*J. Basic. Appl. Sci. Res.*, 3(6)331-336, 2013
© 2013, TextRoad Publication
ISSN 2090-4304
**Journal of Basic and Applied Scientific Research**
*www.textroad.com*

# Performance and Seventy Five Hours Endurance Test of an Engine Generator set Fuelled by Recycling of Used Engine Oil

**Ihwan Haryono**

The Center for Thermodynamics, Engines and Propulsion System
Gd. 230 Puspiptek Setu, South Tangerang, Indonesia 15314

## ABSTRACT

Research on the utilizations of recycling of used oils aims to optimize alternative energy. It also produces environment friendly energy. Some papers report the potentiality of converting used oil as fuels. The fuels might be usage on vehicle or other engines. This paper reports test results of usage fuel made from recycled used engine oil on the engine generator set. As an initial study on the use of fuel from the processing of used engine oil, the test has been performed on a 10 KW generator set engine which is turning on for 75 hours. This test aims to evaluate effect and performance of the test engine fuelled by recycling of used oil. Performance test results prior to the endurance test shows that the engine just a little different than using diesel fuel. Meanwhile during the endurance test the engine began to look into problems after 30 hours testing. Engine power decreased significantly at 60th and the engine to shut off at 75th.
**KEYWORDS:** used oil, engine performance, stationary engine, fuel properties

## INTRODUCTION

Massive exploitation of non renewable diesel fuel results on scarcity of the energy sources. It condition deliver to the research and development of alternative fuels. On the other hand the volume of used oil in Indonesia is quite huge, which in 2012 is estimated up to 800 million and impact on serious problems to the environment. This used oil potentially can be reprocessed for energy fuels. Recycling of lubricating oils is also to create an environmentally friendly energy usage. Until now the recycling products of the used lubricating oils are used for multiple applications such as lubricant base oil, grease, burner oil. Utilization of the processing of used oil as fuel enable on slow moving diesel engine with some limitation [1]. Usage used oil as diesel fuel is still in the research topic.

Most research in used oil themed on the process to produce product oil with minimal oxidation products and contaminants. Many other studies purposed on finding methods in processing lubricating oil to produce cleaner products and better physical properties [2,3,4,5]. Research on applicability the products of recycling used oil as fuel become a lot of chances.

Research on the processing and utilizations of lubricating oil for vehicle fuel have been reported in few papers. Study gasoline-like fuels obtained from waste engine oil have been done by Sharafet. al [6]. They produced the gasoline-like fuels by purifying and distillation of waste oils. Physicochemical properties as spark ignition fuel engine were also discussed.

While reports on converting waste oil to gasoline fuel is difficult to be found then some research on processing waste oils for diesel fuel have been reported. Beg. et.al. have done pre-treatment, blending and filtrations of used engine oil samples from shipyard and light vehicles (bus and truck) at difference percentage. The values as obtained were compared with the fresh diesel and Caterpillar Specific Limit. The results showed that the use of the fuel mixture is limited to 35%. The increase in some physical properties such as viscosity still within the allowable tolerance limits[7].Review of processing and application of diesel fuel from used oil have been done by Naima and Liazid [8]. They studied on conversions and engine test results of 3 types of used lubricating oil, which are from the engine lubricating the vehicle, used cooking oil and plastics. The test results showed that for the used oil fuel produced little difference to new diesel without any problems in terms of engine performance.

Solids materials such as plastic and tire can be processed into fuels. The fuels produced from the pyrolysis process can be used on the engine. Some tests show encouraging results of usage of fuel produced from pyrolysis. Performance and emission characteristics of a direct injection single cylinder engine at constant speed fuelled by waste plastic pyrolysis have been evaluated by Guntur,et. al. Compared to the standard diesel engine, the test engine had higher brake thermal efficiency at part load condition. The CO, CO2 and HC show higher meanwhile O2 was lower [9]. Experimental research of waste plastic oil have performed also by Tamilkolundu and Murugesan[10] and research the use of tyre pyrolysis oil in diesel engines have done by Murugan [11]. The both research have shown the fuels tested produce feasible performance and engine

*Corresponding **Author:** Ihwan Haryono, The Center for Thermodynamics, Engines and Propulsion System Gd. 230 Puspiptek Setu, South Tangerang, Indonesia 15314
E_mail: ihwanharyono@yahoo.comPhone: 081932488959/081380388759

emissions. Used engine oil is produced from base oils which is a liquid, it is proper to be used as fuel for diesel engines.

