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Diesel Engine Performance Test Using Coconut Oil Biodiesel Fuel

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ABSTRACT

This research is motivated by the dwindling energy crisis, while the need is increasing. Biodiesel is an environmentally friendly alternative fuel because exhaust emissions are very low compared to fossil fuels. The process of making biodiesel includes the process of pressing, deguming, esterification, transesterification, and purification then testing the characteristics of biodiesel. This research applies an experimental method using Pertamina's biodiesel fuel process mixed with biodiesel composition B0 and B20. This test was carried out to determine the effect of using B0 and B20 fuel. Biodiesel with a mixture of coconut oil biodiesel against the performance of diesel engines, namely effective power and torque. Based on the test results, in the effective power test, the highest value was obtained on B20 fuel at a load of 300 watts of 325.71 watts while the highest value of effective power for B0 fuel was 310.31 watts at a load of 300 watts because biodiesel has a lower density than biodiesel fuel. The highest torque value is produced when using B20 fuel of 2.48 Nm at 300 watts loading and the highest torque value of B0 fuel of 2.40 Nm at 300 watts loading. This is because two fuels have different characteristics that can affect torque values, differences can also be caused by unstable engines.

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1. INTRODUCTION

Energy in engines is a primary source that must be readily available [1]. One type of energy required by diesel engines is fuel oil. Fuel oil in diesel engines serves as a potential source to generate kinetic and mechanical energy. However, the energy source used in diesel engines is currently still derived from [2]. Petroleum remains the primary source of energy for diesel engines, but its longevity is limited. This is because fuel oil is still derived from the decaying remains of living organisms that died thousands of years ago. Therefore, concrete steps are needed to address fuel needs through the use of alternative energy sources [3].

Alternative energy [4][5] is energy that can be obtained from plant sources. Given Indonesia's geographical location, it possesses abundant natural resources as a source of raw materials. It is not uncommon for Indonesia's rich flora to remain untapped. This can also contribute to reducing dependence on petroleum and improving environmental quality [6]. Various studies have shown that the use of alternative energy can reduce dependence on fossil fuels and improve environmental quality. Therefore, research on the use of alternative energy in engines is needed to assess its quality and impact. One such approach is the use of biodiesel fuel [7].

Biodiesel is a biofuel that can be used in diesel engines. Biodiesel is a renewable fuel [8]. Chemically, biodiesel is a mixture of methyl esters of long-chain acids produced from biological sources such as vegetable oils and animal fats. Indonesia is rich in natural plant resources. One of the plants growing in Indonesia that can be used as a raw material for biodiesel is the coconut plant. This is because alternative energy sources can be obtained from continuously renewable plant sources. The coconut tree, with the Latin name Cocos nucifera, grows and thrives in Indonesia. Coconuts thrive in tropical regions and thrive on the islands of Java, Riau, and Sulawesi. Commercially, coconuts thrive at altitudes of up to 600 meters above sea level, with an optimal altitude of 0-450 meters above sea level. Coconuts contain oil when pressed. According to the oil content of mature coconut flesh, it is 34.7%. Therefore, coconut oil can be used as a biodiesel substitute for fossil fuels [9].

This study examined the performance of biodiesel and castor oil biodiesel on the performance of a 4-stroke diesel engine. This is proven by the best biodiesel and biodiesel (b25) with an increase in torque to 2.79 Nm with a percentage increase of 32.23% at 4500 rpm, a mixture of biodiesel and biodiesel (B25) is good with an increase in power to 17.70 Ps with a percentage increase of 30.02% at 4500 rpm. The average effective pressure is 0.35 kg/cm2 with a percentage increase of 30.02%. This is due to the characteristics of the mixture of biodiesel and biodiesel, namely the cetane number and flash point compared to pure biodiesel.

In this study, the effect of HHO [10] gas and a 5% biodiesel blend (B5) and their combined use in a 315 cc diesel engine was analyzed. Biodiesel was produced through base-catalyzed transesterification and cleaned by emulsification. The calculated cetane index (CCI) was 61.4. HHO gas was produced from the electrolysis of concentrated potassium hydroxide solution. The use of a 5% biodiesel blend resulted in a significant increase in brake thermal efficiency (BTE) of 9.4% and a maximum reduction in brake specific fuel consumption (BSFC) of 8.19%. The HHO enrichment of diesel and biodiesel by 2.81 L/min through the intake manifold increased average torque and power above 3%. The addition of HHO also increased the maximum BTE of diesel by 3.67%. The combination of biodiesel fuel with a high CCI and HHO created a mixture that shortened the ignition timing (ID) to cause adverse effects due to premature combustion as indicated by an average decrease in BTE of 2.97% compared to B5. Thus, B5 it self is the optimal fuel under these conditions.

