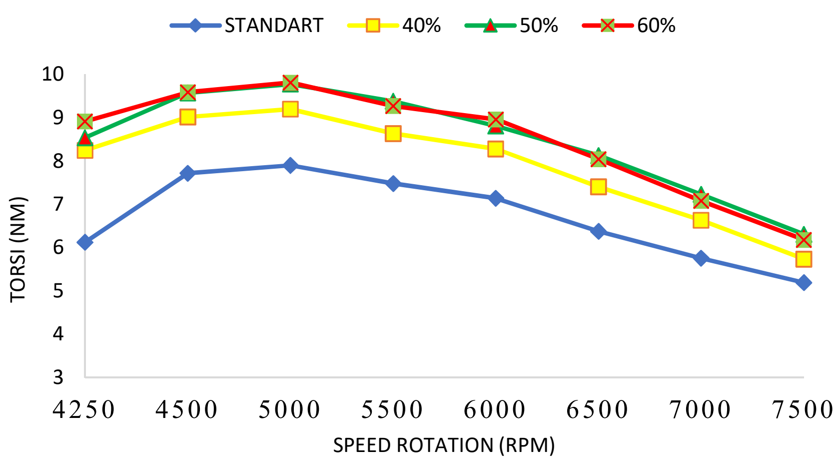

Figure 4. Graph of torque test results

At 5000 rpm, the standard condition is that the highest torque is 8.02 Nm, adding TEC in the 40% position produces the highest torque of 9.19 Nm, placing the TEC in the 50% position produces the highest torque of 9.77 Nm, and placing the TEC in the 60% position produces the highest torque of 9.81 Nm. Nm. The test results show that with the exhaust manifold, adding TEC at the 50% position and adding TEC at the 60% position can produce higher torque when compared to the standard exhaust manifold or adding TEC at 40%. This probably happens because the combustion gases quickly come out by flushing the Torque Expansion Chamber, so that fresh air and fuel pressure will enter the combustion chamber more quickly.

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Power test results

The power test is shown in Figure 5. It produces the same character at 4250 rpm rotation until 6250 rpm rotation, the power will increase, then the rotation is increased until 7500 rpm rotation, the power will decrease. In standard conditions, the highest power is 6.16 HP at 6000 rpm to 6500 rpm, adding TEC to the 40% position produces the highest power of 7 HP at 6000 rpm. Placing the TEC in the 50% position produces the highest power of 7.53 HP at 6000 rpm to 6500 rpm and the TEC in the 60% position produces the highest power of 7.5 HP at 6000 rpm to 6500 rpm. TEC placement at 50% and TEC placement at 60% produces the highest power when compared to a standard exhaust manifold and TEC placement at 40%.

Installing TEC will provide better flushing which will affect the torque and power produced, TEC placement of 50% and TEC placement of 60% produce the best/highest torque and power.

