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The Comparison Of Fuel Consumption And Exhaust Gas Emission Betweenotto Engine Motorcycleand Modified Engine

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Abstract-Nowadays, most engines worldwide works based on the Otto principle. The consumption of fresh fuel – air mixtures into the combustion chamber occurred once per four strokesof piston. In this project the author manipulated the consumption of fresh fuel – air mixtures at Otto engine. The work principle of Otto engine modification is started from sucking a fresh fuel – air mixtures through the intake valve, compression, combustion, disposing combustion gasses through the exhaust valve, sucking back combustion gasses through the exhaust valve, compression, combustion, and disposing the gasses through the exhaust valve. Therefore, the consumption of fresh – air mixtures occurred once per eight strokes of piston. The purpose of this project is to compare the fuel consumption value and exhaust gas emission level between Otto engine standard motorcycleand Otto engine modification. The method used in this project is to calculate the value of fuel consumption using an equation and to test the exhaust gas emission by emission analyzer at 1500, 2000, 2500, 3000, and 3500 rpm with 90 octane fuel. The result of the fuel consumption calculation and emission testingisOtto engine modification is morethriftyand obtained lower pollution than standard in low rotation of the engine and the conclusion from this research is modified engine is more thrifty until 5 % in low rotation of engine with safer pollution, 1,94 % CO ; 4,2 % CO_2 ; 14,78 % O_2 ; 8,75 % HC.
Keywords: fuel consumption, exhaust gas emission, Otto engine, modification, standard.

I. INTRODUCTION

Recently, the development of science and technology is more rapidly, including in the automotive plant. There are so many automotive manufacturers are beginning to develop and create vehicles with lower exhaust gas pollution or environmentally friendly and economical fuel consumption. The governments in every country in the world is also more appealed to many automotive manufacturers to minimize air pollution which caused by exhaust gas of vehicle because many pollutants which caused by exhaust gas of vehicle is dangerous to people's lives.

Basically, the air pollution comes from exhaust gas of vehicle caused by incomplete combustion. Incomplete combustion produces many harmful pollutants such as carbon monoxide (CO) and hydrocarbons (HC). This leads the fuel consumption and fuel air mixtures becomes ineffective and inefficient, because the fuel air mixtures that flowed are not burned out in the combustion chamber so that still leaves a bit of unburned fuel that come out with the exhaust gas flow. In fact, many pollutants that unburned can be burned back like HC and CO. HC that emits together with the exhaust gases is unburned gasoline and CO that emits together with the exhaust gases are compounds that created by oxygen burning deprivation, so that HC and CO can be burned back.

There are many ways can be done to minimize air pollution which caused by exhaust gas of vehicle, one of the way ismodify work principle of anenginein order that can burn back the gases of combustiongasses that is not burned out. The flue gas of unburned gas is sucked by a vacuum of the piston into the combustion chamber to be burned back. In addition to minimizing air pollution, it also can save fuel consumption due to the entry of exhaust gases into the combustion chamber resulting in the inclusion of the fresh fuel air to be delayed, so that the fuel consumption becomes more efficient and thrifty.

Figure 1 are showing the work principle of Otto engine modification.

