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Experimental study of the use of racing CDI on a 4 stroke 1 cylinder gasoline engine on engine performance

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Abstract: *Motorbikes are the most widely used means of land transportation by Indonesian people. Apart from being a means of transportation, motorbikes are also used as a means of speed racing. The aim of this research is to find out how the performance of a 4 stroke 1 cylinder petrol engine using the CDI variation on the Yamaha Jupiter Z 110 cc motorbike. Engine performance was tested at engine speeds of 3000 rpm, 4000 rpm, 5000 rpm, 6000 rpm, 7000 rpm, 8000 rpm and 9000 rpm. Based on the results and discussion of the research, the highest torque produced by an engine using a standard CDI is 9.60 N.m at an engine speed of 3000 rpm. The highest effective power produced by an engine using a racing CDI is 8.2 HP at an engine speed of 8000 rpm. The highest fuel consumption is produced on an engine using a standard CDI of 1.23 Kg/hour at an engine speed of 8000 rpm, while the lowest fuel consumption is produced on an engine using a racing CDI of 0.46 Kg/hour at an engine speed of 3000 rpm. Racing CDI produces higher effective power compared to standard CDI and reduces fuel consumption.*

Keywords: *motorbike, racing CDI, engine speed, engine performance, torque*.

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I. INTRODUCTION

There are various types of land transportation commonly used in Indonesia, from bicycles, pedicabs, motorbikes to cars. Motorbikes are the most widely used means of land transportation by Indonesian people because they are low maintenance and fuel efficient. There are various brands of motorbikes in Indonesia with various advantages, low prices, large engine capacity, as well as models and technological sophistication. Motorbikes are the most common means of transportation in Indonesia (Marlindo, 2012; Prabowo, 2006). Motorbikes as a means of daily transportation have other functions as a means of transporting goods and speed competitions on straight roads (Drag Race) and racing arenas (Road Race) (Prabowo, 2006). Daily motorbikes and racing motorbikes differ in terms of component quality, fuel used, ignition system and engine performance. Motorbikes specifically designed for competition are too expensive, so Indonesian people in general and Indonesian racers in particular use daily motorbikes with improved engine performance (Miftah 2012; Siswantoro, 2006).

Improving the quality of ignition on a motorbike is the main factor in efforts to increase the performance of the motorbike. Ignition quality plays an important role in controlling fuel combustion in the engine (Santoso, 2008), which in turn affects power, efficiency, emissions and engine life. Good ignition quality will produce a stronger and more consistent flame in the combustion chamber (Irvan, 2013, Khumaedi et al, 2020). This allows fuel and air to mix optimally, resulting in more efficient combustion. As a result, engine power will increase, so that the motorbike can accelerate faster and reach maximum speed better (Rochmad et al, 2020; Suyanto, 2009). Better ignition quality can reduce the time lag between the rider's action on the throttle and the engine's response. This makes the motorbike more responsive and increases acceleration capabilities, which is very important in dangerous situations on the road (Nasution et al, 2023).

One of the factors that influences increasing engine performance is ignition, in this case the important role is Capacitor Discharge Ignition (CDI). This is because by using good ignition the combustion in the combustion chamber will be perfect, so that the heat produced from combustion will be optimal. The heat produced purely comes from the explosion of a mixture of air and fuel producing energy from the combustion process, not due to friction between components in the combustion chamber. (Irvan. 2013). Racing CDI is a type of ignition system specifically designed to improve motorcycle performance in racing and high-performance use.

More efficient combustion also means more power is produced from each drop of fuel used. Thus, improving ignition quality can help reduce fuel consumption, save motorbike users money and reduce environmental impacts (Sadri 2014).

