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Performance Test of 1500 cc Fuel Motorcycle Using Pertalite – Bioethanol Mixture Fuel on Exhaust Gas

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ABSTRACT

The increasing world oil prices followed by the increasing demand for fossil fuels as well as the issue of the energy crisis and global warming which demands a better level of environmental quality have encouraged the government to take good policies in overcoming them. Currently the world has been thinking about alternative energy that can be used for diesel or otto motors. One of the alternative fuels developed is alcohol fuel. Alcohol is a type of hydrocarbon in which one of the hydrogen atoms is replaced by the hydroxyl radical OH. Many agricultural products in Indo-nesia have the potential to be developed as bioethanol. In this study, the effect of adding bioethanol on pertalite fuel will be studied. This is because pertalite is a fuel that is in accordance with the demands of automotive needs and developments. This study aims to determine the comparison of power, torque, and air-fuel ratio as well as to determine the comparison of the content of exhaust gas compounds tested on the Toyota Vios Limo 1500CC car using pertalite (E0) fuel, 10% pertalite-bioethanol mixture (E10). and 15% (E15), 20% (E20). The test results obtained that the calorific value of Pertalite fuel is 49411.98 kJ/kg, 10% gasohol has a value of 46764.82 kJ/kg, 15% gasohol has a value of 44262.82 kJ/kg, and then 20% gasohol has a val-ue of 45735.42 kJ/kg. The test results obtained an average torque and power per-formance of 10% gasohol fuel of 109.09 Nm and 71.73 HP. The highest air-fuel ratio in fuel but the table shows the highest air-fuel ratio in 15% gasohol fuel is 15.46 and then the lowest air-fuel ratio in 10% gasohol fuel is 11.58. Exhaust emis-sion levels for each compound tested for each fuel are still below the standard vehicle exhaust emission thresholds set by Toyota and the environmental agency.

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1. INTRODUCTION

The use of subsidized fuel in Indonesia which should be intended for the lower middle class, but currently its use is still widely enjoyed by the upper middle class (BPH Migas, 2015), so that in the near future the government will adopt a policy of limiting the use of subsidized fuel. namely vehicles with a capacity of over 1500cc are not allowed to use subsidized fuels such as pertalite.

Fossil fuels whose use is increasing, so that world oil prices also continue to increase as well as the issue of the energy crisis and global warming, this requires a better level of environmental quality so that the government tries to take good policies in overcoming it.

Currently alternative energy to replace the world's fossil fuels is one of the solutions that must be developed to be used in diesel and gasoline engines.

Alcohol fuel is one of the alternative fuels that can be developed at this time, because alcohol is a type of hydrocarbon in which one of the hydrogen atoms is replaced with a hydroxyl radical. The types of alcohol are Methyl alcohol (methanol), CH3OH, Ethyl alcohol (ethanol), C2H5OH, and Propyl alcohol (propanol), C3H7OH (Pulkrabek, 2004).

Plants such as corn, wheat, cassava or sweet potatoes, molasses or molasses, fruits and vegetable waste are sources of plants that can produce bioethanol. Bioethanol is produced from glucose fermentation and is followed by a distillation process. The purity of the alcohol from this fermentation is still around 40%, so that it can be used as fuel, the alcohol is subjected to another distillation process so that the bioethanol produced has a level of more than 95%.

The corrosivity of ethanol is very high for metals, but its compatibility with plastic materials is very good except with polyamides. The quality of ethanol fuel in terms of heat combustion, vapor pressure, octane number and corrosivity (Bayu, 2009).

Gasohol (gasoline-alcohol) in recent years has been used as an alternative fuel. E10 in mixing bioethanol with gasoline is a mixture of 10% bioethanol and 90% gasoline. Mixing bioethanol with any composition to gasoline has a very good impact on its use.

Combustion with gasohol is more complete than gasoline so that the positive impact of using gasohol is that it can keep spark plugs and engine lubricants clean compared to gasoline (LIPI, 2008). From several other studies, it is stated that gasohol fuel has several positive impacts on the environment, namely less CO2 exhaust gas, and does not produce CO gas and toxic lead dust and gasohol which is used in vehicle engines with higher compression. compared to using pure gasoline.

So that by reducing the use of fossil fuels, it is hoped that it will be able to overcome the problems of the energy crisis and global warming. So, in this case the Indonesian government in the next few years is targeted to replace fuel oil with alcohol to reach 1.8 million kilo liters.

