ADDITION COMBUSTION AIR EFFECT TO ENGINE PERFORMANCE K15-901 USING BIOETHANOL FUEL

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Abstract - Bioethanol has a low calorific value from gasoline, so that in its application in the motorbike, the duration of fuel injection must be multiplied by natural air intake which results in a richer fuel mixture. Based on this problem, a research was conducted which focused on adding combustion air. This research was carried out experimentally on Honda CB150R engine with a compression ratio of 12.5 using 100% bioethanol fuel with modification of ignition timing and duration of fuel injection. The test was carried out by using 92 RON at a compression ratio of 12.5 which used 100% bioethanol fuel as a control group and a variation of adding combustion air using a blower. By taking 3 variations of the addition of air 10%, 20%, 30%. Tests are carried out using the Waterbrake Dynamometer at the opening of the full butterfly valve (Fully Open Throttle) to obtain maximum power at each engine speed and the desired engine speed setting is done by adjusting the load size. Each change in engine speed 2000 to 8000 rpm at intervals of every 1000 rpm. From the experimental results of adding combustion air with E100 bioethanol fuel at a compression ratio of 12.5, the best performance results were obtained in the addition of 10% combustion air. At the addition of air 10% torque, power, temperature and thermal efficiency produced increased by 12.52%, 9.25%, 12.52%, 35.18%, and Specific Fuel Consumption (SFC) down by 29.15%.

Keyword : Air Addition, Bioethanol, Engine K 15-901 and Performance

1. Introduction

Fossil energy, especially petroleum is the main energy source of vehicles whose availability is increasingly limited and can not be renewed. In addition to the limitation of fossil energy, high products such as CO₂ and other emissions resulting from burning fossil fuels as a cause of global warming and environmental damage. Bioethanol as a pure fuel or mixture with gasoline can improve engine efficiency and performance compared to gasoline [3]. For the application of bioethanol to gasoline engines, especially at high concentrations, it is necessary to regulate several combustion parameters, including: ignition time, injection duration, compression ratio and air-fuel ratio.

The research conducted by Gayuh [4] about the effect of the mapping of ignition timing and the duration of fuel injection on the K 15-901 engine fueled by bioethanol 100% with natural air intake shows that the Lambda produced is below 0.8, this is called a fuel-rich mixture so that it makes combustion imperfect and makes exhaust emissions to be high.

In the normal combustion of air and fuel mixture will burn perfectly if the stoichiometric mixture, gasoline fuel can be said to be stoichiometric when to burn 1 kg of fuel requires air as much as 14.7 kg. But in fact the natural intake of air on the engine is not enough to make a stoichiometric mixture because the higher the engine rotation it requires a lot of fuel while the air intake is limited. Based on the description, it was developed or investigated regarding the addition of combustion air by adding a blower to the inlet side of the engine. It is expected to be able to correct the problems that occur related to the rich mix so that the engine performance becomes optimal. This research was conducted on K 15-901 engine with CR 12.5 using 100% bioethanol (E100).

2. Experimental Setup and Procedures

This research uses K 15-901 engine, ignition spark plug 1 cylinder engine. The following table 1 is a K 15-901 engine specification :

| Engine type          | single cylinder |
|----------------------|-----------------|
| Valve system         | DOHC            |
| Bore                 | 63.5 mm         |
| Length               | 47.0 mm         |
| Compression ratio    | 12.5:1          |
| Injection system     | Port Injection  |
| Fuel                 | Bioethanol E100%|
| Piston               | Dome            |

Retrieving data using waterbrake dynamometer with a maximum power capacity of 20 Hp. Measurement of fuel consumption using a 25 ml graduated cylinder, where combustion air intake airflow meter use.
The diagram of Testing Installation is shown in Figure 1:

![Diagram of Testing Installation](image)

**Figure 1: Testing Installation**

| No. | Component Parts                  | No. | Component Parts                  |
|-----|-----------------------------------|-----|-----------------------------------|
| 1   | ECU (Electronic Control Unit)     | 14  | Gas Analyzer                     |
| 2   | Table glass measuring            | 15  | Blower                            |
| 3   | Valve                            | 16  | V-manometer                       |
| 4   | Fuel Pump                        | 17  | Chain                             |
| 5   | Thermocouple oil sensor          | 18  | Voltage regulator                 |
| 6   | Thermocouple block cylinder sensor | 19 | Throttle valve                    |
| 7   | Injector                         | 20  | Roller                            |
| 8   | Spark plug                       | 21  | Wheel                             |
| 9   | Thermocouple exhaust gas sensor  | 22  | Torque reader                     |
| 10  | Accumulator                      | 24  | Waterbrakedynamometer             |
| 11  | Intake manifold                  | 25  | Computer                          |
| 12  | Exhaust manifold                 |     |                                   |

Table 3. Characteristics of Bioethanol 100%

| Property                             | Bioethanol |
|--------------------------------------|------------|
| Density (kg/m³)                      | 794        |
| Research octane number (RON)         | 109        |
| Flash point (°C)                     | 13         |
| Boiling point at 1 bar (°C)          | 79         |
| Lower heating value (MJ/kg)          | 26.95      |
| Latent heat of vaporization (kJ/kg)  | 854        |
| Stoichiometric ratio                 | 9          |

3. Result and Discussion

Engine performance is never the same for every engine speed so we have to know the performance characteristics of the engine for each engine speed. In addition, the impact of using pure bioethanol fuel will also affect engine performance. Engine performance parameters include Torque, Power, Brake mean effective pressure (BMEP), specific fuel consumption (SFC) and thermal efficiency.

