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Characterization of bioethanol from fermented oryza sativa glutinosa as an alternative renewable fuel and blended with gasoline fuel

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Abstract.

The world's petroleum supplies are dwindling, and prices are rising sharply. Biofuel ethanol (C2H5OH) is a renewable energy through fermentation, distillation, and dehydration. Oryza sativa Glutinosa is the primary material for making bioethanol because it contains high enough carbohydrates. This research aims to first determine the characteristics of bioethanol from glutinous rice in terms of ethanol content, density, and viscosity. Secondly, please find out the results of increasing the octane number level after mixing it with RON 90 gasoline fuel. Sample mixing RON 90 gasoline fuel with 5%, 10%, and 15% bioethanol content. The test results of ethanol characteristics are 98.564% ethanol content, density 0.775 g/mL, and viscosity 1.44 cSt. There was an increase in octane number levels of 2%, 3%, and 5%. Bioethanol production needs to be further evaluated and improved to meet the essential parameters of INS standards. Further research can be done to improve bioethanol's characteristics to meet INS test standards. The research demonstrated that the blending of bioethanol had a positive impact on the fuel, resulting in an increase in the octane number values for all three fuels blends.

Keywords

Bioethanol, fermented oryza sativa glutinosa, alternative fuel

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Introduction

Currently, the globe is facing the dual challenges of diminishing fossil fuel reserves and the deterioration of the environment [1]. The development of Automotive Science and Technology in Indonesia is growing rapidly. This follows the current conditions of Indonesian society, which has high mobility and requires adequate means of transportation. Various designs of automotive products have sprung up on the market by offering the latest technologies from each product. Vehicles that already have

injection technology [2–7]. The higher market demand for transportation facilities, especially motorized vehicles, both two-wheeled and four-wheeled, has increased competition from automotive manufacturers to reach as many consumers as possible. Technological developments continue to be sought and explored to meet the needs of high-quality goods [8,9]. Motorized vehicles in this century have become an important facility in the form of human life activity. With the development of vehicle engine technology, the demand for fuel with high octane value to improve engine performance is increasing. According to data obtained from AISI (Indonesian Motorcycle Industry Association), Yamaha Vixion motorbike sales data amounted to 1,604,011 million vehicles starting from 2012-2015. Along with the number of motorcycles crossing the road, the more petrol is used. Of course, this is a special concern because petrol is a non-renewable fuel.

In Indonesia, there are currently Pertalite, Pertamax, and Pertamax Turbo products, with significant price differences for each type of product, to obtain fuel with an octane value that matches engine specifications. Indonesia's vast territory free, frequent fuel shortages and rising world crude oil prices result in vehicle owners buying petrol that is not in accordance with vehicle specifications, causing the vehicle not to work optimally. The octane number indicates fuel quality. This is in line with the statement from [10] that a motorbike that has a higher compression ratio requires a higher-octane number of fuel; the aim is to reduce knocking.

Petroleum supplies in the world are dwindling, and the price is increasing sharply. This is due to the increasing demand for energy sources, especially petroleum. Therefore, alternative energy other than petroleum is needed. Among the alternative energy sources that exist and can be utilized, Bioethanol is one of the main choices because Indonesia is very rich in natural resources in the form of biomass that can be used as energy raw materials [11]. Bioethanol is a biochemical liquid from the fermentation process of sugar from carbohydrate sources using the help of microorganisms. It is then processed to form a renewable additive or make a good fuel that is cost-effective and environmentally friendly.

Presidential decree No. 5 of 2006, on the national energy mix policy, targets the use of biofuels by 2025 at 5%. Biofuel is a renewable alternative fuel. One type of biofuel that can be used is ethanol (ethyl alcohol) (C_2H_5OH), which is a liquid chemical that is easy to store and mix with fuel because of its flammable characteristics, soluble in water, and in the event of pollution does not have a significant environmental impact.

Bioethanol has a much lower boiling point than water. Bioethanol that becomes vapor due to heating will be recovered through the condensation process. Heating at a temperature that matches its boiling point, the Bioethanol will vaporize and condense after passing through a cooling channel. The advantage of bioethanol fuel is that it is readily available and is a renewable energy resource. Bioethanol is particularly suitable in tropical countries with a wide variety of plants that contain carbohydrates and have the potential to produce Bioethanol. Ethanol or ethyl alcohol C_2H_5OH is a clear colorless

liquid, biodegradable, low toxicity, and does not cause major air pollution if leaked [12]. It is a liquid chemical, so it is easy to store and mix with fuel because of its flammable characteristics, soluble in water.