Replacing standard valves with larger valves is one factor in increasing engine performance, both power and torque. The valve is the entrance to the fuel and air mixture into the combustion chamber with the hope that more fuel and air will enter (Ferdiansyah, 2014). In this way, it will produce perfect combustion thereby boosting engine performance. Replacing valves with large diameters must be balanced with wide porting as well. At least the porting diameter is not smaller than the valve leaf. (Miftah. 2013). However, there has been no specific research studying the effect of using a racing CDI on motorbikes under standard conditions, so in this research we will examine in more depth the effect of using a racing CDI on the performance of the Yamaha Jupiter Z 110cc 4 stroke 1 cylinder petrol engine.

II. EXPERIMENTAL PROCEDURE

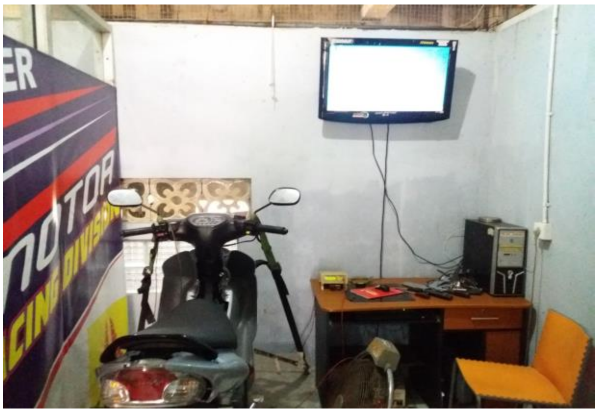
The material used in this research is a 4 stroke 1 cylinder petrol motorbike, Yamaha Jupiter Z 110 cc. Motorcycles run using standard CDI and racing CDI at engine speeds of 3000, 4000, 5000, 6000, 7000, 8000 and 9000 rpm. The data collection method uses experimental methods in the laboratory. The research data is the power, torque and fuel consumption needed to produce power.

Table 1 CDI spesification

No	Description	CDI standard	Racing CDI
1	Uses for	Motorbike (standard)	Semi Tune Up and Racing
2	Engine condition	Manufacture Standard	Semi Tune Up or Full Modification
3	Compression ratio	9,3 : 1	10.5 : 1 s/d 13.8 : 1
4	Ignition Timing	8º s/d 15º before TDC	12º s/d 15º before TDC
5	Advace timing	25º s/d 30º before TDC	27º s/d 42º

After the data was obtained from the Computerized Chassis Dynamometer tool in the form of graphs and tables, the data was then analyzed using an average test by reviewing the graphs formed, because this research aims to determine the performance of engines using standard CDIs compared to using racing CDIs on Yamaha Jupiter Z motorbikes. After conducting research and obtaining the required data in the form of torque, power and fuel consumption data, then the results of the test data using a standard CDI compared to using a racing CDI are compared. The next step is analyzing the data to obtain answers to the problems formulated.

Figure 1 Test equipment setup



III. RESULTS AND DISCUSSIONS

3.1. Torque

Data collection obtained in this research was in accordance with previously determined procedures. The data is processed based on the specified variables, then a discussion is carried out. The torque value produced by the test vehicle can be known directly from the Sportdynotest tool, the data produced is in the form of graphs and tables.

Table 2 Engine torque data

Putaran (rpm)	Torsi N.m	
	CDI standar	Racing CDI
3000	9,60	8,76
4000	8,38	8,14
5000	8,38	8,41
6000	8,29	8,32
7000	7,35	7,87
8000	6,60	7,27
9000	5,31	6,05
10000	-	4,90

In table 2 above, the highest torque is produced on an engine using a standard CDI with a torque value of 9.60 N.m at 3000 rpm, then the torque decreases at the next engine rotation. This happens because at high engine speeds the valve opening and closing process occurs too quickly which results in cylinder filling not being optimal, thereby reducing torque. In addition, due to the valve mechanism, the decrease in torque is also caused by mechanical power lost due to increasing friction between the piston and the piston wall and is the dominant factor in decreasing torque at high engine speeds.