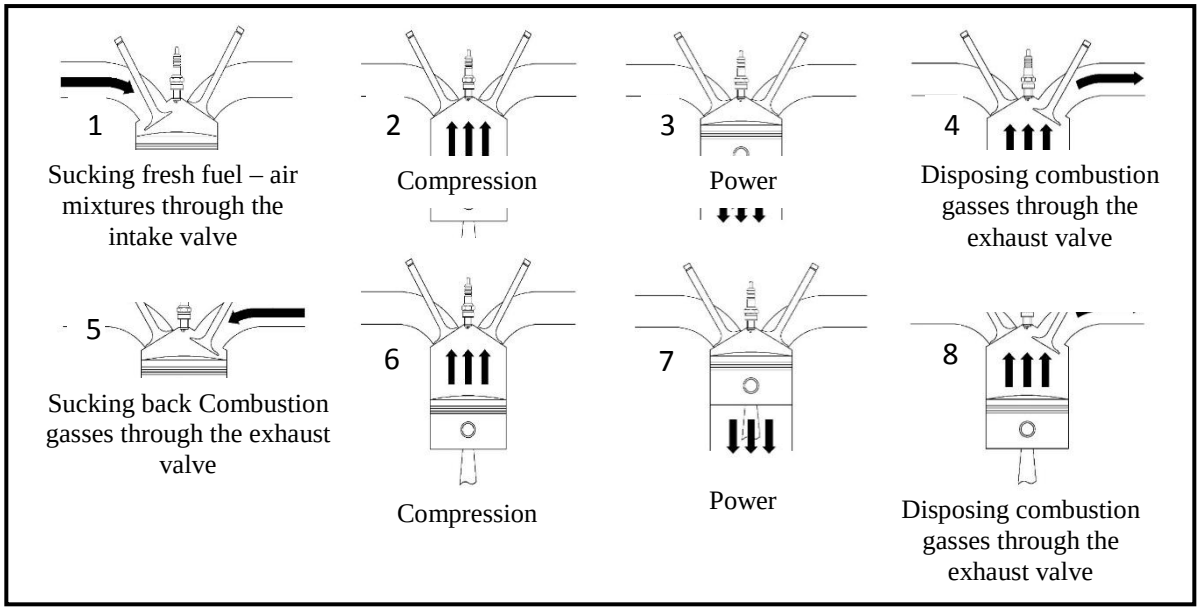

Figure 1. The Work Principle of Otto Engine Modification

II. THE RESEARCH METHODS

This research emphasizes on the comparison of fuel consumption and exhaust gas emission with the aim to find out how frugal fuel consumption value and how much exhaust emission levels are reduced in Otto engine modification. The study did not calculate any other parameters such as torque, power, and speed, due to the engineering materials used as an object of research is not in the form of a motorcycle, but in the form of engine.

The method used in this research is calculation and testing, where the method of calculation used an equation to calculate the fuel consumption and the method of testing useda portable testing type KOEN KEG – 500to test exhaust gas emission in the round of 1500, 2000, 2500, 3000, and 3500 rpm betweenstandard motorcycle and modified engine.The maximum rotation that can be achieved by modified engine is only 3500 rpm. This could occur because the gear ratio between the crankshaft and the camshaft is 4:1, which means 180 ° rotation of the crankshaft is equal to 45° rotation of the camshaft, so that the camshaft in engine modification rotates by 45° per stroke of piston, in order that camshaft can be rotated by 45° correctly, the design of the cam was made more tapered than standard cam design. This caused the engine rotation onmodified enginewas only be able to rotate at low rpmuntil 3500 rpm.

Tools and materialsare used in this research are as follows:

1) Graduated glass with unit of volume in ml.
2) Tachometer.
3) Timer or stopwatch.
4) Drill.
5) Fitting and the fuel hose ofOtto engine standard.
6) Emission analyzer type KOEN KEG – 500.
7) Fuel liquid with 90 octane number
8) Otto engine standard motorcycle.
9) Modified engine.

The equation used in the calculation of fuel consumptions as follows:

$$FC = \left(\frac{Vf \times 3600}{t \times 1000}\right) L/h$$

Source: Suhirta,The Effect of Gas from Electrolysis on Gas Exhaust Emissions. UI, Depok, 2008.

Note:

FC = Fuel consumption,

Vf =Volume of fluid (ml),

t = Time (second).

The equation required two variables, volume of fluid (Vf) and the time to drain the fuel (t). The volume of fluid in this research is 10 ml and the time required to drain 10 ml of fuel liquid each 1500, 2000, 2500, 3000, and 3500 rpm obtained with some of the following steps:

1) Prepare a graduated glass and a tachometer. In this research the author used graduated glass as a fuel tank. The graduated glass with unit of volume in ml is used to determine the volume of spent fuel and the tachometer is used to determine the value of engine rotation.
2) Prepare the appropriate fittings with an outer diameter of the standard fuel hose.
3) Drill the bottom of the graduated glass to make a hole.
4) Install the fitting and fuel hose into the hole of the graduated glass.
5) Install tachometer and graduated glass on modified engine.
6) Fill the fuel liquid into the graduated glass.
7) Prepare the timer or stopwatch.
8) Switch on the engine until it reaches working temperature.
9) Set the rotation of engine at idle condition (1500 rpm).
10) Turn on the timer and observe the volume of fuel in the graduated glass that reduced.
11) Turn off the timer when the volume of fuel is reduced by 10 ml.
12) Repeat the observation at 2000, 2500, 3000, and 3500 rpm.
13) Compare the result withstandard motorcycle.