In figure 2 shows the line from the AFR engine rotation function. The graph above tends to be the same, that is from the lower rpm the AFR tends to rise until it reaches the peak at the middle engine speed and finally decreases with increasing engine speed. On 100% bioethanol fuel that has been modified the compression ratio becomes 12.5. Before the addition of air is seen AFR is in the mixture too rich, the average AFR produced is 6.146. In E100% fuel with the addition of combustion air 10% the average AFR produced is 8.079, while the addition of combustion air 20% the average AFR produced is 8.77, and at the addition of combustion air 30% the average AFR generated is 9.504.

In figure 3 shows the lambda value of the engine at each engine speed. Lambda produced from the engine, all of them have increased with increasing engine speed from 2000 to the peak of the highest value of 5000 rpm and has decreased in rounds of 6000 to 8000 rpm. In the modified 100% bioethanol fuel the compression ratio to 12.5 lambda averaged 0.68. Whereas the engine with a compression ratio of 12.5 has 100% bioethanol fuel with the addition of combustion air 10% lambda. The average yield is 0.90, in addition to combustion air 20% lambda the average yield is 0.97, and at the addition of combustion air 30% lambda on average is 1.06.

With the increase in combustion air, the actual AFR will be greater with a fixed theoretical AFR value, the greater the lambda value. This is because the actual AFR produced by adding air is high along with the addition of air.
Figure 4. Torque – RPM Graph

Torque increase occurs with increasing engine speed. In the standard engine with pertamax fuel, the maximum torque produced by the engine is 13.33 Nm at 7000 rpm and the 100% bioethanol fuel has been modified the compression ratio to 12.5. Before the addition of air, torque is 17.16 Nm at 7000 rpm. While at E100% fuel with the addition of air 10%, 20%, and 30% the maximum torque of each one produced is 17.75 Nm, 17.45 Nm, and 17.35 Nm at 7000 rpm.

With increasing combustion air, the engine torque will be smaller. This is because with increasing air, it will make the fuel mixture become poor in the combustion chamber, so that the heat that can be absorbed by the engine gets smaller. But overall the torque produced by the addition of air is greater than that produced before the addition of air is carried out.

Figure 5. Power – RPM Graph

Figure 5 shows the engine power value for each cycle. The engine generated power all increases with increasing engine speed from 2000 to 8000 rpm. In the standard engine with pertamax fuel the maximum power produced is 11.03 KW at 8000 rpm, and in the 100% bioethanol fuel which has been modified the compression ratio to 12.5 the resulting power is 13.22 KW at 8000 rpm. engines with a compression ratio of 12.5 with 100% bioethanol fuel with the addition of combustion air 10%, 20% and 30% obtained power of 13.87 KW, 13.28 KW and 13.28 KW at 8000 rpm.

Figure 6. BMEP – RPM Graph

Figure 6 shows the engine effective average pressure trendline at each engine speed. The BMEP generated from the engine all increased with increasing engine speed from 2000 to the peak of the highest value of 7000 rpm and will decrease at 8000 rpm. In the standard conditions with maximum BMEP pertamax fuel produced is 560,609 KPa at 7,000 rpm, and the 100% bioethanol fuel that has been modified the compression ratio to 12.5 BMEP maximum is produced at 721,372 KPa at rpm 7000. Whereas the engine compression ratio 12.5 with 100% bioethanol fuel with the addition of combustion air 10%, 20% and 30%, obtained maximum BMEP of 746,104 KPa, 733,73 KPa and 729,616 KPa at 7,000 rpm.

Figure 7. BSFC – RPM Graph

Figure 7 shows the value of specific fuel consumption at each engine rotation in standard conditions with pertamax fuel specific consumption of minimum fuel produced is 0.202 kg / kW.hour and on 100% bioethanol fuel which has been modified the compression ratio to 12.5 consumption the specific minimum fuel produced is 0.307 kg / kW.hour. Whereas for engines with a compression ratio of 12.5 fueled with bioethanol 100% with the addition of combustion air 10%, 20% and 30%, the minimum specific fuel consumption is 0.258 kg / kW.hour, 0.262 kg / kW.hour and 0.264 kg / kW. hours.
Figure 8 shows the value of the thermal efficiency of the engine at each engine speed. In standard conditions with the first fuel the maximum thermal efficiency produced is 0.415 and the 100% bioethanol fuel which has been modified the compression ratio to 12.5 the maximum thermal efficiency produced is 0.434. Whereas in engines with a compression ratio of 12.5 bioethanol fuel 100% with the addition of combustion air 10%, 20% and 30%, maximum thermal efficiency of 0.517, 0.508 and 0.505 was obtained.

With the addition of combustion air, the thermal efficiency produced by the engine will decrease further. This is due to the increase in combustion air so that the fuel in the combustion chamber decreases so that the heat stored in the fuel to be converted into effective power becomes small which results in small thermal efficiency produced.

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