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Analysis exhaust emissions (CO, CO_2 and HC) on FI motorcycle with variations in ignition timing, injector timing and fuel variations

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Abstract
This study discusses changes in the value of CO,CO_2 and HC levels of exhaust emission on FI Motorcycle with the use ECU Programmable (4 variation of ignition timing and injector timing) and use 3 variations fuel in every treatment. The purpose of this study was to determine how much influence the use ECU Programmable and variation of fuel on exhaust emissions produced by the research object. This type of research is experimental research. The object of this research is the FI Motorcycle. The lowest CO and HC level produced by FI Motorcycle with the use of a Programmable ECU is obtained in the treatment at ignition timing of 7°BTDC and injector timing 350°ATDC using Gasohol E30 fuel, while the lowest CO_2 level is obtained at the ignition timing treatment of 3°BTDC and when injector timing 350°ATDC uses Pertamax Turbo fuel, where the results obtained show significant changes after going through a comparative test using the T test with a significant level of 5%.

Keywords
Exhaust Emissions, ECU Programmable, Ignition Timing, Injector Timing, Fuel

Introduction
ECU (Electronic Control Unit) is an electronic device equipped with electronic components whose function is to control various systems (fuel system, engine system, cooling system, and electrical system) in EFI vehicles [1]. The EFI system uses various sensors to detect the working conditions of the engine and vehicle. And the ECU calculates the volume of fuel injection, ignition timing, fuel pump work [2]. This ECU tuning plays an active role in improving vehicle performance. Motorcycle manufacturers are not only competing in releasing their latest products, but they are also competing in releasing spare part that have been modified to improve the performance of the vehicle itself, so that vehicle users are satisfied with the performance of their vehicles. ECU modification is used to complement the weaknesses of the factory standard ECU which

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cannot be used to improve performance of motorcycle, 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 by using a Programmable ECU to improve performance on the motorcycle [3].

Various ways to reduce emission levels in vehicles by making modifications to both the engine, air induction system, fuel system and ignition system for the combustion process. To be able to do this, then a reprogrammable ECU system is required, so that various systems in fuel injection vehicles can be programmed according to needs. One type of reprogrammable ECU that has been spread in the aftermarket market is the ECU Programmable by using this type of ECU it is possible to reprogram the injection system of vehicle. In this research, the reprogramming that will be carried out is on the ignition timing control system on the spark plug and the injector timing control system, with the aim of seeing how changes in exhaust emissions from the vehicle itself. So to carry out this control, it is necessary to change the ignition timing on the spark plug and injector timing using the ECU Programmable on the FI motorcycle. Based on the above background, the author will conduct research on "Analysis Exhaust Emissions on FI Motorcycle with Variations in Ignition Timing, Injector Timing and Fuel".

The fuel injection system or EFI can be described as a fuel delivery system that uses a fuel pump at a certain pressure to convert liquid fuel into gas form and mix it with air which then enters the combustion chamber through an injector which is generally placed at the end of the intake manifold when the intake valve is open, namely in the suction step, so that the incoming air can mix with fuel [4]. Ideally, the fuel injection system must be able to supply fuel sprayed from the injector so that it can easily mix with air and produce a homogeneous mixture in the right mixture ratio according to the engine load rotation with the current atmospheric temperature [5].

Programmable ECUs that have been successfully developed by several manufacturers such as the ECU that we use in this study are Programmable ECUs sold in the aftermarket equipment that can be programmed using remotes and laptops so that they are more practical and easy to use to make fuel and ignition discharge settings. This ECU can adjust Injection Mapping (Mapping Correction), Injector Timing (Spraying Time), Ignition Timing (Ignition Curve), Revolution Limiter (Engine Speed Limit) and TPS (Throttle Position Sensor) Calibration [3].

There are several types of injection (spraying) in the EFI system of petrol motors (especially those with two or more cylinders), including simultaneous injection and independent injection. Simultaneous injection type is when the injection occurs simultaneously, while the separate injection type is when the injection of each injector is different from one another, usually in accordance with the ignition sequence or firing order (FO) [6]. The magnitude of the effect of advancing or retreating the time of injection by 2° also changes the combustion in the combustion chamber so that it can support engine performance and can reduce or increase exhaust emissions pollution [7].

Ignition moment can be defined as the time or moment when the spark plug starts to extinguish the flame in the combustion chamber, related to the position of the piston during the compression stroke. Ignition timing is usually measured in degrees of piston and axle crank position before top dead centre (BTDC) [3].