According to Suriansyah [13], a petrol motor is one type of energy conversion machine as a prime mover that uses chemical energy as fuel. The thermal energy obtained from combustion is used to perform mechanical work on the crankshaft. The working principle of a gasoline motor is a motor that works to use energy from the hot gas resulting from the combustion process, where the combustion process takes place in the engine cylinder itself so that the combustion gas also functions as a working fluid into power or heat energy. A piston/piston combustion motor uses one or more cylinders where there is a piston that moves back and forth, or translation is converted into rotary motion or rotation of the crankshaft. The combustion gases can move the piston, which is forwarded by the connecting rod (connecting road) and connected to the crankshaft. Several things affect the performance of gasoline engines, including the magnitude of the compression ratio, the level of homogeneity of the fuel mixture with air, the octane number of gasoline as fuel, and the air pressure entering the combustion chamber. The greater the air ratio, the more efficient the engine will be. However, the greater compression ratio will cause knocking on the engine, which has the potential to reduce engine power and can even cause serious damage to engine components. To overcome this, fuel that has a high-octane number must be used. The octane number in Otto engine fuel indicates its ability to avoid burning the fuel-air mixture prematurely (self-ignition), which causes tickling. Knocking is the emergence of the sound of enclosure due to a very large pressure wave that hits the cylinder wall. To improve the quality of the fuel-air mixture, the airflow is made turbulent, so it is expected that the level of homogeneity of the mixture will be better.

The anti-detonation quality of a fuel is the main thing. If the anti-detonation quality of the fuel is too low, Detonation or tickling will occur, while if the anti-detonation quality is too high, it will eliminate Detonation, and the engine sound will be smooth. There are two causes of Detonation: the first is caused by premature Ignition of the fuel and air mixture, and the second is that the fuel octane number is too low. How much fuel mixes with air that can be burned effectively in the engine is closely related to the results of its power output. The ideal mixture of fuel and air is about 1 15 to 1 13 or, more specifically, 1: 14.7, but in practice, the engine requires a mixture of air and fuel in different ratios.

Characterization of bioethanol derived from fermented Oryza sativa glutinosa (glutinous rice) and its potential as an alternative renewable fuel, particularly when blended with gasoline, presents an intriguing avenue for research. Addressing these research gaps can contribute to advancing the understanding and implementation of bioethanol derived from fermented Oryza sativa glutinosa as a renewable fuel source, both independently and when blended with gasoline, thereby promoting sustainable energy solutions and reducing dependency on fossil fuels

Materials and Method

The research method used in this study is experimental, namely true experimental design. The experimental research method can be interpreted as a research method used to find the effect of certain treatments on others in controlled conditions (Figure 1) [1,14–19]. Bioethanol is formed through fermentation, distillation, and dehydration processes. This research will be conducted by blending fuel with bioethanol from fermented glutinous oryza sativa. This process aims to obtain an alternative fuel or similar fuel mixture.

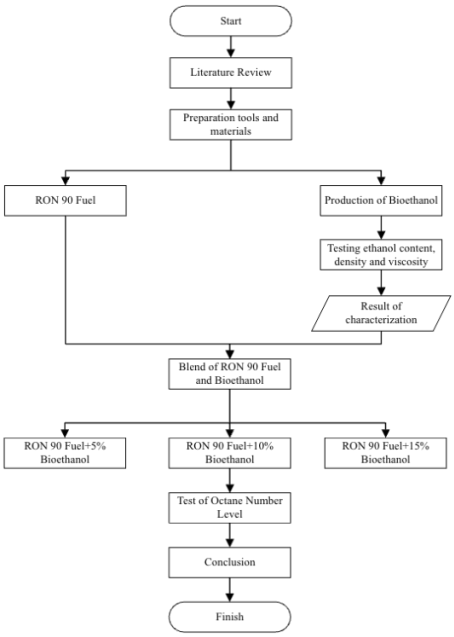

Figure 1. Flow chart of Research

Result and Discussion

To obtain ethanol that is recommended as a mixture of petrol fuel, the author made it independently using fermentation from glutinous rice. Fermentation that has been obtained is then distilled 3 times to achieve purity in accordance with INS (Indonesia National Standar). The purpose of the author choosing ethanol with a purity level of 99% is because to minimise damage to the motorbike due to the use of mixed fuel types, with 99% ethanol purity very small water content in the ethanol, even almost none, therefore the author chose this type of ethanol.

