Chapter 6
Experimental Analysis of Carburetor System on Turbocharger Performance

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Abstract This thesis deals with the experimental study of a micro-turbocharger test rig for engine performance with a racing carburetor and a standard carburetor. In order to achieve higher performance, bigger engine is needed. But with the turbocharger, the performance can be increased without the need of bigger engine. Therefore, the objective of this thesis is to observe the flow rate and fuel efficiency of the carburetor and evaluate the engine performance with the racing and standard carburetors. The project uses the turbo IHi RHF3, Lifan 160 cc, Taikom 28 mm carburetor, and Deni 18 mm carburetor and was selected according to the specification that needed to investigate the flow rate and fuel efficiency. All the data of the engine performance are collected, and some calculations are made to obtain the result.

Keywords Turbocharger · Carburetor · Experiment

6.1 Introduction

Most of the vehicles on the road nowadays are powered by an internal combustion engine or also known as (ICE). Most of the internal combustion engines use fossil fuel such as gasoline or diesel to make it run (Kalghatgi 2014). The internal combustion

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engine mainly consists of four cycles, that is, intake, compression, combustion, and exhaust strokes. During the intake stroke, the engine will induce the air outside the engine to mix with the fuel. After that, it will continue in the compression stroke; that is, the air–fuel mixture inside the engine will be compressed by the piston inside the combustion chamber. The engine power is directly proportional to the air–fuel mixture inside the combustion chamber. In this experimental study, a four-stroke horizontal motorcycle engine that has a cubic centimeter of 160 will be used in order to analyze the performance and potentially make more power by adjusting or replacing the main jet and pilot jet of the carburetor. The power of the engine greatly depends on the amount of air that can be delivered through the intake (Abdullah et al. 2014).

6.2 Literature Review

6.2.1 *Carburetor*

A comparison study done by Suthisripok et al. (2011) stated that, a vcf x Honda Nice 100S motorcycle whose carburetor was purposely designed for the use of gasoline could achieve the optimum performance condition. The study was conducted by using two different types of fuel, that is, the Gasoline 91 and the E85. The engine was tuned up on the dynamometer at a relatively fuel-rich mixture of 0.85 which in theory would give the best power output. The test conducted was done on the road, that is, a long riding test and a city riding test. The result of the experiment shows that the types of fuel used influence the fuel consumption of the vehicle as agreed by Mothilal et al. (2017). In Fig. 6.1, it shows the comparison from a performance perspective of the vehicle.

There is also a study by Lin and Liu (2008) which focuses on the exhaust gas emissions by using gasoline and ethanol-blended fuels. Figure 6.2 shows the comparison between the fuel blends. The study uses a single-cylinder engine 125 cc four-stroke Taiwan motorcycle that uses a GY6 carburetor fuel system. The result of the study concludes that by blending ethanol with gasoline by several ethanol concentration-blended fuels. The air–fuel ratio also decreased as engine inlet vacuum pressure increased. Air–fuel ratio decreased as the auxiliary nozzle diameter increased under the same main nozzle diameter. Also, air–fuel ratio decreased as the main nozzle diameter increased under the same auxiliary nozzle diameter.

In contrast, Alimin et al. (2009) stated that in two-stroke engine, carburetors are less efficient. This is because of the engine's operation that is two-stroke. In its typical operation, for two-stroke engine, the carburetion involves entrainment of fuel in the intake air stream before intake air begins to enter the engine crankcase. The underside of the piston will compress the charged mixture and enters the cylinder when the piston uncovers the transfer ports. Continuous presence of combustion products from the previously completed combustion power stroke is forced out from the cylinder

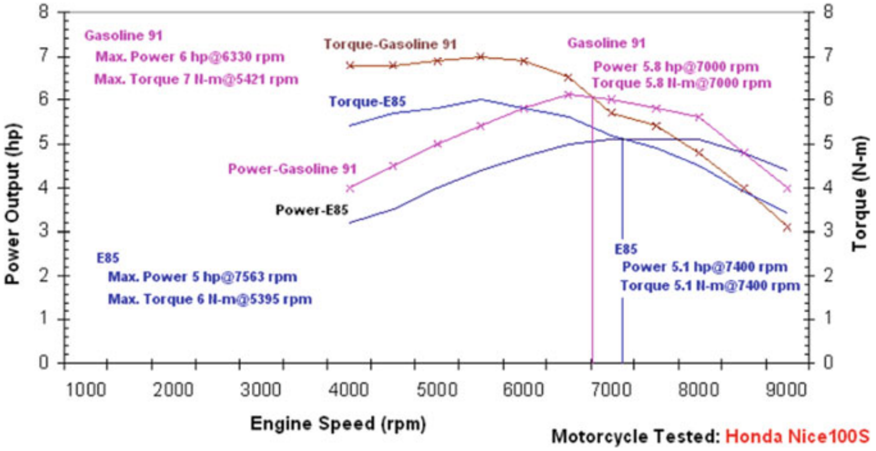
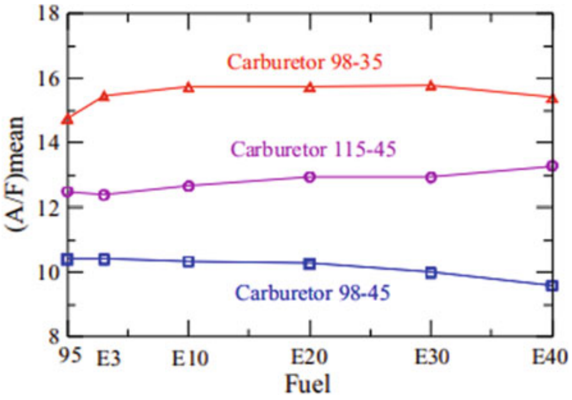


