Effect of Using B30 Palm Oil Biodiesel to Deposit Forming and Wear Metal of Diesel Engine Components

Zeka Angger Hartono[1], Beny Cahyono[2]
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***Abstract*— alternative fuels for diesel engines have attracted the world's attention as an impact of the world energy crisis. For this reason, alternative fuel needs to reduce the need for fossil fuels. Biodiesel fuel with the raw material of palm oil is the once alternative fuel to replace diesel fuel. This is because Indonesia is the largest producer of crude palm oil (CPO) in the world. But, the use of vegetable oil biodiesel can affect losses to engine lifetime. It is increasing metal wear rates in diesel engines. The experiment carried out by running diesel engines for 200 hours with Engine Manufacturer's Association (EMA) standard. B30 palm oil biodiesel affected the wear metal contact in diesel engines. Aluminum content in used lubricating oil fueled by B30 palm oil biodiesel is 19.8% greater, iron content 0.75% greater, and chromium content greater than metal content in used lubricating oil driven by diesel fuel. Also, the use of B30 palm oil biodiesel causes a more massive piston ring gap and worse condition on journal bearing. But, deposit forming in the diesel engine components fueled by B30 palm oil biodiesel is 4.27% lower than diesel fuel. It can conclude that the use of B30 palm oil biodiesel causes more significant metal wear than the use of diesel fuel.**

Keywords—biodiesel B30, deposits, diesel engine, palm oil, wear.

I. INTRODUCTION

To reduce fuel production from petroleum, the government requires the use of biodiesel. At present, biodiesel fuel has attracted considerable attention from researchers, to reduce fuel from oil and utilize renewable energy sources. Biodiesel is used as an alternative fuel because of its advantages in reducing emissions and performance is comparable to diesel fuel.

In its use, biodiesel can affect the performance of the diesel engine. Hanif [1] in his research about the influence of palm oil biodiesel reported that the use of palm oil biodiesel resulted in an increase in fuel consumption of diesel engines by 11.93% to 13.48%, decreasing in thermal efficiency decreased by 2.96% to 5.33%, and volumetric efficiency is relatively same as a pure diesel fuel engine. Nurhadi [2], in his research about the use of biodiesel on patrol vessels, resulted that the use of biodiesel causes a decrease in the load, power, and temperature of the exhaust gas from the vessel's main engine rather than using High-Speed Diesel (HSD) fuel. On the other hand, the use of biodiesel causes an increase in the number of fuel consumption when compared to the use of HSD. Pandey et al. [3], in his research on the effect of Karanja oil methyl ester, caused a decrease in the main brake power on the 780 HP engine. Yuksek et al. [4], in his research, rapeseed biodiesel isn't caused a significant difference in performance. However, biodiesel causes an increase in fuel consumption by 6%. The use of rapeseed biodiesel causes a decrease in CO and THC emission, but a significant increase in NOx emission.

However, the effects of biodiesel on diesel engines for the long-term isn't widely known. One of the problems in using biodiesel is deposit forming on the diesel engine, especially at the combustion chamber. Biodiesel has different properties with diesel fuel. Biodiesel has low thermal stability, high density, and high viscosity. These properties can affect the formation of deposits in the engine. Deposits can include several materials and residues which can accumulate on vital components in the internal combustion engine such as the combustion chamber, piston crown, intake valve, and exhaust valve. The thickness of deposits on the cylinder is strongly influenced by the temperature form cylinder and the surface which hit by fuel. A combination of temperature and non-combustible fuel causes more deposits in the combustion chamber [5].

New deposits forming in the engine occurs due to changes in operating condition because of modification of engine design or combustion process. Increased deposit forming formation can occur under certain conditions, so the prediction of deposit formation will greatly help the development of diesel engine production. In several analyzes, deposit forming in diesel components occurs due to the presence of organic material such as carbon, hydrogen, oxygen, and nitrogen. In addition, there are inorganic materials such as sulfur and metal (lead, barium, and calcium). The structure of deposits varies depending on the temperature and location where the deposits are formed [6].

At low temperature (<200°C), dark material including black carbon, wet hydrocarbon as well as tar-like parts are visible. Deposits mainly consist of low and high boiling hydrocarbons and soot. At medium temperature (between 200-300°C), nearly dry soot and tar-like

Zeka Angger Hartono, Department of Marine Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia, Email: zekaangger2@gmail.com
Beny Cahyono, Department of Marine Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia, Email: benyjtsp98@gmail.com

Materials are observed. Lacquer coating at the deposit indicates that the lubricants dominate deposit formation. At high temperatures (>300°C), different light deposit colors are visible [6].

