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Original Research Paper

Engineering

THE PERFORMANCE ANALYSIS OF A DIESEL ENGINE FUELED WITH BLENDS OF BIODIESEL FROM COCONUT OIL AND DIESEL FUEL

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ABSTRACT The article discusses the diesel fuel mixed with biodiesel. Diesel fuel mixed with 10% biodiesel is called B10 and diesel fuel mixed with 20% biodiesel is called B20. The purpose of this study is to determine the performance of the engine which consists of optimum power, optimum torque and minimum fuel consumption, when using B10 and B20 fuels that have been mixed with diesel fuel. It also determines the optimum power, optimum torque and minimum fuel consumption, when using B10 and B20 fuels that have been mixed with dexlite. The engine performance test method uses an experimental laboratory based on ISO 1585 standards when engine speed is 1500 - 4500 rpm with multiples of every 500 rpm.Then the data is presented in graphical form to be analyzed. Based on the results of the analysis, the power increases 1.68% when using B10 dexlite fuel, torque increases 1.68% when using B10 dexlite fuel, and fuel consumption decreases up to 5% when using B10 dexlite fuel.

KEYWORDS : Biodiesel Mixture, Dexlite, Engine Performance, Solar.

INTRODUCTION

The Biodiesel is used as an alternative energy substitute for fuel oilfor diesel fuel (solar) types. Biodiesel can be applied in the 100% form (B100) or a mixture with diesel fuel at a certain concentration level [12]. One of the methods of the Indonesian government in the use of biodiesel is the B20 program, the B20 program is a government program to require the mixing of 20% biodiesel with 80% diesel fuel [4].

In this study, trying to mix the diesel fuel with biodiesel made from coconut oil with a stirring process at the level 10% and 20% concentrations are then applied to the diesel engine to be analyzed its effect on the performance of the diesel engine consisting of power, torque, and specific fuel consumption.

[6][7][8][9][10]The comparison of the effects of diesel and biodiesel temperatures to the performance of direct injection diesel enginesfor biodiesel fuel showed that the best thermal efficiency was 21.3% at 70°C with 11% BSFC, and in this condition there was a decrease in specific fuel consumption by 8% [11].

[2] The comparative experimental investigation of combu stion,performance and emission in a single cylinder diesel engine using diesel fuel and biodiesel. It is shows when at maximum load the specific fuel consumption of LHR engine fueled with biodiesel is higher by about 5.24% than diesel fuel. The high fuel consumption is due to the low heating value and high density of biodiesel fuels.

[3] showsthe performance characteristics and analysis of multi cylinder turbocharged engines using diesel fuel mixed with biodiesel from jatropha plants at a percentage of 20%, 30%, and 40% showed power, torque, and thermal efficiency using biodiesel fuel is higher than that produced by diesel fuel. Fuel with 20% biodiesel percentage shows better performance than other types of fuel.

[5] The diesel engine performancesfueledwith oxidized biodiesel shows that the use of B20 fuel had 16.2% higher power and specific fuel consumption was 11.2% lower than diesel fuel.

MATERIALS

The materials used in this study are diesel fuel with the numbers of cetane 48 (pure diesel fuel), 51 (dexlite) and biodiesel (B100). Biodiesel fuel (B100) used in this studyfrom coconut oil. This study uses a variation of the fuel mixture which is then applied to the diesel engine to find out how much influence on engine performance. The composition of the fuel mixture used in this study includes:

a. B10 Solar = 10% biodiesel (B100) + 90% Solar (cetane 48)
b. B20 Solar = 20% biodiesel (B100) + 80% Solar (cetane 48)
c. B10 Dexlite = 10% biodiesel (B100) + 90% Dexlite (cetane 51)
d. B20 Dexlite = 20% biodiesel (B100) + 80% Dexlite (cetane 51)

After all the fuels have been mixed, the next step is to test the characteristics of the fuel mixture which includes testing the density of the fuel.

[1] There is a difference between pure coconut oil (PCO) and jathropa oil methyl ester (JOME) and diesel fuel. The difference is due to differences in the structure of the fuel. The higher the viscosity and density of PCO and JOME the results will affect the difficulty of fuel injection in the combustion chamber, fuel atomization, and the mixture of fuel with air so that it will affect the performance of diesel engines.

Thetest used in this study include dynamometer type chassis dynamometer (single-axle dynamometer) to measure the power and torque produced by a diesel engine, a fuel consumption measuring gauge consisting of flowmeter and stopwatch, flowmeter to measure fuel flow speed, stopwatch to measure the duration of fuel consumption of a diesel motor (s), measuring glass1 Liter and burette to determine fuel percentage, tachometer to measure engine speed (rpm), fan to cool the engine used for testing and placed in front of the engine, and the diesel engine for test. The specifications of the diesel engine used in this study can be seen in Table 1.

