Engine Performance and Oil Analysis of Biodiesel from Bulk Oil

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***Abstract*—Biodiesel is one of the alternative fuel made from vegetable oil, friendly for environment and has no effect on health and can reduce the emission compared with diesel fuel. To obtain Biodiesel, the vegetable oil or animal fat is subjected to a chemical reaction termed t*ransesterification*. In that reaction, the vegetable oil or animal fat is reacted by catalyst with an alcohol (usually methanol) to give the corresponding methyl esters. In this study, Biodiesel are made from bulk oil, and used two catalyst; KOH and NaOH. And then, Biodiesel Bulk Oil blended 20% (B20) with petrodiesel. In oil analysis showed that cetane number for B20 using catalyst KOH (B20KOH) is higher 3.71 % than using B20 catalyst NaOH (B20NaOH). Experiment was conducted in one hour engine running test. Test fuels are petrodiesel as a datum, B20KOH,B20NaOH, pure bulk oil with catalyst KOH (B100KOH) and pure bulk oil with catalyst NaOH (B100NaOH). The results, in minimum load to 60% load, B20KOH and B20NaOH are more efficient up to 11.6% than petrodiesel. In contrary, for maximum load (80%), Petrodiesel is more efficient 0.5 % than B20KOH. And B100KOH is the most inefficient compared with other fuels.**

***Index Terms*— Bulk Oil, transesterification, NaOH, KOH, Blend**

I. INTRODUCTION

Biodiesel is made from vegetable oil or animal fat are *triacylglycerols* (often also called triglycerides) reacted with methanol or ethanol and a catalyst, yielding biodiesel (fatty acid methyl or ethyl esters) and glycerin as a by-product. To obtain biodiesel, the vegetable oil or animal fat is subjected to a chemical reaction named *transesterification*. In that reaction, the vegetable oil or animal fat is reacted in the presence of a catalyst (usually a base) with an alcohol (usually methanol) to give the methyl esters [1]. Biodiesel can be produced from a great variety of feedstocks. These feedstocks include most common vegetable oils (e.g., soybean, jatropa, palm, coconut) and animal fats as well as waste oil. The choice of feedstock depends on the geography. Depending on the origin and quality of the feedstock, changes to the production process may be necessary [1].

Biodiesel is miscible with petrodiesel in all ratios. In many countries, this has led to the use of blends of biodiesel with petrodiesel instead of neat biodiesel.

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Often blends with petrodiesel are donated by acronyms such as B20, which indicates a blend of 20% biodiesel with petrodiesel [1].

II. RESEARCH METHODOLOGY

A. Preparing Biodiesel

In Indonesia, Bulk oil is made from oil palm. Bulk oil it selves has no name in branded. The quality and hygiene for bulk oil is not fully guaranteed by the government.

In this study, biodiesel from bulk oil are made from two compositions: First, bulk oil 100%: Methanol 20 cc: catalyst NaOH 0,5 grams. In the results, methyl esters (Biodiesel) produced was clean and the glycerin was a little solid. Second, bulk oil 100%: Methanol 20cc: catalyst KOH 1 grams. In the results, methyl esters (Biodiesel) produced was clean and the glycerin was a little liquid. The composition of catalyst KOH and NaOH have a little difference because after several experiments, those compositions can produce biodiesel in good quality such as clean and transparent. Biodiesel from bulk oil blends with petrodiesel in composition of 20% biodiesel bulk oil and 80% petrodiesel.

B. Test Engine

These experiments were conduct on 1000cc single cylinder engine and direct injection. The engine specification is shown in table 1.

TABLE 1 . Engine Specification

Parameter	Specifications
Brand Name	Tianli
Type	AS 195
Made In	China
Max Power	14 HP
Rated Power	2200 rpm
Capacity volume	1000 cc
Number of Cylinder	one
Load	Electricity generators, One phas

Experiments were carried out following SAE Technical Series 942010 “Diesel Fuel Detergent Additive Performance and Assessment” [2]. As mentioned in that reference, experiments were done in diesel engine one cylinder with zero load, 45% load, 65% load and maximum load. The operating condition was in 1500 rpm and with zero load, 1 kW, 2 kW, 3 kW and 4 kW (4kW=80%) and the data was taken two times, total in one hour.

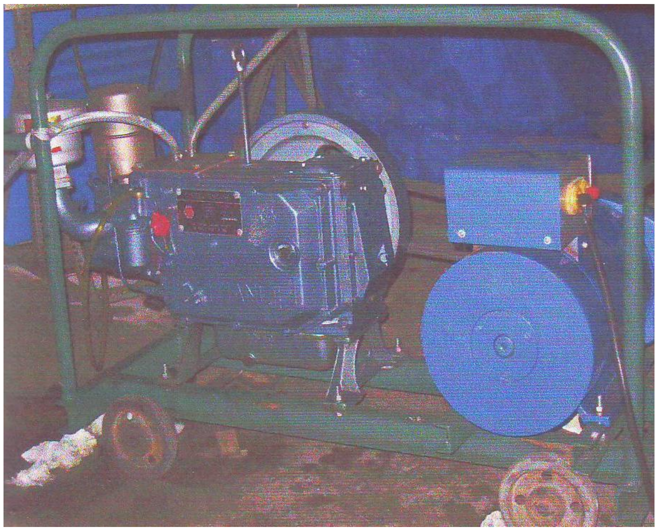

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Figure 1.Diesel Engine (Tianli)