The most common fuel used in motorcycles is petrol. The main elements of petrol are carbon (C) and hydrogen (H). Gasoline consists of octane (C8H18) and nepthane (C7H16). The selection of petrol as a fuel is based on the consideration of two qualities; calorific value which is the amount of heat energy that can be used to produce work/effort and volatility which measures how easily petrol will evaporate at low temperatures. These two things need to be considered because the higher the calorific value, the lower the volatility, whereas low volatility can cause petrol to be difficult to burn [8].

One of the fuels that can be used to replace petrol is ethanol. Ethanol, also known as ethyl alcohol, has the chemical formula C2H5OH and is liquid at room temperature. Ethanol can be made from the cooking, fermentation and distillation of several types of plants such as sugar cane, corn, cassava or other plants with high carbohydrate content. In fact, in other studies, ethanol can also be made from agricultural waste (biomass). Therefore, ethanol has a bright potential as a substitute for petrol [9]. The results of research by Sugiartono, et al (2020) on the use of coconut skin bioethanol mixture in Pertamax fuel have the effect of reducing the level of exhaust emissions produced when tested using a Yamaha Xeon RC motorcycle. The increase in emission levels is accompanied by an increase in the level of the bioethanol mixture [10]. Where as in Anh Tuan Hoang's research (2019) the use of E5, E10 and RON95 on Wave RX 110 motorbikes reduced CO and HC exhaust emissions for E10 compared to E5 and RON95 [11].

In general, combustion is defined as a chemical reaction or reaction of oxygen fuel compounds (O_2) as an oxidant with a temperature greater than the flash point. There are two possibilities that occur in petrol engine combustion, namely normal combustion and abnormal combustion (not stoichiometric) [12].

Exhaust emissions are pollutants that pollute the air resulting from vehicle exhaust gases. There are four main emissions produced by vehicles. The four emissions are hydrocarbon (HC), carbon monoxide (CO), nitrogen oxides (NOx) and particles that come out of the exhaust gas [13]. Exhaust emissions are gases resulting from the combustion of incompletely burned fuel in the combustion chamber". The combustion process requires three basic components, namely oxygen (O_2), fuel and heat. The combustion process cannot take place if one of these basic components is not available. The combustion process must take place perfectly, so that the exhaust gas produced is perfect in the form of carbon dioxide (CO_2) and water vapour (H2 139 O) [12].

Based on research that has been done before with the title "The Effect of Fuel Injection Timing on Torque, Power and Exhaust Emissions on Beat FI Motorcycles". The lowest CO levels value of 1.59% and the lowest CO2 levels value of 3.33% was obtained in the

ECU Programmable treatment when injector timing 350°ATDC. The lowest HC levels value of 162.3ppm was obtained in the ECU Programmable treatment when injector timing 365°ATDC [14].

Method

This research uses an experimental method. The experimental research method can be interpreted as a research method used to find the effect of certain treatments on others under controlled conditions [15]. This research is intended to determine the comparative analysis between the use of Standard ECU and Programmable ECU with ignition timing and injector timing variations on FI motorcycles on exhaust emissions through direct data collection, either through treatment or referring to existing data. In this research pattern, there are two groups, namely the experimental group and the control group, which can be seen in Table 1.

Table 1. Specification of RE60 small car

Group	Treatment	Results Testing	Description
R	X1	Y1	No treatment (using Standard ECU)
R	X2	Y2	Treatment using ECU Programmable (ignition timing 3°BTDC and injector timing 355°ATDC).
R	X3	Y3	Treatment using ECU Programmable (ignition timing 7°BTDC and injector timing 355°ATDC).
R	X4	Y4	Treatment using ECU Programmable (ignition timing 3°BTDC and injector timing 350°ATDC).
R	X5	Y5	Treatment using ECU Programmable (ignition timing 7°BTDC and injector timing 350°ATDC).

Object of Research

The object of research is the target or object that is the subject of discussion in research. The object of research in this study is FI motorcycle. In this research, motorcycle exhaust emissions were measured with a gas analyser. Measurements were made between using the Standard ECU and ECU Programmable treatment of ignition timing and injector timing variations with 3 different types of fuel. Before measurements were taken, the motorcycle used was calibrated according to the manufacturer's standards without any changes or treatments.

