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Description Bioethanol is ethanol produced from glucose fermentation followed by the distillation process. The purpose of this study was to examine the performance of gasoline-fueled motors using bioethanol fuel mixed with pertamax (RON 90) and pertalite (RON92) fuels with a mixed percentage of B0%, B5%, B10%, B15%, and B20%. In this research, bioethanol is made from basic ingredients of coconut roomie (*Cocos nucifera*), which is fermented then continued with the distillation process to obtain bioethanol with a purity level of 80%. Bioetahnol is used as a fuel mixture using a gasoline fuel motor. The results of testing the mixture of bioethanol B20% and pertamax (RON 90) fuel with the highest torque is 11.94 Nm at rotation 2600 rpm. Bioethanol B20% and pertalite (RON 92) fuel with the highest torque is 11.79 Nm at rotation 2600 rpm. Bioethanol B20% and pertamax (RON 90) fuel the highest initial power is 4.58 hp at ...

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The effect of bioethanol mixture of raw coconut roomie (*Cocos nucifera*) with Pertamina (RON 92) and Peralite (RON 90) fuels on the performance of a gasoline motor

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Abstract. Bioethanol is ethanol produced from glucose fermentation followed by the distillation process. The purpose of this study was to examine the performance of gasoline-fueled motors using bioethanol fuel mixed with Pertamina (RON 90) and Peralite (RON 92) fuels with a mixed percentage of B0%, B5%, B10%, B15%, and B20%. In this research, bioethanol is made from basic ingredients of coconut roomie (*Cocos nucifera*), which is fermented then continued with the distillation process to obtain bioethanol with a purity level of 80%. Bioethanol is used as a fuel mixture using a gasoline fuel motor. The results of testing the mixture of bioethanol B20% and Pertamina (RON 90) fuel with the highest torque is 11.94 Nm at rotation 2600 rpm. Bioethanol B20% and Peralite (RON 92) fuel with the highest torque is 11.79 Nm at rotation 2600 rpm. Bioethanol B20% and Pertamina (RON 90) fuel the highest initial power is 4.58 hp at rotation 2900 rpm. Bioethanol B20% and Peralite (RON 92) fuel's the highest power is 4.52 hp at rotation 2900 rpm. Bioethanol B20% and Pertamina (RON 90) fuel shows that the lowest specific fuel consumption is 0.28 kg/hp.h. Bioethanol B20% and Peralite (RON 92) fuel the lowest specific fuel consumption Peralite is 0.29 kg/hp.h. The greater the percentage of in Pertamina (RON 90) fuel and Peralite (RON 92) fuel, the specific fuel consumption will be more efficient. In the mixture of Pertamina (RON 90) fuel and bioethanol B20% is the largest value torque and power, but specific fuel consumption is the lowest.

1. Introduction

In Indonesia, in 2010 oil reserves were around 7.99 billion barrels and natural gas around 159.64 TSCF (Trillion Standard Cubic Feet). If no new energy reserves are found, oil is expected to be depleted in 23 years and natural gas in the next 55 years over the next 31 years (2019-2050). National energy needs are predicted to increase by an average of 3% per year [1], so that the increased energy needs can be met while fossil-based energy reserves are certain to decrease, thus requiring an unlimited amount of alternative energy.

One alternative energy source that can be used and replace fossil energy sources include bioethanol. Bioethanol is ethanol which is produced from glucose fermentation followed by a distillation process [2].



2. Theory

2.1 The Coconut

The coconut is a plantation crop with the widest area in Indonesia compared to oil palm, and ranks first for crop cultivation after rice. Coconut occupies an area of 3.70 million ha or 26 percent of the total 14.20 million ha of plantation area. Approximately 96.60 percent of coconut plantations are managed by farmers with an average ownership of 1 ha per family head [3], and most of it is cultivated monoculture (97%), mixed gardens or as a plantation. For the estimation of the coconut area in Sumatra, the largest coconut planting is Riau Province with an estimated total area of 327,500 ha, while for Bengkulu Province, an estimated total area of 7,441 ha [3, 4].

2.2 The Fermentation

The fermentation is the process of producing energy in cells in anaerobic conditions (without oxygen) or aerobes with decomposing bacterial rocks. Fermentation is the process of breaking down organic substances from complex to simple or with the help of microorganisms to produce energy.

2.2.1 Yeast (*Saccharomyces cerevisiae*)

Fermentation with yeast has long been used in the alcohol and alcoholic beverages industry; instead has the ability to ferment glucose into ethanol. The interesting thing is the process of ethanol fermentation in the yeast takes place in anaerobic conditions. According to Pasteur, the presence of oxygen will inhibit the fermentation pathway in yeast cells, so that the existing carbon source will be used as a respiration pathway. This phenomenon is often referred to as the Pasteur Effect [5,6].