In order to determine the applicability of fuel from recycling used oil, much more tests and research should be carry out intensively. The tests can be conducted on the vehicle or stationary engine.

As an initial study on the use of fuel from the processing of used lubricating oil, a test has been performed on a 10 KW generator set engine is turned on for 75 hours. This test aims to determine the effect of the use of fuel from an oil recycling process on the engine performance. This paper reports the test conditions and the performance of the engine during testing.

## TESTING METHODS

### TestingProcedure

Before testing the major components such as engine piston rings and injector replaced with a new one while cylinder liner certainly not scratches. After checking the components assembled, fuel sprays was checked using diesel fuel and processed used oil fuel tested. Run-in is done while looking after the engine operating at a stable operating condition which takes about 5 hours. Initially performance test using diesel fuel on the continuous load. Performance parameters including engine torque, power, and specific fuel consumption were measured by data acquisition. After first performance test using diesel fuel, the fuel drained and replaced by diesel fuel from processed used lubricating oils with heated 120$^{o}$C. The test did in the same condition as testing using diesel fuel. After the performance test conducted durability testing with fuel heated 100$^{o}$C with continuous load.

### Installation and testing equipment

Following the installation of the test bench is used (Figure 1).

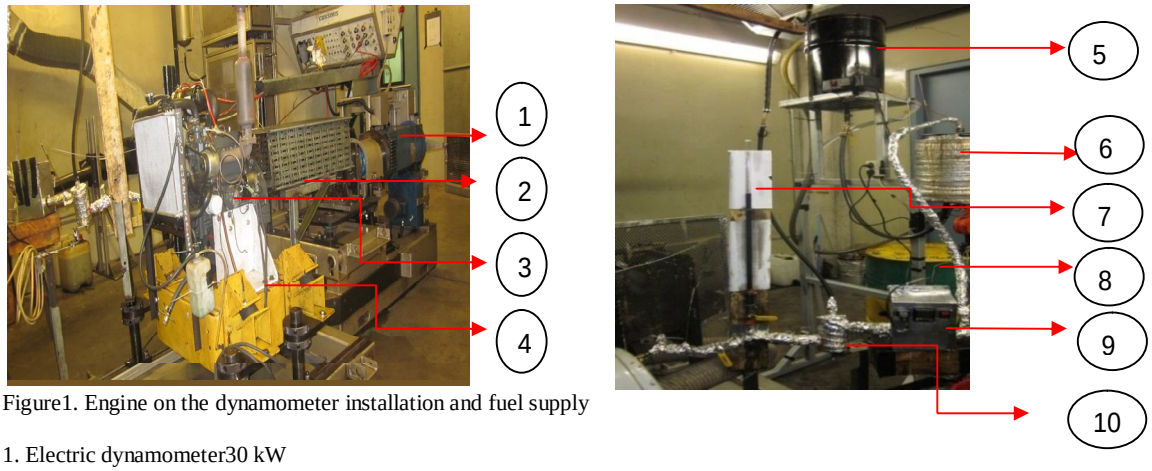



Figure1. Engine on the dynamometer installation and fuel supply

1. Electric dynamometer30 kW
2. Propeller shaft
3. Kubota Engine Genset + D 722 J310 STD
4. Engine mounting
5. Reservoir tank
6. Heater 1
7. Burette
8. Tested fuel drum
9. Heater 2
10. Steam trap damper