Several stages in the testing of exhaust gas emission between Otto engine standard motorcycle andmodified engine is as follows:

1) Prepareemission analyzer equipment testingtype KOEN KEG – 500.
2) Switch on the engine and allow it for warming up.
3) Turn on the testing equipment tool and allow it for a while until it appears the word “ready” on the monitor screen of the testing equipment.
4) Enter the connector into the muffler.
5) Enter theprobeinto the connector.
6) Press the “ENT” on thecontrol panelto start the test.
7) Wait the numbers on the monitor till stable.
8) Press the “HOLD” three times to printthe value of the test that shown on themonitor screen.
9) Press the “ESC” on the control panel to resetthe numbers back to zero.
10) Turn off the emission testing equipment.

III. RESULT AND DISCUSSION

Here are the results that obtained in this research:

Table1. The Result of the Testing onOtto Engine Standard Motorcycle

Round (rpm)	Volume (ml)	Time (s)
1500	10	178
2000	10	133
2500	10	94
3000	10	49
3400	10	46

Table2. The Result of the Testing on Modified Engine

Round (rpm)	Volume (ml)	Time (s)
1500	10	239
2000	10	175
2500	10	165
3000	10	100
3400	10	65

Table 1 and table 2 displayedthe time that requiredto drain 10 ml fuel liquidon Otto engine standardandmodification engine.

Based on the equation that used to calculate fuel consumption, the result shown in Figure 2:

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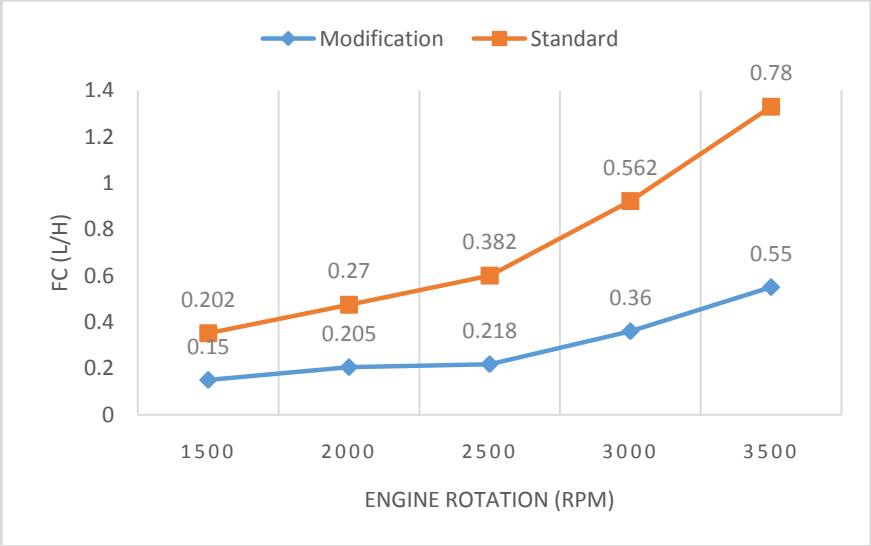

Figure2.Graph of Fuel Consumption

From Figure 2, it can be analyzed several things:

- Fuel consumption of modified enginein 1500 to 3500 rpm always lower thanOtto engine standard.This proves that fuel consumption of modified engine is more efficient than Otto engine standard.
- The Smallest value differences in fuel consumption is in the round of 1500 rpm and the greatest value differences is in the round of 3500 rpm.
- The increasing of fuel consumption on modified engine at any engine rotation is not too sharp compared to Otto engine standard.This showed that fuel consumption on modified engine is more efficient than standard.