2.2.2 Calcium Oxide (CaO)

Calcium Oxide is a compound commonly used to maintain acidity (pH), and the use of CaO on the roomie is usually to maintain the pH of the roomie to remain high, so that it can inhibit hydrolysis both by microorganisms and the influence of acids. CaO in water to form Ca(OH)_2 . It produces free OH ions which make an alkaline solution. In principle, the addition of CaO in the roomie will cause an increase in roomie pH due to OH ions [5,6].

2.2.3 Raru Plant Skin (*Garcinia mangostana*)

Raru plant is a type of forest plant that has a height of 70-85 m, has thick skin. The content contained in the skin raru is endophytic microbes that are tolerant to high alcohol. The bark of the raru plant used is capable of producing ethanol hydrolyzate, which in endophytic microbial fermentation is associated with healthy plant tissue which is neutral or beneficial in the fermentation of coconut roomie [7].

2.3 The Distillation

The distillation is a way of separating liquid from its mixture based on differences in boiling point or the ability of a substance to evaporate, where the liquid is heated to its boiling point, as well as flowing steam into the condenser and condensation as a liquid [8].

2.4 The Bioethanol

The Bioethanol can be obtained from the fermentation of ingredients containing starch, sucrose, glucose, and fructose. Bioethanol can also be consumed by humans as alcoholic beverages, and as pharmaceutical and cosmetic raw materials. Bioethanol is obtained from fermentation (the process of breaking down sugar), both in the form of glucose, sucrose, or fructose by yeast, especially *saccharomyces* sp, or *zymomonas mobilis* bacteria. In this process, sugar will be converted into bioethanol and carbon dioxide gas [9 – 11].

2.5 The Pertamina Fuel [RON 92] & Peralite Fuel [RON 90]

Pertamax fuel is intended for vehicles that require the use of unleaded high-octane fuel. Pertamina fuel is recommended for vehicles using technology equivalent to electronic fuel injection and catalytic

converters. Peralite fuel is a cleaner and more environmentally friendly product, the quality of peralite fuel is better, and it is produced to suit all types of vehicles. Pertamina and peralite fuels are fuel oil products from the processing of the Indonesian State Oil Company [12-14].

2.6 The Gasoline Motor

The gasoline motor comes with spark plugs and carburetors. Spark plugs acts as a spark generator that will ignite the air mixture with fuel. Because of this, gasoline motors are also called spark ignition engines. The 4-step gasoline motor cycle work can be seen in Figure 1 [15-17].

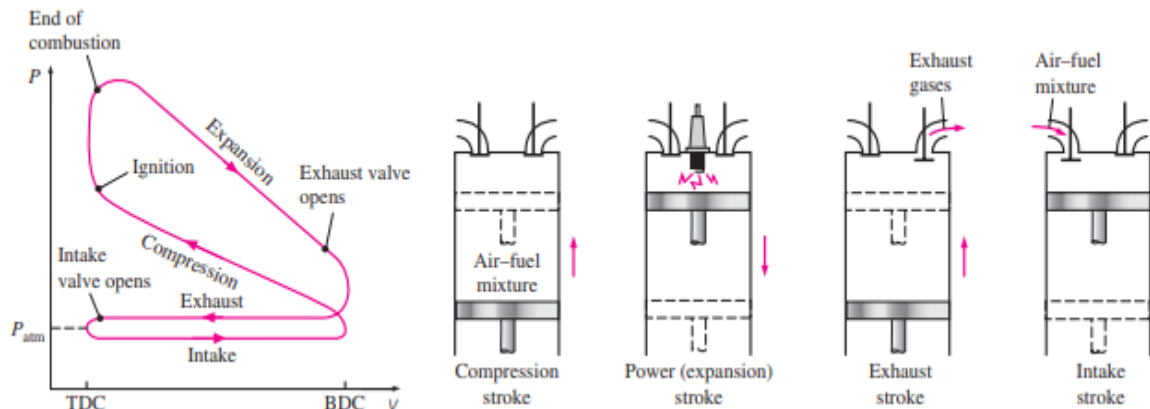


Figure 1. 4-Steps Motor Work Principle

2.7 The Gasoline Motor Performance Parameters

The gasoline motor performance parameters are force, torque, power, and specific fuel consumption.

