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Effect of ECU programmable reprogramming of 4-stroke motorcycle modified injection on engine performance with variations in injection timing, ignition timing and fuel type

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Abstract

This research discusses the effect of reprogramming the ecu programmable 4-stroke motorcycle injection modification on engine performance with variations in injection timing, ignition timing and fuel variations by looking at the comparison of torque, power and exhaust emissions. Experiments are the research method used in this study, this research was conducted at teqleck Speedshop, in the treatment of the use of variations in the mixture of pertalite fuel with ethanol, the best emission results were obtained in the variation of the mixture of pertalite with ethanol, namely 80% pertalite with 20% ethanol, and the maximum mixture was in the mixture of pertalite 60% with 40% ethanol, while in the treatment of fuel variations of firstx with ethanol, the best emissions were obtained in the mixture of firstx 40% with 60% ethanol and the maximum was in the mixture of firstx 20% with 80% ethanol. From the exhaust gas emission data above, it can be seen that the best emissions are found in the mixture of 40% pertamax and 60% ethanol, namely the mixture of 60% pertamax ethanol, where the CO content can be seen at 0.07%, CO_2 at 5.6%, and HC at 100 (ppm).

Keywords

Engine performance, Injection timing, Ignition timing, ECU

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Introduction

Currently, the development of technology in the automotive field encourages humans to create various innovations, one of which is a means of transportation, namely motorcycle vehicles. There are many automotive companies that issue various types of motorbikes, ranging from conventional using a carburetor system to the latest technology, namely the EFI or Electronic Fuel Injection system. EFI is one of the systems that uses digital on motorbikes. This EFI system is a fuel spraying system whose work is controlled by the ECU (Engine Control Unit) (Wahyu, 2013).

At this time, motor vehicle manufacturers are not only competing in releasing their latest products, but they are also competing in releasing spare parts and components that have been modified in order to improve the performance of the vehicle itself, so that vehicle users feel satisfied and comfortable with the performance of their vehicles.

The use of modifications to the ECU is usually done especially for machines whose product use has passed (+ 5 years), or there are other things such as the desire of the vehicle owner to improve performance more than the performance provided by the vehicle manufacturer itself or because the vehicle will be used for certain conditions and situations, for example during the race.

Modification of the ECU is used to complement the weaknesses of the factory standard ECU which cannot be used to improve motorcycle performance because it is limited by the factory setting system which cannot be changed. So to complement the weaknesses of using the factory standard ECU, another alternative can be found, namely by using a programmable ECU to improve the performance of the motorcycle itself.

There are several ways to get perfect combustion in motorcycle vehicles, including controlling the amount of fuel into the engine so that the fuel can be adjusted according to the needs of the motorcycle engine and controlling the combustion process with the right ignition advance timing so that the entire fuel mixture with air burns perfectly. The ECU works in digital logic with a microcontroller that functions to process data by comparing and calculating data to be adjusted to the needs of the engine. Data processing from various sensors, namely throttle position sensor (TPS), Engine Oil Temperature (EOT), Oxygen Sensor (O2), Crank Position Sensor (CKP). Various ways are done by vehicle users to improve the performance produced by a vehicle, including increasing the cylinder volume (bore up), changing the camshaft opening angle, to the use of piggy backs.

Given the increasing number of vehicles, exhaust emissions containing hazardous substances in motor vehicles are also increasing. As a result, HC (Hydrocarbon) gas and nitrogen oxides clump in the air, blocking sunlight and a photochemical reaction occurs and forms chemical substances and other oxygen, especially the ozone layer, which is the strongest oxidant, causing the phenomenon of fog. This will obstruct vision, irritate the eyes and cause cancer. In general, the impacts caused by exhaust emissions on health are very numerous, such as causing an itchy throat, coughing, triggering hypertension and others (Bahrur Amin & Faisal Ismet, 2012).

Then the results of the study by Mulfi Hazmi, et al (2016) with the title of the study of the performance analysis of the EFI and Carburetor combustion system engines on gasoline engines, with the results of the study for the same engine speed, namely 3500 rpm, the power produced by the EFI engine is 44.179 Kw, while on the carburetor engine the power produced is 43.154 Kw with an increase of 2.37% with the conclusion that the power produced by the carburetor engine is smaller than the EFI engine.

In this study, the reprogramming that will be carried out by researchers is on the control system when injecting and also when igniting the purpose of programming on the control system when injecting. which is injected by the injector, namely to see how the performance of the vehicle itself. So to do the control, it is necessary to change the Injector Timing and ignition timing using a programmable ECU.

Method

This research is classified as experimental research. The experimental research method can be interpreted as a research method used to find the effect of certain treatments on others under controlled conditions. This study is intended to determine the effect of using variations in injection timing and ignition timing on the ECU programmable on the Yamaha vega zr modified injection motorcycle on its power and torque on the 4-stroke engine motor. In this research design there are two groups, namely experimental and control groups with the pattern in the Table 1.