## TEST RESULTS AND DISCUSSION

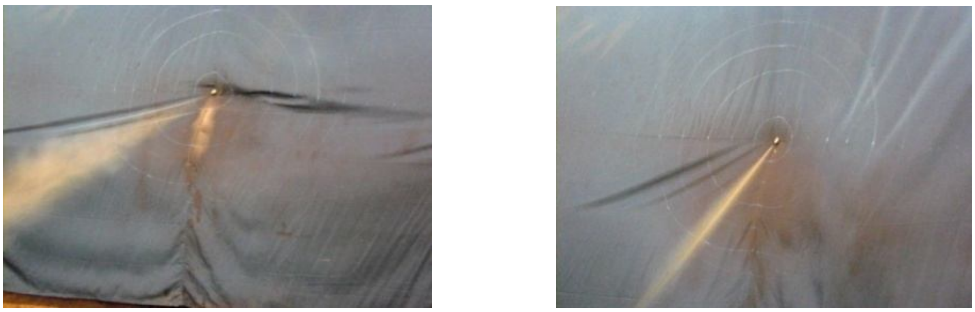
### Fuel Characteristics and Spray Pattern of Nozzle Injector Test

In testing the test fuel which processed from used oil show that the fuel still poor quality compared with the properties of diesel fuel (solar) (Table 1).

Nature of the properties will affect the performance of the engine is used, as shown in the measurement of torque / power in endurance test (durability). The viscosity was still too high, 55.2 cSt would affect the quality of the spray in the combustion chamber which ultimately affects the combustion and engine power. High viscosity of a fuel will form large spray (droplets) result in incomplete combustion and less energy produced [12,13]. High viscosity is more suitable for low speed engines, such as marine engines, in which combustion time enough [14,15]. This was consistent with the results on the visual checks. Spray from the injector nozzle of processed used oil (Fig. 2) was seen difficult to spread while spray of diesel fuel (solar) better spread.

Table 1: Physical and chemical properties of fuel

| Parameters | Used Oil Processing | Diesel fuel (Solar) |
|---|---|---|
| Kinematic viscosity, 40$^{o}$C | 55.12 cSt | 2.0 to 4.5 cSt |
| Kinematicviscosity,100$^{o}$C | 8.40 cSt | - |
| Distilled water content | 0.1% v | - |
| Carbon residue | 3.05 wt% | 0.3% m/m |
| Total acid number (TAN) | 0.62 mgKOH/g | 0.3 mgKOH / g |
| The content of energy (LHV) | 44.12 MJ / Kg | 45.84 MJ / Kg |



(a) (b)

Figure 2: Fuel spray: a) Solar, b) test fuel-heated temperature of 120$^{o}$C

Fuel test results of processing used oil still showed residual carbon and water. Carbon content in the fuel as well as having a high boiling point would likely produce deposit on the engine. Because of the amount of residue in the fuel and 90% evaporated distillation temperature should be limited. Dirt and water contamination should be avoided to protect the critical components to prevent wear [16]. The content of TAN (total acid number) caused by fuel source derived from lubricating oil. The Water and TAN value indicates that still has lubricant fuel oxidation yield components [17,18]. This component has the potential to be impurities in the fuel supply system or gas emissions.

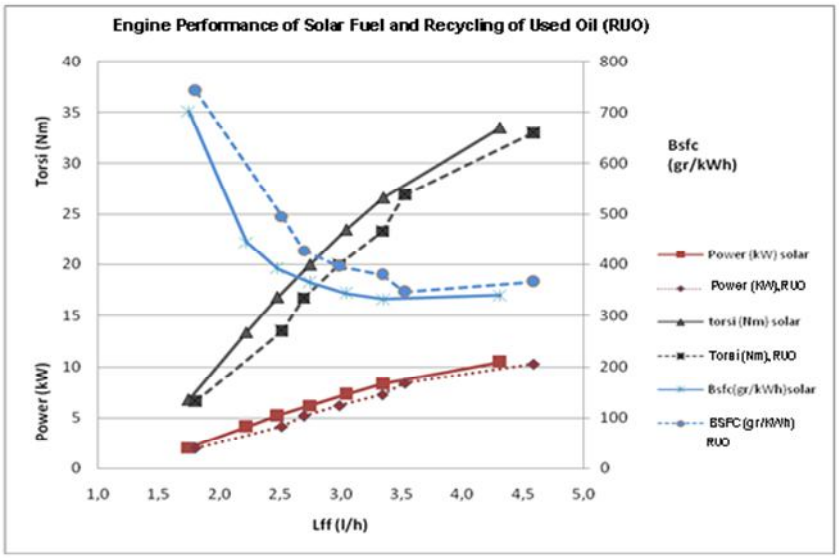



Figure 3. Comparison of engine performance between processed used oil and solar

**Performance Test**

Performance test results before the durability test indicates that the engine torque / power fuelled made from used lubricating oil not much different than the diesel fuel (Figure 3). The graphic show that between the fuel processed from used oil with diesel fuel almost coincide and at some points have difference of about 1 KW. To charts Torque at some point difference of about 3 Nm, while the BSFC chart difference can reach 5-6gr /

