Feasibility Analysis of Excavator Vaia Car (Special Equipment) Engine Oil at the Ngrombo Railway Maintenance Center

Hari Boedi Wahjono[1*], Fadli Rozaq[2], Dimas Adi Perwira[3], Naufal Wirawan[4]

Author Affiliation
[1,2,3,4]*Mechanical Railway Technology Indonesian Railway Polytechnic Street Tirta Raya, Madiun Indonesia*
hariboedi@ppi.ac.id

Abstract. An oil Change is the act of maintenance on the Excavator Vaia Car (Special Equipment) at the Ngrombo Railway Maintenance Center. The research aimed to investigate the feasibility of engine oil for the Excavator Vaia Car. The method was taking the engine sample oil from 0 months to 6 months with 1 month intervals. Oil samples were tested, including kinematic viscosity, water contamination, total acid number, and total base number. The test showed that the average value for 6 months from each test shows positive results or the oil is in the feasible condition.

Keyword: Excavator vaia car, special equipment, maintenance, Engine oil, railway

1. INTRODUCTION

Maintenance is an activity to prevent damage by checking facilities and equipment periodically, visually, or using other tools. This maintenance can maintain the performance and condition of the machine so that it is always ready for operation[1]. The facility's condition of ready for operation can bring various benefits, such as minimizing maintenance costs and preventing fatal damage. This damage can hamper facility operation activities and influence work safety for facility operators when operating the facility. One of the places for maintaining railway facilities is the Ngrombo Railway Maintenance Center.

The Ngrombo Railway Maintenance Center is a technical implementation unit within the Ministry of Transportation and is responsible to the Director General of Railways. It has functions to maintain state owned railway facilities, including periodic and heavy maintenance, and implementing quality control of maintenance of state-owned railway facilities under the Indonesian Minister of Transportation. There are currently 168 state-owned railway facilities spread over 3 regions, Sumatera, Java, and Makassar. Special equipment is one of the facilities that is subject to maintenance. It is a railway facility as a supporting tool for special purposes, namely assisting the maintenance process, such as the Vaia Car Excavator. This facility is used to lift rails, replace sleepers, compact ballast, and loading and unloading materials. Based on interviews with Mr. Duwi and Mr. Joko, staff at the Ngrombo Railway Maintenance Center, they said that this special equipment (Excavator Vaia Car) rarely operated, but they still do the

A. Pradipta et al. (eds.), *Proceedings of the 2nd International Conference on Railway and Transportation 2023 (ICORT 2023)*, Advances in Engineering Research 231,
https://doi.org/10.2991/978-94-6463-384-9_14

maintenance. One of the maintenance carried out by the center is an oil change, at 6 monthly maintenance (P6).

Based on the interviews with staff, engine oil changes are carried out every 6 months, namely at 6 monthly maintenance (P6) and 12 monthly maintenance (P12). During this maintenance, the engine oil was drained and changed with 7 liters of new oil. Routine oil changes aim to maintain and improve engine performance. This maintenance is carried out using a TBM (Time Based Maintenance), where maintenance refers to certain predetermined times. The weakness of TBM is the change of some parts which are in good condition [2]. This requires changes in the development of maintenance strategies, such as changing engine oil by considering the operating time of the facility and laboratory test results. Implementing this strategy can be a more efficient option in reducing costs and being environmentally friendly because engine oil is used up to its useful life limit.

2. RESEARCH METHOD

2.1 Literature Study

The test method of the research was testing the sample of engine oil in the laboratory. The tests were carried out with the parameters kinematic viscosity at a temperature of 40°C, kinematic viscosity at a temperature of 100°C, water contamination, total acid number, and total base number.

2.2 Sampling

Sampling of new and used engine oil is carried out at the Ngrombo Railway Maintenance Center. Oil samples were taken directly from the Excavator Vaia Car engine around 250 ml.

2.3 Test Design

The tests in this research were testing engine oil samples in the laboratory. The tests of oil samples were carried out with the parameters kinematic viscosity at a temperature of 40°C, kinematic viscosity at a temperature of 100°C, water contamination, total acid number, and total base number. The test is carried out at Petrolab Services.

3. RESULT AND ANALYSIS

Sample test of engine oil of Excavator Vaia Car carried out at Petrolab Services. The tests consisted of a kinematic viscosity test, water contamination test, total acid number, and total base number. The kinematic viscosity test was carried out using a Bath Koehler Viscometer at temperatures of 40°C and 100°C. Water contamination testing was carried out using a Karl Fischer Coulometric Titration tool. Metrohm Titrator was used to test the total acid number. And, Mettler Toledo used to test the total base number. Table 1 presents the test result of engine oil samples of the Excavator Vaia Car based on kinematic viscosity parameters at temperatures of 40ºC and 100ºC, water

contamination, total acid number, and total base number. Table 2 presents the standard limit for the feasibility of engine oil of the Excavator Vaia Car.