Table 1. Treatment Groups and Test Descriptions

Group	Treatment	Test Result	Remarks / Description
R	X1	Y1	Treatment using carburetor data
R	X2	Y2	Treatment using standard ECU data
R	X3	Y3	Treatment using Juken 5 BRT ECU data
R	X4	Y4	Treatment by advancing fuel injection timing by 5° and ignition timing by 1°
R	X5	Y5	Treatment by advancing fuel injection timing by 10° and ignition timing by 2°
R	X6	Y6	Treatment by retarding fuel injection timing by 5° and ignition timing by 1°
R	X7	Y7	Treatment by retarding fuel injection timing by 10° and ignition timing by 2°

Results and Discussion

Research using pertalite fuel, the best emission data was obtained on the carburetor at idle speed with 3 tests carried out and the average exhaust gas emissions were CO of 2.24%, CO_2 of 1.2%, and HC 458.33 (ppm) at idle speed. while at medium speed the data was obtained, namely CO of 3.32%, CO_2 of 2.23%, and HC 196 (ppm). For emissions at high speeds, the results were CO of 3.49%, CO_2 of 2.57 and HC of 164.33 (ppm).

Research using pertalite fuel, the best emission data was obtained on the standard ECU at idle speed with 3 tests carried out and the average exhaust gas emissions at idle speed were CO of 1.61%, CO_2 of 3.87%, and HC of 92.67 ppm. Research using variations of fuel pertalite with ethanol, then the data obtained from the exhaust emission test results in 3 rounds with 3 tests carried out and the average of 3 tests was obtained in testing variations of fuel pertalite with ethanol. variation of fuel pertalite with ethanol, then the data of the exhaust emission test results were obtained in 3 rounds with 3 tests carried out and the average of 3 tests was obtained in the test of variations of fuel pertalite with ethanol.

The performance characteristics of 4-stroke engines under different configurations and fuel variations are illustrated in Figures 1 through Figure 4. Figure 1 shows the power output comparison between the carburetor system, standard ECU, and programmable ECU, while Figure 2 presents the corresponding torque comparison among the same systems. The effect of ethanol fuel variations on engine power using a standard ECU is depicted in Figure 3, and Figure 4 displays the torque results under the same fuel variations, highlighting how ethanol content influences engine performance when using a standard ECU configuration.

The results obtained were that the CO content in exhaust emissions decreased by an average of 39.1% with a difference of 0.63% and the CO_2 content increased by an average of 68.99% with a difference of 2.67% and the HC content decreased by 394.58%, namely with a difference of 365.66 ppm, so it can be concluded that the increase in exhaust emissions in the EFI system is good.