This research will examine how the influence of the amount of bioethanol to be mixed in pertalite type fuel. The use of pertalite fuel in this study is due to the dominance of people who use this fuel. The purpose of this research to determine the comparison of power, torque, and air-fuel ratio as well as to determine the levels of exhaust gas compounds tested on the Toyota Vios Limo 1500 CC using pertalite (E0) fuel, a 10% pertalite-bioethanol mixture (E10) and 15% (E15), 20% (E20).

2. RESEARCH METHOD

This research was conducted by experimental method. Testing the initial conditions of the test, namely testing using 100% pertalite fuel, then comparing the results of this initial test with tests using a mixture of pertalite-bioethanol (gasohol) with ethanol content of 10%, 15% and 20% so that the differences in each performance can be ident.

Research Stages

The main steps of this research can be seen in Figure 1 below:

Figure 1. Research Satges

The composition of the mixture to be used in this study is as shown in table 1 below:

Variasi	**Pertalite**	**Bioetanol**
E_0 (Pertalite)	10000 ml	0 ml
E_{10} (Bioetanol10%)	9000 ml	1000 ml
E_{15} (Bioetanol15%)	8500 ml	1500 ml
E_{20} (Bioetanol20%)	8000 ml	2000 ml

Experimental Scheme

The experimental scheme of the research can be seen in Figure 2 below:

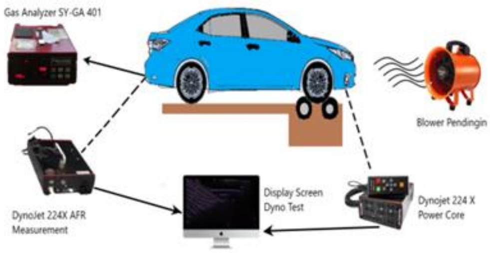

Figure 2. Set Up Dynotest Testing and Exhaust Emissions

The test steps carried out to obtain compounds from exhaust emissions are as follows:

1. Prepare the car for testing, then prepare the SUKYOUNG SY-GA 401 Gas Analyzer test equipment.
2. Fuel is filled into the tank.
3. The machine is heated for 5 - 10 minutes so that the condition is ready to work.
4. Connect the SUKYOUNG SY-GA 401 Gas Analyzer test tool to an electric current.
5. The switch button is turned on (located behind the tool).
6. Select the standby/ready menu.
7. Select the measurement menu.
8. Select the standard test menu. Then the gas analyzer unit for approximately 60 seconds will automatically warm up.
9. Then select the zero-calibration menu whose function is to automatically reset data from the beginning.
10. Insert the sensor probe into the exhaust.
11. Engine speed is set at 2000, 2500, 3000, 3500, 4000, 4500, 5000 rpm.
12. Wait for the numbers on the SUKYOUNG SY-GA 401 Gas Analyzer screen to stabilize.
13. The test results on the SUKYOUNG SY-GA 401 Gas Analyzer are printed.
14. Steps 1 to 13 are carried out repeatedly with variations in the pertalite-bioethanol fuel mixture E10, E15 and E20

Gasoline Engine Performance

To find out the effectiveness of using this gasohol on the engine, it is necessary to know how the performance of the machine is.

Factors that affect engine performance include:

a. Fuel Calorific Value

The upper calorific value (HHV) can be interpreted as the calorific value obtained experimentally using a calorimeter, then the fuel combustion products are cooled to room temperature so that most of the water vapor formed from the combustion of hydrogen condenses and releases its latent heat.

The HHV value can be formulated as follows:

HHV= (*t2* - *t1* - *tkp*) x *CV*;

where:

HHV = High Heating Value (upper calorific value)

t2 = water temperature after ignition (^{o}C)

t1 = water temperature before ignition (^{o}C)

tkp = resulting temperature rise ignition wire (0.05^{o}C)

CV = calorime bomb type heattar (73529.6 kJ/kg ^{o}C)

Lower calorific value (Low Heating Value, LHV), is the calorific value of fuel without latent heat originating from condensing water vapor.

LHV = *HHV* – 3240 kJ/kg

b. torque

Torque is the product of force and distance. The amount of torque can be calculated by the following equation:

$$T = \frac{P\,60}{2\pi n}$$

P = Power (W)

T = Torque (Nm)

n = Engine Speed (rpm)

c. Power

Engine power is the amount of engine work for a certain time.

$$P = \frac{2\pi n}{60} T$$

P = power (W)
T = torque (Nm)
n = engine speed (rpm)
Thermal Efficiency
Thermal efficiency is calculated to see the maximum work that can be produced from burning a certain amount of fuel.

$$\eta_t = \frac{P}{\dot{m}_f \cdot LHV} x3600$$

where:
ηt = thermal efficiency
$\dot{m}\_f$ = fuel flow rate
P = power (W)
LHV = low heat wishing value
n = Engine Speed (Rpm)
e. Air to Fuel Ratio (AFR)
Actually, the AFR value is formulated by:

$$AFR = \frac{\dot{m}_a}{\dot{m}_f}$$

Where:
AFR = air fuel ratio
$\dot{m}a$ = mass flow rate of air.
$\dot{m}f$ = fuel flow rate

Exhaust gas emissions

Exhaust emissions are the residue from burning fuel in the engine that is expelled through the exhaust system. The elements in vehicle exhaust that will be measured are HC (Hydrocarbon), CO (Carbon monoxide), CO2 (Carbon-dioxide), and O2 (Oxygen) compounds.

