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IMPROVING UNDERBONE MOTORCYLES IGNITION SYSTEM USING CDI PROGRAMMED BY CAMSHAFT DURATION ON A 4-STEP 125 CC MOTOR

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ABSTRACT

This study aims to determine the engine performance characteristics of underbone motorcycles using Genuine CDI and CDI programmable, as well as the differences in engine performance characteristics of underbone motorcycles using Genuine CDI and CDI programmable.

The investigation employed an experimental methodology. The subject of the research was a 125cc, 1-cylinder underbone motorcycles. The apparatus utilized for measuring power was a dynotest underbone motorcycles. Experiments conducted with underbone motorcycles in its standard factory configuration (no modifications).

The results indicated that (1) Underbone motorcycles equipped with Genuine CDI produce the most power at 6542 RPM and the most torque at 5085 RPM. While the RPM after it was replaced with Programmable CDI was 8.2 at 6556 RPM with 10.33 lb-ft of torque at 4670 RPM, the maximum power was 8.2 at 6556 RPM. (2) There was a performance difference between Genuine CDI and CDI Programmable. 8,2 HP is the maximum power obtained in nearly all Programmable CDI variantion. By advancing the Programmable CDI Timing by 2 degrees, the maximum torque of 10,33Nm was obtained at 4,670 RPM.

Keywords: *engine performance, Genuine CDI, CDI programmable*

INTRODUCTION

Internal Combustion Engines and External Combustion Engines are the two most common varieties of engines used for both personal and industrial applications. The most prevalent internal combustion engine used in daily life. An internal combustion engine is a machine that derives its power from the expansion of heated, high-pressure gases produced by the combustion of a mixture of fuel and air in an enclosed space or combustion chamber motorcycles, particularly the type of underbone, are the most popular internal combustion engine vehicles among the general public, particularly in Indonesia.

Multiple supporting systems allow underbone motorcycles to function effectively. Engine, chassis, power transfer, and electrical systems comprise the system. The electrical system comprises the fueling system, the illumination system, the starter, and the ignition system. The ignition system produces flames to ignite the fuel and air mixture that has expanded into high-pressure, high-temperature gas as a result of the piston's compression in the cylinder. In order to produce flames at the spark plug electrodes, a voltage of 10,000 Volts or higher is required (Anonymous, 1995:6-12). The ignition system can produce optimal output if the spark is robust and the timing is correct (Anonymous, 1994; Anonymous, 2001; Jalius Jama, 2008).

The ignition system on a motorcycle is one of the components serviced during tune-up procedures. Maintenance is performed to ensure that the system continues to function optimally. Treatment is administered based on the type of ignition system employed. There

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are two varieties of ignition systems available today: conventional (platinum) and electronic.

According to Jalius Jama (2008:199), the types of motorcycle ignition systems are typically categorized as follows:

1. Conventional Ignition System (using a contact breaker/platinum)
   a. Magneto Ignition System
   b. Battery and Coil Ignition System
2. Electronic Ignition System
   a. Semi Transistor Ignition System (With Platinum)
   b. Full Transistor Ignition System (Without Platinum)
   c. Capacitor Discharge Ignition (CDI) Ignition System

AC CDI ignition systems and DC CDI ignition systems are the two varieties of CDI ignition systems based on the voltage source. On standard motorcycle engines with CDI ignition, the ignition timing is set by the timing circuit on the CDI unit, in accordance with the manufacturer-specified ignition curve, and cannot be altered (is preset). Using this ignition curve, the ignition timing at each engine speed generates the optimal combustion pressure based on the design and standard specifications of engine components (PT. Suzuki International: 1996). With the application for programmable CDI, the ignition waveform can be modified in response to variations in engine specifications. Using a program/software on a PC (personal computer) that is connected to the CDI device via a USB to serial converter cable, the settings are configured. Inside the programmable CDI is an EEPROM (electrically erasable programmable memory) IC, which allows the ignition curve data to be stored and erased (originating from www.rextor-tech.com).