Analysis shows that at stable speeds, the amount of CO [11], HC [12], and PM [13] produced decreases with the addition of HHO. Furthermore, HHO has the greatest effect on PM. The amount of NO produced increases by 9.52% when the diesel engine is operated according to its external characteristics, and the amount of HC, CO, and PM produced decreases by 31.6%, 11.3%, and 20.71%, respectively. Finally, the gross particle mass decreases by 67.48% and 42.53% at the highest torque and stated operating conditions, respectively, with the diameter distribution shifting toward a smaller size. Incorporating HHO into diesel fuel can effectively reduce PM formation, which plays a positive role in reducing smoke pollution.

2. METHOD

The research method used was an experimental method. Experimental methods [14] were used to directly test the performance of a diesel engine to determine effective power and torque. Prior to testing, a blending process of coconut oil biodiesel with pure fuel was carried out. The biodiesel fuel used was Biosolar with the addition of coconut oil biodiesel. The composition of the coconut oil biodiesel blend fuel is shown in Table 1.

Table 1. Composition of Diesel Fuel with Coconut Oil Biodiesel Mixture

Fuel Composition		Code
Biodiesel	**Coconut oil**	
100%	0%	B0
10%	20%	B20

After pure diesel fuel is mixed with coconut oil biodiesel, effective power and torque testing is carried out using a diesel engine. The effective power and torque test tool begins by warming up the diesel engine for ± 10 minutes so that the lubricant can protect the rubbing components and the diesel engine performance is maintained. Then prepare a tachometer which is used to measure the speed of the rotating motion of the flywheel in one minute or revolutions per minute (rpm). The distance between the flywheel and the tachometer is 30 cm with data collection for 60 minutes. After that, set the load without lights, loading 100 watts, 200 watts, 300 watts. Record the electric current using an avometer whose positive and negative valve ends are inserted into a power outlet which is useful for knowing the electric charge when electricity is loaded and calculating the potential difference that increases with each load using a clamp meter by connecting one of the cables connected to the lamp. Then repeat the test with different variations of mixed fuel (B0 and B10) for 3 repetitions. The following diesel engine performance testing scheme can be seen in Figure 1.