Research Scheme

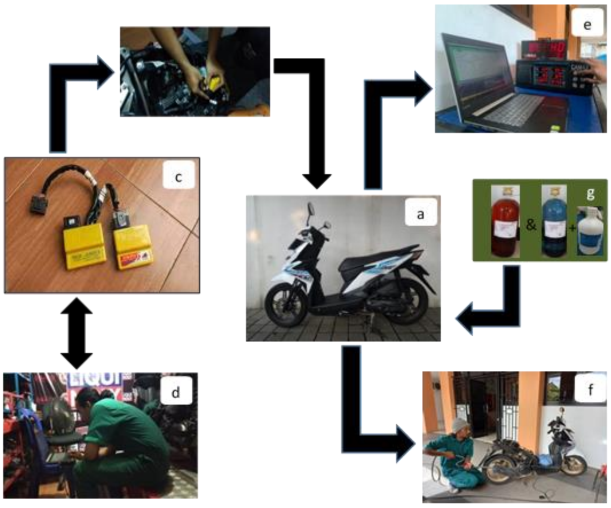

Figure 1. Description: a. FI motorcycle, b. Standard ECU, c. Programmable ECU, d. Laptop (programme), e. Gas analyzer, f. Test process, g. Fuel.

Data Analysis Technique

The data obtained in this study are displayed descriptively in the form of tables and graphs. This analysis technique is used to determine exhaust emissions using the Standard ECU and Programmable ECU, so the following analysis is carried out.

1. Exhaust emission data generated by the vehicle was obtained from a gas analyzer.
2. A t-test was conducted to see the significance of the data obtained.

$$Sx = \sqrt{\frac{\sum(x_i - \tilde{x})^2}{n-1}} \quad (1)$$

Description:

Xi : data value

X̄ : average

N : number of data

1. The standard deviations of samples 1 and 2 that have been obtained are entered into the t formula:

$$t = \frac{(\bar{x} - \bar{y})}{\sqrt{\frac{(nx-1)s_x^2 + (ny-1)Sy^2}{nx+ny-2}} \cdot \sqrt{\frac{1}{nx} + \frac{1}{ny}}} \quad (2)$$

Description:

t = test result

$\bar{x}$ = Average of 1st sample

$\bar{y}$ = Average of 2nd sample

x_i = data value

s_x^2 = Deviation standard of sample 1

s_y^2 = Deviation standard of sample 2

n_x and n_y = Number of samples

The df price used for the t table is:

$$df = n_x + n_y - 2$$

Result and Discussion

Testing Data Results

The data obtained from the exhaust emission test are the levels of CO, CO_2 and HC at idle speed which can be seen in Table 2 –6.

Table 2. Exhaust emission test results with Standard ECU

Fuel	ECU Standard											
	CO (%)				CO2 (%)				HC (ppm)			
	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.
Pertalite	0.62	0.59	0.59	0.60	12.4	12.1	12.2	12.2	177	159	266	200.7
Pertamax	0.66	0.58	0.58	0.61	12.7	12.5	12.7	12.6	206	212	250	222.7
P. Turbo	1.41	1.18	1.35	1.31	10.3	9.4	10.3	10.00	265	262	245	257.3
Gas. E10	1.63	1.72	1.72	1.69	11.1	12.4	12.3	11.93	471	634	565	556.7
Gas. E30	0.61	0.61	0.42	0.55	10.7	11.1	10.0	10.60	579	588	555	574.0

Table 3. Emission test results with ECU Pro. (ignition timing 3°BTDC and injector timing 355°ATDC)

Fuel	ECU Programmable (ignition t. 3°BTDC and injector t. 355°ATDC)											
	CO (%)				CO2 (%)				HC (ppm)			
	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.
Pertalite	4.21	4.04	4.05	4.10	9.4	8.6	8.7	8,90	673	560	538	590.3
Gas. E10	3.36	3.35	3.91	3.54	11.0	10.6	10.6	10,73	501	480	590	523.7
Gas. E30	2.73	2.93	3.78	3.15	9.0	9.3	9.9	9.40	829	829	899	852.3

Table 4. Emission test results with ECU Pro. (ignition timing 7°BTDC and injector timing 355°ATDC)