Several studies have been conducted to see how the effects of biodiesel use on deposit formation. Arifin et al. [5], in their research about the effect of coconut biodiesel in diesel engines, reported that deposit forming of an engine fuelled by coconut biodiesel is lower than the engine fuelled by palm oil biodiesel. Liaquat et. al. [7] in his research about the effect of injector deposits reported that deposit in the injector of a diesel engine fuelled by 20% Jatropha biodiesel is drier and more. Firdaus [8] in his research about the effect of biodiesel on wear and deposits at diesel engine components, reported that deposits in diesel engine components fuelled by bio solar are more distributed dan less compared with engine fuelled by diesel fuel, and lower metal wear on engine fuelled by bio solar. Suryantoro et al. [9], in his research about the effect of biodiesel on deposits forming, reported that the use of B100 biodiesel affected more deposits compared with diesel fuel (B0).

Meanwhile, the effect of using biodiesel also influences wear rates, which different than the use of diesel fuel. Several studies have been conducted to see how the effects of biodiesel use on wear rates of diesel engine components. Sinha and Agrawal [10] have investigated the effect of using B20 biodiesel which has lower metal Fe, Cr, Cu, Zn, Ni dan Mg content in used lubricating oil compared with diesel fuel. Meanwhile, Pb and Al content greater on engine fuelled by B20 biodiesel. Agarwal et al. [11] in his research about the effect of biodiesel reported that lower presence of metal content Fe, Cu, Zn, Mg, Cr, Pb, and Co in used lubricating oil fuelled by B20 biodiesel.

This research discusses the effect of B30 biodiesel from palm oil on deposits forming and wear in diesel engine components. The method used is testing metal content in used lubricating oil and weighing of deposits on a diesel engine that has run for a long time.

II. METHOD

A. Production of Biodiesel B30

In this research, palm oil processed becomes biodiesel with a transesterification method. Methanol and KOH were used as a catalyst in this process. Then, B100 (pure biodiesel) from palm oil blend with B20 biodiesel from the government. The composition of the blend is 1: 7 with the B100 is less than B20. Some laboratory testing is done to determine the properties of B30 palm oil biodiesel. The properties which tested are kinematic viscosity, density, flash point, pour point, and low heating value. These properties were tested will be compared with diesel fuel. The laboratory test results about the properties of fuel shown in table 1.

TABEL 1.
PROPERTIES OF B30 PALM OIL BIODIESEL

Properties	B30 Palm Oil Biodiesel	Indonesia Biodiesel Standard	Diesel Fuel
Cetane Number	69,8	Min. 51	56,7
Viscosity (40°C) [cSt]	4,43	2,3 – 6,0	2,92
Density [kg/m³]	856	850 – 890	845,7
Flash Point [°C]	96	Min. 100	65
Pour Point [°C]	-4	Max. 18	-3
Low Heating Value [kJ/kg]	45,470.97	-	47054,2

B. Engine Setup

In this step, the arrangement of diesel engines and other supporting elements is carried out, such as alternator and load for the engine. The diesel engine which used in this research is a single-cylinder, four-stroke, direct injection, and compression ignition engine. In this test used lubricating oil with specifications as in the requirements of engine manufacture. This is lubricating oil with SAE 40. In the second test, the engine was dismantled and some engine components were replaced with new components such as piston rings, crankpin bearings, injectors. In addition, the engine components which contained the deposit are cleaned again. after that the engine is set to the same condition as the first test. The specification of the diesel engine used in this research can be seen in table 2 and the schematic of the engine setup shown in figure 1.

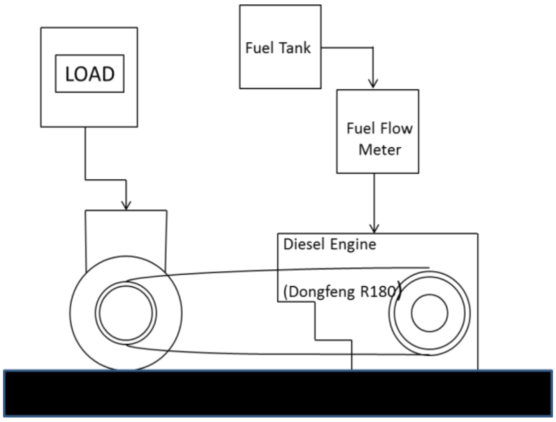

Figure. 1. Engine Setup.