In the exhaust gas emission test, results obtained are indicated on the graph below:

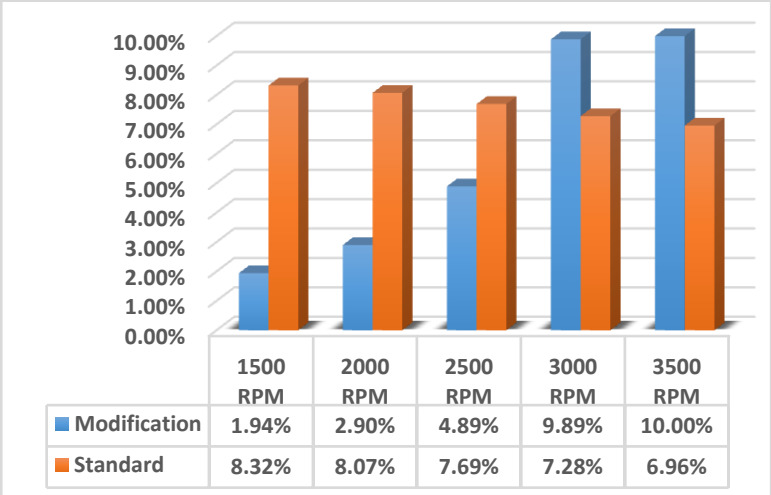

Figure3. The Graph ofCarbon Monoxide Comparison

In Figure 3 states that concentrations of carbon monoxide which produced by modified engine is so little compared toOtto engine standard in the round of 1500 rpm until 2500 rpm. The smallest concentration of carbon monoxide on modified engine is at 1500 rpm so that in this round, the toxins which produced by carbon monoxide has decreased considerably compared to the Otto engine standard. Therefore the using of modified engine is more effective and efficient in low rpm when seen from the level of carbon monoxide production.

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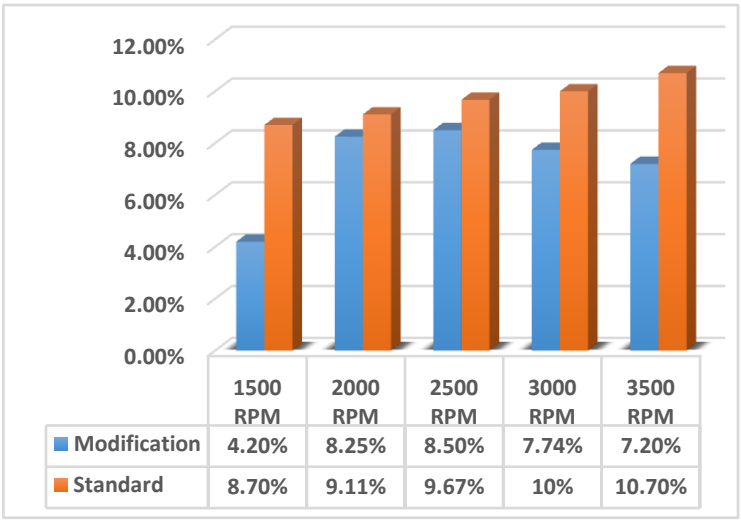

Figure4. The Graph ofCarbon Dioxide Comparison

Figure 4 states that the average concentration of carbon dioxide which generated by modified engine is lower than standard. High carbon dioxide levels is also indicates more perfect combustion, so that when it seen from the graph above, the combustion that occurs inmodified engine is bad, so that the Otto engine standardhave been more perfect than modified engine in every rotation especially in the higher rotation of engine (3500 rpm).