Fuel	ECU Programmable (ignition t. 7°BTDC and injector t. 355°ATDC)											
	CO (%)				CO2 (%)				HC (ppm)			
	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.
Pertalite	3.52	4.46	4.96	4.31	9.6	10.6	10.2	10.13	499	567	700	588.7
Gas. E10	2.10	2.71	3.05	2.62	9.8	10.0	10.4	10.07	516	505	545	522
Gas. E30	2.02	3.13	3.20	2.78	9.0	8,5	9.1	8.87	534	531	582	549

Table 5. Emission test results with ECU Pro. (ignition timing 3°BTDC and injector timing 350°ATDC)

Fuel	ECU Programmable (ignition t. 3°BTDC and injector t. 350°ATDC)											
	CO (%)				CO2 (%)				HC (ppm)			
	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.
Pertalite	2.62	3.71	3.89	3.41	6.4	8.3	8.4	7.70	570	674	655	633
Gas. E10	4.41	3.95	4.46	4.27	9.5	8.5	9.3	9.10	510	475	536	507
Gas. E30	0.37	1.0	1.63	1.00	11.3	11.0	10.8	11.03	422	449	607	493

Table 6. Emission test results with ECU Pro (ignition timing 7°BTDC dan injector timing 350°ATDC)

Fuel	ECU Programmable (ignition t. 7°BTDC and injector t. 350°ATDC)											
	CO (%)				CO_2 (%)				HC (ppm)			
	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.	Test 1	Test 2	Test 3	Aver.
Pertalite	3.73	3.70	4.03	3.82	8.3	8.4	8.8	8.50	567	458	741	588.7
Gas. E10	4.30	3.55	3.96	3.94	9.5	7.6	8.1	8.40	731	541	775	682.3
Gas. E30	0.02	0.02	0.02	0.02	8.8	8.4	9.2	8.80	485	469	487	480.3

Graphics

1. Comparison chart of CO levels of exhaust emission test results

The comparison chart of CO levels of exhaust emission test results can be seen in Figure 2 and Table 7 shows the comparative T-test Results of CO Levels.

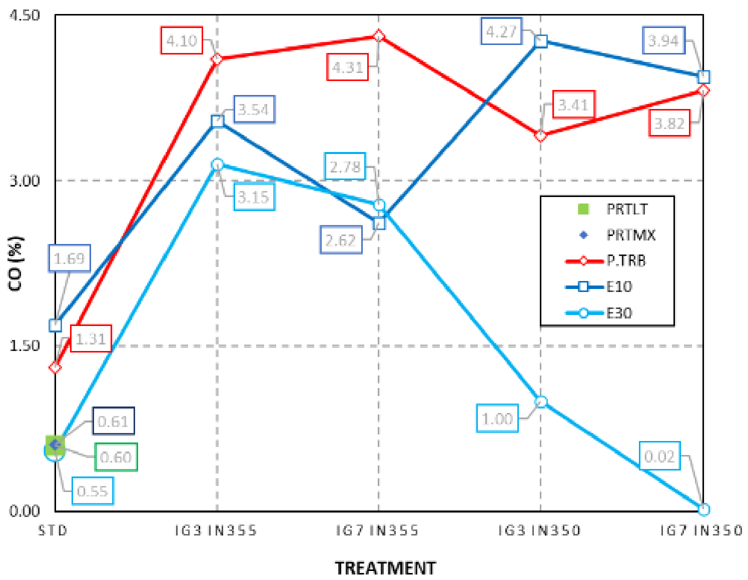

Figure 2. CO Levels Comparison Chart

Table 7. Comparative T-test Results of CO Levels.