KWh. This is in line with the content of calorific value (LHV) of 44.12 MJ / kg which is almost equal to the solar value 45.84 MJ / Kg. Difference in value of torque / power is also influenced by imperfect the used oil fuel in forming moisture when spraying into the combustion chamber so that less energy release. Results of tests carried out by others also showed in line results [7,8]. These results indicate that the fuel from used oil has the potential to be used as fuel for diesel engines.

**Endurance Test (Durability)**

While the performance test results showed encouraging results, the results of durability test engines showing operating problems that starting after 30 hours (1800 minutes). In the trend chart throttle and power, showed a decline in power (power) while adding throttle openings.

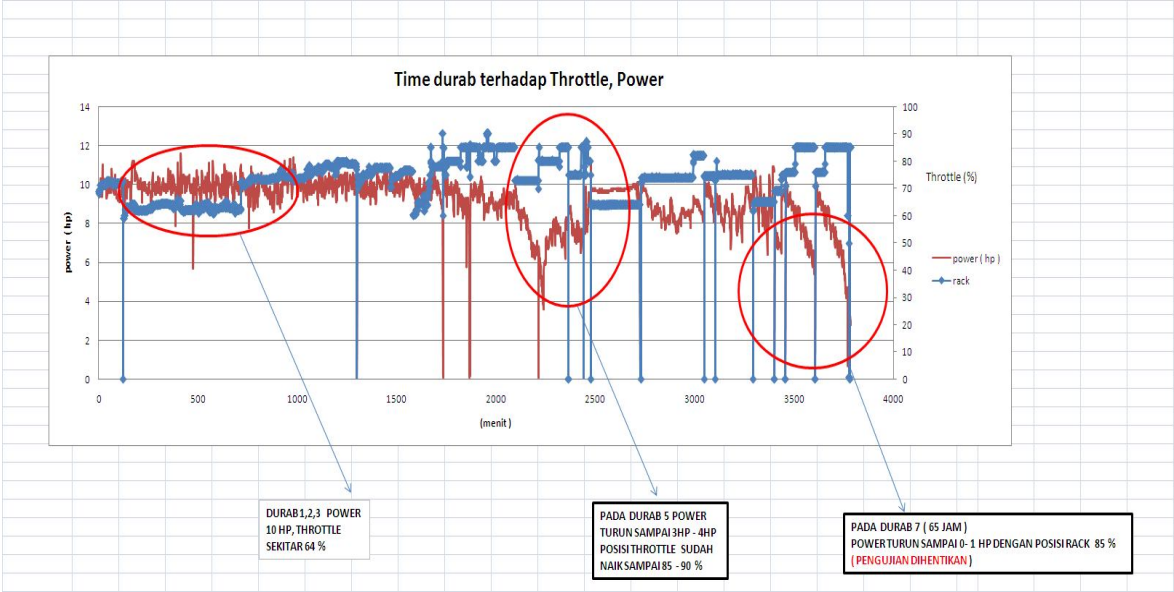



Figure 4: Trend of test conditions

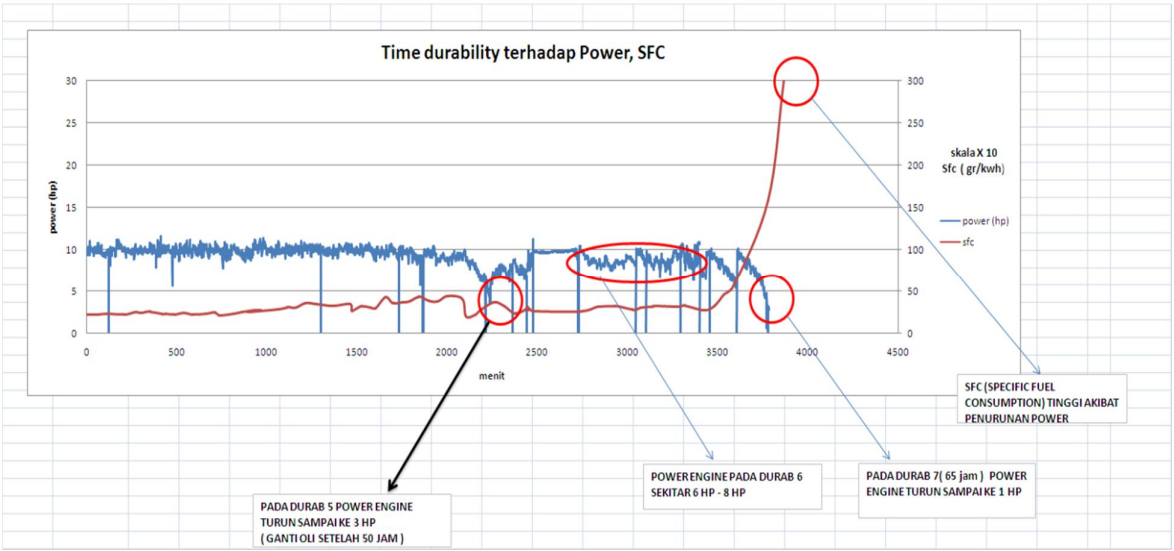
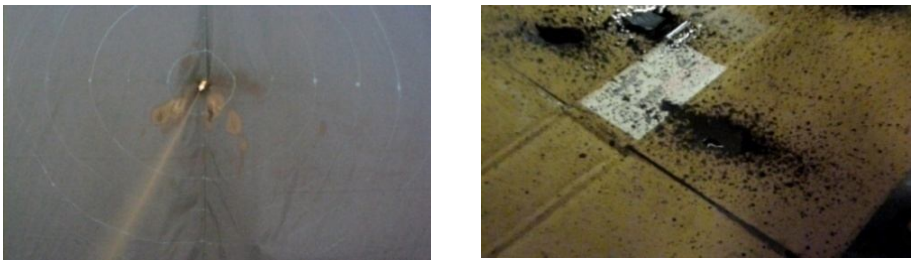



Figure 5: Graph trends specific fuel consumption and engine power

At the cycle 5 (1 cycle for 6 hours), the value decreases to 3 HP while 90% throttle opening. Repairing by engine setting is only temporary where engine power direct come to decrease. It started in the 45th hour (2700 minutes). In 60$^{th}$ hours, the engine condition was always decreasing while the throttle opening was increasing, until the engine shut off at 75th (Figure 4).