Table 1. Bioethanol Testing Results from Oryza Sativa Glutinosa

Testing	INS	Result
Result of Bioethanol (Liter)	-	1
Ethanol Content (%)	99,5	98,57
Density (g/mL)	0,7936 – 0,7961	0,78
Viscocity (cSt)	-	1,44
Octane Numbers	-	*Unidentified*

Table 1 contains complete information on bioethanol quality related to four important parameters and can be used to evaluate whether bioethanol samples fulfill INS quality standards that must be met in testing. There is no INS value for bioethanol yield (liters), as no standard has been set for it. The test results show the result of bioethanol produced from a sample of 0.650 liters; in testing, the ethanol content (%) INS value is 99.5%, and the test results show that the sample ethanol content of 98.567%, still below the expected standard levels.

To get the best research results, it must use the length of fermentation time that produces the highest alcohol content. In this study, the results of alcohol content from the fermentation time of 96 hours (4 days) with a normal temperature of 23-25°. The length of fermentation time affects the results of ethanol content produced. Before testing the alcohol content, alcohol detection is carried out using an alcohol sensor. Once it is confirmed that it contains alcohol, it can be continued by distillation to separate water from alcohol. Table 4.1 shows the results of the bioethanol test, comparing the test results with the standards and quality of bioethanol-type biofuels with other fuels marketed in Indonesia.

Bioethanol Content

According to the Ministry of Energy and Mineral Resources of the Republic of Indonesia No.23204.K/10/Djm.S/2008 Standards and Quality (Specifications) Biofuel Type Bioethanol as another fuel marketed in the country, the standard value for ethanol content is 99.5%. At the same time, the test results of bioethanol amounted to 98.567%. These results show that bioethanol still has a fairly low water content and is almost close to the standards set by the government. This is due to the addition of the dehydration process using limestone, which reduces the water content and dries the ethanol. This statement is in line with Novitasari et al, that the more adsorbent mass is used, the higher the capacity to absorb water, so the ethanol content is higher [20].

Density

Density is a property that affects engine performance, or more specifically, the injection pump, which measures the fuel supplied to the system [21,22]. According to the Ministry of Energy and Mineral Resources of the Republic of Indonesia No.23204.K/10/Djm.S/2008 on Standards and Quality (Specifications) Biofuel Type Bioethanol as another fuel marketed in the country, the standard value for bioethanol density is 0.7936 - 0.7961 g/mL. Based on the test results, the density of bioethanol is 0.7705 g/mL. The test results show that the bioethanol produced does not reach the minimum standard value. With a small difference in density test results, it cannot significantly affect engine performance. However, the higher the proportion of ethanol in the mixture, the lower the heat energy generated and the lower the engine output. In this case, if the specific gravity of bioethanol blended with gasoline fuel is below the set standard, it can affect the quality of the fuel mixture, including engine performance. Low-density fuel blends generally result in lower combustion efficiency and poor engine performance. In addition, low-density fuel blends can also affect the octane number of

the blend, which in turn can affect the propensity of the engine to experience knocking. The effective density function, which is calculated by dividing the mass of a particle by the volume of its mobility equivalent sphere, can be used to characterize the structure of soot particles [23,24]. Additionally, it can be utilized to transform particle size distributions into particle mass distributions, enabling the determination of the overall concentration of particle mass [25]. Therefore, before blending gasoline fuel with bioethanol, it is important to test the density of bioethanol to ensure that it meets the standards set by the Ministry of Energy and Natural Resources of the Republic of Indonesia. Thus, the resulting fuel mixture is of good quality and safe to use in vehicle engines.