TABLE 2.
ENGINE SPECIFICATION

Maker	Dong Feng R180
Number of Cylinder	1
Type	Four-stroke, water-cooled
Bore x Stroke	85 x 87 mm
Piston Displacement	493 cc
Power/rpm	5.5 kW/2200 RPM
Maximum Torque	3.44 kg.m / 1600 rpm
Lubricating Oil	SAE 40
Lubricating Oil Capacity	2.2 L
Compression Ratio	18 1

C. Experiments

The test is done by testing the durability of diesel engines using the method of the Engine Manufacturer Association (EMA). Tests were carried out for 200 hours with variations in rotation and load including:

a. low idle (30 minutes): At no load, the throttle was varied to achieve the manufacturer's recommended curb idle. (850 rpm, no load)
b. idle high (30 minutes): The load was set at 25% of maximum torque, and the throttle is varied to achieve an engine speed of 90% of rated speed. (1980 rpm, 750 watts)
c. rated power speed (60 minutes): The engine was operated at full throttle, a load was applied until the engine speed decreases to the manufacturer's specified rated speed. (2200 rpm, 250 watts)
d. maximum torque speed (60 minutes): The engine was operated at full throttle, a load was applied until the engine speed decreases to the speed of rated torque as described by the manufacturer. (1900 rpm, 3000 watts)

The steps are carried out sequentially, after completing the maximum torque speed stage, the steps will be repeated until the time accumulates to 200 hours.

III. RESULTS AND DISCUSSION

Analysis of the effects of new alternative fuel use on component wear on diesel engines is very important to assess the suitability of new fuels for existing engines. The analysis was carried out by testing the metal content of lubricating oil (SAE 40) after used on a diesel engine fuelled by B30 palm oil biodiesel and diesel fuel for 200 hours. The used lubricating oil sample was tested in the laboratory. The test was conducted to determine the metal content of lubricating oil after diesel engine run during 200 hours fuelled by B30 palm oil biodiesel and diesel fuel. In addition, to measure the wear rate of components, gap measurements, and mass weighing of deposits on several diesel engine components are measured.

A. Wear of Diesel Engine Components

To determine the level of wear diesel engine components, the metal content in lubricating oil is tested and measurement of gaps from piston and journal bearing is measured. Used lubricating oil was taken after used in long term test 200 hours on direct injection engine fuelled by diesel fuel and B30 palm oil biodiesel. Metal content which tested on used lubricating oil were aluminum, iron, and chromium. Metal content from used lubricating oil after tested with B30 palm oil biodiesel and diesel fuel can be seen in table 3.

TABLE 3.
METAL CONTENT IN USED LUBRICATING OIL AFTER TESTED WITH B30 PALM OIL BIODIESEL AND DIESEL FUEL

Wear Metal Content	Lubricating Oil With B30 Palm Oil Biodiesel (mg/l)	Lubricating Oil With Diesel Fuel (mg/l)	Method
Aluminium (Al)	7.5	6.26	Flame AAS
Iron (Fe)	1.35	1.34	Flame AAS
Chromium (Cr)	<0.006	<0.006	Flame AAS

Whereas to determine the formation of deposits in diesel engine components tested with palm oil B30 biodiesel fuel is done by releasing deposits on diesel engine components, then weighed to determine differences in mass of deposit. Components that investigated are a piston, cylinder head, and injector. Mass of deposits forms the components that can be seen in table 4.

TABLE 4.
MASS OF DEPOSIT ON DIESEL ENGINE COMPONENTS AFTER TESTED WITH B30 PALM OIL BIODIESEL AND DIESEL FUEL

Component	Mass of Deposit in Engine With B30 Palm Oil Biodiesel (g)	Mass of Deposit in Engine With Diesel Fuel (g)
Piston	0.357	0.293
Cylinder Head	0.563	0.673
Injector	0.043	0.04
Total	0.963	1.006

1. Aluminum (Al)

In this research, the Testing of aluminum metal content was intended to determine the wear rate of diesel engine components as a result of the use of palm oil B30 palm oil biodiesel. The biggest source of aluminum metal in diesel engine components is the piston. Almost all pistons without exception are made of aluminum or its alloy [12].