Figure 1. Carburetor power graph, standard ECU and programmable ECU

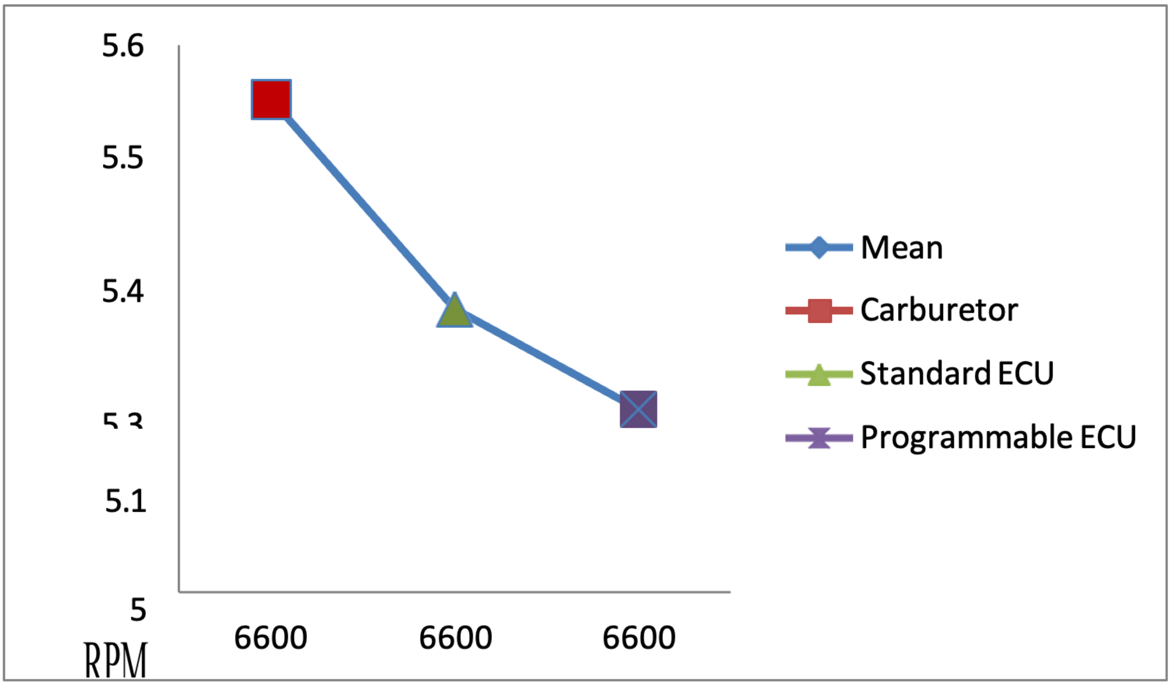


Figure 2. Carburetor torque graph, standard ECU and programmable ECU

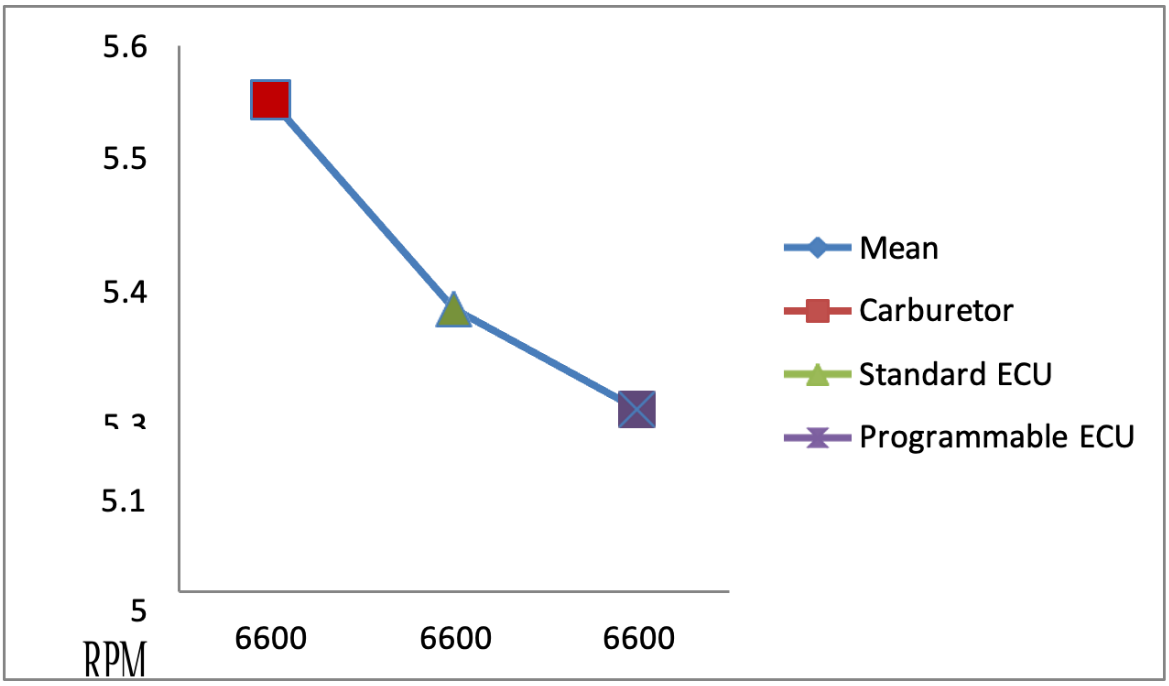


Figure 3. Graph of the results of testing the power of a 4-stroke engine using a standard ECU with ethanol variations