Engine operating conditions are also shown in Figure 5. The chart shows that in the minutes to 1800, specific fuel consumption began to be unstable and decreased engine power. Specific fuel consumption began to increase at 60 hours (3600 minutes) while the engine power is always decreasing (drop). At 75 hours the specific fuel consumption can not produce combustion and engine power so totally shut off.



(a) (b)

Figure 6: Nozzle spray at the 50th (130$^{o}$C) (a) and after the engine shut off (b)

At 50$^{th}$ hours, in checking of spray nozzle where the fuel was heated at a temperature of 130$^{o}$C, visible fuel spray fogging does not occur properly. This condition would be difficult to produce perfect combustion. At 75th hours, after engine shutting off, the spray nozzle resulted from engine pump just put out some small black thick oil. This fuel certainly did not produce combustion. Impurities contained in the fuel will accumulate and clog the fuel supply system components that cause the failure of the fuel spray into combustion chamber [19].

From thetest results above may indicate that the fuel from used oil can be developed into fuel for diesel engines. Quality fuel from the processing of used lubricating oil is key factor of performance of the fuel in the engine.

## CONCLUSION

From the results of performance testing showed not much difference on the performance between diesel engine fueled with used oil processed fuel using and diesel fuel (solar). Use of used oil processed as a fuel will cause the engine problems if the physical and chemical property does not meet the necessary requirements.

