Vol. 4, No. 2, October 2023, page 197-206
JTTM: Jurnal Terapan Teknik Mesin
p ISSN 2721-5377| e ISSN 2721-7825
http://jurnal.sttmcileungsi.ac.id/index.php/jttm

Analysis of the auto lube system electric grease pump against the unscheduled breakdown of the dump truck unit brand k type HD 1500-7

Indra Widarmadi, Sahidul Anam*, Basuki Wisnu, Husodo Sumardi

* Faculty of Industrial Technology, Budi Utomo Institute of Technology, Jakarta, Indonesia

*✉ syahidulanam1@gmail.com

Submitted: 31/05/2023 Revised: 24/06/2023 Accepted: 25/06/2023

Abstract: A lubrication failure resulted in damage to the HD 1500-7 dump truck unit auto lube system, making the system ineffective and leading to lubrication failure on the frame components. Because the damaged HD 1500-7 dump truck unit is inoperable when it occurs, this damage may have an impact on its production. The goal of this study was to ascertain whether maintenance performance on the Dump Truck Brand K type HD 1500-7 unit was impacted by lubrication failure in the auto lube system. Additionally, learn how to assess the Auto lube system on the Dump Truck Brand K type HD 1500-7 and how much electricity the Grease Pump Auto lube system Dump Truck unit Brand K type HD 1500-7 uses. Using a quantitative approach, discover what is causing the HD 1500-7 dump truck unit and the auto lube system to malfunction. The analysis of the Dump Truck HD 1500-7 unit's maintenance performed from February to April 2022 revealed that the average MTBF value is 352.9 hours, the average MTTR value is 5.388 hours, and the average PA value is 96.38%. The oil-powered reciprocating pump produces 537.81 Watts of power. At a grease pressure of 2500 psi, the displacement (grease) pump requires 163.29 Watts from the reciprocating (oil) pump to operate, compared to 58.67 Watts at a grease pressure of 1500 psi. The standard working pressure for the displacement (grease) pump is 2500 psi, whereas the standard working pressure for the reciprocating (oil) pump is 400 psi. The working pressure on the oil and grease does not achieve the standard pressure, an error arises and results in lubrication failure in the frame components, and this might have an impact on the HD 1500-7 unit's maintenance performance.

Keywords: Auto lube system; grease pump power; maintenance

1. INTRODUCTION

The lubricant is gathered, sucked up, and then evenly dispersed to each component element of the linkage group by the heavy equipment unit Brand K Type HD 1500-7's lubrication system [1]. Grease is the lubricant employed in this system because it can enter the spaces between the linkage group components [2]. The automatic lubrication system, also known as the Auto lube system, is utilized in the Dump Truck HD 1500-7 unit's lubrication system [3]. Regular maintenance is required for the Auto lube system, especially regarding the grease level in the grease tank and the pressure of the grease coming from the electric grease pump [4][5].

Some issues lead to lubrication failure and damage to the Auto lube system [6]. Because the auto lube system is ineffective, the linkage group's components (torque rods, pins, and bushings) are not properly lubricated [7]. When the torque rod components, pins, and bushings are damaged, the unit cannot work, which reduces production. It consequently results in losses for units and mining contractors, particularly in coal mining, in terms of production and product image [8][9][10].

The goal of this study was to ascertain whether maintenance performance on the Brand K type HD 1500-7 dump truck unit was affected by lubrication failure in the auto lube system.

2. METHOD

In this study, PT X, North Sangatta, East Kutai, East Kalimantan, 75611 was the site of the research. The study was carried out between 10 February and 10 July 2022. Figure 1 depicts the processes that must be completed in this analysis.