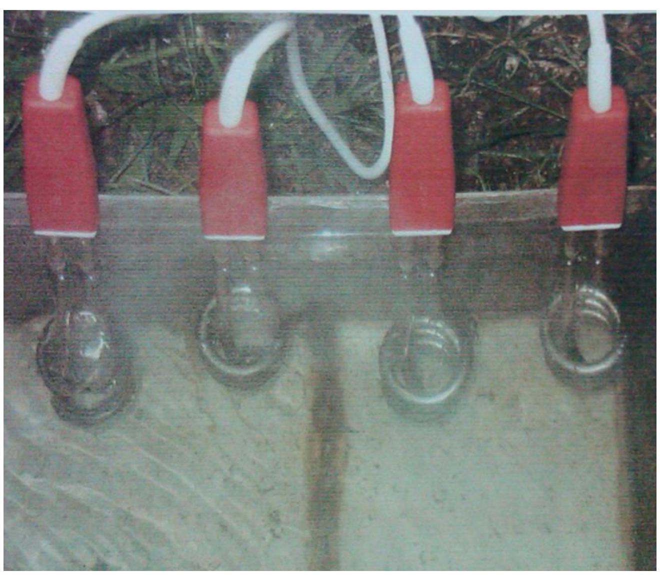

Figure 2. Electrical Loads

For Engine loads, we used four electrical heats and each of load has 1000 watt.

Figure 3. Instalation of Diesel Engine With Electrical Loads

III. RESULT AND DISCUSSION

A. Biodiesel Analysis

Fig.4.Biodiesel catalyst KOH

Fig.5.Biodiesel Catalyst NaOH

From the figure above, the biodiesel from bulk oil using catalyst KOH and NaOH are made. The differences, the glycerin from catalyst KOH is more liquid than using catalyst NaOH. And by using catalyst KOH, the capacity of biodiesel is more than catalyst NaOH.

Biodiesel bulk oil with catalyst KOH was blended with petrodiesel, with the compositions of bulk oil 20% and petrodiesel 80% (B20KOH). And biodiesel bulk oil with catalyst NaOH 20% was blending to petrodiesel 80% (B20NaOH). The oil analysis from B20KOH and B20NaOH can be shown in table 2.

TABLE 2
Specification of Bulk Oil ,Standard Biodiesel and Petrodiesel (ASTM Method)

Property	Unit	B20 KOH	B20NaOH	Standard biodiesel	Petro diesel
Viscosiy kin at 40°C	mm^2/s	4.30	4.35	3.5-5.0	1.9-4.1
Density at 15°C	kg/m^3	858	858	860-890	-----
Total Acid Number	mgKOH/g	0.05	0.09	max 0.80	-----
Water Content	%vol	<0.02	<0.02	max 0.50	max 0.05
Flash Point	°C	38	46	min 120	≥52
Pour Point	°C	-9	-9	----	----
Metal :				max 5	
Ca	ppm	13	11		----
Mg	ppm	<1	<1	max 5	----
Zn	ppm	8	2		----
Cetane Number		48.5	46.7	max 51	≥40

From the table shows that Cetane number of B20KOH is higher 3.7% than B20NaOH. And CN for both B20kOH and B20NaOH are in standard biodiesel and standard petrodiesel.

Cetane Number (CN) is a dimensionless descriptor of the ignition quality of a petrodiesel [1]. Too high or too low a CN can cause operational problems. If a CN is too high, combustion can occur before the fuel and air are properly mixed, resulting in incomplete combustion and smoke. If The CN is too low, engine roughness, misfiring, higher air temperatures, slower engine warm-up and also incomplete combustion occur [1]. Most engine manufactures in the United States designate a range of required CN, usually 40-50, for their engines [1]. For petrodiesel, higher CN were correlated with reduced nitrogen oxides (Nox) exhaust emissions [5]. This correlation led to efforts to improve the CN of biodiesel fuels by means of additives known as cetane improver [6].

Flashpoint (FIP) is the temperature at which the fuel will give off enough vapor to produce a flammable mixture. In this study, FIP for B20KOH and B20NaOH if we compared to standard biodiesel are low than 120 °C. This happened because B20KOH and B20NaOH were blending with petrodiesel..

