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Effect of Rocker Arm Variation on the Perfonmance of a Single Cylinder Petrol Engine

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***Abstract*— The rocker arm functioned as a link between the camshaft and the valve which was responsible for regulating the rise and fall of the valve. Based on how it worked, the roller rocker arm with a conventional rocker arm were the same. However, a significant difference was seen in the roller placed at one end that made direct contact with the camshaft. The use of a conventional rocker arm produced considerable friction, so researchers replaced it with a roller rocker arm. The purpose of this study was to improve the performance of a single cylinder petrol engine using a roller rocker arm that had diameter sizes of 15 mm and 17 mm against the standard. The performance testing method used the variable open throttle to obtain data. Furthermore, the data was presented in graphical form and analyzed using anova. The independent variables were roller rocker arm whose diameter were 15 mm and 17 mm, conventional rocker arm and round 3000, 3500, 4000, 4500, 5000, 5500, 6000, 6500, 7000 rpm. The dependent variables were power, torque and specific fuel consumption. The control variables were engine 100 cc and 92 octane fuel. The largest power result at 6500 rpm was 6.25 Hp using a conventional rocker arm. The largest torque at 3500 rpm was 7.23 Nm using a 15 mm roller rocker arm. The smallest specific fuel consumption was 0.1546 kg/Hpxh at 5000 rpm using a 15 mm roller rocker arm.**

Keywords : Rocker Arm, Power, Torque, Specific Fuel Consumption

I. INTRODUCTION[1]

The The development of the automotive world is very advanced in terms of technology, such as motorbikes[1]. Basically all types of transportation in the manufacture of the factory has provided a standard worthy of use tests such as safety and comfort concerning power or power is no exception to motorbike transportation, but in some users of engine performance motorbike engine performance factory default or this standard is still felt to be less Maximum so that makes them decide to improve performance produced by the motorbike[2]. Improving engine performance can be done by replacing the conventional rocker arm to roller rocker arm, the amount of volumetric efficiency of air and fuel entering the combustion chamber in order to get the optimal efficiency of the engine[3]. The rocker arm is an engine component located above the cylinder head, this component functions to connect the camshaft with the valve which causes the valve to rise and fall [4]. The use of conventional rocker arm on motorbikes produces considerable frictional force, resulting in camshaft wear, rough noise and this condition results in a decrease in engine power[5].

When the camshaft is subjected to friction, the rocker arm surface will wear. High engine speed and hot temperatures can accelerate the wear of the components. As a result of the wear of the two components, there can be a large gap between the rocker arm and the camshaft. So that the valve opens less optimally which affects engine power. By using a roller rocker arm to reduce friction between the two components. This condition results in increased engine power and efficiency, thereby reducing the working weight of the engine[6]. The smaller the friction in the engine working process, the better. The roller rocker arm can reduce the friction that inhibits engine rotation so that the camshaft surface is not easily worn.

[7]Entitled comparison of the use of conventional rocker arm with roller bearing rocker arm on motorbike. Concluded that conventional rocker arm produces maximum power of 6.8 Hp and torque of 10.92 Nm. The roller rocker arm power is 5.9 Hp and 11.43 Nm of torque. Efficient fuel consumption using roller rocker arm. Environmentally friendly exhaust emissions using the roller rocker arm and testing both rocker arms obtained the same compression results at 90 Psi and 6.2kg/$cm2$ against the standard 10-11kg/$cm2$.

[8]In his research entitled modified cam test and rocker arm with roller on yamaha 5D9. Concluded that the use of modified camshaft and roller rocker arm has an effect on increasing torque by 0.04 Nm and power by 3.4 Hp, but can increase CO and HC emissions.

[9]Concluded that the greatest power using roller rocker arm. At 5000 rpm conventional rocker arm produces 7.715 Hp power while roller rocker arm produces 8.834 Hp power. The study was entitled the effect of using a roller rocker arm on motor power on a mio fino motorbike.