2.7.1 Force

A force as an impulse or attraction to an object. Style has direction and magnitude, is a vector that follows the rules of addition [18-20]:

$$F = m \cdot g \quad (1)$$

Information: m = mass (kg), g = acceleration of gravity (m/s^2)

2.7.2 Torque and Power

Torque is a good parameter in determining the performance of a machine, torque is defined as a force acting at a momentary distance in units (Nm) [18-20]:

$$T = F \cdot r \quad (2)$$

Information: r = radius (m), F = force (N)

Power can be defined as the level of work of a machine, can be calculated by the equation [18-19]:

$$P = T_m \cdot \omega \quad (3)$$

$$P = T_m \cdot n \cdot \frac{2\pi}{60} \quad (4)$$

Information: P = power (hp), ω = engine rotation (rad/sec), T_m = engine torque (Nm), n = rotation (rpm)

2.7.3 Specific Fuel Consumption (SFC) [18-20]

Specific fuel consumption is interpreted as the amount of fuel used to produce one unit of power in a vulnerable time. The mass of fuel, which enters the carburetor can be calculated by the equation:

$$mf = vf \cdot \rho_f \quad (5)$$

Information: vf = fuel volume (m^3), ρ_f = fuel density (kg/m^3), mf = fuel massa (kg)

$$\text{SFC} = \frac{mf}{P \cdot \Delta t} \quad (6)$$

Information: SFC = specific fuel consumption (kg/hp.h), Δt = time (sec)

3. Research Methodology

The steps of the flowchart procedure as shown in Figure 2.

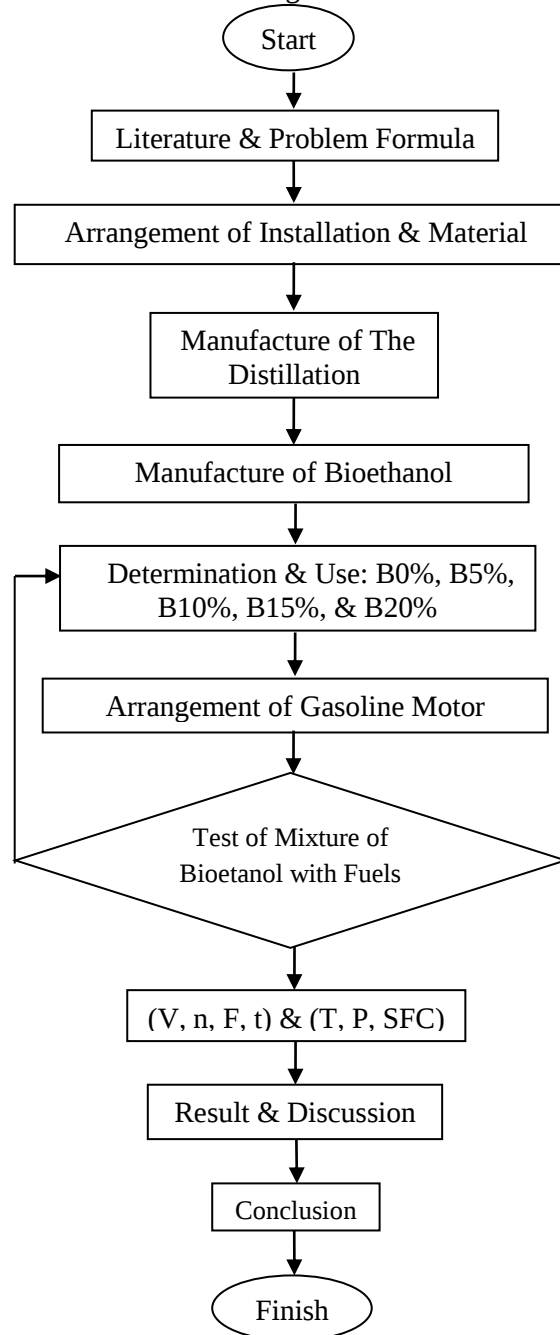


Figure 2. Research Methodology Flowchart

4. Discussion

In this discussion section discuss about analysis of rotation vs torque value, analysis of rotation vs power value, and analysis of rotation vs specific fuel consumption value.

4.1 Analysis of Rotation vs Torque Value

After obtaining the test results and calculation results, the torque value will be obtained for each variation of the bioethanol mixture with pertamax fuel and pertainite fuel, which is then analyzed in the form of a graph, which can be seen in Figure 3 A and B.