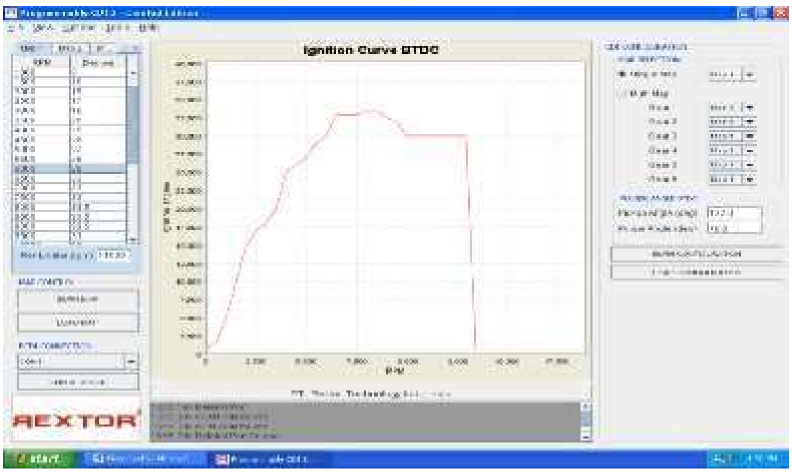

Figure 1. Software Programmable CDI

The electronic ignition system has many advantages but also disadvantages, such as expensive components and the difficulty of detecting damage to this form of ignition system. Disturbances in the ignition system can lead to fuel waste, increased emissions, and diminished engine output. In more severe disturbances, such as when there is no ignition, the combustion process may fail, preventing the engine from being initiated. Faults can be caused by a feeble alternator, pulser, ignition coil, leaky or dead spark plugs, or a dead CDI. CDI damage is irreparable due to the fact that the CDI unit is cast with specific materials, making opening extremely difficult and unlikely.

Common ignition system problems on underbone motorcycles include excessive fuel consumption and aberrant motor rotation. According to Soedarmo (2008: 53), one of the potential causes of aberrant motor rotation is a malfunctioning ignition system component. According to Suwarto (2008:10), there are five potential causes for underbone motorcycles' excessive gasoline consumption, one of which is an unstable ignition system.

Thus, interference with the ignition system can affect engine performance. Engine performance can be identified by two main parameters, namely torque and power produced. Torque is the force to rotate an axle, torque is also known as turning moment. In vehicle engines, engine torque is the power to rotate the crankshaft which is continued by the primary gear, ratio gear and final gear to turn the vehicle wheels. The four-stroke engine produces a piston thrust force on the power stroke, the combustion pressure (P) pushes the piston with a certain area (A) to produce a piston thrust (F). While power is the amount of work that can be produced per unit time, in a machine the power value is affected by the value of the torque and engine rotation. (W. Arismunandar, 2002: 5)

The torque and power values generated at each engine speed (rpm) can be displayed in the form of a curve known as the engine performance characteristic curve to illustrate the performance characteristics of the engine. From the trajectory, the following equipment characteristics can be determined:

1. *Peak torque* is the maximum torque point that can be produced by a machine.
2. *Torque band* is the area where at that rotation the engine produces almost the same/constant amount of torque, shown by curved lines that form lines that are close to straight and horizontal lines.
3. *Peak power* is the maximum power point that can be produced by a machine.
4. *Power band* is the area where the rotation of the engine produces almost the same amount of power, indicated by a curved line that forms a line that is almost straight and horizontal. The wide power range indicates a near-constant power output over a long engine rpm range. (source: www.otomotifnet.com,)

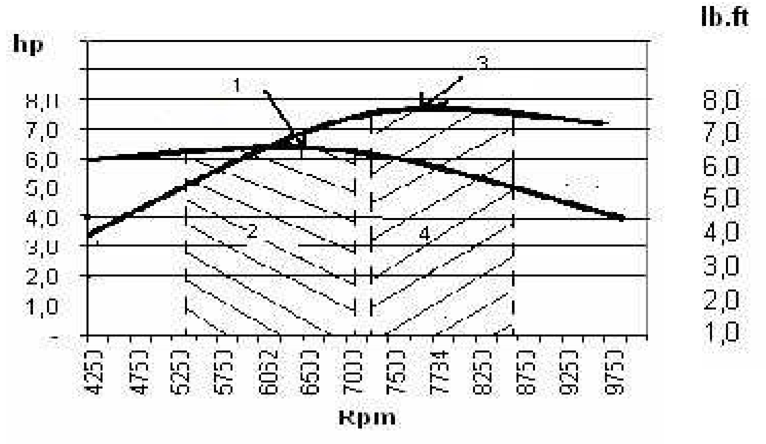

Figure 2. Engine Performance Characteristics Curve

Information:

1. Peak Torque
2. Torque Band
3. Peak Power
4. Power Band

This study aims to determine the performance characteristics of a 1-cylinder 125 cc duck motorbike engine using a standard CDI (genuine) and programmable CDI and to determine the differences in performance characteristics of a 1-cylinder 125 cc duck motorbike engine using a genuine CDI and programmable CDI.

RESEARCH METHOD

Research design

This study used a 1-cylinder 125 cc motorcycle as an object. In the first experiment, power and torque tests were carried out using the standard CDI. The second experiment, the standard CDI was replaced with a Programmable CDI. The next experiment was to vary the ignition timing on the Programmable CDI, namely adding 1o and 2^{o} and subtracting 1^{o} and 2^{o} to get the highest power and torque. This research design can be described as shown below:

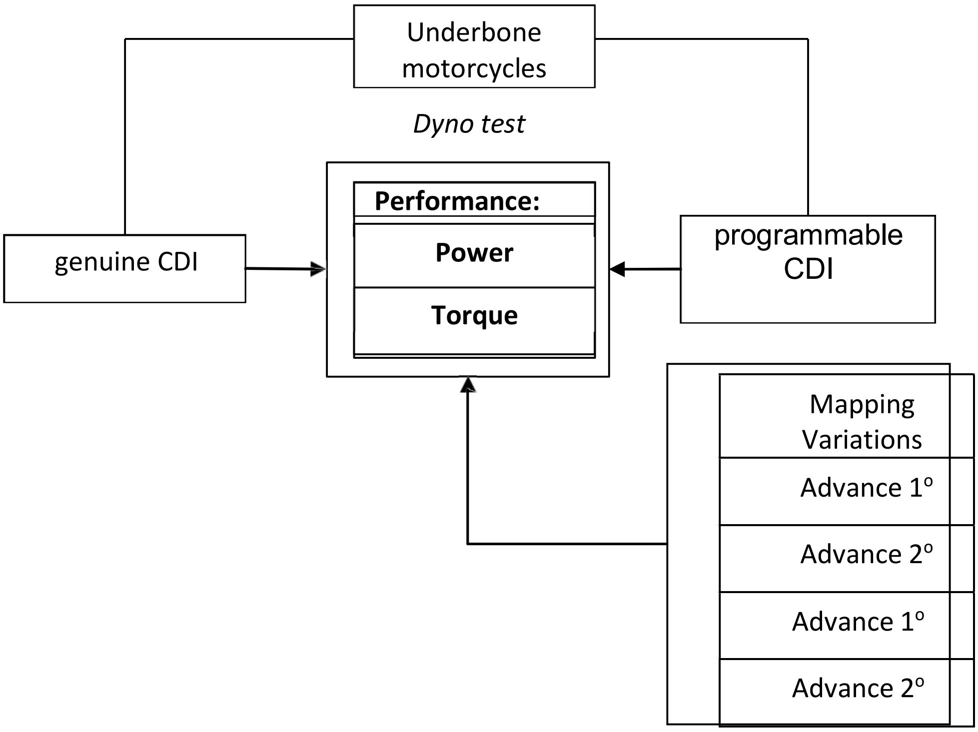

Figure 3. Research Design

Materials and intruements

Materials: Underbone Motorcycle 1 Cylinder 125 cc and programmable CDI.