[10]In his research entitled the effect of the use of rocker arm on the performance and efficiency of a 4 stroke 200cc motorbike. Concluded the use of a standard camshaft and roller rocker arm at a distance of 100 m getting an acceleration timer of 5.25 seconds and a distance of 200 m getting an acceleration timer of 10.5 seconds. Camshaft modification 1 and roller rocker arm distance 100 m get timer 4.9 seconds, distance 200m acceleration timer 9.8 seconds. Camshaft modification 2 using roller rocker arm at a distance of 100 m known acceleration timer 4.7 seconds and a distance of 200 m known 9.4 seconds. Fuel consumption produced by roller rocker arm with standard camshaft is more economical than roller rocker arm with modified camshaft.

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1.1 literature review

1. Petrol Engine

A petrol engine is an internal combustion engine that uses petrol to power the engine. In an internal combustion engine, the chemical energy of the fuel is converted into heat energy and then converted into mechanical energy. there are two types of internal combustion engines, namely two stroke engines and 4-stroke engines. A 4-stroke engine is an internal combustion engine that requires four piston strokes[11].

Working cycle of a 4-stroke petrol motor:

a. Suction step

The piston moves from TMA (Top Dead Centre) to TMB (Bottom Dead Centre) to suck in the air and fuel mixture. The position of the suction valve is open and the exhaust valve is closed[12].

b. Compression stroke

The piston moves from TMB to TMA. The air and fuel mixture under homogeneous conditions is compressed to a certain pressure. The suction valve and exhaust valve are closed. At the end of the compression stroke, the combustion process occurs because of the spark through the spark plug[13].

c. Business steps

The piston moves from TMA to TMB. The high-pressure combustion gases push the piston downwards. The position of the suction valve and exhaust valve is closed[14].

d. Exhaust stroke

The piston moves from TMB to TMA. The position of the exhaust valve is open and the suction valve is also open so that the remaining combustion gases come out. In this process, overlapping occurs to clean the remaining combustion gases[15].

2. Timing Valve

The valve mechanism has a gap or valve clearance at the end of the intake and exhaust valve stems to prevent expansion when the engine is operating. Providing a gap in the valve can affect engine performance and valve gaps must be in standard conditions. The goal is to achieve timeliness when opening and closing the valve, so that the power obtained is more optimal[16].

3. Power

Power is the energy of engine combustion for each unit of time. The power function produces optimum speed when the road condition is flat[17]. Engine power is influenced by the engine speed given, if the greater the engine speed given, the greater the power given[18]. Power formula:

$$P = T.\boldsymbol{\omega}$$

The mass formula for omega is,

$$\boldsymbol{\omega} = \frac{2.\pi.n}{60}$$

Description:
P : Power (Watt)
n : Engine speed (rpm)
T : Torque (Nm)

4. Torque

Torque is a measure of the engine's ability to do work, so torque is an energy[19]. Torque can also be referred to as the ability of a machine to do work.[20] Torque formula

$$\mathrm{T} = \frac{P}{\omega}$$

The mass formula for omega is,

$$\boldsymbol{\omega} = \frac{2.\pi.n}{60}$$

Description:
T : Torque (Nm)
P : Daya (Watt)
n : Putaran mesin (rpm)

5. Specific fuel consumption

Specific fuel consumption also shows the mass of fuel required by the engine for each unit of time[21]. The amount of specificfuel consumption is as follows.

$$SFC = \frac{mf}{Ne}$$

Description:
Sfc : Fuel Consumption (kg/Hp.hour)
mf : Fuel flow rate ((kg/hour)
Ne : Power (Hp)

The mass formula for fuel flow is,

$$mf = \frac{v}{t}\ x\ \frac{3600}{1000}\ x\ pbb$$

Description:
mf : Fuel flow rate ((kg/hour)
v : Volume of measuring cup (cc)
t : Time (seconds)
pbb : Specific gravity of fuel (kg/l)

II. Method

The study uses a single-cylinder petrol engine by varying the rocker arm diameter with a quantitative method. The independent variables were roller rocker arm whose diameter were 15 mm and 17 mm, conventional rocker arm and round 3000, 3500, 4000, 4500, 5000, 5500, 6000, 6500, 7000 rpm. The dependent variables were power, torque and specific fuel consumption. The control variables were engine 100 cc and 92 octane fuel.