Treatment	N	Mean	S	S2	Df	t count	t table	Description
ECU Standar Pertalite	**3**	**0.6**	**0.017**	**0.0003**				
ECU Standar Pertamax	3	0.61	0.046	0.002133	4	0.234	2.776	Insignificant
ECU Standar Pertamax Turbo	3	1.31	0.119	0.004267	4	10.226	2.776	Significant
ECU Standar Gasohol E10	3	1.69	0.052	0.028322	4	34.446	2.776	Significant
ECU Standar Gasohol E30	3	0.55	0.11	0.005408	4	0.778	2.776	Insignificant
ECU Pro.IG.3.IN.5 P.Turbo	3	4.1	0.095	0.0242	4	62.523	2.776	Significant
ECU Pro.IG.7.IN.5 P.Turbo	3	4.31	2.16	0.018202	4	2.975	2.776	Significant
ECU Pro.IG.3.IN.10 P.Turbo	3	3.41	0.687	9.3312	4	7.082	2.776	Significant
ECU Pro.IG.7.IN.10 P.Turbo	3	3.82	0.183	0.943938	4	30.423	2.776	Significant
ECU Pro.IG.3.IN.5 Gs.E10	3	3.54	0.32	0.066613	4	15.89	2.776	Significant
ECU Pro.IG.7.IN.5 Gs.E10	3	2.62	0.481	0.2048	4	7.269	2.776	Significant
ECU Pro.IG.3.IN.10 Gs.E10	3	4.27	0.281	0.462722	4	22.579	2.776	Significant
ECU Pro.IG.7.IN.10 Gs.E10	3	3.94	0.376	0.157922	4	15.386	2.776	Significant
ECU Pro.IG.3.IN.5 Gs.E30	3	3.15	0.558	0.282151	4	7.919	2.776	Significant
ECU Pro.IG.7.IN.5 Gs.E30	3	2.78	0.662	0.621613	4	5.702	2.776	Significant
ECU Pro.IG.3.IN.10 Gs.E30	3	1	0.63	0.876488	4	1.099	2.776	Insignificant
ECU Pro.IG.7.IN.10 Gs.E30	3	0.02	0	0.7938	4	58	2.776	Significant

2. Comparison chart of CO_2 levels exhaust emission test results

The comparison chart of CO_2 levels of exhaust emission test results can be seen in Figure 3 and Table 8 shows the comparative T-test Results of CO_2 Levels.

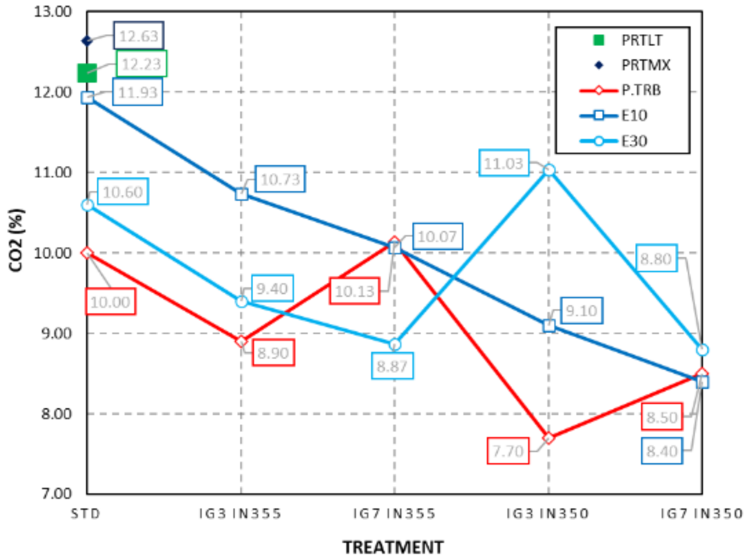

Figure 3. Comparison Chart of CO_2 Levels.

Table 8. Comparative T-test Results of CO_2 Levels

CO_2								
Treatment	**N**	**Mean**	**S**	**S2**	**Df**	**t count**	**t table**	**Description**
ECU Standar Pertalite	**3**	**12.2**	**0.153**	**0.023333**				
ECU Standar Pertamax	3	12.6	0.115	0.013333	4	3.618	2.776	Significant
ECU Standar Pertamax Turbo	3	10.0	0.520	0.270400	4	7.137	2.776	Significant
ECU Standar Gasohol E10	3	11.9	0.723	0.522729	4	0.711	2.776	Insignificant
ECU Standar Gasohol E30	3	10.6	0.557	0.310249	4	4.898	2.776	Significant
ECU Pro.IG.3.IN.5 P.Turbo	3	8.9	0.436	0.190096	4	12.497	2.776	Significant
ECU Pro.IG.7.IN.5 P.Turbo	3	10.1	0.503	0.253009	4	6.930	2.776	Significant
ECU Pro.IG.3.IN.10 P.Turbo	3	7.7	1.127	1.270129	4	6.904	2.776	Significant
ECU Pro.IG.7.IN.10 P.Turbo	3	8.5	0.265	0.070013	4	21.165	2.776	Significant
ECU Pro.IG.3.IN.5 Gs.E10	3	10.7	0.231	0.053361	4	9.402	2.776	Significant
ECU Pro.IG.7.IN.5 Gs.E10	3	10.1	0.306	0.093330	4	10.970	2.776	Significant
ECU Pro.IG.3.IN.10 Gs.E10	3	9.1	0.529	0.279841	4	9.856	2.776	Significant
ECU Pro.IG.7.IN.10 Gs.E10	3	8.4	0.985	0.970028	4	6.662	2.776	Significant
ECU Pro.IG.3.IN.5 Gs.E30	3	9.4	0.458	0.209764	4	10.165	2.776	Significant
ECU Pro.IG.7.IN.5 Gs.E30	3	8.9	0.321	0.103041	4	16.387	2.776	Significant
ECU Pro.IG.3.IN.10 Gs.E30	3	11.0	0.252	0.063353	4	7.079	2.776	Significant
ECU Pro.IG.7.IN.10 Gs.E30	3	8.8	0.400	0.160000	4	13.889	2.776	Significant