1) 1) Vehicle Specifications

Machine	:	4-step SOHC.
Cooling System	:	Air conditioner
Step Diameter	:	52.4 x 57.9 mm
Step Volume	:	124,8 ccCompression
Comparison	:	9,0: 1
Maximum Power	:	9,3 PS / 7.500 rpm
Maximum Torque	:	1,03 kgf.m / 4000 rpm

2) Programmable CDIs

Table 1. Programmable CDI specifications

No	Parameter	Specification
1	input voltage	11,5 – 16 volt
2	output voltage	210 – 250 volt
3	microprocessor ICs	Motorolla 8 Kbyte MC908KX8
4	Number of Connections	3 (Main, RS 232, Gear position sensor)
5	Data Connection	Serial port DB 9 (RS 232)
6	PC operating system	Window 2000, XP, 7, Linux all Distro
7	protection system	Cut Off pada tegangan dibawah 10volt

Data analysis method

The data obtained from all trials were carried out descriptive analysis. The data obtained from the standard CDI experiment was compared with the Programmable CDI experiment. Thus, the performance characteristics of underbone motorcycles using standal CDI and programmable CDI is known.

RESULTS AND ANALYSIS

Results

1. Performance characteristics of a 1-cylinder 125 cc motorcycle engine using Genuine CDI. Based on the results of testing the performance of underbone motorcycles using Genuine CDI, data has been obtained that the highest power that can be generated in the RPM range of 4250 - 9750 is 8HP obtained at RPM 6542. Meanwhile the lowest power is at 9750 RPM, which is 3.5HP. Meanwhile, the highest torque is 10.12 NM at 5085 RPM. The torque value continues to decrease until at the 9750 RPM limit it only produces 2.5 NM of torque. In addition to obtaining torque and power test data, data regarding emissions, especially lambda, is also obtained to determine the condition of the fuel and air mixture. It is known that the Lambda value is 1.395, which means that the fuel and air mixture is poor, meaning that the amount of air exceeds the amount of air for an ideal mixture. In this study, the fuel mixture was not controlled (according to standards), as well as when underbone motorcycles used Programmable CDI.
2. Performance characteristics of a 1-cylinder 125 cc motorcycle engine using Programmable CDI
   a) Performance characteristics of a 1-cylinder 125 cc motorcycle engine using the Standard Programmable CDI.

   Based on the results of testing the performance of underbone motorcycles equipped with the standard Programmable CDI, the maximum power that can be generated in the RPM range of 4000 to 9750 is 8.2HP, which is attained at RPM 6468. While the lowest power is at 9750 RPM, which is 3.5 power. In contrast, the maximum torque is 10.3 Nm at 4530 RPM. The torque value decreases until it reaches 9750 RPM, at which point only 2.52NM of torque are produced. In addition, the obtained data indicates that the Lambda value is 1.46, which indicates that the fuel-to-air mixture is poor, i.e., the quantity of air exceeds the optimal amount.

b) Performance characteristics of a 1-cylinder 125 cc motorcycle engine using Programmable CDI with variations in ignition angle.

1) Advance the ignition timing by 1^{o}

The following is a table of dyno test results on power and torque indicators:

Table 2. Variation Dynotest Results Timing +1

Indikacor		Timing Variation	RPM
Power(HP)	Min	3,5	9750
	Max	8,2	6613
Torque (Nm)	Min	2,52	9750
	Max	10,28	5144

In addition, it is known that the Lambda value is 1.459, which indicates that the fuel and air mixture is classified as poor (the quantity of air exceeds the optimal amount of air).

2) Advance the ignition timing by 2°

The following is a table of dyno test results on power and torque indicators:

Table 3. Dynotest results with Timing Variation +2

Indicator		Timing Variation	RPM
Power (HP)	Min	3,7	9750
	Max	8,2	6556
torque(Nm)	Min	2,69	9750
	Max	10,33	4670

In addition, the obtained data indicates that the Lambda value is 1.501, indicating that the fuel-air mixture is inadequate (the quantity of air exceeds the optimal amount).

3) Setting the ignition timing back by 1° (-1°)

The following is a table of dyno test results on power and torque indicators:

Table 4. Dyno test results with Variation Timing -1

Indicator		Timing Variation	RPM
Power(HP)	Min	3,9	9750
	Max	8,2	6654
Torque(Nm)	Min	2,78	9750
	Max	10,19	4843

While the Lambda value is 1.5. This value implies that the mixture of fuel and air is classified as poor, meaning that the amount of air exceeds the amount of air for an ideal mixture.