The process of taking power and torque using a dynotest:

1. Raising the vehicle on the dynotest.
2. Attach the dynotest tachometer probe to the vehicle's spark plug coil wire.
3. Start and warm up the engine for approximately five minutes to allow the engine to reach temperature.
4. Before starting the test, put the transmission gear in the 3rd acceleration gear. Open the throttle fully until the engine speed reaches the limit and press the data collection start button.
5. Power and torque tests were carried out 3 times to get accurate results. The results were entered into Ms. Excel for further analysis.

Specific fuel consumption is taken as follows:

1. Attach the burette to the carburettor using the petrol hose.
2. Install the tachometer on the vehicle.
3. Filling the burette using RON 92 fuel.
4. Start the engine, open the gas according to the predetermined rpm and measure the fuel contained in the burette using a stopwatch.

Figure 1. Testing scheme power and torque


Figure 2. Testing scheme SFC

III. Results and Discussion

1. Power

TABLE 1.
COMPARISON POWER

No	RPM	Power (Hp)		
		Standard	Diameter 15mm	Diameter 17mm
1	3500	2,83	3,53	3,31
2	4000	3,84	4,01	3,87
3	4500	4,25	4,49	4,32
4	5000	4,87	4,99	4,82
5	5500	5,47	5,35	5,25
6	6000	5,84	5,54	5,39
7	6500	6,25	5,39	5,34
8	7000	5,89	5,24	5,26

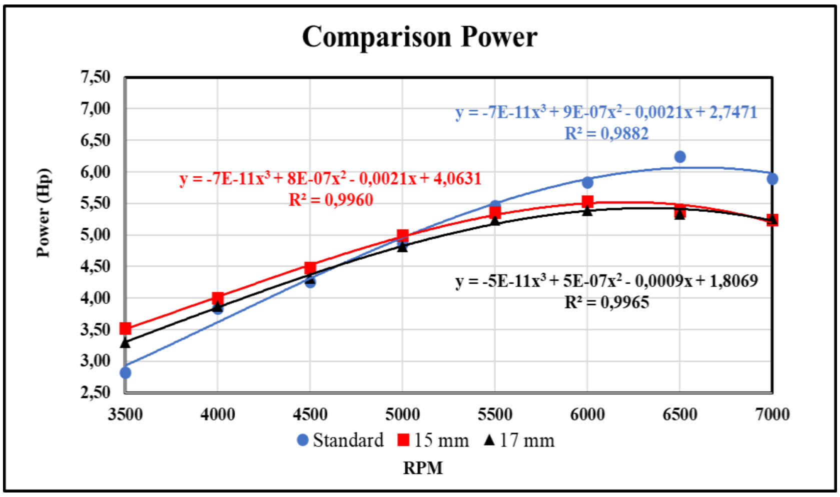

Figure 3. Comparison power

Test results using a conventional rocker arm of 6.25 Hp at 6500 rpm and the smallest power of 2.83 Hp at 3500 rpm. Roller rocker arm roller diameter of 15 mm produces the largest power of 5.54 Hp at 6000 rpm and the smallest power of 3.53 Hp at 3500 rpm. The 17 mm roller diameter rocker arm roller produces the largest power of 5.39 Hp at 6000 rpm and the smallest power of 3.31 Hp at 3500 rpm.

The use of roller rocker arm roller diameter of 15 mm decreased by 0.71 Hp (11.3%) against conventional rocker arm. The 17 mm roller rocker arm diameter roller gets the largest power of 5.39 Hp at 6000 rpm and the smallest power of 3.31 Hp at 3500 rpm. The 17 mm roller diameter roller rocker arm also decreased against the conventional rocker arm by 0.91 Hp (14.6%).

Engine power rises along with the increase in engine speed so that the fuel entering the combustion chamber is also more and more which results in increased power. The mixture of air and fuel entering the combustion chamber is well mixed so that combustion takes place perfectly and results in increased engine power. When the engine reaches maximum power, the engine power decreases which is caused by several factors.