3. RESULTS AND ANALYSIS (10 PT)

Research Result Data
The 1500cc Otto engine used is the Toyota Vios car as a test tool for engines that use gasoline. This machine uses EFI (Electronic Fuel Injection) with electronic methods as fuel mixing.

3.1. Bomb Calorimeter Test Data

The bomb calorimeter test data is shown in Figure 3 below.

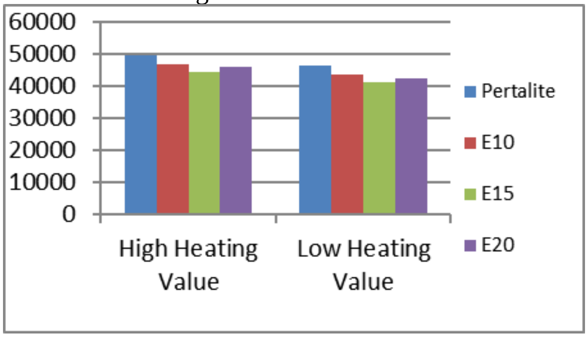

Figure 3. Bomb calorimeter testing data

From Figure 3 above, it can be concluded that there was a decrease in the calorific value of the fuel for each pertalite-bioethanol mixing variable and for E15 fuel (15% pertalite-bioethanol) there was a decrease in the highest fuel calorific value compared to the pertalite fuel calorific value. From the data it can be seen that the heating value at E15 is lower than the heating value of pure pertalite and E10 and E20. So that in a combustion process the energy produced by E15 fuel is lower than pure pertalite, E10 and E20.

3.2. Sub section 2

Proper citation of other works should be made to avoid plagiarism. When referring to a reference item, please use the reference number as in [1] or [1, 3, 5, 6] for multiple references. The use of "Ref [5]..." should be employed for any reference citation at the beginning of sentence. For any reference with more than 3 or more authors, only the first author is to be written followed by et al (e.g. in [4]). Examples of reference items of different categories shown in the References section. Each items in the references section should be typed using 9 pt font size.

3.2. Characteristic Test Results Fuel

Tests were carried out with the research parameters being density and viscosity with samples of petalite fuel, bioethanol with the following results:

Table 2. Viskositas

No	**Sampel**	**Viskositas (*P*)**
1	**Bioetanol Tebu**	**1,0916**
2	**Pertalite**	**0,5924**
3	**E10**	**0,6460**
4	**E15**	**0,6281**
5	**E20**	**0,6288**

Source: Test Results Data in the Lab. USU Physics

Tabel 3. Densitas

No	Sampel	Densitas (gr/ml)
1	Bioetanol Tebu	0,8018
2	Pertalite	0,7513
3	E10	0,7562
4	E15	0,77062
5	E20	0,7564

3.3. Torque (T)

The results of the torque test can be seen in Figure 4 below:

Figure 4 Dynotes Torque Graph using WINPEP 8 Software

Dynotest torque highest value data

o Pertalite = 108.16 Nm round 3732.24 rpm.

o E10 = 107.97 Nm round 3683.97 rpm.

o E15 = 109.17 Nm round 3645.63 rpm.

o E20 = 108.51 Nm round 3686.33 rpm.

Data on the highest value of the Dynotest torque show that 15% Gasohol (E15) is superior to Pertalite and 20% Gasohol (E20) fuel, while 10% Gasohol (E10) is the lowest.

3.4. Horse Power

The results of the power test can be seen in Figure 5 below:

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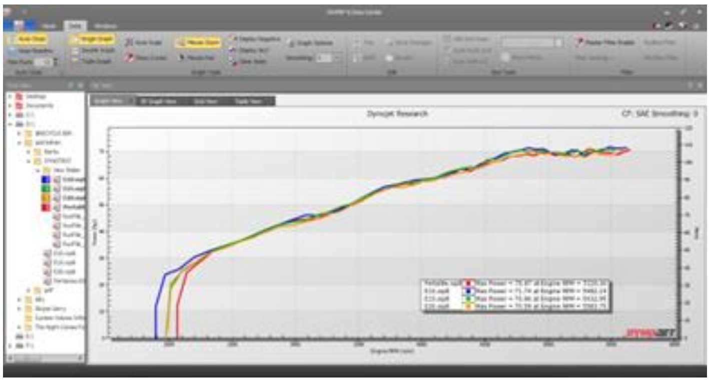

Figure 5. Dynotest Torque Graph using WINPEP 8 Software.