4) Setting Ignition time back by 2° (-2°)

The following is a table of dyno test results on power and torque indicators:

Table 5. Timing Variation Dynotest Results -2

Indicator		Timing Variation	RPM
Power(HP)	Min	4,2	9750
	Max	8,1	6547
Torque (Nm)	Min	3,03	9750
	Max	10,22	4658

In addition, data obtained shows that the Lambda value is 1.422. This means that the mixture of fuel and air is classified as poor (the amount of air exceeds the amount of air for an ideal mixture).

Dsicussion

1) Power Analysis

According to test data for underbone motorcycles equipped with Genuine CDI, the maximum power that can be generated in the RPM range of 4250 to 9750 is 8 power, which is achieved at RPM 6542. According to the vehicle's specifications, the utmost power is 9.3 at 7500 RPM. It is evident from these results that the experimental results' power is still far below the maximum power. One of the potential causes is an inadequate fuel combustion, as indicated by the Lambda value of 1.39, which is significantly greater than 1. As is common knowledge, the fuel composition impacts the vehicle's output of power. In this investigation, the variable fuel mixture was not regulated, so optimum power was not achieved.

After a Programmable CDI was installed, there was an increase in maximal output. This increase was observed in all tested ignition angle variations, including the standard Programmable CDI angle, +1, +2, -1, and -2. In almost all variants, the maximum output is 8.2 power at 6468 to 6654 revolutions per minute; only in the -2 variant is the maximum output 8.1 power at 6547 revolutions per minute. As we know, the optimum power of an engine can be achieved when a relatively large quantity of fuel and air enters the combustion chamber and can burn properly, thereby increasing piston speed and engine rotation. This increase causes an engine to produce a great deal of power.

If connected to a Lambda value still well above 1 (1.422 – 1.501), the resulting mélange is not optimal (too much air). This influences the combustion process and the amount of energy produced by the combustion. As the rotational speed increases, friction increases, and as a result, the power decreases, as demonstrated by the fact that the lowest power is 3.0 at the maximum RPM limit of 9750.

2) Torque Analysis

According to the Dyno test results (Dyno test results in Appendix 1), the maximum torque for underbone motorcycles using Genuine CDI is 10.12 Nm at 5085 RPM. The torque value continues to decrease until it reaches 9750 RPM, which produces only 2.5NM of torque. The torque graph tends to begin to decline at 5250 RPM until it reaches the study's upper limit of 9750 RPM. As is well known, there is a correlation between torque and fuel mixture combustion. When air and fuel can mix and burn appropriately according to the engine's requirements, the torque will be at its peak. At 5085 RPM, the air and fuel mixture is therefore mixed and incinerated as required. Using a Programmable CDI yields data indicating that the maximum torque is 10.3 NM at 4530 RPM. The torque value continues to decrease until it reaches the maximum RPM of 9750, which produces only 2.52Nm of torque.

When a genuine CDI is replaced with a standard Programmable CDI, the torque increases by 0.18Nm. When the Programmable CDI ignition timing was altered by an additional 2 degrees (advance 2 degrees), the greatest increase in torque was 10.33Nm at 4670 RPM. This is the highest level of torque obtained during this investigation. This can be interpreted to mean that by switching the Genuine CDI to Programmable and then advancing the ignition timing by 2 degrees, you can maximize the fuel mixture's combustion. This may be due to the initial propagation of the combustion process, which maximizes the combustion and yields maximal torque. In contrast, the lowest torque is achieved when the Programmable CDI ignition angle is decreased by 1 degree (reversed by 1 degree). At 4843 RPM, only 10.19Nm of torque is produced by this variant. This could be due to the delayed propagation of combustion, which results in suboptimal combustion and, consequently, suboptimal torque production.

CONCLUSION

From the results of this research, it can be concluded that:

1. Genuine CDI-equipped underbone motorcycles produce 8 power at 6542 RPM, and 10.12 foot-pounds of torque at 5000 RPM. When the CDI is replaced with a Programmable CDI, the maximum power is 8.2 at 6556 RPM and the maximum torque is 10.33 at 4670 RPM.
2. There is a performance difference between Genuine CDI and Programmable CDI. In nearly all Programmable CDI variations, 8.2 power represents the maximum output. By advancing the Programmable Timing CDI2 degrees, the maximum torque is attained, which is 10.33Nm at 4670 RPM.

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