The greatest power is generated by the conventional rocker arm, as the valves open earlier and close later. So the duration of valve opening is longer than using a roller rocker arm. Long duration of valve opening, the mixture of air and fuel entering the combustion chamber is more. The more air and fuel that enters the combustion chamber, the greater the power obtained. If the valve opening time is slowed down, the volume of fuel is reduced. This conventional rocker arm is suitable for use on flat roads such as urban roads, as it does not require a large torque.

TABLE 2.
COMPARISON TORQUE

No	RPM	Torque (Nm)		
		Standard	Diameter 15mm	Diameter 17mm
1	3500	5,80	7,23	6,76
2	4000	6,66	7,14	6,95
3	4500	6,76	7,10	6,84
4	5000	6,95	7,12	6,87
5	5500	7,02	6,94	6,80
6	6000	6,93	6,58	6,44
7	6500	6,71	5,91	5,85
8	7000	6,36	5,33	5,35

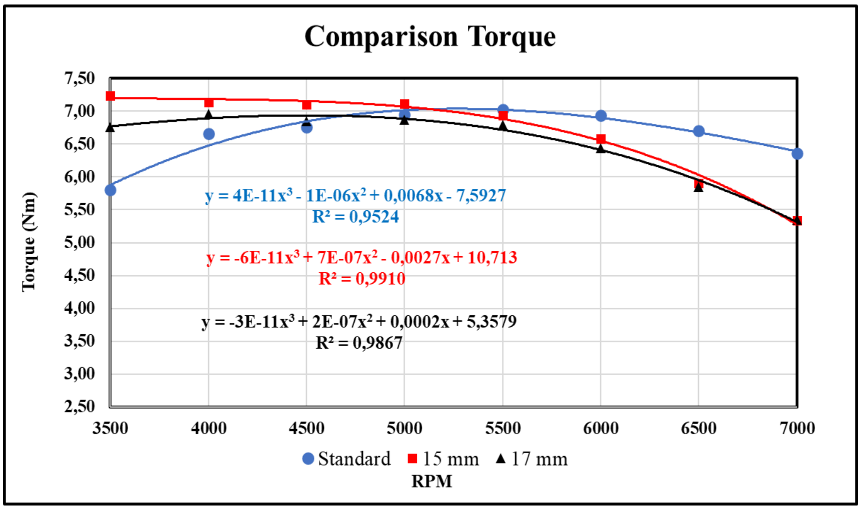

Figure 4. Comparison torque

The largest torque using a conventional rocker arm was 7.02 Nm at 5500 rpm and the smallest torque was 5.80 Nm at 3500 rpm. The largest torque using roller rocker arm roller diameter 15 mm 7.23 Nm at 3500 rpm and the smallest torque 5.33 Nm at 7000 rpm. The largest torque using roller rocker arm roller diameter 17 mm 6.95 Nm at 4000 rpm and the smallest torque 5.35 Nm at 7000 rpm.

The use of roller rocker arm roller diameter 15 mm there is an increase in torque of 0.21 Nm (2.90%) against conventional rocker arm. The largest torque when using a 17 mm roller diameter roller rocker arm is 6.95 Nm at 4000 rpm and the smallest torque is 5.35 Nm at 7000 Rpm. The use of 17 mm roller diameter roller rocker arm decreased torque by 0.07 Nm (0.99%) against conventional rocker arm.

The largest torque is produced by the roller rocker arm roller diameter of 15 mm, because the friction of the two components that intersect is smaller. The effect on the engine becomes more efficient with reduced botot or work resistance of an engine. So that the engine temperature is slower to heat and volumetric efficiency increases thanks to the relatively cooler engine botot or work resistance of an engine. So that the engine temperature is slower to heat and volumetric efficiency increases thanks to the relatively cooler engine temperature which results in increased torque. Similar to power, torque has a limit to how much it peaks. Then the torque will decrease due to several factors. The use of a roller rocker arm is suitable for use on inclines or mountain roads because it requires a large torque.