Table 1. The Test Result of Engine Oil Samples of The Excavator Vaia Car

Engine Hours (h)	Kinematic Viscosity 40ºC (cSt)	Kinematic Viscosity 100ºC (cSt)	Water Contamination (%)	Total Acid Number (mgKOH/g)	Total Base Number (mgKOH/g)
0	141,7	17,64	0	0	10,5
44	119,28	15,64	0,05	0,53	8,1
66	115,17	15,28	0,05	0,75	7,7
83	110,96	14,91	0,07	0,98	7,3
105	106,88	14,54	0,1	1,21	6,9
121	102,64	14,16	0,13	1,44	6,5

Table 2. The Standard Limit for The Feasibility of Engine Oil of The Excavator Vaia Car.

Parameter Kelayakan Oli Mesin	Minimum Limit	Maximum Limit
Kinematic Viscosity 40ºC	76,3	141,7
Kinematic Viscosity 100ºC	11,76	17,64
Water Contamination	0	0,2
Total Acid Number	0	2,9
Total Base Number	4,2	-

This picture represent results viscosity kinematics, water contamination, total acid number, total base number compared to engine oil eligibility limit standards.

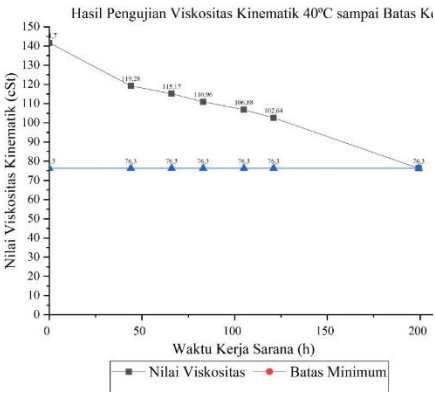

Fig. 1. Test Result Viscosity Kinematic at 40ºC.

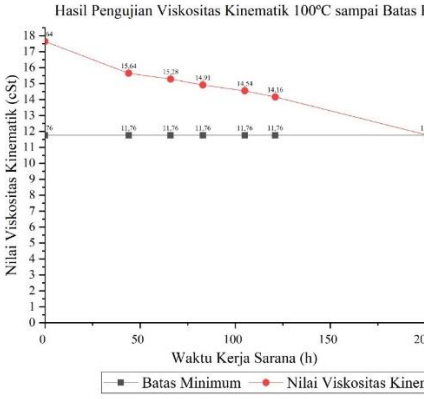

Fig. 2. Test Result Viscosity at 100ºC.

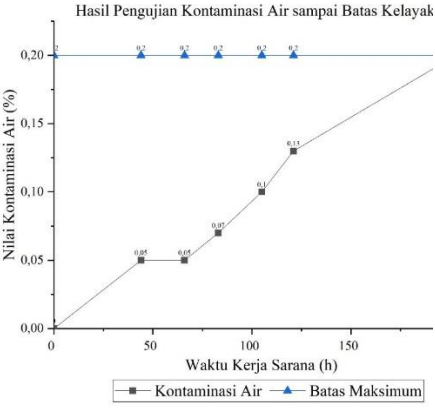

Fig. 3. Test Result of Water Content.

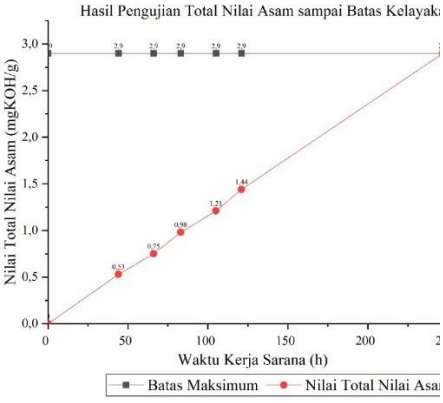

Fig. 4. Test Result of Total Acid Number.

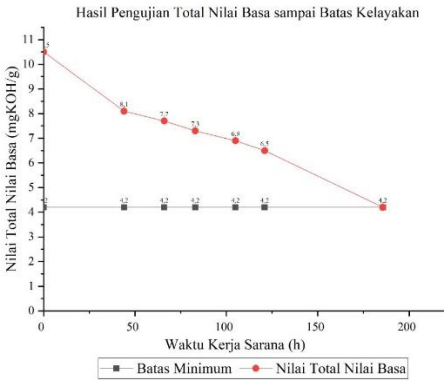

Fig. 5. Test Result of Total Base Number.

