ISOMAse
International Society of Ocean, Mechanical and Aerospace Scientists and Engineers

Proceeding of Ocean, Mechanical and Aerospace -Science and Engineering-
4th October 2018. Vol.5 No.1

October 4, 2018

Modification of Engine Diesel for the Use Waste Lubricant Oil as an Alternative Fuel

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Paper History

Received: 15-September-2018
Received in revised form: 25-September-2018
Accepted: 4-October-2018

ABSTRACT

Waste lubricant oil is a residue of pure oil that comes from many kind of industrial activities and engine means. After waste oil is converted to fuel without special treatment, waste oil can be used as fuel for the internal combustion engine. The engine diesel is modified in the fuel filter system and the addition of the fuel pump. Filter system use fuel filter which is positioned parallel with two filtering stages. In the first stage the filter is given a magnet to pull the iron powder that is contained on the oil and the second filter has the function to filter out of the whole of the dirt that causes the nozzle to clog. This Fuel Pump serves to supply waste lubricant oil into the fuel injection system. From the experimental results showed that the value of volumetric efficiency in diesel fuel reached 51.6316% and the value of volumetric efficiency in waste lubricant oil reached 51.6335%.

KEY WORDS: *waste engine oil, diesel engine, filter, pump*

NOMENCLATURE

TDC	Top Dead Center
m_f	Fuel Flow Rate (kg/h).
ρ_t	Density of fuel (kg/l).
V_t	The volume of fuel tested (ml).
t_f	The time to spend fuel is as much as the volume tested (s).
SFC	Specific fuel consumption (kg/kW.h).
PB	Output power (Watt).
VL	Piston step volume (m^3)
D	Cylindrical circle diameter (m)
L	The piston step length from TDC to BDC (m)
N	Number of cylinders on the engine
$\dot{m}_{ui}$	Ideal Air Usage Rate
Ne	Effective Shaft

1. INTRODUCTION

In a life that now the number of vehicles in the world is increasing so that the consumption of diesel fuel continues to increase from year to year. For that source of diesel fuel will gradually decrease, which is derived from fossils of living things that have died.

Innovations in the technology field have increased rapidly, including finding alternative energy sources for the needs in the environment itself, for example waste lubricant oil. Waste lubricant oil it self is one of the results of the remaining lubrication in a machine. Development of derivative products from waste lubricant oil requires innovation into other derivative products, in this case waste lubricant oil and its waste will have the opportunity to be used for alternative fuel sources.

Waste lubricant oil will be used as an alternative fuel, the problem is whether the use of waste lubricant oil needs special treatment or not. This kind of thing needs to be investigated or investigated to find out various ways to make this waste as fuel. As is known that waste lubricant oil has a high enough viscosity, for this reason it is necessary to use the waste lubricant oil such as diesel fuel and most importantly it can burn easily in the diesel engine combustion chamber.

The engine is modified by giving a fuel filter to filter the impurities contained in used oil, the fuel pump on the engine functions to pump used oil into the combustion chamber.

POMAse | Received: 15-September-2018 | Accepted: 4-October-2018 | [(5) 1: 23-27]
Published by International Society of Ocean, Mechanical and Aerospace Scientists and Engineers, www.isomase.org., ISSN: 2443-1710

2. FUNDAMENTAL THEORY

In diesel engines, only air is compressed during the compression stroke, eliminating the possibility of auto ignition. Therefore, diesel engines can be designed to operate at much higher compression ratios, typically between 12 and 24. Not having to deal with the problem of auto ignition has another benefit: many of the stringent requirements placed on the gasoline can now be removed, and fuels that are less refined (thus less expensive) can be used in diesel engines.

Figure 1. In diesel engines, the spark plug is replaced by a fuel injector, and only air is compressed during thecompression process.

The fuel injection process in diesel engines starts when the piston approaches TDC and continues during the first part of the power stroke. Therefore, the combustion process in these engines takes place over a longer interval. Because of this longer duration, the combustion process in the ideal Diesel cycle is approximated as a constant-pressure heat-addition process. That is, process 1-2 is isentropic compression, 3-4 is isentropic expansion, and 4-1 is constant-volume heat rejection.