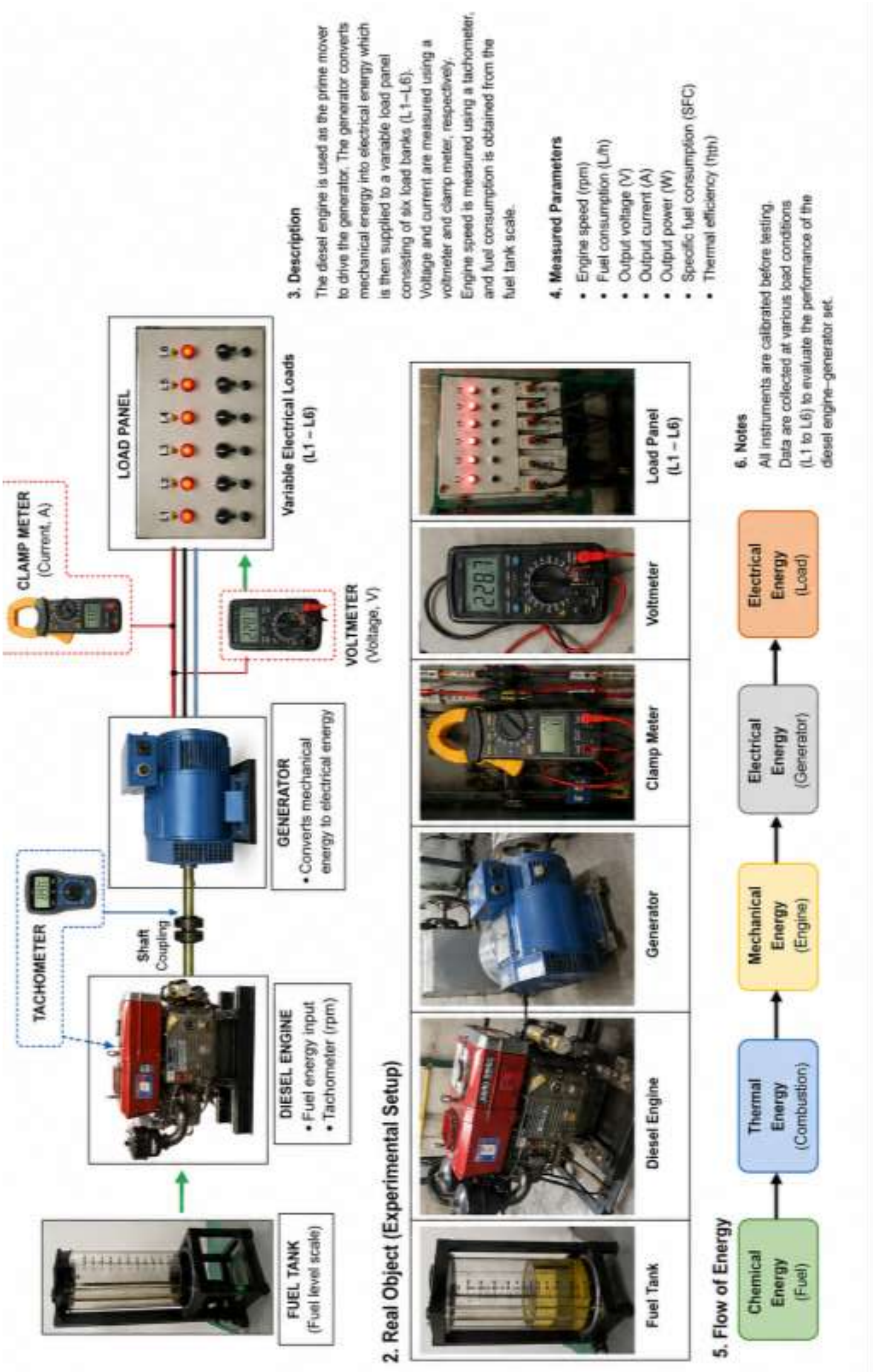


Figure 1. Testing scheme

3. RESULTS AND DISCUSSION

The results of diesel performance testing using pure biodiesel fuel with the addition of 20% coconut oil biodiesel. The discussion of the research results is discussed in sub 3.1 to 3.2.

3.1. Effective Power

Pure Biodiesel Fuel (B0) and Biodiesel Fuel with 20% Coconut Oil Mixture (B20). Below are the test data results for pure biodiesel fuel (B0) and biodiesel fuel with 20% coconut oil mixture (B20) which can be seen in Figure 2.

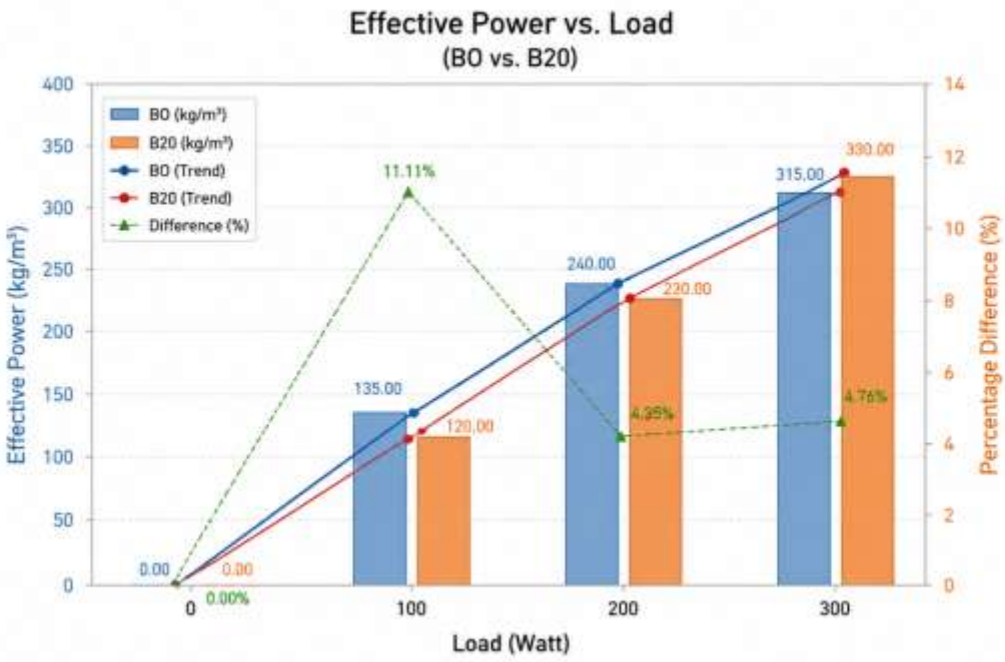
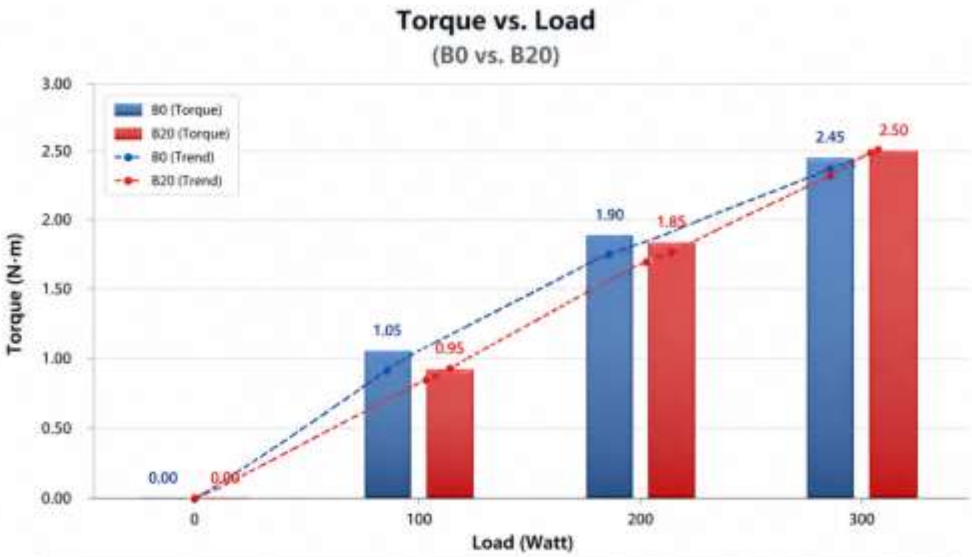