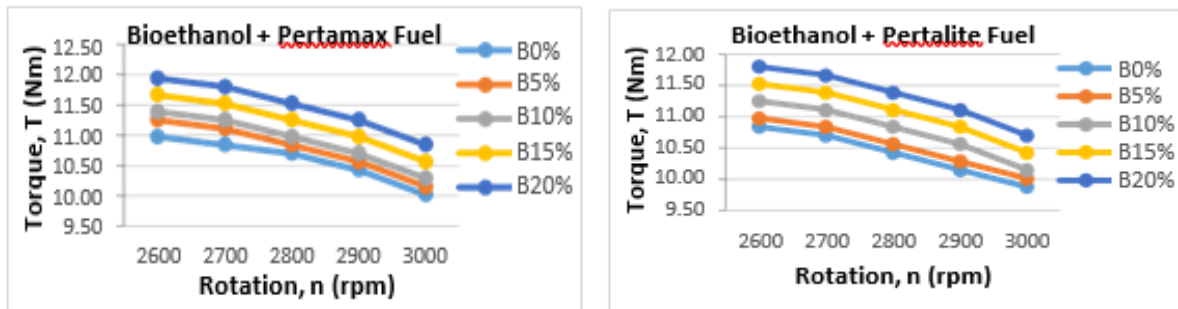


Figure 3. Rotation vs torque for: (A) bioethanol + pertamax fuel; (B) bioethanol + pertainite fuel

Figures 3 (A) and 3 (B) are graphic images of the relationship of the rotation value, n (rpm) to the torque value, T (Nm) on the condition of each variation of bioethanol mixture with pertamax fuel and bioethanol mixture with pertainite fuel. Where the two figures show that the higher engine rotation (the addition of engine rotation), the resulting engine torque will be lower. The two figures also with such a thing, shows the conditions inversely proportional to the percentage of the mixture of bioethanol with pertamax fuel and pertainite fuel. That the higher the percentage of the bioethanol mixture given at the same engine rotation, the higher the engine torque value produced.

The higher the rotation (the addition of rotation), the resulting engine torque will be lower. This phenomenon is directly proportional. This happens because, with increasing rotation, the force produced by the engine is lower with the same loading distance. This means that the engine rotation increases will have an impact on the low force of the engine, which is a function of engine torque.

For the condition of bioethanol mixture with pertamax fuel, the highest engine torque value is 11.9364 Nm at engine rotation value 2600 rpm rotation with mixed percentage B20% and the lowest engine torque value is 10.0156 Nm at engine rotation value 3000 rpm with a mixed percentage B0%. For the condition of bioethanol mixture with pertainite fuel, the highest engine torque value is 11.7992 Nm at engine rotation value 2600 rpm rotation and mixed percentage B20%, and the lowest engine torque value is 9.87840 Nm at engine rotation value 3000 rpm rotation with a percentage of bioethanol mixture B0%.

4.2 Analysis of Rotation vs Power Value

The power values will be obtained for each variation of the bioethanol mixture with pertamax fuel and pertainite fuel, which is then analyzed in graphical form, which can be seen in Figure 4 A and B.

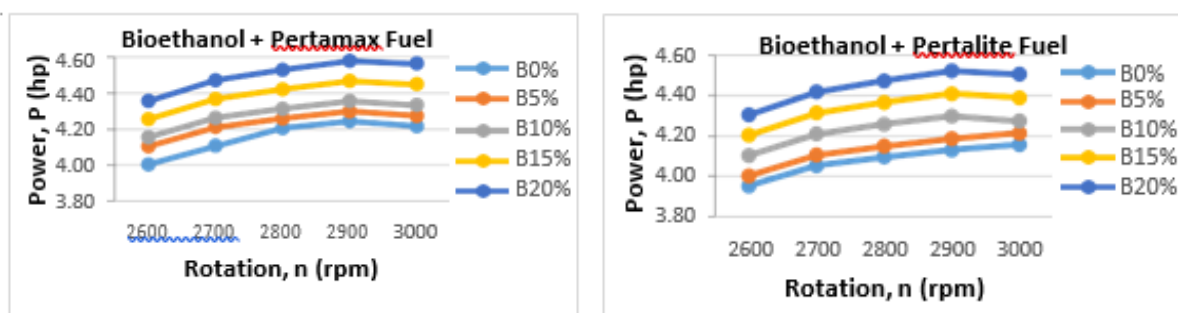


Figure 4. Rotation vs power for: (A) bioethanol + pertamax fuel; (B) bioethanol + pertainite fuel

Figures 4 (A) and (B) are graphic images of the relationship of the value of engine speed, n (rpm) to the value of engine power, P (hp) in the conditions of each variation of bioethanol mixture with pertamax fuel and bioethanol mixture with pertalite fuel. Where the two figures show that the higher the value of rotation (the addition of rotation), the value of the resulting engine power becomes higher. The two figures also with such a thing, shows the condition is directly proportional to the percentage of the mixture of bioethanol with pertamax fuel and pertalite fuel. That the higher the percentage of bioethanol mixture that is given at the same engine rotation, the higher the value of the engine power produced.