Fig. 6.1 Torque and power output of the used four-stroke motorcycle on dynamometer—Gasoline 91 and E85

Fig. 6.2 Air–fuel ratio comparison



by this new air–fuel mixture. Unfortunately, the exhaust ports are also open at this time, allowing 30–40% of the fuel to be lost directly into the exhaust stream (Radzak et al., 2019); at idle conditions, the losses can be as high as 70%. The process is illustrated in Fig. 6.3.

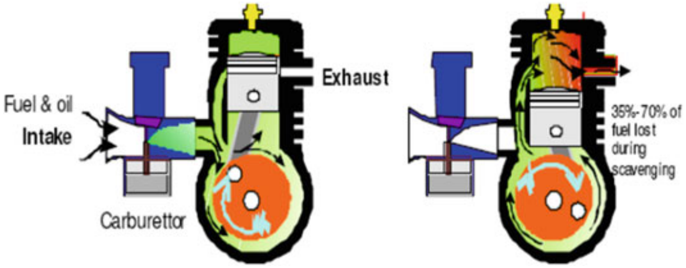


Fig. 6.3 Two-stroke engine cycle with carburetor

6.3 Methodology

6.3.1 Methodology Process

First and foremost, this idea is generated according to the problem statement, which is the existing test rig is not efficient as it supposes to be. In order to achieve higher efficiency and performance, the carburetor needed to be configured to the proper air–fuel mixture. A carburetor is a component that mixes air and fuel before sending the mixture into the combustion chamber. If the mixture is too rich or too lean, it may cause an incomplete combustion process, thus effecting the efficiency and performance. The main jets and the pilot jets of the carburetor are important to be tuned correctly. The function of the pilot jet is to supply the fuel when the engine is on idle or about 15%–20% of the throttle. The main jet functions when the throttle is above 20% or wide open. By selecting the proper size of both jets, the engine will have a more stable idling RPM and more power during wide open throttle.

6.3.2 Parameter Study

There are two important parameter studies about the engine performance before and after the improvement which are:

1. Fuel consumption (mf)
2. Flow rate (Q).

The data for fuel consumption (mf) will be collected from the anemometer with some derivation calculations in order to get the result to be analyzed for the engine performance before and after the improvement. The fuel consumption of the engine will be measured by using RON 95-type fuel.

Fuel consumption (mf)

$$\dot{m}f = \frac{W_1 - W_2}{T} \tag{6.1}$$

Flow rate (Q)

$$Q = \nu A \tag{6.2}$$

6.4 Results and Discussion

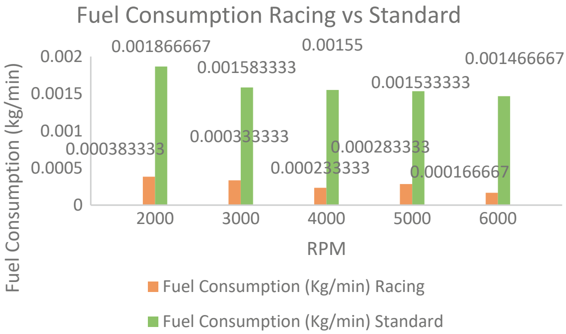
The flow rate and fuel consumption are set from the same revolution per minute in order to compare the performance. It starts from 2000 until 6000 RPM.

6.4.1 Fuel Consumption

The four-stroke motorcycle engine was operated by under different speed by using the same type of petrol which is RON 95 but different carburetors. The graph has shown different fuel consumptions between the racing and standard carburetors at which the most and less fuel consumption takes place when the engine is operated.

The overall fuel consumption is done by investigating the comparison graph in Fig. 6.4, and the standard carburetor uses more fuel than the racing carburetor. This is due to the standard carburetor that tends to vibrate more than the racing carburetor due to the structure of the test rig. Furthermore, upon investigation, the standard carburetor's air flow area is not as big as the racing carburetor that could take air more efficiently to be used in the combustion chamber and tends to fuel overflow due to the float of the carburetor that vibrates vigorously inside. The maximum efficiency obtained is at 6000 RPM with 88%.