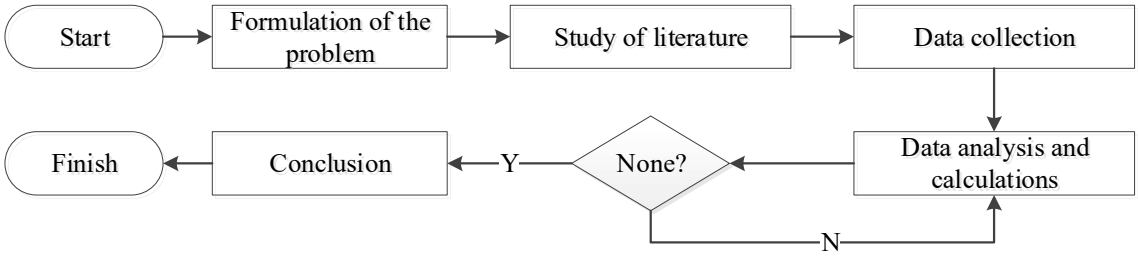

Figure 1. Analysis flowchart.

An analysis of the HD 1500-7 Dump Truck unit auto lube system, calculation of the hydraulic system that supplies oil to the reciprocating, work standards for the HD 1500-7 Dump Truck unit auto lube system, discussion of the analysisof the results, and a conclusion are all included in the flowchart in **Figure 1**.

The study of literature involves investigation. Introducing the K type HD 1500-7 hydraulic dump truck. components in the HD 1500-7 dump truck unit auto lube system, as well as its operation and maintenance, according to the service manual. Course in basic mechanics one training course on fundamental maintenance, Shop HD 1500-7 Munal dump truck. Making observations, specifically direct observations in the field, and supported by data obtained related to the auto lube system and breakdown unscheduled unit dump truck HD 1500-7, articles on Pertamina lubricants guide, and monthly data from PT X in the form of 2022 wheel unit Pareto problems [11].

2.1. Data collection.

72 units area operating at PT X, divided into two parts, wheel and digger in **Table 1** and **Figure 1**.

Table 1. **Population unit PT X.**

No	Unit	Total
1	HD 785-7	36
2	HD 1500-7	23
3	PC 2000-8	5
4	PC 3000-6	3
5	PC 4000-6	5

Table 1 lists the heavy equipment units in use at PT X, including the two types of heavy duty-dump trucks, 59 units (36 HD 785-7, 23 HD 1500-7, and 13 units of hydraulic excavators, made up of 5 PC 2000-8, 3 PC 3000-6, and 5 PC 4000-6 units), and 59 units of each type [12][13].

3. RESULTS AND DISCUSSION

Calculation of the K Type HD 1500-7 dump truck unit's maintenance performance. Using the maintenance performance calculation:

a) Calculation of performance maintenance in February 2022.

$$\text{MTBF} = \frac{2847}{8} = 355{,}8\ hour \quad (1)$$

$$\text{MTTR} = \frac{77}{8} = 9{,}625\ hour \quad (2)$$

$$\text{PA} = \frac{2847}{2924} x100\% = 97{,}36\% \quad (3)$$

b) Calculation of maintenance performance in March 2022.

$$\text{MTBF} = \frac{2525}{7} = 360{,}7\ hour \quad (4)$$

$$\text{MTTR} = \frac{113}{7} = 16{,}142\ hour \quad (5)$$

$$\text{PA} = \frac{2525}{2638} x100\% = 95{,}71\% \quad (6)$$

c) Calculation of performance maintenance in April 2022

$$\text{MTBF} = \frac{3424}{10} = 342{,}4\ hour \quad (7)$$

$$\text{MTTR} = \frac{140}{10} = 14\ hour \quad (8)$$

$$\text{PA} = \frac{3424}{3564} x100\% = 96{,}07\% \quad (9)$$

Table 2. Total operating time data for February-April 2022.

Month	Breakdown Frequency	Total Operating Time		
		Working Time (Hours)	Bus Duration (Hours)	Total (hour)
February	8	2924	77	2847
March	7	2638	113	2525
April	10	3564	140	3424

The HD 1500-7 dump truck unit's maintenance performance is calculated in **Table 2** in three parts: Mean Time Between Failure (MTBF), Mean Time To Repair (MTTR), and Physical Availability (PA [14][15].