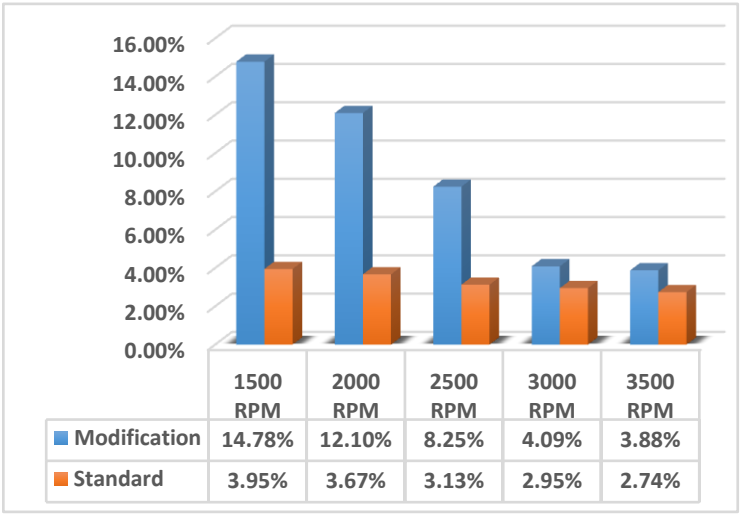

Figure 5. The Graph ofOxygen Comparison

Figure 5 shows that the oxygen produced by modified engine is higher than Otto engine standard. If There is an engine with higher oxygen, it means more levels of oxygen are not used in the combustion process of an engine and this happens because incomplete combustion. Therefore, the characteristics of ideal combustion of an engine should generate a small amount of oxygen, and when it seen from the graph above, the process with more complete combustion occurs in Otto engine standard.

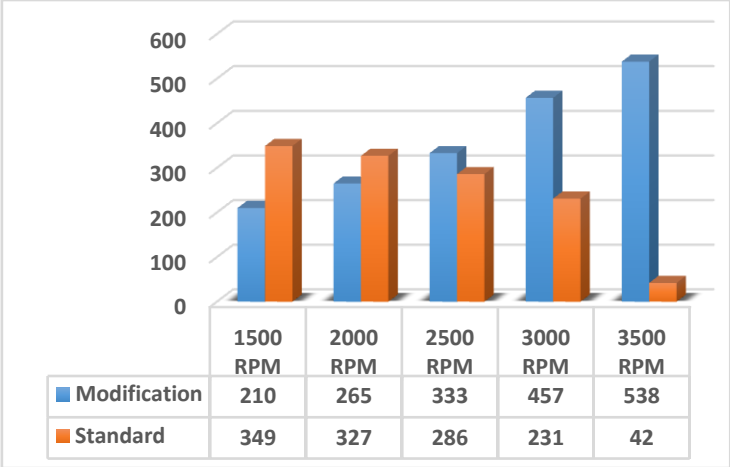

Figure6. The Graph of Hydrocarbon Comparison

In the figure 6 shows that the concentration of hydrocarbons in the round of 1500 rpm up to 3500 rpm on modified engine is inversely proportional to the standard. If the combustion process of modified engine occurred in the higher rotation, the level of toxin which produced by hydrocarbon will be increased, in contrast to the Otto engine standard, if the rotation of the engine is getting higher than the level of toxin which produced by hydrocarbon will be decreased, so from the graph above it can be seen that the good combustion process for modified engineis occurred atlower rotation and forOtto engine standard is occurred at high speed.

IV. CONCLUSION

Based on the result and discussion of the research above, it can be conclude that:

1) The fuel consumption of modified engine at 1500, 2000, 2500, 3000, and 3500 rpmis more efficient than standard.
2) The most frugal fuel consumption for modified engine occurs in the round of 3500 rpm.
3) Carbon Monoxide and Hydrocarbon are the dangerous concentration that can contaminate the environment, so if the levels of their concentration is lower than before, it will make the pollution on the air decreased.
4) Carbon Monoxide and Hydrocarbon are the concentration that can be burned back in lower rotation in the modified engine.
5) Carbon Monoxide can be burned back maximum until 6.38 % in the round of 1500 rpm.
6) Hydrocarbon can be burned back maximum until 139 ppm in the round of 1500 rpm.
7) Neither oxygen nor carbon dioxide can be burned back.
8) The emission which generated by the exhaust gasof modified engineis more environmentally friendly than standard engine in low rotation (1500 rpm – 2500 rpm).
9) The ideal combustion of modified engine occurs in the low rotation and the ideal combustion on Otto engine standard occurs in the high rotation.
10) The modified engine in stationery rotation (1500 rpm) is more thrifty 5 % with safer emission level: 1.94 % CO; 4.2 % CO_2; 14.78 % O_2; 8.75 % HC.

V. REFERENCE

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