3. Comparison chart of HC levels of exhaust emission test results

The comparison chart of HC levels of exhaust emission test results can be seen in Figure 4 and Table 9 shows the comparative T-test Results of HC Levels.

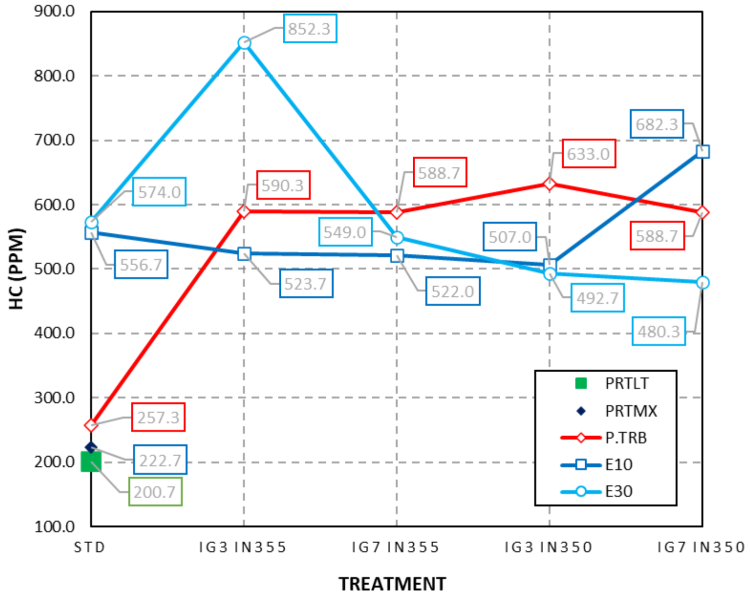

Figure 4. Comparison Chart of HC Levels.

Table 9. Comparative T-test Results of HC Levels.

HC								
Treatment	**N**	**Mean**	**S**	**S2**	**Df**	**t count**	**t table**	**Description**
ECU Standar Pertalite	**3**	**200.7**	**57.292**	**3282.333333**				
ECU Standar Pertamax	3	222.7	23.861	569.333333	4	0.614	2.776	Insignificant
ECU Standar Pertamax Turbo	3	257.3	10.786	116.335000	4	1.683	2.776	Insignificant
ECU Standar Gasohol E10	3	556.7	81.819	6694.333333	4	6.174	2.776	Significant
ECU Standar Gasohol E30	3	574	17.059	291.009481	4	10.817	2.776	Significant
ECU Pro.IG.3.IN.5 P.Turbo	3	590.3	72.432	5246.394624	4	7.308	2.776	Significant
ECU Pro.IG.7.IN.5 P.Turbo	3	588.6	102.237	10452.404169	4	5.733	2.776	Significant
ECU Pro.IG.3.IN.10 P.Turbo	3	633	55.381	3066.999780	4	9.398	2.776	Significant
ECU Pro.IG.7.IN.10 P.Turbo	3	588.7	142.739	20374.422121	4	4.370	2.776	Significant
ECU Pro.IG.3.IN.5 Gs.E10	3	523.7	58.398	3410.326404	4	6.839	2.776	Significant
ECU Pro.IG.7.IN.5 Gs.E10	3	522	20.664	427.000896	4	9.138	2.776	Significant
ECU Pro.IG.3.IN.10 Gs.E10	3	507	30.610	936.972100	4	8.168	2.776	Significant
ECU Pro.IG.7.IN.10 Gs.E10	3	682.3	124.360	15465.409600	4	6.093	2.776	Significant
ECU Pro.IG.3.IN.5 Gs.E30	3	9.4	0.458	0.209764	4	10.165	2.776	Significant
ECU Pro.IG.7.IN.5 Gs.E30	3	8.9	0.321	0.103041	4	16.387	2.776	Significant
ECU Pro.IG.3.IN.10 Gs.E30	3	11.0	0.252	0.063353	4	7.079	2.776	Significant
ECU Pro.IG.7.IN.10 Gs.E30	3	8.8	0.400	0.160000	4	13.889	2.776	Significant