3.1. Auto lube system dump truck unit brand K Type HD 1500-7.

3.1.1. How the oil pump works on the HD 1500-7 auto lube system.

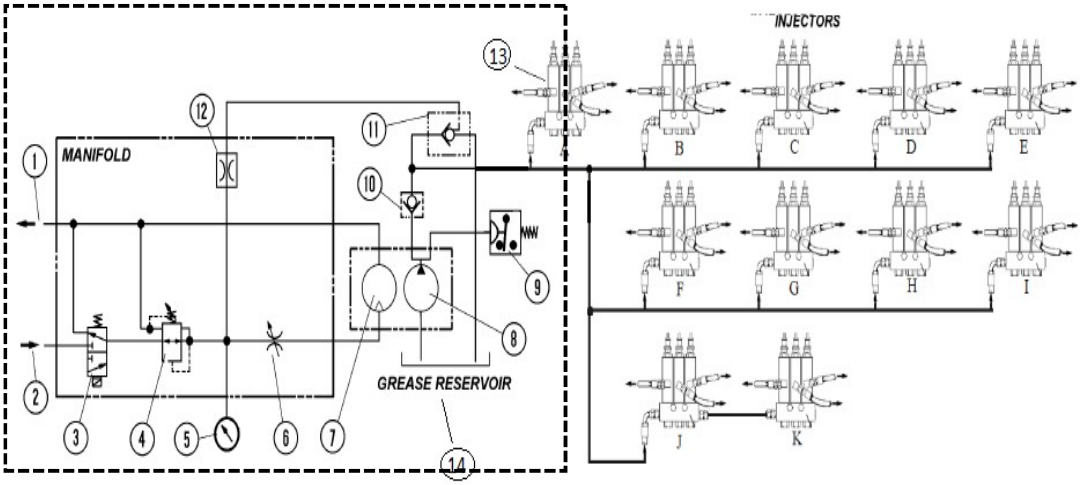

Figure 2. The hydraulic circuit of the HD 1500-7 auto lube system.

Information:

1. Hydraulic oil outlet (from auto lube system to hydraulic tank)
2. Hydraulic oil inlet (from steering system to auto lube system)
3. Solenoid Valves
4. Reducing Valve
5. Pressure Gauge Oli
6. Flow Control Valve
7. Reciprocating pump (Oil)
8. (No. 12) Office

Figure 2 when the standby condition is oil entering through the hydraulic oil inlet (2) and when the auto lube system is running the controller or timer sends a signal to the solenoid valve (3) to open the hydraulic oil line from (2) to the reciprocating pump (7) which passes through the reducing valve (4), oil pressure gauge (5) and flow control valve (6). In addition, there is hydraulic oil that goes to the vent valve (11) through the orifice (12). For the standard pressure that works on the hydraulic circuit, which is 400 psi, if the oil pressure is not according to the standard, it will affect the performance of

the displacement (grease) pump [16]. The workings of the hydraulic circuit can be seen in the flowchart of **Figure 3**.