TABLE 3.
COMPARISON SFC

No	RPM	SFC (kg/Hpxh)		
		Standard	Diameter 15mm	Diameter 17mm
1	3500	0,1963	0,1612	0,1687
2	4000	0,1924	0,1605	0,1645
3	4500	0,1903	0,1557	0,1670
4	5000	0,1888	0,1546	0,1664
5	5500	0,1911	0,1621	0,1716
6	6000	0,1933	0,1710	0,1823
7	6500	0,1968	0,1911	0,1904
8	7000	0,2101	0,2050	0,2018

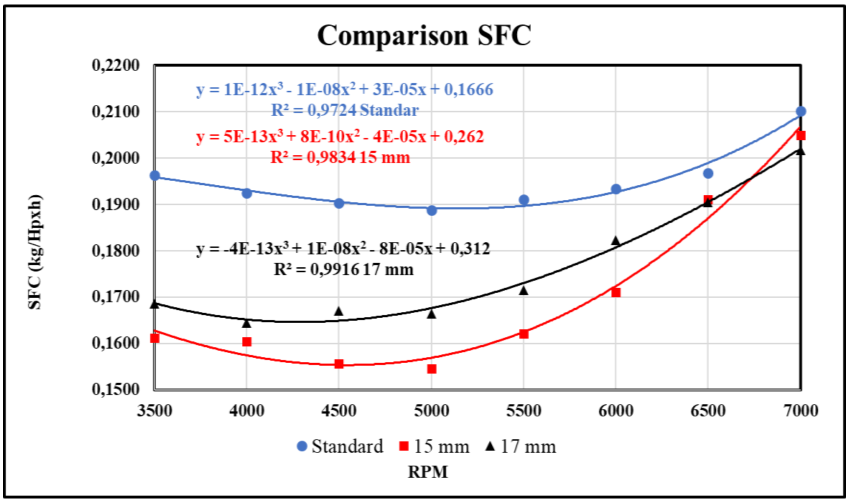

Figure 5. Comparison SFC

The largest specific fuel consumption using conventional rocker arm 0.2101 kg/Hpxh at 7000 rpm and the smallest specific fuel consumption of 0.1888 kg/Hpxh at 5000 rpm. The largest specific fuel consumption using roller rocker arm roller diameter 15 mm 0.2050 kg / Hpx hour at 7000 rpm and the smallest specific fuel consumption 0.1546 kg / Hpx hour at 5000 rpm. The largest specific fuel consumption using roller rocker arm roller diameter 17 mm 0.2018 kg / Hpx hour at 7000 rpm and the smallest specific fuel consumption 0.1645 kg / Hpx hour at 4000 rpm.

The use of roller rocker arm roller diameter 15 mm decreased specific fuel consumption by 0.0342 kg / Hpx hour (18.11%) against conventional rocker arm. While the use of roller rocker arm roller diameter 17 mm decreased specific fuel consumption by 0.0243 kg / Hpx hour (12.87%) against conventional rocker arm. Roller rocker arm roller diameter of 15 mm is more economical than conventional rocker arm because the friction produced is lower. The effect on the engine is efficient with less drag or weight on the engine. With a shorter valve opening duration, less air and fuel enter the combustion chamber. The less air and fuel that enter the combustion chamber, the more fuel efficient it is. If the valve opening time is short, the volume of fuel is reduced.

IV. Conclusion

The biggest power test result using conventional rocker arm is 6.25 Hp at 6500 rpm. The greatest power is produced by conventional rocker arm, because the duration of valve opening is longer than using roller rocker arm. Long valve opening duration can increase the mixture of air and fuel into the combustion chamber.

The largest torque using a roller rocker arm roller diameter of 15 mm is 7.23 Nm at 3500 rpm. The largest torque is produced by the roller rocker arm roller diameter of 15 mm, because the friction of the two components that intersect is smaller. The effect on the engine becomes more efficient with reduced botot or work resistance of a machine.

The smallest specific fuel consumption using a roller rocker arm roller diameter of 15 mm 0.1546 kg / Hpx hour at

5000 rpm. The 15 mm roller diameter roller rocker arm is more economical than the conventional rocker arm because of the lower friction produced. The effect on the engine becomes more efficient with reduced resistance or engine work weight. Shorter valve opening duration, less air and fuel entering the combustion chamber.

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