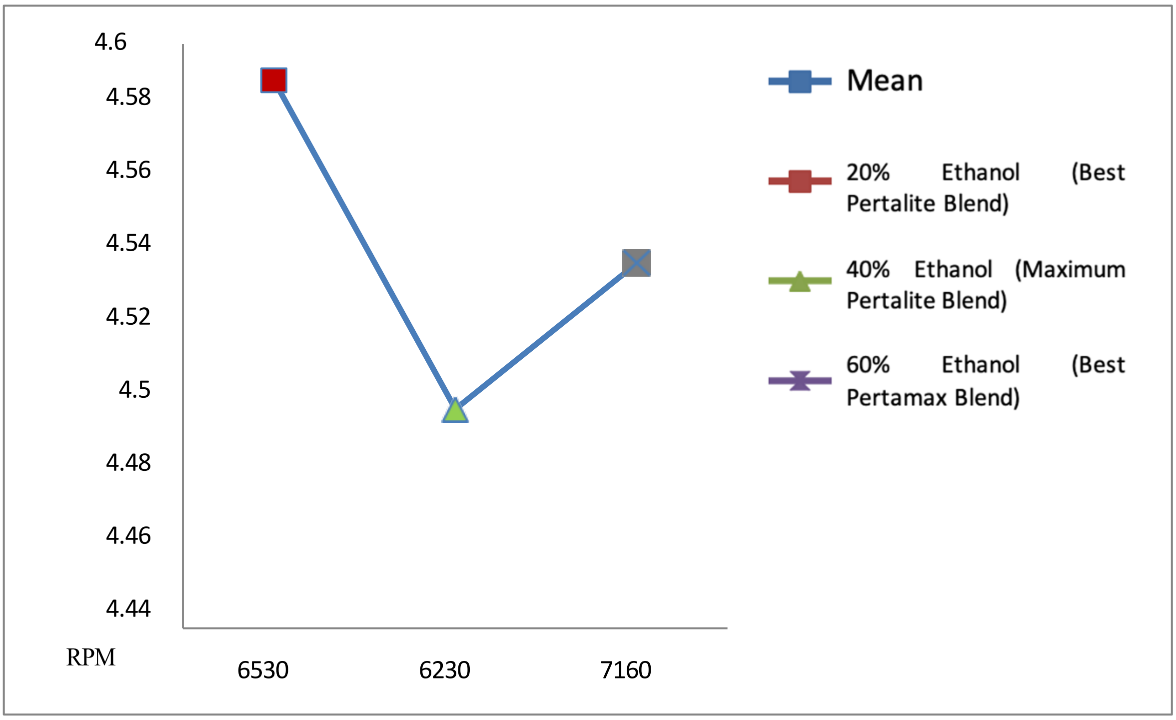
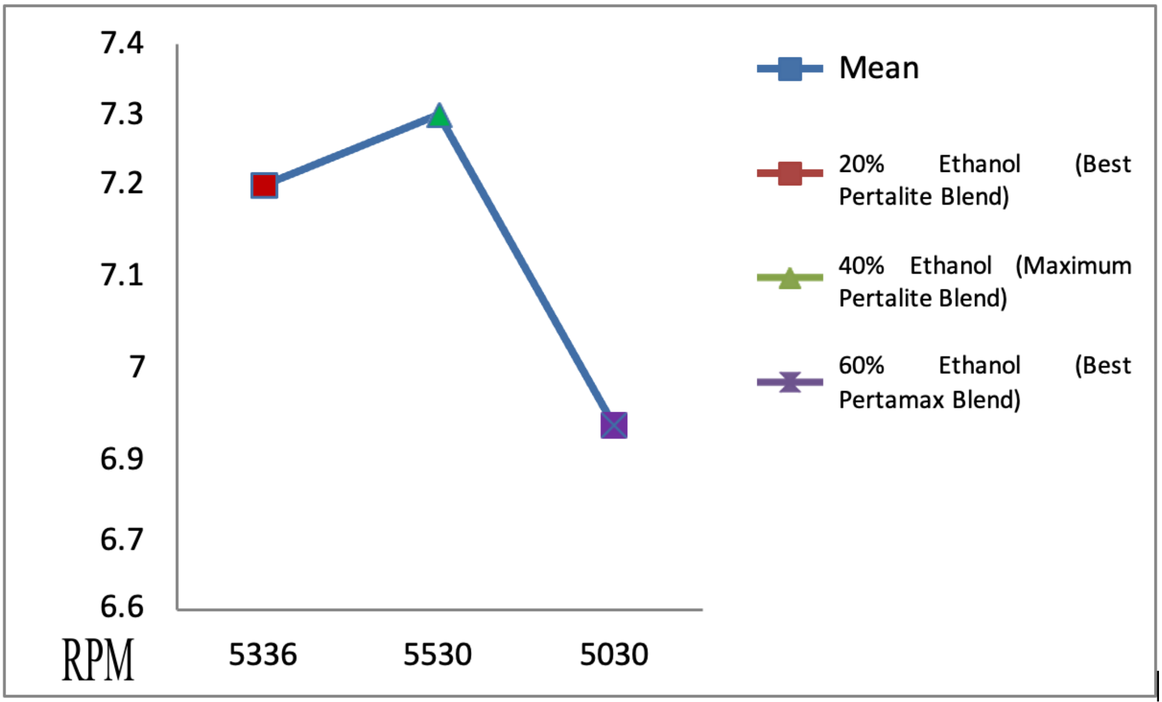


Figure 4. Torque test results graph of standard ECU 4-stroke motor with ethanol variations



Conclusion

This study examines the impact of reprogramming the programmable ECU on torque, power, and emissions in modified 4-stroke EFI motorcycles with variations in injection timing, ignition timing, and fuel type. The findings reveal that CO emissions decreased by 39.13% but were not statistically significant, while CO_2 emissions increased significantly by 68.99%. Power and torque both experienced significant reductions, by 4.33% and 6.95% respectively. Additionally, the best performance was observed with the ethanol–pertalite fuel blend, which outperformed the ethanol–pertamax blend with a smaller power decrease of only 1.10%.

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