Table 1. Spesification of Diesel Engine

Engine Type	4-stroke, Direct Injection
Number of Cylinder	4
Diameter x Stroke	93 mm x 92 mm
Displacement	2499 cm3
Compression Ratio	18,4 : 1
Maximum Power	85 hP / 3900 rpm
Maximum Torque	17.5 Kg.m / 2000 rpm

METHODS

In this study there are 2 tests, namely density testing of fuel and diesel engine performance testing. Diesel engine performance testing use dynamometers (Chassis Dynamometers: Single-axle dynamometer). The diesel engine performance testing method uses P-max method. The diesel engine are operated in the range of 1250 rpm to 4500 rpm. Then record every change in power and torque in the specified engine speed range.

In fuel consumption testing, the diesel engine is operated in the range of 1500 rpm to 4000 rpm. Fuel consumption testing is measured using a flowmeter and stopwatch. Measure the amount of time (s) the diesel engine needs to consume 10 grams of fuel using a stopwatch. Make a data records of the variables needed, namely the time of fuel consumption per engine speed at each variation of the fuel mixture.

For testing the density using a pycnometer. Fig. 1 shows set up engine performance testing.

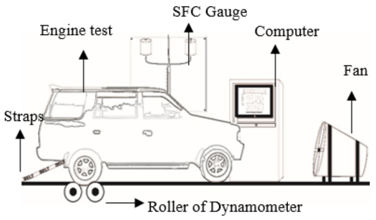

Fig. 1 Set Up Engine Performance Testing

RESULT AND DISCUSSION

THE RESULT OF FUEL CHARACTERISTICS TESTING

The results of fuel density tests show that diesel fuel with the same type of cetane number, when mixed with biodiesel can increase the density of the fuel, for example diesel fuel (solar) with a concentration of biodiesel mixture of 20% has a greater density compared to diesel fuel (solar) with a concentration of biodiesel mixture of 10%. The changes of the density cause differences in the structure (chain) of the fuel is longer, so that a higher density indicates the density between molecules in the fuel is solid and fused, resulting in higher fuel viscosity. This condition affects the difficulty of fuel injection, fuel atomization, and the mixture of fuel with air so that it will affect the performance of diesel engines. In the fuel density test results, show in the table 2.

Table 2. The Density of all Variant of Fuel

No	Fuel	Fuel Composition	Density (Kg/m3)
1	Biodiesel	100% biodiesel	860
2	B10 Solar (standart)	10% biodiesel (B100) + 90% Solar (cetane 48)	849
3	B20 Solar	20% biodiesel (B100) + 80% Solar (cetane 48)	887
4	B10 Dexlite	10% biodiesel (B100) + 90% Dexlite (cetane 51)	839
5	B20 Dexlite	20% biodiesel (B100) + 80% Dexlite (cetane 51)	845

ENGINE PERFORMANCE TESTING RESULTS

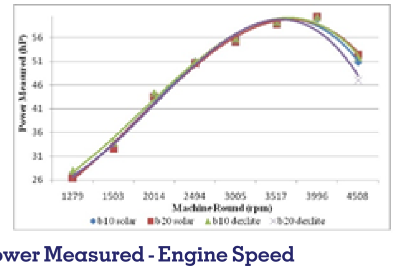

Fig. 2 Power Measured - Engine Speed

Fig.2shows, the power measured by using B20 diesel fuel producing power measured is lower than that produced in standard conditions (B10 diesel fuel). At 1279 rpm the power produced is 1,19% lower than that producedin standard conditions. When 1503 rpm there was andecrease in power of 0,22%, in 2014 rpm was 0,31%, when 2494 rpm was 0,92%, when 3005 rpm was 1,93%, and when 3517 rpm was 0,08%.

When averaged, for the significant effect there was an increase in power measured of 1,68% by using B10 dexlite fuel compared to using standard fuel and the power measured of B10 dexlite fuelis higher than that produced in standard conditions, B20 diesel fuel, and B20 dexlite.It is because the density of B10 dexlite fuel has the lowest value than the density of other fuels, which indicates the intermolecular density of B10 dexlite fuel is more subdued. The causes the viscosity of the B10 dexlite fuel is lower than the viscosity of other fuels , so that it can simplify the process of injection (extraction) of fuel. Injected fuel is more easily integrated with air (homogeneous) so that more fuel is burned and more combustion energy produced. The power produced will also be far greater than that produced by other types of fuel, including standards.

The amount of power produced also depends on engine speed and fuel temperature. When the engine speed is low, the piston motion is slow so that the amount of mixture of air and fuel entering is low. Conversely, when the engine rotation is high, the piston movement is fast and the amount of air entering will be large. However, at certain rotation limits if the motor rotation is too high, it is possible the intake valve closes before the air has not entered the cylinder. During beginning engine speed (1279 rpm) the fuel temperature is lower than the temperature at 3996 rpm. So that the viscosity of fuel at the beginning of the engine speed is higher than at 3996 rpm, which causes the power that produced at the beginningof engine speed smaller than the power at 3996 rpm.. The results of engine performance testing (power measured) can be shifted or different compared to the standard specifications of the vehicle, due to various factors including errors due to the testing process, setting or reading data as well as or power reading errors due to the dynamometers.