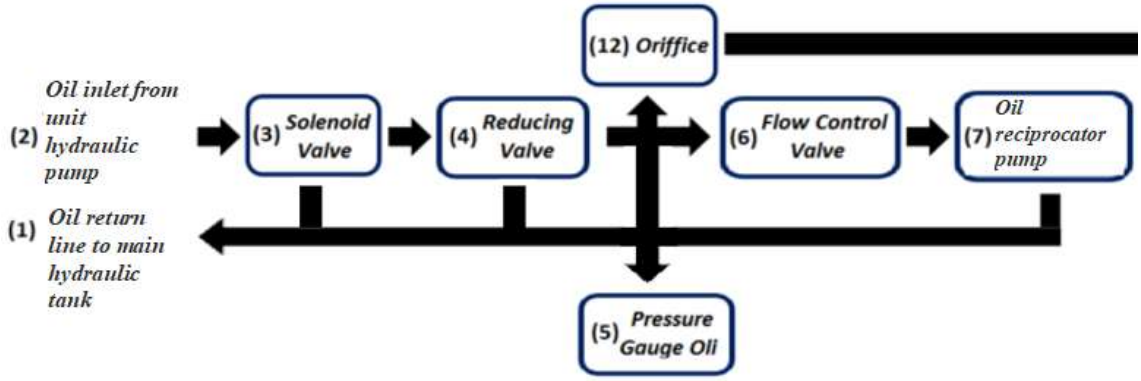

Figure 3. Flowchart of the hydraulic circuit of the HD 1500-7 auto lube system.

3.1.2. How the grease pump works on the HD 1500-7 auto lube system.

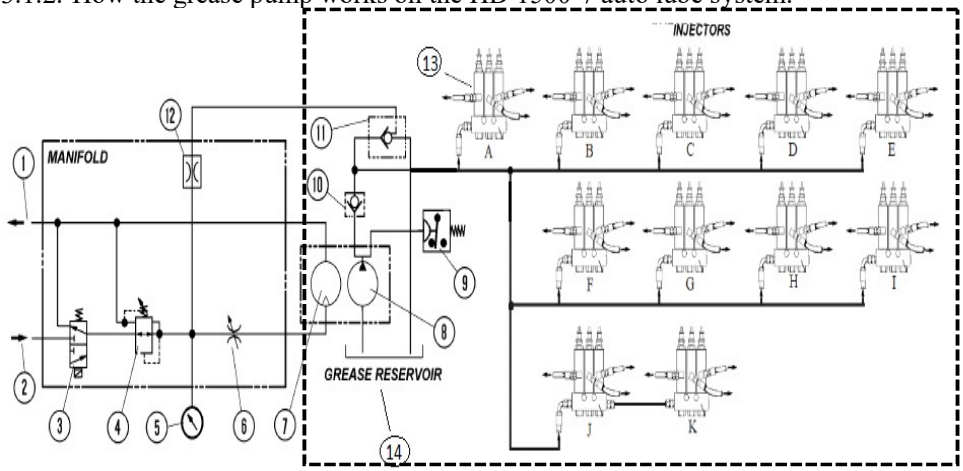

Figure 4. HD 1500-7 auto lube system grease circuit.

Information:

1. (No. 8) Displacement Pump (Grease)
2. (No. 9) Pressure Switch
3. (No. 10) Check the Valve
4. (No. 11) Vent Valve
5. (No. 13) Grease injectors (A-K are the lube injectors group to the lubrication point)
6. (No. 14) Grease Tank

Figure 4 and **Figure 5** grease circuit when the displacement pump, grease (8) works to pump grease from the grease shelter or grease reservoir (14) then the grease will come out to the grease injector (13) through the pressure switch (9) and check valve (10)). There is grease going to the vent valve (11) to return to the grease tank (14) at the same time there is a supply of hydraulic oil from the office (12) to close the return path to the grease tank (14) so that the grease that is pumped only goes to the grease injector (13). The pumped grease pressure is 2500 psi, if the pressure has reached the standard pressure of 2500 psi during the working time of the grease pump, the pressure switch (9) will send a signal to the auto lube controller which will then cut off the flow to the solenoid valve so that the oil supply to the manifold includes the oil that is pumped. to the vent valve (11) disconnects and returns to the hydraulic oil tank of the unit [16]. The way the grease circuit works can be seen in the flowchart of **Figure 4**.