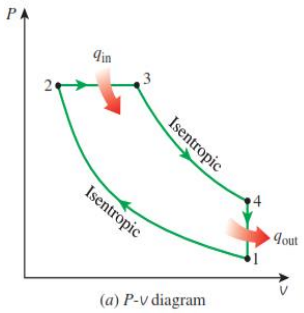

Figure 2. P-v diagrams for the ideal Diesel cycle.

In this experiment, with the use of used oil as fuel there are several considerations regarding specifications that can be applied to diesel engines.

1) The particle mesh that can be injected on the nozzles is 2/1000 cc, because the fuel used is in the form of vehicle lubricant which has dirt from the combustion residue and iron powder from friction that occurs in the engine.
2) The viscosity of the fuel is high enough that the fluid is blocked to flow.

2.1 Research Methodology

The type of research conducted is an experiment in the form of measuring the power produced from the engine rotation using diesel fuel and using used oil. Some of the main components can be seen in Figure 1.

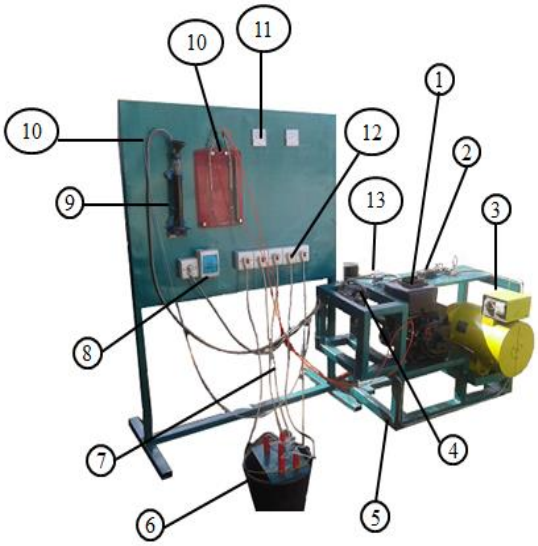

Figure 1. Layout Research

Information:

1. Diesel Engine
2. Adapter
3. Dynnamometer
4. Filter Fuel
5. Frame
6. Water Heater
7. Cable
8. MCB electric
9. Measuring cup
10. Hose
11. Indicator Voltage
12. Electric socket
13. Fuel Pump

2.2 Engine Diesel

The machine used is a Huachai diesel engine with specifications that can be seen in Table 1.

Table 1 Specifications of engine

Fiture	Description
Model	R175
Type	4 steps
Combustion System	Navel Room Burn Room
Number of cylinders	1 Cylinder
Diameter x Step Length	75 mm x 80 mm
Cylinder Volume	353 cc
Compression Comparison	22 : 1
Maximum Power / RPM	7HP/2600
Average Power	6.5HP
Use of fuel	294.2
Oil capacity	2 Liter
Cooling System	Water with Hoper
Lubricating System	Pressure / Splash
How to turn on	Crank
Oil Type	SAE 40 Diesel Type

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Tank Capacity	4.75 Liter
Crate Size	7 Liter
Bruto	77 kg

a. Pump

Fuel Pump is one component in the fuel system in a vehicle or internal combustion engine. Some engines do not require a fuel pump because from the design and by gravity, the fuel will flow by itself in the fuel system. Others have to use a pump to drain fuel from the fuel tank. In the engine using used oil, the pump is hurt to supply fluid to the injection chamber, this is necessary because the level of viscosity in the lubricant oil is quite high compared to fuel in general.

b. Filter

This fuel filter is one of the important components related to the fuel system. The filter is useful for filtering impurities contained in the fuel, so that dirt does not enter in the combustion chamber. The filter filters the fuel that drops from the fuel tank and then passes it to the fuel pump or Injection Pump.