1. Data on the results of the highest Dynotest power value
a. Pertalite = 70.87 HP at 5320.00 rpm.
b. E10 = 71.74 HP round 5482.19 rpm.
c. E15 = 70.96 HP round 5432.95 rpm.
d. E20 = 70.59 HP round 5583.75 rpm.
2. The data for the highest power Dynotest value shows that Gasohol 10% (E10) is superior to Pertalite and Gasohol 15% (E15) at rotation above 5400 rpm while Gasohol 20% (E20) is the lowest.

3.5. AFR (Air Fuel Ratio)

The results of the AFR test can be seen in Figure 6 below:

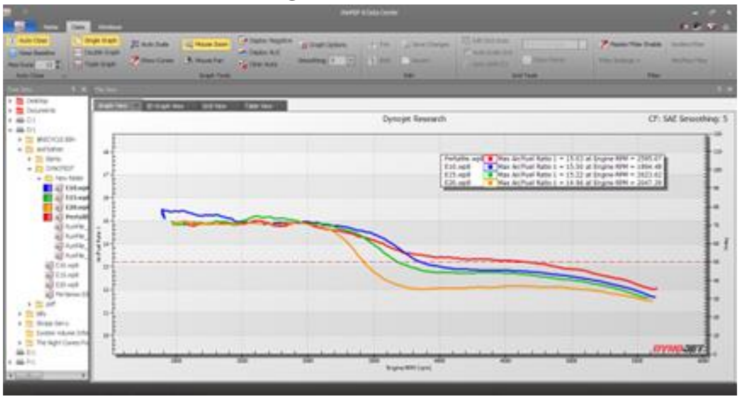

Figure 6 AFR graph using Dynotest

1. Data for the highest AFR Dynotest score
   a. Pertalite = 15.03 revolutions 2595.07 rpm.
   b. E10 = 15.50 revolutions 1894.48 rpm.
   c. E15 = 15.22 revolutions 2623.62 rpm.
   d. E20 = 14.96 revolutions 2047.39 rpm.
2. The data for the highest AFR Dynotest value shows that Gasohol 10% (E10) is superior to Pertalite and Gasohol 15% (E15) at rotation above 1894.48 rpm while Gasohol 20% (E20) is the lowest.

3.6. Exhaust Emission Test Results

Data from the exhaust emission test results were obtained from direct readings of the Qro-tech 401 Gas Analyzer through the exhaust emission sensor mounted on the exhaust of the Toyota Vios car.
Table 3 Standard Value of Exhaust Emissions on the Toyota Vios.

	MIN	MAX
CO	0	3
CO_2	11	15
HC	0	50
O_2	0	25

Source: AUTO 2000 Medan.

4. CONCLUSION

The use of a Pertalite fuel mixture with Bioethanol in each rotation will have an impact on increasing the performance of the Otto 1500 CC engine and the effect on exhaust gases. From the research results it can be concluded:

1. The highest torque of the engine is 109.09 Nm on 10% gasohol fuel with a rotation of 5000 rpm, while at the same rotation the pertalite fuel has a torque value of 99.95 Nm, and the lowest torque of the engine occurs on pertalite fuel with 5500 rpm engine speed of 90.43 Nm. 71.73 HP, while at the same speed pertalite fuel has a power value of 69.84 HP, and the lowest engine power occurs on pertalite fuel at 2500 rpm engine speed of 34.98 HP.

   The highest AFR on the engine occurred in the 15% gasohol fuel test at 2500 rpm rotation, which was 15.46 and pure pertalite had the highest AFR value of 14.94 at 2500 rpm engine speed, then the lowest AFR value on the engine was in the 10% gasohol fuel test at engine speed of 5500 rpm, which is equal to 11.58, and pertalite fuel has an AFR value of 11.73 at high engine speed of 5500 rpm. In the same round, there was a decrease in the AFR level for each addition of the percentage of the bioethanol mixture.
2. The level of exhaust emissions for each compound tested for each fuel is still below the standard threshold for vehicle exhaust emissions determined by Toyota and the environmental agency, except for 20% gasohol indicating O2 emission levels very high reaches the specified maximum limit

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