## REFERENCES

[1] Vest Heino. Reuse and Refining of Waste Engine Oil.revised in 2000. Gate Eschborn, Germany. http://www.gtz.de/gate/gateid.afp

[2] Lianna Johannna, Karyati Junia, Santosa Herry. Used Lubricating Oil Purification Methods A Utilization adsorption Back Used As Lubricant Base Oil. Journal of Chemical Technology and Industry, Vol. 1, No..1, In 2012

[3] Andarini Metalia. Used Oil Recycling Using Extraction With Sulfuric Acid and Surfactants. Thesis Chemistry Department of the Bogor Agricultural University. 2012

[4] Manasomboonphan Wisa, Junyapoon Suwannee. Production of Liquid Fuels from Waste Lube Oils Used by Pyrolysis Process.International Conference on Biomedical Engineering and Technology IPCBEE vol. 34 IACSIT Press, Singapore. 2012

[5] Lam Su Shiung, Russell Alan D. and Chase Howard A. Pyrolysis Using Microwave Heating: A Sustainable Process for Recycling UsedCar Engine Oil. ACS Publications.Ind. Eng. Chem. Res. 2010, 49, 10845–10851

[6] Sharaf Juhi, Mishra Beena, Sharma R B. Production of gasoline-like fuel obtained from waste lubrication oil and its physicochemical properties. International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 3, Issue 3, May-Jun 2013, pp.113-118 113

[7] Beg R.A., Sarker M.R.I. and Pervez Md. Riaz. Production of Diesel Fuel from Used Engine Oil. International Journal of Mechanical and Mechatronics Engineering., IJMME-IJEN. Vol. No. 10. 2

[8] Naima K. and Liazid A.. Waste Oils as Alternative Fuel for Diesel Engines: A Review. Journal of Petroleum Technology and Alternatives Fuels vol. 4 pp 30-43, March 2013

[9] Guntur Rajesh, Kumar M.L.S. Deva,Reddy K. Vijaya Kumar. Experimental Evaluation of a Diesel Engine with Blends of Diesel Oil – Plastic Pyrolysis. International Journal of Engineering Science and Technology (IJEST). Vol. No. 3. 6 June 2011

[10] Tamilkolundu Senthilkumar and Murugesan Chandrasekar. The Evaluation of blend of Waste Plastic Oil-Diesel fuel for use as alternate fuel for transportation.2nd International Conference on Chemical, Ecology and Environmental Sciences (ICCEES'2012) Singapore April 28-29, 2012

[11] Murugan S., Ramaswamy, M.C. and Nagarajan G. The use of tyre pyrolysis oil in diesel engines. Waste Management. Volume 28, Issue 12, December 2008, Pages 2743-2749

[12] Reynolds Robert E. et. al. Change in Diesel Fuel. Downstream Alternatives, Inc.. South Bend, IN. p:5

[13] von Wielligh AJ, Burger NDL, de Vaal PL. Diesel Injector Failures and the Consequences-Caused by Fuel Quality: Case Study. International Conference of the South African Institute of Tribology. 24 March 2004

[14] John Bacha, et. al. Diesel Fuel Technical Review. Chevron Corperation. 2007. p: 2

[15] Anonymous. Diesel fuel characteristics and resources.

http://www.ufa.com/petroleum/resources/fuel/diesel_fuel_resources.html

[16] Alex Marcus. Diesel Fuel Basics.PassageMarker Inc. Magazine. 1999

[17] A Technical Article by C.C.JENSEN A/S. Oxidation of oil and filtration of oxidation residuals in oil. http://www.cjc.dk/fileadmin/user_upload/pdf/News_Press/Press_Info/Oxidation_of_Oil_2006.pdf

[18] Ihsan Hamaw and , Yusaf Talal , and Rafat Sardasht. Recycling of Waste Engine Oils Using a New Washing Agent.Energies. February 2013, 6, 1023-1049; doi:10.3390/en6021023

[19] Ullmann Jorg, et.al. Effects of Fuel Impurities and Additive Interactions on the Formation if Internal Diesel Injector Deposits. Corporate Sector Research and Advance Engineering.CR/ARA, Germany.

http://www.infineum.com/Documents/Fuels%20Technical%20Papers/TAE/Esslingen%202009.pdf