Fig. 6.4 Overall fuel consumption



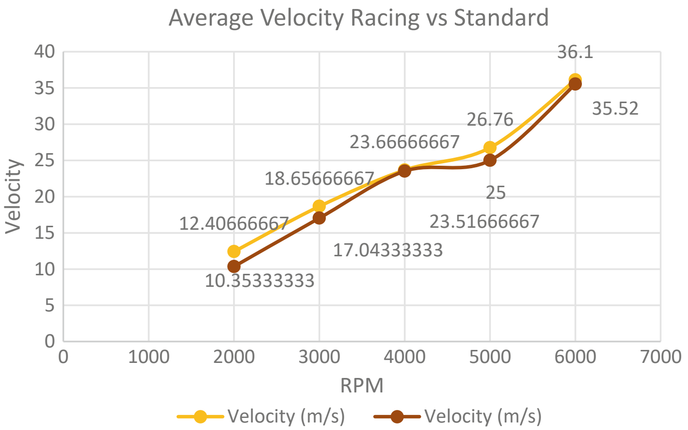


Fig. 6.5 Average velocity between racing and standard carburetors

6.4.2 *Velocity*

The velocity of the test rig is taken from the exhaust pipe, after the exhaust turbine. The velocity is taken to determine the amount of exhaust gas flow that comes out from the test rig. The velocity is taken three times to get the average velocity of the test rig before and after modification.

Figure 6.5 shows the average velocity of the exhaust gas from the exhaust pipe between both types of carburetors. The average velocity of the racing carburetor starts higher than the standard carburetor that is around 19% higher than the standard carburetor and more linear. But the standard carburetor almost matched the velocity of the racing carburetor at 4000 RPM, and the difference is around 0.64%. After that, for the standard carburetor, there is a stagnant of value in the graph, while the racing carburetor experiences a little drop but still an increase of 7%. Furthermore, the standard carburetor tends to rev itself, and the throttle is unresponsive.

6.4.3 *Flow Rate*

After the average velocity has been determined, the flow rate of both carburetors can be calculated. The flow rate of the test rig and the amount of exhaust gas are being discharged from the turbocharger.

The flow rate of the test rig can be observed in the comparison graph in Fig. 6.6. The flow rate of both types of carburetor is relatively similar. The flow rate of the racing carburetor is more linear and a bit higher than the standard carburetor, but at 4000 RPM, both have an almost similar value. The stagnation of the graph on the standard carburetor may be due to the inconsistency of the fuel and air mixture being

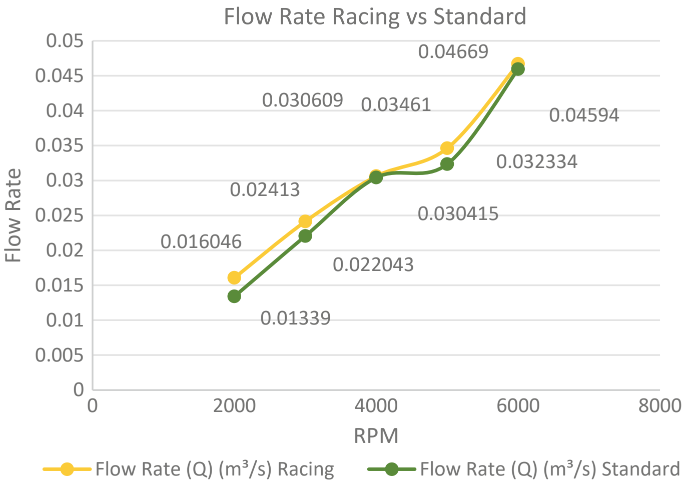


Fig. 6.6 Comparison between racing and standard

supplied due to the structure vibration that causes the carburetor float to shake. As for the racing carburetor, the structure is modified, the exhaust pipe has been extended, and there is less vibration overall on the test rig.

6.5 Conclusion

In this project, an experiment has been conducted to investigate the parameter that influences the micro-turbocharger system mainly on the types of carburetors used. This project focuses on the fuel consumption and the flow rate of the discharged exhaust gas that came through the turbine exhaust. The result shows that by using the racing carburetor, the fuel consumption as well as exhaust flow rate increased about 88% for fuel efficiency at 6000 RPM and 19% for flow rate at 2000 RPM compared to when using the standard carburetor. The graph line on the racing carburetor also is linear and does not flat out as the standard carburetor. The racing carburetor is tuned and made for high performance use even though a turbocharger is installed which is not common to be use on a motorcycle compared to the standard carburetor, which is made for daily commute and not suitable for high performance usage, let alone with a turbocharger installed.

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