Figure 2. Relationship between torque and engine speed

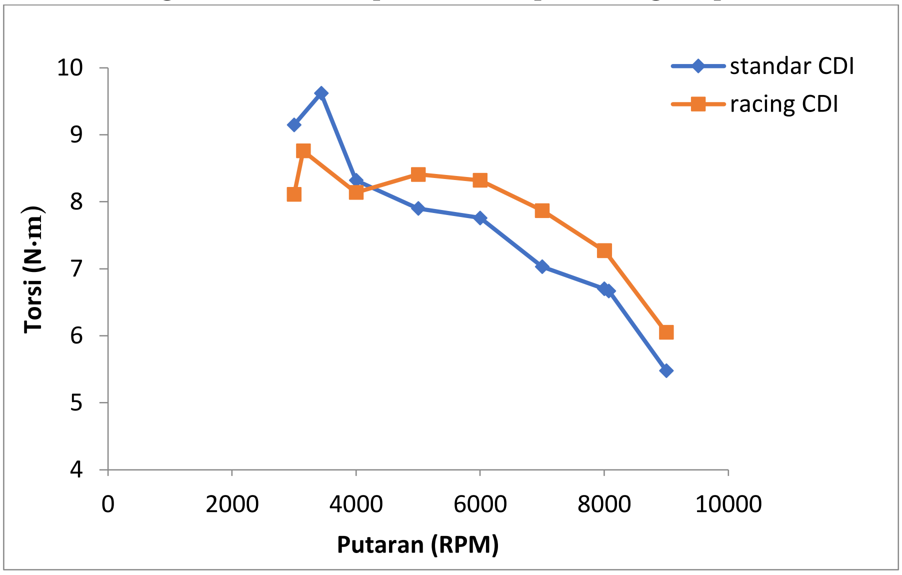


Figure 2 shows the relationship between torque and engine speed. It can be seen that when testing the engine using a racing CDI, the torque produced has almost the same trend as a standard CDI. The highest torque occurred in the engine test using a standard CDI of 9.60 N.m at 3000 rpm, while the engine speed at 9000 rpm produced the smallest torque of 5.31 N.m in the engine test with standard valves using a standard CDI. The use of racing CDI produces higher torque. This is because the use of a racing CDI means that more gas mixture enters the cylinder chamber and is burned with greater ignition, causing complete combustion to occur. So that the amount of burnt gas mixture and losses is smaller than standard CDI, the pressure of the resulting combustion gas increases so that the resulting torque increases.

At low engine speeds, using the standard CDI provides slightly higher engine torque, while at engine speeds above 4000 rpm, using the racing CDI produces higher torque compared to the standard CDI. This is because racing CDI provides maximum ignition in the combustion chamber so that it can burn fuel and air up to an engine speed of 10,000 rpm and the resulting torque is higher. Apart from the valve mechanism, the increase in torque is due to the use of racing CDI providing maximum ignition to burn the gas mixture up to an engine speed of 10,000 rpm, thus producing higher torque. This is in line with research (Irvan, 2013; Khumaedi, et.al, 2020)) that the increase in torque is also due to the increase in engine speed, the more work strokes will be experienced in the same unit of time, this results in more fuel and air entering the cylinder space so that the resulting torque increases.