The use of biodiesel affects the performance of lubricating oil, which affects the metal content of lubricating oil. The aluminum content of lubricating oil used in diesel engines with biodiesel B30 palm oil is 19.8% greater than that of Pertamina Dexlite. This concentration is slightly larger so that it can be concluded that the use of B30 palm oil biodiesel slightly results in increased wear of aluminum metal compared to the use of diesel fuel.

The source of aluminum used lubricating oil is from the wear of piston, pushrod, lubricating oil pump, and bearing [13]. The presence of this wear can be caused by the form of thinner oil film due to a decrease in the viscosity of the lubricating oil. Because used lubricating oil fuelled by B30 palm oil biodiesel has a lower viscosity, so oil film in the engine fuelled by biodiesel is thinner. So, friction between components such as piston with cylinder liner will be more likely to occur. This can be seen in piston wear in figure 3(a) and (b).

2. Iron (Fe)

In this research, the Testing of iron metal content was intended to determine the wear rate of diesel engine components as a result of the use of palm oil B30 palm oil biodiesel. In an engine, cylinder liner and crankshaft are the major wearing components along with timing gears, shafts, and valves. Iron is the major constituent of the gears, shafts, and antifriction (rolling element) bearings [12].

The use of B30 palm oil biodiesel affects iron wear in a diesel engine. Can be seen in figure.2(b). that use of B30 palm oil biodiesel resulting in the presence of iron wears 0.75% greater than diesel fuel. Source of iron metal in the diesel engine are a piston, piston ring, cylinder liner, valve, camshaft, crankshaft, cylinder block, bearing, sitting valve, wrist pin, and corrosion [13]. The presence of iron ion in the diesel engines also can cause corrosion. When iron ion reacts with water (which contains oxygen) and oxygen from outside air, the reaction will form corrosion.

In this research, there is guess corrosion of the component piston and cylinder head when the engine tested fuelled by B30 palm oil biodiesel. This can be seen in figure 5(c) and 6(c). So it can be concluded the presence of iron in used lubricating oil caused by wear of piston and cylinder liner.

3. Chromium

In this research, the Testing of chromium metal content was intended to determine the wear rate of diesel engine components as a result of the use of palm oil B30 palm oil biodiesel. The use of B30 palm oil biodiesel affects

Chromium wear in the diesel engine. The result of the laboratory tests from both used lubricating oil has the same chromium content that is <0.006 mg/l. In the diesel engine, the usual piston ring is made from chromium or coated with chromium. In some cases, cylinder liner is also coated with chromium, and the piston ring is made of iron metal. In addition to the other components such as shaft, gear, and bearings, there is also chromium as an alloy for its manufacture [12].

In this research, chromium wear can be seen on the piston ring gap in the engine, which fuelled by B30 palm oil biodiesel and diesel fuel. Piston ring gap can be seen in table 5 and table 6. Piston ring in the engine fuelled by B30 palm oil biodiesel has a larger gap addition. Therefore it can be concluded that more chromium metal content is found on engine fuelled by B30 palm oil biodiesel.

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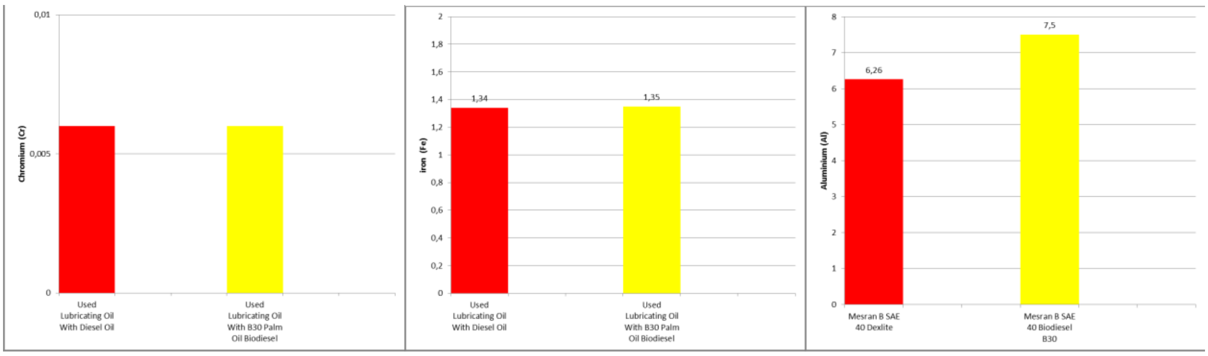
Greater metal wear on engine fuelled by palm oil B30 biodiesel is due to the decrease in the viscosity of lubricating oil, which is greater than diesel fuel. The decrease in viscosity will cause thinning of the oil film layer, which is formed between the metal friction like the piston ring and cylinder liner.