Viscosity

Viscosity is the resistance that a fluid flowing in a capillary pipe has to the force of gravity. It is usually expressed in the time it takes to flow a certain distance. The value of viscosity the researcher obtained is 1.44, and according to INS data, the viscosity value is 1.17 cSt. The test results show that the bioethanol produced reaches the minimum standard value. If the viscosity is higher, the resistance to flow will be higher. This characteristic is very important because it affects the performance of the injector in the engine. Viscosity is the primary characteristic of fuel oil that significantly influences the quality of the combustion process, consequently improving the performance of the system. Fuel atomization is highly dependent on kinematic viscosity, injection pressure, and injection orifice size. Higher viscosity will make the fuel atomize into larger droplets with high momentum and tend to collide with the relatively cooler cylinder wall. The presence of high viscosity is a significant challenge in extracting low API gravity oil resources from heavy oil and bitumen deposits. Although thermal recovery is generally regarded as the most efficient approach for reducing viscosity, it is not advisable to introduce heat using frequently employed thermal methods in some reservoirs [26,27]. Relatively higher kinematic viscosity has better lubrication properties [28].

Octane Number Value

The octane number is a reference for measuring the quality of gasoline used as petrol motor fuel. The higher the octane number, the lower the tendency of gasoline to knock. By having a high compression ratio, it is recommended to use high-octane fuel to ensure the engine is durable and long-lasting and produces perfect power.

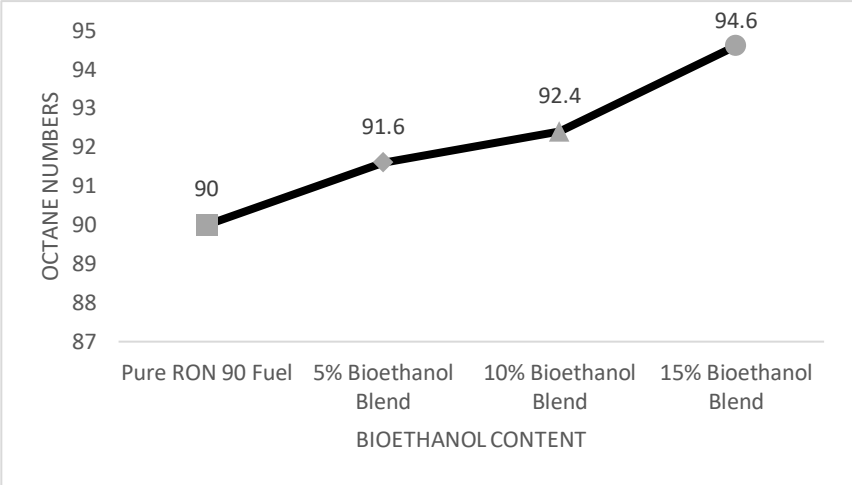

Figure 2. Graph of Bioethanol Content Against Fuel Octane Number

The highest-octane number was found in a blend of RON 90 gasoline fuel and bioethanol with a 15% content of 94.6. Then, the blend with 10% bioethanol content has an octane number of 92.4. Then, the 5% bioethanol blend has an octane number of 91.6. As a comparison, the octane number of gasoline fuel has an octane number of 90. Bioethanol is a sustainable and oxygen-rich bio-derived substance that has the capacity to decrease particle emissions. Blending bioethanol with gasoline can increase the octane number (Figure 2) [29]. A fuel with a higher-octane rating can be used in an engine with a greater compression ratio without experiencing detonation or engine knocking [30]. Compression is positively correlated with thermodynamic efficiency; however, the utilization of mixed bioethanol can result in a reduction of the fuel's heating value.

Conclusion

The test results of ethanol characteristics are 98.564% ethanol content, density 0.775 g/mL, viscosity 1.44 cSt. Bioethanol production needs to be further evaluated and improved to meet the important parameters of INS standards. Further research can be done to improve the characteristics of bioethanol so that it meets INS test standards. Bioethanol production needs to be further evaluated and improved to fulfil the important parameters of the INS standard. Further research can be done to improve the characteristics of bioethanol so that it meets INS test standards. The research demonstrated that the blending of bioethanol had a positive impact on the fuel, resulting in an increase in the octane number values for all three fuels blends. The notable surge was seen when utilizing gasoline 90 combined with a 15% amount of bioethanol. However, the test results of RON 90 gasoline fuel and bioethanol fuel mixtures that have been carried out, the results show great potential in the development of alternative fuels that are more environmentally friendly and efficient, so further research and development are needed.

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