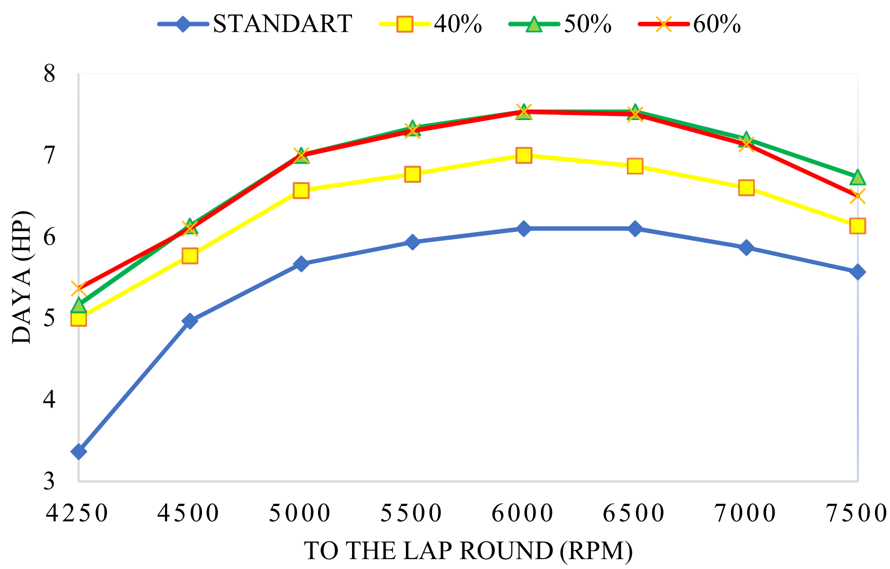

Figure 5. Graph of power test results

Specific fuel consumption test results

The Specific Fuel Consumption (KBBS) test results are shown in Figure *6*. They have the same character, from 4250 rpm to 5500 rpm the KBBS will decrease, then the rotation is increased until 7500 rpm KBBS will increase. Installing TEC on the exhaust manifold affects the specific fuel consumption of a motorbike.

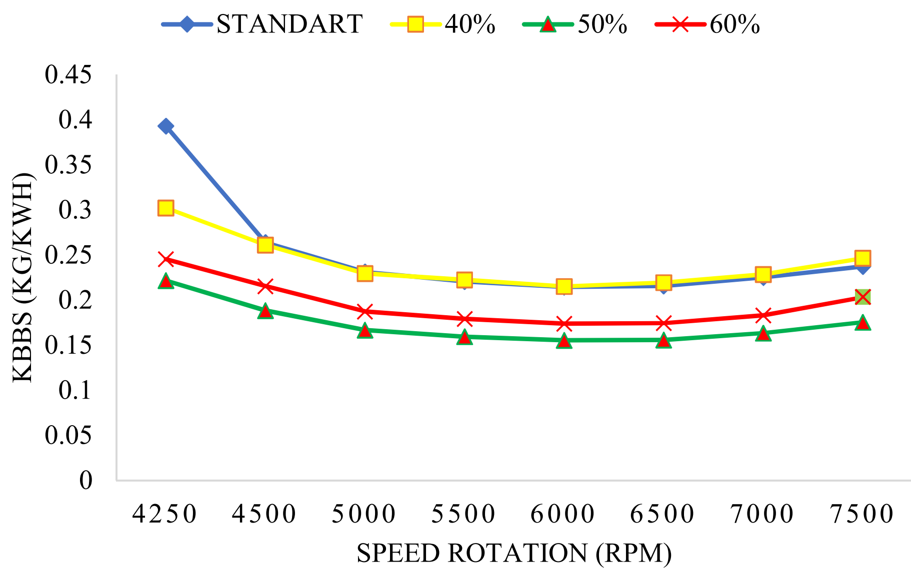

Figure 6. Graph of KBBS test results

On the standard manifold the lowest specific fuel consumption is 0.214 kg/kWh at 6000 rpm and with TEC placement of 40% the lowest specific fuel consumption is 0.215 kg/kWh at 6000 rpm. TEC placement in the 60% position has the lowest specific fuel consumption of 0.173 kg/kWh at 6000 rpm, and TEC placement in the 50% position has the lowest specific fuel consumption of 0.154 kg/kWh. at 6250 rpm.

From all the graphs in Figure 6, it shows that using the Torque Expansion Chamber at the 50% position is the best variation compared to the 40% and 60% positions. Placing the Torque Expansion Chamber in the 50% position results in the exhaust gas coming out being held briefly in the exhaust manifold so that the heat released is reduced.

3 CONCLUSION

Adding a Torque Expansion Chamber to the exhaust manifold with a placement of 40%, 50%, 60% has an effect on motorbike performance. Highest torque with TEC placement in the 50% position and TEC placement in the 60% position at 5000 rpm. Highest power with TEC placement at 50% and TEC placement at 60% from 6000 rpm to 6500 rpm. Lowest specific fuel consumption with the addition of TEC position of 50% at 6000 rpm.

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