(a) (b) (c)

Figure. 2. (a) Aluminium Content, (b) Iron Content, (c) Chromium Content In Lubricating Oil After Tested Using Diesel Oil And B30 Palm Oil Biodiesel.

4. Piston Ring

In figure 3, it can be seen visuality can be seen visually; there is no significant difference in the piston ring when the engine is running with diesel fuel and B30 palm oil biodiesel. The only way to find out the difference in the condition of the piston ring when the engine is running using different fuels is to measure the gap of the piston ring.

In table 5 can be seen in the condition of the top dead center (TDC) on compression piston ring 1, the engine fuelled by Dexlite fuel is 0.05 mm larger than the B30 palm oil biodiesel. In the same condition, the compression piston ring 2 on the engine fuelled by Dexlite fuel is smaller than 0.1 mm. While in the compression piston ring 3 there is no difference between the piston rings. This means that at the time of TDC, the use of palm oil B30 biodiesel has little effect on the piston ring.

TABLE 5.
GAP OF RING PISTON TESTED WITH DIESEL OIL FUEL

Ring Piston	Top Dead Centre		Bottom Dead Centre	
	Before Testing (mm)	After Testing (mm)	Before Testing (mm)	After Testing (mm)
1	0.5	0.7	0.5	0.6
2	0.5	0.6	0.4	0.5
3	0.5	0.55	0.3	0.45

Whereas in bottom dead center (BDC) conditions, the gap of compression piston rings 1 bigger by 0.05 mm on engine fuelled by Dexlite fuel than engine fuelled by B30 palm oil biodiesel. In the BDC condition, gap of compression piston ring 2 and compression piston ring 3, there is a greater addition of 0.15 mm and 0.05 mm on the engine fuelled by B30 palm oil biodiesel. This proves that the use of palm oil B30 biodiesel has affected wear from the piston ring at BDC condition.

TABLE.6.
GAP OF RING PISTON TESTED WITH BIODIESEL B30 PALM OIL TABLE

Ring Piston	Top Dead Centre		Bottom Dead Centre	
	Before Testing (mm)	After Testing (mm)	Before Testing (mm)	After Testing (mm)
1	0.5	0.65	0.5	0.55
2	0.5	0.7	0.4	0.65
3	0.5	0.55	0.3	0.5

(a) (b) (c)

Figure. 3. (a) Ring Piston Before Tested, (b) Ring Piston After Tested Using Diesel Oil, (c) Ring Piston After Tested Using B30 Palm Oil Biodiesel

This addition of piston ring's gap can be caused by differences in the viscosity of the lubricating oil on the engine, which can result in differences in oil film formation when lubricating the piston ring which rubs against the cylinder liner. However, the difference between the piston rings that are not too far away can be tolerated because it is still within the tolerance of the piston rings gap in the engine manual book.