The influence between the working time of the means and the kinematic viscosity at temperatures of 40ºC and 100ºC the longer the working time of the means, the lower the value of the kinematic viscosity of the oil[3]. The increase in operating time of the facility results in friction that occurs continuously in the engine room and the quality of the lubricating oil molecules decreases. As a result of this, the cohesive force in the lubricating oil weakens and the quality of the lubricating oil also decreases. the water contamination value is still within the feasibility standards. The longer the facility's operating time, the greater the water contamination. In these conditions, oil can trigger corrosion of engine components, can damage the chemical molecular content of the oil, can trigger cavitation (pressurized steam), and can damage the lubricating power of the oil[4]. Oil with reduced lubricating power can increase the level of wear and friction between engine components, resulting in can worsen quality oil[5]. Increased water contamination of oil machine can caused from a number of factor like water leaks in the cylinder jacket, water leaks in the oil cooler, occur condensation on the crankcase, and addition oil at the time of oil volume not enough of the specified oil level. the total acid number value is still within the eligibility standards. The TAN value of oil increases with increasing working time of the facility. The increase in the TAN value is because when the facility is in operation the engine oil will experience oxidation because the oil reacts with air so that the acid value will increase[6]. If the total acid number exceeds the appropriate limit, it can cause rust on engine components. In addition , oil with a high acid concentration will easily corrode engine parts and block the oil flow due to the formation of varnish and sludge. the total base number is still within the eligibility standards. The TBN value of oil decreases with increasing operating time of the facility. The decreasing TBN value is caused by neutralizing the increasing amount of acid. If the base concentration is less than the appropriate limit, the performance of the acid neutralizer will be lost and quickly increase corrosion in the engine[7].

4. CONCLUSION

Based on the discussion, it concluded that the operating time of the equipment affects the feasibility value of the Excavator Vaia Car engine oil and that the longer the operating time of the equipment, the feasibility quality of the engine oil decreases.

5. THANK YOU NOTE

The author would like to express gratitude to the academic community of the Indonesian Railway Polytechnic, who have supported the completion of this research.

REFERENCE

[1] A. Crespo del Castillo, J. A. Marcos, and A. K. Parlikad, "Dynamic fleet maintenance management model applied to rolling stock," *Reliab. Eng. Syst. Saf.*, vol. 240, no. September, 2023, doi: 10.1016/j.ress.2023.109607.

[2] Y. Zhao, V. Cozzani, T. Sun, J. Vatn, and Y. Liu, "Condition-based maintenance for a multi-component system subject to heterogeneous failure dependences," *Reliab. Eng. Syst. Saf.*, vol. 239, no. May, 2023, doi: 10.1016/j.ress.2023.109483.

[3] S. Nagano, S. Yamamoto, M. Nagakubo, K. Atsumi, and M. M. Watanabe, "Physical Properties of Hydrocarbon Oils Produced by Botryococcus Braunii: Density, Kinematic Viscosity, Surface Tension, and Distillation Properties," *Procedia Environ. Sci.*, vol. 15, pp. 73–79, 2012, doi: 10.1016/j.proenv.2012.05.012.

[4] R. K. Abdulsattar *et al.*, "Optical-microwave sensor for real-time measurement of water contamination in oil derivatives," *AEU - Int. J. Electron. Commun.*, vol. 170, p. 154798, 2023, doi: 10.1016/j.aeue.2023.154798.

[5] E. Rostek and M. Babiak, "The experimental analysis of engine oil degradation utilizing selected thermoanalytical methods," *Transp. Res. Procedia*, vol. 40, pp. 82–89, 2019, doi: 10.1016/j.trpro.2019.07.014.

[6] P. C. Mandal, A. Bin Abdullah, and M. M. Rahman, "Total Acid Number Reduction of 2, 6-Naphthalenedicarboxylic Acid Using Subcritical Methanol for Reducing Acidity of Heavy Oil: A Kinetic Study," *Procedia Eng.*, vol. 148, pp. 1213–1219, 2016, doi: 10.1016/j.proeng.2016.06.454.

[7] C. Winterfield and F. R. van de Voort, "Automated Acid and Base Number Determination of Mineral-Based Lubricants by Fourier Transform Infrared Spectroscopy: Commercial Laboratory Evaluation," *J. Lab. Autom.*, vol. 19, no. 6, pp. 577–586, 2014, doi: 10.1177/2211068214551825.