Figure 2. Results of the Effective Power Test Graph of Pure Biodiesel Fuel (B0) and Biodiesel Fuel with a 20% Coconut Oil Mixture (B20)

From Figure 2 above, B0 fuel without any loading up to 300 watts of loading experienced an increase in the effective power value. This is due to an increase in each load, without any loading of 2.38 kg/m3 while at 300 watts of loading it was 310.31 kg/m3. The size of the current is determined by the engine speed. In contrast to B20 fuel at no load up to 300 watts of loading continues to increase, without loading 2.38 kg/m3 while at 300 watts of loading it was 325.71 kg/m3. The increase in the effective power value is caused by several factors, one of which is the addition of loading, having a higher density than biodiesel fuel, thus increasing the power produced by a stable engine [15].

3.2. Torque

Pure Biodiesel Fuel (B0) and Biodiesel Fuel with 20% Coconut Oil Mixture (B20). Below are the results of the difference in torque of pure biodiesel fuel (B0) and biodiesel fuel with 20% coconut oil mixture (B20) which can be seen in Figure 3.



Load (Watt)	0	100	200	300
B0 Torque (N·m)	0.00	1.05	1.90	2.45
B20 Torque (N·m)	0.00	0.95	1.85	2.50

Figure 3. Torque Test Results of Pure Biodiesel Fuel (B0) and Biodiesel Fuel with 20% Coconut Oil Mixture (B20)

From Figure 3 above, pure biodiesel fuel (b0) and biodiesel fuel with a mixture of 20% coconut oil (b20). Torque is a measure to determine the amount of work a diesel engine can do in a certain period of time. It can be seen from the graph that the torque has similarities. From pure biodiesel fuel, the highest torque is 2.40 Nm at a power load of 300 watts for maximum torque. While in B20 fuel, the highest torque value is 2.48 Nm at a load of 300 watts for maximum torque. From the graph data above, it can be concluded that with a mixture of coconut oil, it can provide an increase in the torque value of a diesel engine [15] compared to without the addition.

4. CONCLUSION

Based on the effective power test, biodiesel fuel mixed with B20 coconut oil biodiesel can affect the effective power of a diesel engine. The highest effective power value for B20 fuel was 325.71 watts at a 300-watt load, while the highest effective power value for the B0 coconut oil biodiesel blend was 310.31 watts at a 300-watt load. This shows that using B20 fuel increases the effective power value relatively, while using B0 fuel decreases the effective power value relatively.

The effect of adding coconut oil biodiesel blends can affect torque on diesel engine rotation, this is due to differences in fuel characteristics. The highest torque value for B20 fuel is 2.48 Nm at a 300-watt load, while the highest value for B0 fuel is 4.29 Nm at a 300-watt load. This is because the two fuels have different characteristics that can affect torque values. The difference can also be caused by engine instability. For further research, a more in-depth study can be conducted, such as increasing load variations to identify deviations in test results. When operating the diesel engine, the operator should double-check the equipment used to determine if it could affect the measurement results.

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