3.2. Effective Power

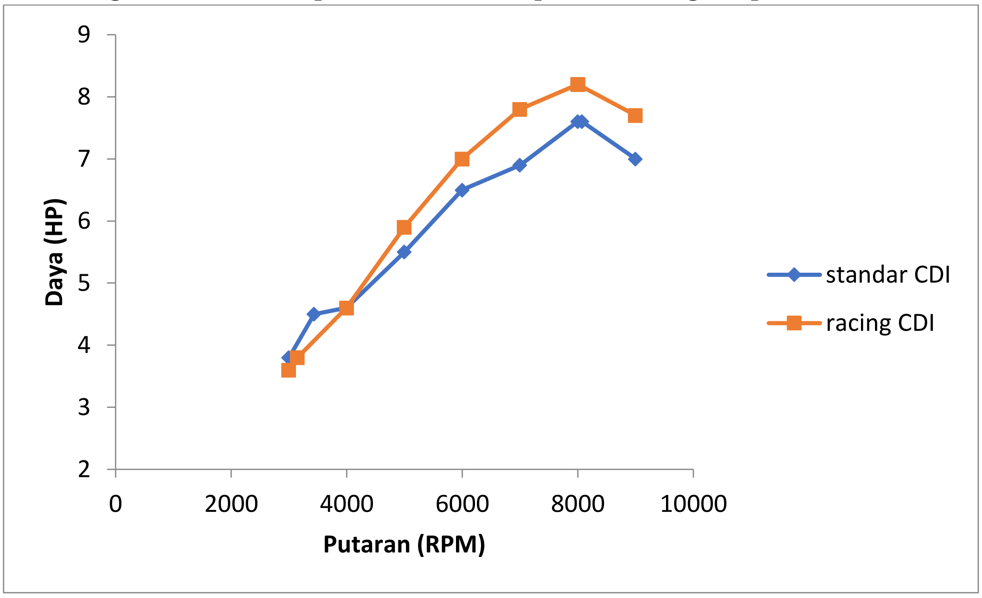
The average value of the effective power produced by the test engine can be found directly from the Sportdynotest tool, the data results obtained are in the form of graphs and tables. The following table shows the average value of effective power produced by the engine.

Table 3 Effective engine power

Rotation (rpm)	Power (HP)	
	Standard CDI	Racing CDI
3000	4,3	3,8
4000	4,7	4,6
5000	5,9	5,9
6000	7,0	7,0
7000	7,7	7,8
8000	7,5	8,2
9000	6,8	7,7
10000	5,8	6,9

From table 3, the engine testing using a racing CDI at an engine speed of 10,000 rpm has not experienced a decrease in effective power because the engine using a racing CDI can provide maximum ignition so that complete combustion occurs which results in the effective power produced being still large. In testing the engine using a racing CDI, the maximum effective power was 8.2 HP at an engine speed of 8000 rpm, while the effective power produced by an engine using a standard CDI was 7.7 HP at 7000 rpm.

Figure 3 Relationship between effective power and engine speed



From Figure 3, the relationship between effective power and engine speed can be seen that the effective power produced is directly proportional to engine speed. When using a racing CDI, it provides greater power than using a standard CDI. This is because there is a difference in ignition time before TDC on a racing CDI compared to a standard CDI, and also on a standard CDI it still has a limiter or engine speed which is limited to a specified speed, while the limiter on a CDI is set or programmed according to engine performance so that the engine can work. exceeds 9000 rpm. In engine testing using a racing CDI, it provided greater and more stable power than using a standard CDI. This is because the use of racing CDI provides a large amount of ignition to burn fuel and air until the specified rotation. This is because racing CDI can provide maximum ignition to burn the gas mixture up to an engine speed of 10,000 rpm, so that complete combustion occurs in the cylinder space which produces greater power compared to standard CDI (Khumaedi, et.al, 2020).

Apart from that, the increase in effective power is also due to the increase in engine speed, the more work steps will be experienced in the same unit of time, which results in a greater amount of fuel and air entering, so that the combustion process produces large power (Marlindo, 2012). However, after the increase reaches the maximum engine speed of 8000 rpm, the effective power decreases at high rpm because the increase in engine speed cannot compensate for the decrease in torque that occurs . The decrease in torque at high rpm is due to valve opening and closing too quickly which causes incomplete cylinder filling so that volumetric efficiency decreases.CDI racing provides faster engine response to throttle changes, this is especially important in situations that require instant acceleration. CDI racing allows for fine-tuning of the ignition timing so that it can increase the effective power of the engine.

3.3. **Fuel Concumption (FC)**

Fuel consumption data shows the amount of fuel consumed by the engine in a certain period of time. Table 4 is the average value of engine fuel consumption using CDI variations in kg/hour.