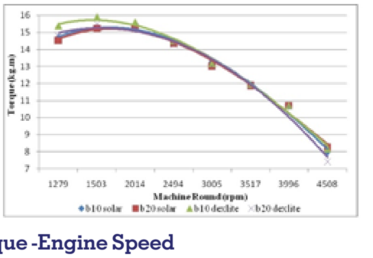

Fig. 3Torque -Engine Speed

Fig. 3 shows, the torque by using B10dexlite fuel is higher than that produced in standard conditions, B20 diesel fuel, and B20 dexlite. At 1279 rpm the torqueproduced is 4,66% higher than that producedin standard conditions. When 1503 rpm there was an increase in torque of 4,07%, in 2014 rpm was 1,71%, when 2494 rpm was 0,08%, when 3517 rpm was 0,79%, when 3996 rpm was 0,56%, and when 4508 rpm of 2.31%. During high rotation, B20 dexlite produces the lowest torque compared to other fuel mixture

When averaged, for the significant effect there was an increase in torque of 1,68% by using B10 dexlite fuel compared to using standard fuel. It is because the torque value produced depends on the engine speed and power measured (Ne) produced by the diesel engine. This refers to the torque formula which is directly proportional to the power produced, but inversely proportional to the engine speed. The higher the speed of the engine and if not accompanied by a large increase in power, the resulting torque will be smaller. Fig. 3, which tends to decrease with increasing engine speed. At engine speed of 3517 rpm, the torque produced by all types of fuel is in a position that coincide with each other, this indicates that at the engine speed the mixture of air fuel for all types of fuel approaches the stociometry so that it produces the same torque value. The results of torque can be shifted or different compared to the standard specifications of the vehicle, due to various factors including errors due to the testing process, setting or reading data as well as or power reading errors due to thedynamometers.

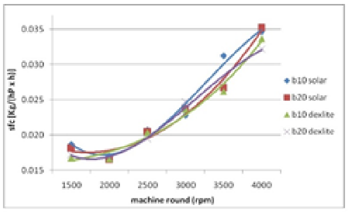

Fig. 4 Specific Fuel Consumption (SFC) - Engine Speed

Fig. 4shows the specific fuel consumption (sfc) using B20 dieselfuel is lower (economical) than produced in standard conditions. At 1500 rpm the sfc produced 2,85% lower than that produced in standard conditions. When 2000 rpm there was a decrease of 3% sfc, while 2500 rpm was 1,35 %, and while 3500 rpm was 14,6%. Based on testing, B10 diesel produces the highest sfc than any other fuel mixture.

When averaged, for the significant effect there was a 5% decrease in SFC fuel consumption by using B10 dexlite compared to using standard fuels. It is because the value of the specific fuel consumption depends on the power measured (Ne), the density of the fuel, fuel temperature, and engine speed. Increased engine speed will be accompanied by an increase in fuel temperature which will affect the viscosity of the fuel, as well as an increase in temperature will increase the measured power (Ne). It also refers to the formula of specific fuel consumption (sfc) which is inversely proportional to the power measured (Ne) that produced (sfc = mf / Ne). So that with the same engine speed on all types of fuel, the higher the power measured (Ne), the specific fuel consumption produced will be smaller. We can see that the value of power measured (Ne) at 3500 rpm with B10 dexlite fuel is 0.79% higher than that produced by the standard, which results in the fuel consumption value of B10 dexlite being smaller than the standard fuel consumption. The specific fuel consumption can be shifted or different compared to the standard specifications of the vehicle, due to various factors including errors due to the testing process, setting or reading data as well as or power reading errors due tothe dynamometers.

CONCLUSION

The main purpose of this study is to analyze the performance of diesel engines, when using diesel fuel mixed with biodiesel from coconut oil at a concentration level of 10% and 20%. Based on the results of diesel engine performance testing, it shows that the B10 dexlite fuel produces optimum power and torque than other fuel mixtures namely B10 diesel (sandard), B20 diesel, and B20 dexlite. For the specific fuel consumption test, it shows that B10 dexlite produces the minimum fuel consumption than other fuel mixes, namely B10 diesel (sandard), B20 diesel, and B20 dexlite.

Engine performance testing is carried out on a diesel engine by using various variations of biodiesel blends from coconut oil in the range 1500 rpm - 4500 rpm. From the test results, biodiesel from coconut oil can be used as an alternative fuel for diesel engines and B10 dexlite is suitable blend of biodiesel from coconut oil.

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