For the condition of bioethanol mixture with pertamax fuel, the highest engine power value is 4.5776 hp at engine rotation value 3000 rpm with a mixed percentage of B20%, and the lowest engine power value is 4.0039 hp at engine rotation value 2600 rpm with a mixed percentage of B0%. For the condition of bioethanol mixture with pertalite fuel, the highest engine power value is 4.5218 hp at engine rotation value 3000 rpm and B20% mixed percentage, and the lowest engine power value is 3.9539 hp at engine rotation value 2600 rpm with percentage of bioethanol B0%.

4.3 Analysis of Specific Fuel Consumption (SFC) Value

The specific fuel consumption (sfc) value of the fuel will be obtained for each variation of bioethanol mixture with pertamax fuel and pertalite fuel, which is then analyzed in graphical form, which can be seen in Figure 5 A and B.

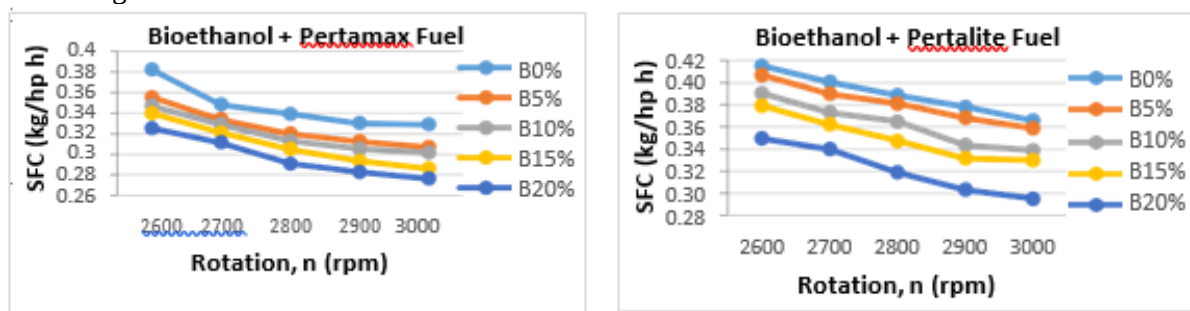


Figure 5. Rotation vs SFC for: (A) bioethanol + pertamax fuel; (B) bioethanol + pertalite fuel

Figures 5 (A) and 5 (B) are graphic images of the relationship of rotation value, n (rpm) to the value of specific fuel consumption, SFC (kg/hp h) under each condition of each variation of bioethanol mixture with pertamax fuel and bioethanol mixture with pertalite fuel. Where the two figures (curves) show that the higher the rotation (the addition of rotation), the lower the specific fuel consumption. The two figures also with such a thing, shows the conditions inversely proportional to the percentage of the mixture of bioethanol with pertamax fuel and pertalite fuel. That the higher the percentage of bioethanol mixture given at the same rotation, the value of specific fuel consumption will be higher.

The higher the rotation (the addition of engine rotation), the lower the specific fuel consumption. This phenomenon is inversely proportional. This happens because, with increasing engine rotation, the amount of fuel used is lower at the same volume of fuel or the same mass of fuel. This means that higher engine rotation will have an impact on the low amount of fuel used (due to the use of bioethanol which has a higher density compared to the density of pertamax fuel and pertalite fuel), and this is a function of engine specific fuel consumption.

For the condition of bioethanol mixture with pertamax fuel, the lowest specific fuel consumption value is 0.2762 kg/hp h at engine rotation value 2600 rpm engine speed with a mixed percentage of B20% and the highest specific fuel consumption value is 0.3819 kg/hp h at engine rotation value 3000 rpm with a mixed percentage of B0%. For the condition of bioethanol mixture with pertalite fuel, the lowest specific fuel consumption value is 0.2952 kg/hp h at engine rotation value 2600 rpm rotation and the percentage of B20% mixture, and the highest specific fuel consumption value is 0.4151 kg/hp h at engine rotation value 3000 rpm with a percentage of B0% bioethanol mixture.

5. Conclusion

From the results of testing and discussion, it can be concluded that:

1. The highest engine torque and engine power values and the lowest specific fuel consumption is a mixture of bioethanol and pertamax fuel.
2. The greater the percentage of bioethanol mixture (in this case B20%) in pertamax and pertalite fuels, the engine torque value and the value of the engine power produced at the same engine speed, the greater and the lower specific fuel consumption (economical).

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