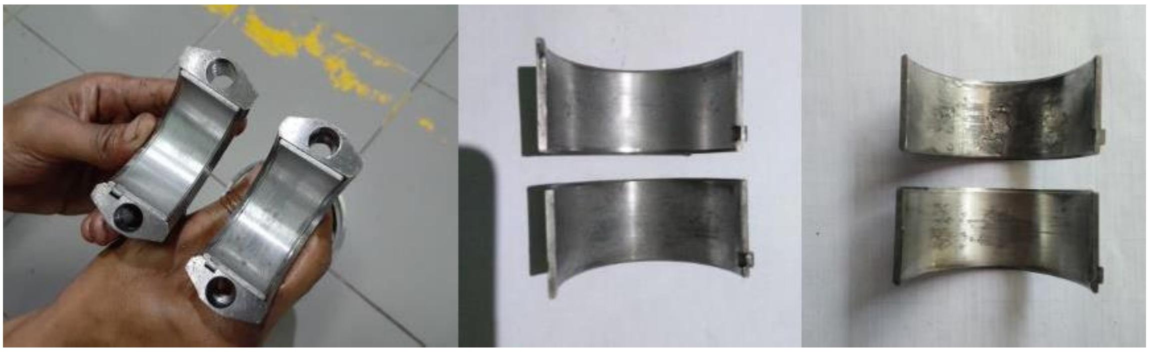
5. Journal Bearing

Visually there is a significant difference in the journal bearing on engine fuelled by diesel fuel compared journal bearing on engine fuelled by B30 palm oil biodiesel fuel. It is proven in figure 4a-4c that the journal bearing on engine fuelled by diesel fuel only has thin scratches on the surface while the journal bearing on engine fuelled by B30 palm oil biodiesel fuel has little damage, but not a too disturbing performance from the engine.

To be more convincing, the gap of journal bearing was measured using a plastic gauge. The results of the measurements can be seen in table 7.

TABLE.7.
THE GAP OF JOURNAL BEARING

Fuel	The gap before the experiment (mm)	Gap after experiment (mm)
Diesel Oil	0,05	0,063
Biodiesel B30 CPO	0,05	0,05



(a) (b) (c)

Figure. 4. (a) Journal Bearing Baseline, (b) Journal Bearing After Tested Using Diesel Oil, (c) Journal Bearing After Tested Using B30 Biodiesel.

In table 7, it can be seen the measurement results of the gap of journal bearing on engine fuelled by B30 palm oil biodiesel lower than journal bearing on engine fuelled by diesel fuel, which is 0.05 mm for engine fuelled by B30 palm oil biodiesel and 0.063 mm for engine fuelled by diesel fuel.

B. Deposit Forming On Diesel Engine Components

1. Piston

The use of B30 palm oil biodiesel affects deposit forming on piston, proven in figure 5. Figure 5 shows the piston on an engine that fuelled by B30 palm oil biodiesel has accumulated an uneven deposit of the piston on an engine which fuelled by diesel fuel. Piston with B30 palm oil biodiesel also has a small amount of corrosion. This is due to an oxidation reaction from biodiesel fuel in the combustion chamber. Where Fe ions will soluble into biodiesel or deposited on the metal surface so it will react with free fatty acids in biodiesel and form fatty acid salts on the metal surface. The reaction that occurs in the corrosion process are :

$Fe + 3O_2 \rightarrow 2Fe_2O_3$
$Fe_2O_3 + 6R'COOH \rightarrow 2Fe(R'COO)_3 + 3H_2O$
$2R'COOH + Fe \rightarrow Fe(R'COO)_2 + H_2$

This reaction was based on the research of corrosion forming on the metal surface due to the use of biodiesel conducted by Nantha [13]. In addition to visual observation, analysis of wear components on diesel engines also carried out by weighing the deposit.

Figure 8a shows the mass of deposit on piston after tested using both fuels. From the weighing of deposits, mass on a piston engine, which running using B30 palm oil biodiesel, has deposits mass 21.8% greater than piston on the engine, which running using diesel fuel. Deposits on piston crown are caused by fuel film that unburned due to no air-fuel ratio (AFR) has been achieved. Fuel film layer can be formed as a result of heavy gaseous component condensation or wetting of the combustion chamber wall by fuel. The temperature of the combustion chamber wall is lower than the fuel that sprayed; this is caused by the fuel in the form of gas attached to the wall that will deliver the heat to the combustion chamber wall. Due to heat delivered to the wall, so this gas will be condensed, forming a film layer on the combustion chamber's wall [6].

Wetting the wall directly also contributes to deposits forming. The fuel that sprayed by injector will partially burn-in diffusion, but some fuel will unburn because AFR is not reached, so attached in the combustion chamber wall. The area that affected by direct wetting is possible to have a deposit with a large enough amount, such as piston crown and injector tip [6].

(a) (b) (c)

Figure. 5. (a) Piston Before Tested, (b) Piston After Tested Using Diesel Oil, (c) Piston After Tested Using B30 Palm Oil Biodiesel.

2. Cylinder Head

B30 palm oil biodiesel affected deposit forming in the cylinder head. This is showed in figure 6a-6c. It can be seen that there is a difference that occurs in the cylinder head engine, which tested with B30 palm oil biodiesel and diesel oil fuel.