2.3 Diesel Motor Achievement

An understanding of what is happening inside the cylinder of a diesel motor, especially with respect to combustion, can be greatly aided by a graphical presentation called a pressure diagram - volume or P-V diagram. In the diagram the ordinate or vertical distance indicates gas pressure and abscissa or the horizontal distance indicates the corresponding volume occupied by the gas, ie the volume between the cylinder head and piston at that time. The work process of the diesel cycle itself can be described or explained by a P-V cycle diagram (pressure-volume diagram).

a. Spesific Fuel Consumption (SFC)

Specific Fuel Consumption (SFC) is a machine performance parameter that is directly related to the economic value of a machine, because knowing this can be calculated the amount of fuel needed to produce a certain amount of power in a certain time interval.

The fuel flow rate is calculated using the following Equation (1) formula:

$$m_f = \frac{\rho_t \times V_t \times 10^{-3}}{t_f} \quad (1)$$

To calculate the Specific Fuel Consumption (SFC), the Equation formula (2) is obtained.

$$SFC = \frac{m_f \times 10^3}{P_B} \quad (2)$$

b. Fuel Consumption ($\dot{m}_{bb}$)

Fuel consumption is the amount of fuel consumed over a period of time using Equation (3).

$$\dot{m_{bb}} = \frac{V_{bb} \times \rho_{bb}}{t} \quad (3)$$

c. Power Measurement

A dynamometer measures the result of a combustion motor that is balanced with a resistance or load at a constant rotation speed (n). If the value of n changes then the fuel motor produces power to accelerate or slow down the rotating part and this power cannot be shown by the dynamometer. Usually the combustion motor is connected to a dynamometer in order to get the output from the combustion motor by connecting the motor shaft with the dynamometer shaft using an elastic coupling (Soenarto N. dan Shoichi F, 1985)

d. Effective Shaft (Ne)

In the combustion motor the shaft power is used to drive the load, the shaft power itself is generated by the indicator power which is the combustion gas power that drives the piston. The power value is expressed in Watt, rotation speed per minute and torque in N.m, so power can be formulated with equation (4).

$$Ne = T \times \omega$$

$$\omega = \frac{2 \times \pi \times n}{60}$$

$$Ne = \frac{T \times 2 \times \pi \times n}{60} \quad (4)$$

e. Calculating Piston Step Volume

The piston step volume can be calculated using the tube volume formula because the engine cylinder is generally tubular. The piston step volume can be calculated using equation (5)

$$VL = \frac{\pi}{4} \times D^2 \times L \times N \quad (5)$$

f. Ideal Air Usage Rate ($\dot{m}_{ui}$)

The amount of fuel that can burn depends very much on the amount of air in the cylinder, therefore it is necessary to review the amount of air entering the cylinder during the suction step. In actual circumstances the amount of air entering the cylinder chamber absorbs calories from suction valves and cylinder walls, therefore the air temperature becomes higher than the ambient temperature so that the specific gravity becomes lower. In ideal conditions the air rate entering the motor fuel cylinder can be calculated using equation (6).

$$\dot{m_{ui}} = VL \times \rho_{Air} \times Z \times n \times \frac{1}{2} 60 \quad (6)$$

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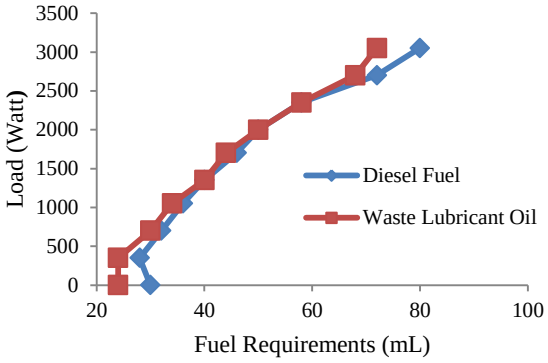
3. RESULTS AND DISCUSSION

The measurement results shown from this experiment are the voltage generated from the engine rotation and passed to the dynamometer rotation.