Table 4 Fuel Consumption (Kg/hour)

Putaran (rpm)	FC (Kg/jam)	
	CDI standar	Racing CDI
3000	0.50	0.46
4000	0.57	0.54
5000	0.65	0.60
6000	0.78	0.65
7000	0.99	0.80
8000	1.23	1.10

In engine testing using a standard CDI, it was seen that fuel consumption was 0.50 Kg/hour at an engine speed of 3000 rpm, whereas in engine testing using a racing CDI the fuel consumption was 0.46 Kg/hour at 3000 rpm. There is a small fuel saving of around 4%. This is because using a racing CDI saves a little fuel compared to using a standard CDI, because the difference in ignition time is not that big or almost the same as a standard CDI.

Figure 4 Relationship between fuel consumption and engine speed

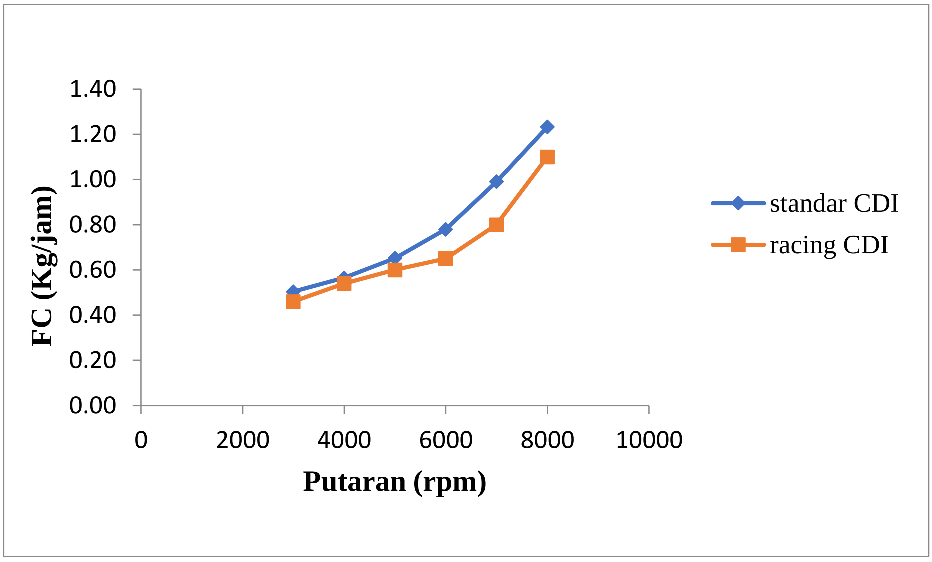


Figure 4 shows the relationship between fuel consumption and rotation. It can be seen that in engine testing using a standard CDI at 8000 rpm, fuel consumption was 1.23 Kg/hour. In engine testing using a racing CDI, fuel consumption was 1.10 kg/hour. The higher the engine speed, the higher the fuel consumption per unit time. Where the higher the engine speed, the more fuel the engine requires. CDI racing produces faster and more consistent ignition compared to conventional ignition systems. So combustion is better and fuel consumption is slightly lower compared to standard CDI. Racing CDIs are often able to increase engine power better than conventional CDIs. This allows the motorcycle to reach higher maximum speeds and gives it an edge in racing competitions. The strong and consistent ignition system in CDI racing produces more efficient combustion. This means more power is produced from every drop of fuel used, reducing fuel consumption and excess exhaust emissions.

IV. CONCLUSION

Based on the results of the analysis and discussion of research regarding engine comparisons using standard CDI variations and racing CDI, the following conclusions can be drawn. The highest torque in engine testing using a standard CDI was 9.60 N.m at 3000 rpm, while the racing CDI can extend torque to 10,000 rpm. The highest effective power in engine testing using a racing CDI was 8.2 HP at 8000 rpm and the racing CDI produced higher effective engine power at almost all engine speeds. The use of racing CDI provides lower fuel consumption compared to engines using standard CDI.

Conflict of interest

There is no conflict to disclose.

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