B. Engine Performance

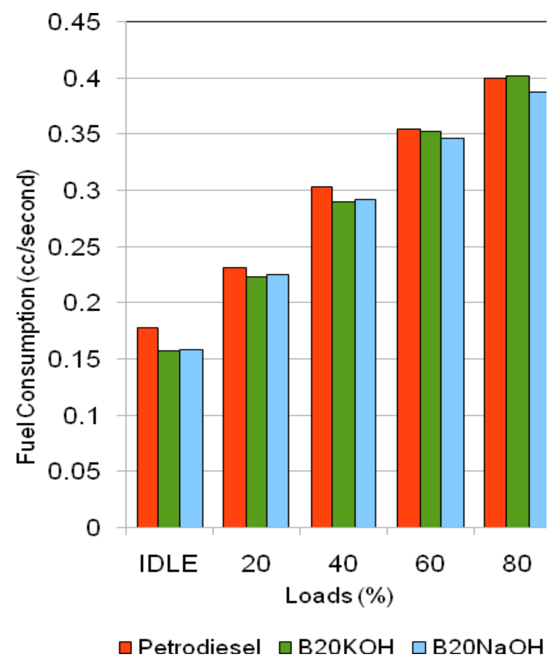

Fig.6. Specific Fuel Consumption Between Petrodiesel, B20KOH and B20 NaOH

TABLE 3
Average Data from Figure 6

Loads	Petrodiesel cc/s	B20KOH cc/s	B20NaOH cc/s
IDLE	0.17780939	0.1570302	0.157768522
20	0.23135295	0.2227668	0.224779716
40	0.30315892	0.2896536	0.291307388
60	0.35468539	0.3519392	0.346668516
80	0.39984006	0.4022203	0.38702686

From figure 6 most of the fuel consumption between B20KOH and B20NaOH compared with petrodiesel are more efficiency. In minimum load to 60% load, B20KOH and B20NaOH are more efficient up to 11.6% than petrodiesel. In contrary, for maximum load (80%), Petrodiesel is more efficient 0.5 % than B20KOH.

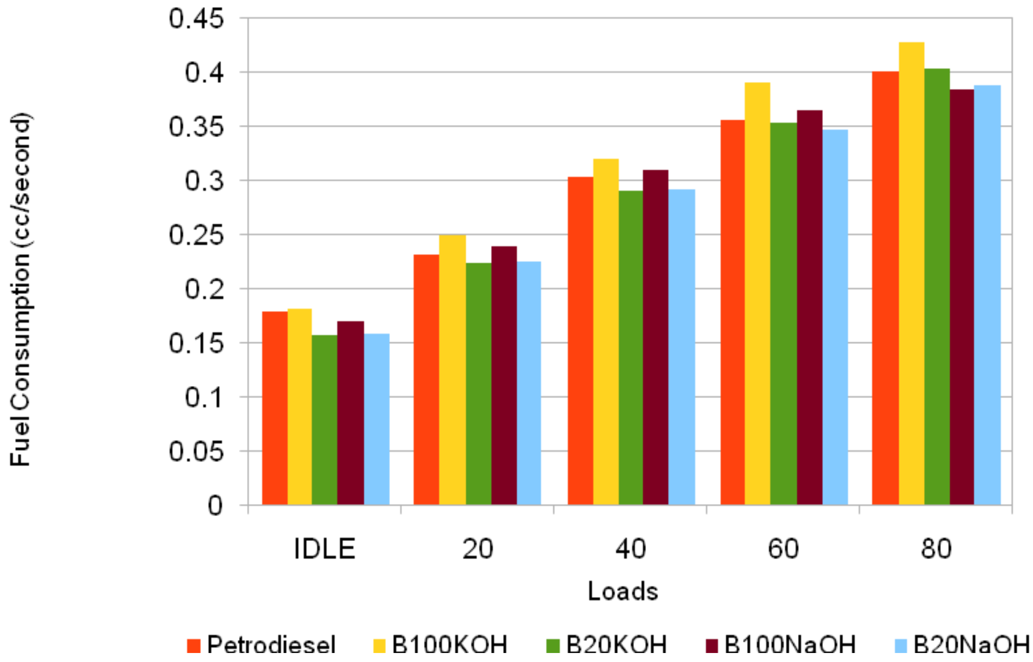

Figure 7. Specific Fuel Consumption Between Petrodiesel and Bulk Oil in Different Composition

TABLE 4
Average Data from Figure 7

Loads	Petrodiesel cc/s	B100KOH cc/s	B20KOH cc/s	B100NaOH cc/s	B20NaOH cc/s
IDLE	0.177809388	0.1810151	0.1570302	0.16981388	0.1577685
20	0.231352952	0.2485584	0.2227668	0.2384586	0.2247797
40	0.303158916	0.3198158	0.2896536	0.30942509	0.2913074
60	0.354685394	0.390046	0.3519392	0.36453777	0.3466685
80	0.399840064	0.4268761	0.4022203	0.38361209	0.3870269

From figure 7 shows that in maximum and minimum load B100KOH is the most inefficient compared to other fuels. And in maximum load (80%) B100NaOH is more efficient 3.3% than petrodiesel. In maximum load B20NaOH is more efficient up to

IV. CONCLUSION

Most of the fuel consumption between B20KOH and B20NaOH compared with petrodiesel are more efficiency. In minimum load to 60% load, B20KOH and B20NaOH are more efficient up to 11.6% than petrodiesel. In contrary, for maximum load (80%), Petrodiesel is more efficient 0.5 % than B20KOH. And B100KOH is the most inefficient compared with other fuels. Cetane number of B20KOH is higher 3.7% than B20NaOH.

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