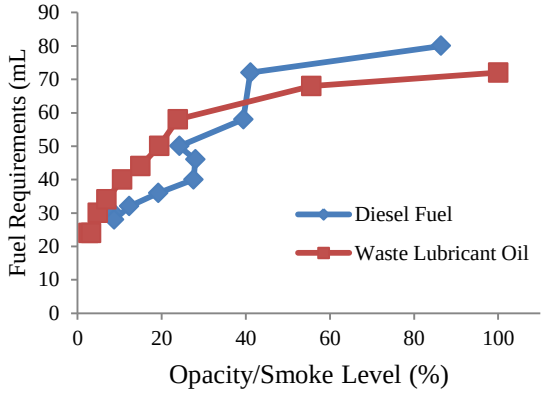
The following is a graph of the measurement results obtained

Load Vs Fuel Requirements



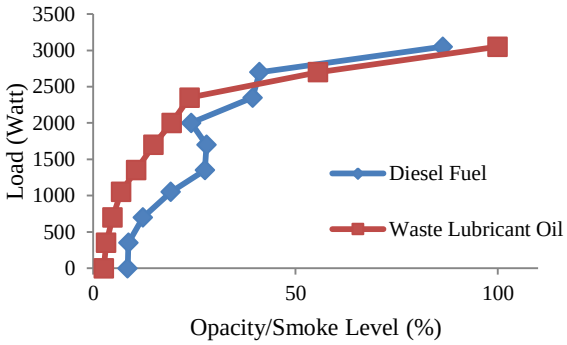
From the graph shows that fuel consumption uses less used oil than using diesel fuel.

Fuel Requirements Vs Smoke Level



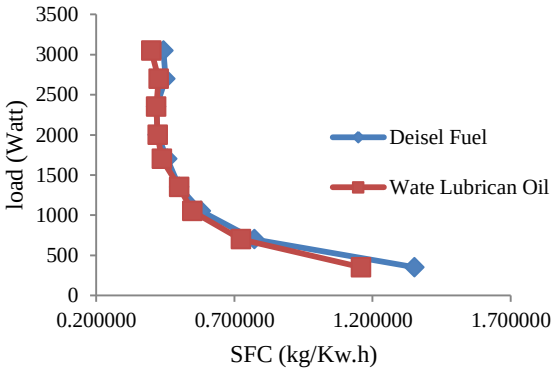
In terms of smoke output, the resulting opacity (smoke level) of smaller used oil causes smoke compared to using diesel fuel. But at maximum load, the smoke output produced using used oil has the highest value from the experimental results.

Load Vs Opacity/Smoke Level



From the graph shows that the smoke caused by diesel engines uses less waste lubricant oil than using diesel fuel, but the smoke generated by the engine with maximum load on the use of waste lubricant oil has a high smoke level.

Specific Fuel Consumption Vs Load



From the graph shows that the consumption of specific fuel (SFC) uses less used oil than using diesel fuel. This means that used oil is better used in this study.

4. CONCLUSION

After conducting research on Modification of Diesel engine for the use of waste lubricant oil as alternative fuels, the following conclusions can be drawn.

1) Use of Used Oil as a fuel for diesel engines can be operated and used without special treatment on the used oil.
2) Modification of the diesel engine is located in the fuel filtering system by using Fuel Filters in diesel fueled cars. filtering is arranged in parallel with two filtering stages, in the first stage the filtering is given a magnet which is used to pull the iron powders contained in used oil, in the second stage, namely filtration which serves to filter and clean used oil

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from impurities which can cause blockages on the fuel nozzle with three filtering parts.

3) The level of efficiency of diesel engines using used oil fuels is better than the efficiency of diesel engines using diesel fuel with volumetric efficiency in used oil by 51.6335% and on diesel fuel by 51.6316%.

ACKNOWLEDGEMENTS

The authors would thanks to DPRM RISTEK DIKTI for support this research grant. The authors would also acknowledge Mr Rifdarmon who has contributed as members in this study.