Discussion

In accordance with the data obtained from the results of exhaust emission testing, it is known that the lowest CO level produced with the ECU Programmable is obtained in the treatment of ignition timing 7°BTDC and injector timing 350°ATDC using E30 Gasohol fuel with a level value of 0.02%, where there is a decrease with a difference of 0.58% from the previous standard data of 0.60%. This is also evidenced by the t test with a significant level of 5% showing a result of 58.000 with a t table comparison of 2.776. The highest CO levels produced with the ECU Programmable were obtained in the treatment of ignition timing 7°BTDC when injector timing 355°ATDC using Pertamax Turbo fuel at 4.31%, where there was an increase with a difference of 3.71% from the previous standard data of 0.60%. This is also evidenced by the t test with a significant level of 5% showing a result of 2.975 with a t table comparison of 2.776. The lowest CO level obtained from the relevant research sample was 1.59%, produced with the ECU Programmable injector timing treatment of 350°ATDC (pushed back 10° from the standard ECU Programmable data) using Pertalite fuel.

In accordance with the data obtained from the results of exhaust emissions testing, it is known that the lowest CO_2 levels produced with the ECU Programmable are obtained in the treatment of ignition timing 3°BTDC and injector timing 350 °ATDC using Pertamax Turbo fuel with a level value of 7.70%, where there is a decrease with a difference of 4.53% from the previous standard data of 12.2%. This is also evidenced by the t test at a significant level of 5% showing a result of 6.904 with a comparison of t table 2.776. The highest CO_2 levels produced with the ECU Programmable were obtained in the treatment of ignition timing 3°BTDC and injector timing 350°ATDC using E30 Gasohol fuel with a level value of 11.0%, where there was an increase with a difference of 1.2% from the previous standard data of 12.2%. This is also evidenced by the t test at a significant level of 5% showing a result of 7.079 with a comparison of t table 2.776. The lowest CO_2 level obtained from the relevant research sample was 3.33%, produced 261 with the ECU Programmable injector timing treatment of 350°ATDC (pushed back 10° from 262 the standard ECU Programmable data) using Pertalite fuel.

In accordance with the data obtained from the results of exhaust emissions testing, it is known that the lowest HC levels produced with the ECU Programmable are obtained in the treatment of ignition timing 7 °BTDC and injector timing 350 °ATDC using E30 Gasohol fuel with a level value of 480.3ppm, where there is an increase with a difference of 279.6ppm from the previous standard data of 200.7ppm. This is also evidenced by the t test at a significant level of 5% showing a result of 8.311 with a comparison of t table 2.776. The highest HC levels produced with the ECU Programmable were obtained in the treatment of ignition timing 3°BTDC and injector timing 355°ATDC using E30 Gasohol fuel with a value of 852.3ppm, where there was an increase with a difference of 651.6ppm from the previous standard data of 200.7ppm. This is also evidenced by the t test at a significant level of 5% showing a result of 16.098 with a comparison of t table 2.776. The lowest HC level obtained from the relevant research sample was 162.3ppm, produced with the ECU Programmable injector timing treatment of 365°ATDC (advanced 5° from the standard ECU Programmable data) using Pertalite fuel.

Conclusion

The best exhaust gas emissions produced by FI motorbikes with the use of 281 Programmable ECUs are obtained at 7°BTDC ignition timing and 350°ATDC injector timing using E30 Gasohol fuel with a CO content value of 0.02% CO_2 content of 8.80% HC content of 480.3 ppm where the results obtained show significant changes. Motorcyclists and other vehicle users need to understand the adjustment of fuel octane number to engine specifications, this is so that the levels of harmful elements from the resulting exhaust emissions can be lower, so that contamination of the air is also reduced. For researchers who continue this test (Use of Programmable ECU) is expected to remap the duration of injector spraying or replace standard injectors with racing injectors as needed, the type of spark plug used, and consider the octane value of the fuel used in accordance with the compression ratio and engine specifications in the next study.

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