On visual observation can be seen that in cylinder head engine with B30 palm oil biodiesel fuel, there is little corrosion. This is because biodiesel fuel used has water content, so the fuel is corrosive. Cylinder head in the engine, which runs with B30 palm oil biodiesel fuel, there is less crust and deposit than cylinder head in engine with diesel fuel.

Figure 8b shows the mass of deposit in cylinder head after tested using both fuels. Engine with B30 palm oil biodiesel affects deposit forming 19.5% lower than an engine with diesel fuel. This means that the use of B30 palm oil biodiesel causes less wear on the cylinder head than diesel fuel.

The difference in deposits mass is caused by differences in temperature of the combustion chamber and cylinder head. The temperature of the cylinder head is lower than the temperature of the combustion chamber because the cylinder head cooled by cooling water. A combination of lower temperatures on cylinder head surface and unburn fuel inflict greater deposit [5].

(a) (b) (c)

Figure. 6. (a) Cylinder Head Before Tested, (b) Cylinder Head After Tested Using Diesel Oil, (c) Cylinder Head After Tested Using B30 Palm Oil Biodiesel.

3. Injector

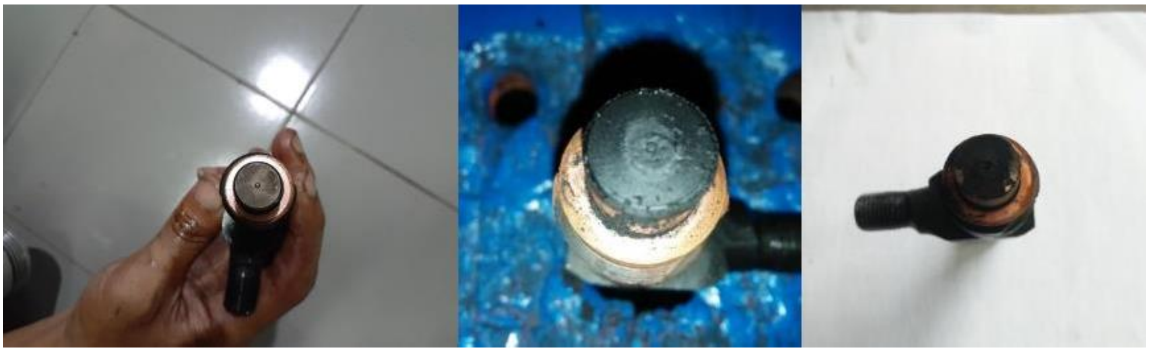
B30 palm oil biodiesel influence on deposit forming in the injector. They have proved in figure 7a-7c, although that there is no contrast difference on the injector in engine tested with B30 palm oil biodiesel and diesel fuel where both injectors have deposited. But however, the deposits formed have different properties and distributions at the location of the deposit.

However, the deposit in the injector with B30 palm oil biodiesel fuel is drier, so it is more difficult to release from the injector. The location of the deposit on injector with B30 palm oil biodiesel is only at injector tip. Whereas the deposit on injector with diesel fuel is more evenly distributed than an injector with B30 palm oil biodiesel. Deposit on injector with diesel fuel is wetter, so it is easier to remove, but it's more sticky.

The difference in the deposit mass in the injector can be seen in figure 8c. That deposit mass in both injectors is almost the same, which is only 0.003 gram with deposits mass of injector with B30 palm oil biodiesel fuel is heavier. This difference is caused by the difference in viscosity of both fuels, so affected fuel spray to the combustion chamber.

Higher viscosity and lower volatility from fuel affected worse fuel atomization and air-fuel mixing. This is because of the fuel droplets from which bigger during fuel atomization in the engine. Bigger fuel droplets will cause ignition delay. In fuels with higher viscosity, there will be an increase in ignition delay than fuel with lower viscosity. Thus the tendency of deposit formation rates can increase [7].

In addition, deposits on injectors with biodiesel fuel occur because of the decomposition of biodiesel that occurs at higher temperatures. This allows biodiesel to decompose during the ignition delay period to produce a deposit at the injector tip. Because biodiesel tends to be unstable at high temperatures [7]. However, because the difference in the deposit mass in both injectors is not too much, it means that the B30 palm oil biodiesel fuel does not significantly affect the performance of injectors in diesel engines.



(a) (b) (c)

Figure. 7. (a) Injector Before Tested, (b) Injector After Tested Using Diesel Oil, (c) Injector After Tested Using B30 Palm Oil Biodiesel.