REFERENCE

1. Ashar S. 2018. *Proses Terjadinya Pembakaran pada Mesin*. http://otomotifsmkmanggala.blogspot.com/2013/03/proses-terjadinya-pembakaran-pada-mesin.html. Diakses 15 April 2018
2. A.Wiranto dan K. Tsuda. 2004. *Motor Diesel Putaran Tinggi*. Edisi 10. Pradnya Paramita. Jakarta
3. Bari S., T.H. Lim dan C.W. Yu. 2002. Renewable Energy: Effects of Preheating of Crude Palm Oil (CPO) on Injection System, Performance and Emission Of A Diesel Engine. *Elsevier Science*. 27 (3):339-351
4. Bhaskar T, Uddin MA, Muto A. 2004. Recycling of waste lubricant oil into chemical feedstock or fuel oil over supported iron oxide catalysts. Fuel 83:9e13
5. Cengel Yunus A., Michael A. Boles. 2015. *Thermodynamics An Engineering Approach*. Edisi 8, Mc Graw Hill Education. New York.
6. Famula G. 2015. *Pengertian Teori Modifikasi Dalam Penelitian*. http://jaribandel.blogspot.com/2015/07/pengertian-teori-modifikasi-dalam-penelitian.html. Diakses 9 Agustus 2018
7. Industri P. 2015. *Defenisi Bahan Bakar Diesel (Solar)*. https://www.prosesindustri.com/2015/02/defenisi-bahan-bakar-diesel-solar.html. Diakses 16 Agustus 2018
8. K. Naima and A. Liazid. 2013. Waste oils as alternative fuel for diesel engine. *Journal of Petroleum Technology and Alternative Fuels*. Vol. 4(3):1-15
9. Komponenalatberat. 2017. Siklus dan Prinsip Kerja Engine Diesel 4 Langkah. *https://komponenalat-berat.blogspot.co.id/2017/04/siklus-dan-prinsip-kerja-engine-diesel.html*. Diakses 16 April 2018
10. Lim T.H., S. Bari dan C.W. Yu. 2002. Renewable Energy: Using Crude Palm Oil (CPO) As Diesel Engine Fuel. *ASEAN Journal on Science and Technology for Development*. 19 (2): 1-14.
11. Mukhibin. 2011. *Mengubah Oli Bekas Menjadi Solar*. Edisi 1 Pustaka Solomon. Yogyakarta
12. Nofica G. 2012. Teori Dasar Mesin Diesel.*http.//www.eprints.undip.ac.id/41566/3/BAB_II_giant.pdf.html*. Diakses 11 April 2018
13. Santoso A.B. dan Bambang S. 2013. *Karakterisasi Unjuk Kerja Mesin Diesel Generator Set Sistem Dual-Fuel Solar dan Biogas dengan Penambahan Fan Udara Sebagai Penyuplai Udara*. ITS
14. Sari S. P. dan Eko P. Unjuk Kerja Motor Diesel Tipe S-1110 dengan Bahan Bakar Biodiesel M20 Dari Minyak Jelantah dengan Katalis 0,35% NaOH.
15. Saifudin. 2013. *Teknik Dasar Motor Diesel*. http://teknikmotordiesel.blogspot.com/2013/02/bab-iii.html. Diakses 17 April 2018
16. Soenarto N. dan Shoichi F. 1985. *Motor Serba Guna*. Edisi 1. Pradnya Paramita. Jakarta
17. Soenarto N. dan Shoichi F. 2002. *Motor Serba Guna*. Edisi 3. Pradnya Paramita. Jakarta
18. Sukoco dan Zainal A. 2008. *Teknologi Motor Diesel*. Edisi 1. Alfabeta. Bandung
19. Tamam, Zuhri. 2015. *Karakterisasi Unjuk Kerja Mesin Diesel Generator Set Sistem Dual Fuel Solar dan Syngas Batubara*. Tesis Magister. Institut Teknologi Sepuluh Nopember. Surabaya

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