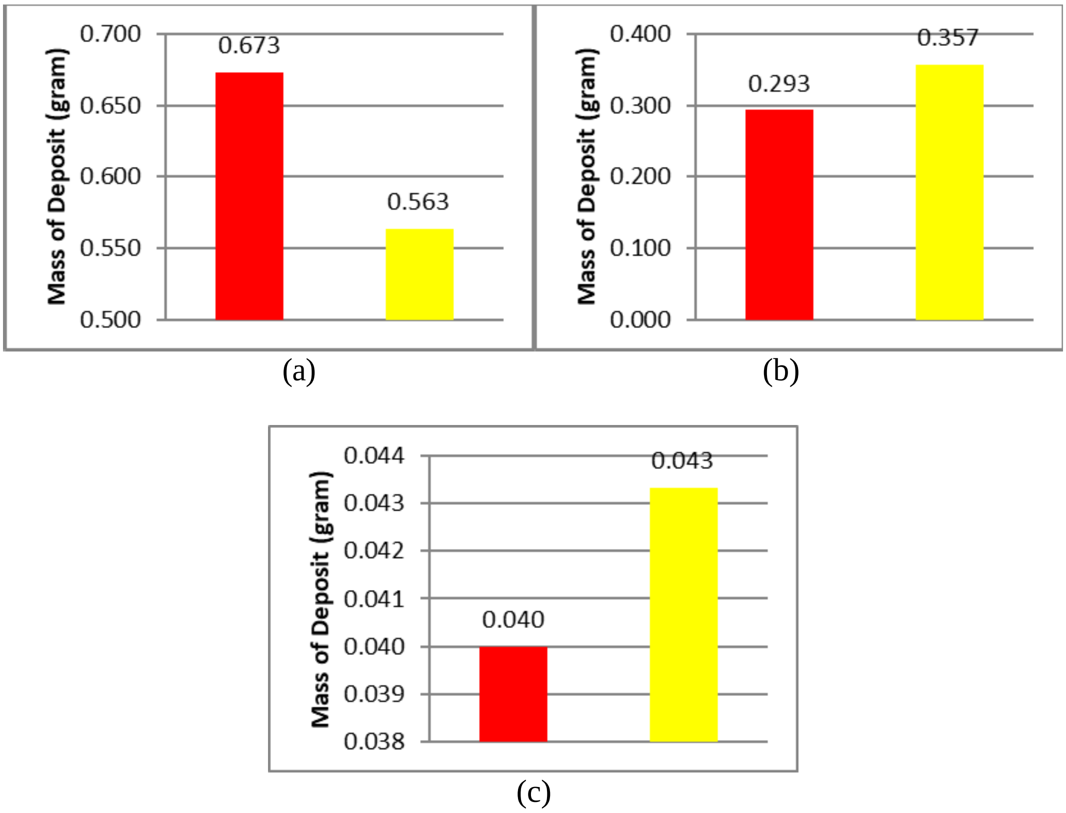


Figure. 8. (a) Mass of Deposit On Piston, (b) Mass of Deposit On Cylinder Head, (c) Mass of Deposit On Injector After Tested Using Diesel Fuel And B30 Palm Oil Biodiesel.

IV. Conclusion

This research discusses the durability of diesel engines using B30 palm oil biodiesel and diesel fuel. The durability of a diesel engine is measured by carrying out 200-hour Testing on a diesel engine and then compared to the metal content of lubricating oil and deposits on several components that have been tested using both fuels.

The use of B30 palm oil biodiesel cause bigger metal wear in used lubricating oil than use diesel oil. B30 palm oil biodiesel cause aluminum content is 0.75% bigger, iron content 19.8% bigger, and metal chromium bigger in the lubricating oil after used in diesel engines. Moreover, the use of B30 palm oil biodiesel cause a bigger gap in piston rings and worse condition on journal bearing. It can be concluded that the use of B30 palm oil biodiesel is affecting bigger metal wear in a diesel engine than the use of diesel fuel.

The deposit formed in diesel engines with B30 palm oil biodiesel is 4.27% lower in diesel engine components. From the amount of deposit on diesel engine components, it can be concluded that the use of B30 palm oil biodiesel is better than the use of diesel oil.

Based on the research that diesel engine, can we conclude that use of B30 palm oil biodiesel affects bigger metal wear, but affect lower deposit forming on a diesel engine than the use of diesel fuel.

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