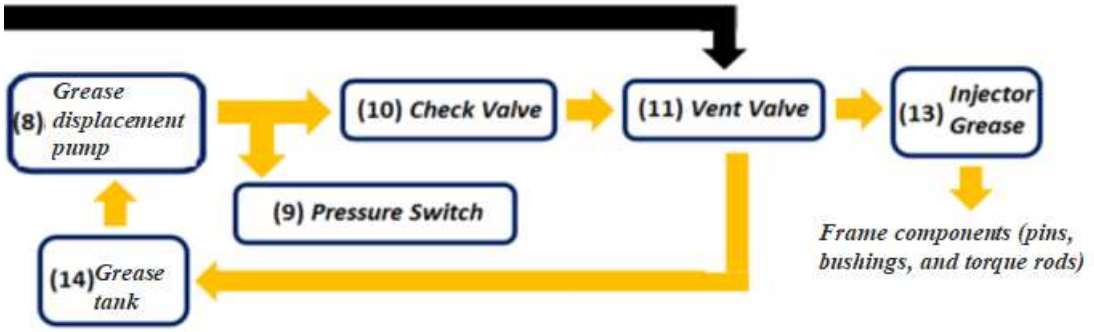

Figure 5. Flow diagram of the HD 1500-7 auto lube system grease circuit.

The pressure switch (7) will not send a signal to the auto lube controller if the pumped grease pressure does not reach the operating standard pressure of 2500 psi within the allotted period, and the controller will then determine that the lubrication system is malfunctioning [1].

3.2. Analysis.

3.2.1. Performance analysis of dump truck HD 1500-7 unit maintenance.

a) Analysis of damage to the pins, bushings, and torque rods caused by the auto lube system's failure to lubricate, which led to damage to the frame unit components of the HD 1500-7 dump truck.

b) Repair Method
- Replace pins, bushings, and torque rods.
- Executing the line boring operation on the HD 1500-7 dump truck unit auto lube system torque rod maintenance component

c) Method of Prevention
- Installing an alarm buzzer to detect lubrication failure on the auto lube system
- Installing a grease pressure gauge to determine if the auto lube system is in a normal or abnormal condition.

d) Analysis before and after repairs are carried out

Table 3. Problem breakdown unschedule HD 1500-7 after repair.

No.	Component Code	Before repair (Feb-Apr 2022)		Before repair (Feb-Apr 2022)	
		Frequency	Duration (Hours)	Frequency	Duration (Hours)
1	Electrical	66	130.00	10	125.91
2	Suspension	4	7.58	5	8.23
3	Engine	80	250.00	64	210.30
4	Cabin	13	25.67	8	20.21
5	Brake	3	10.41	3	9.35
6	Hyd & Steer	10	61.83	4	40.78
7	AC	9	15.25	38	18.89
8	Frame	25	330.00	0	0
9	Transmission	10	30.83	6	40.00
10	Optional	7	12.92	12	22.02
11	Axle	3	3.33	2	12.09

Damage to the frame components is shown in Table 3 of the data analysis performed. After repairs were done in May–July 2022 for damage to the frame components to zero, there were 25 occasions between February and April 2022 with a total duration of 330 hours.

Table 4. Details of damage to frame components.

No.	Frame Components	Before Repairs (Feb-Apr 2022)		After Repairs (May-July 2022)	
		Frequency	Duration (Hours)	Frequency	Duration (Hours)
1	*Pin*	11	63	0	0

2	Bushing	8	77	0	0
3	Torque Rod	6	190	0	0
	Jumlah	25	330	0	0

Data from Table 4's study of the specifics of frame component damage for February through April show that the pin was damaged 11 times over a 63-hour, the bushing eight times over a 77-hour, and the torque rod six times over a 190-hour. It became 0 once the pins, bushings, and torque rods were fixed. As a result, the HD 1500-7 dump truck unit's auto lube system performs at its best during the lubrication procedure for the frame components [17].

3.2.2. Analysis of the HD 1500-7 dump truck unit auto lube system

Analysis of damage to the dump truck unit auto lube system HD 1500-7.

- Low-pressure auto lube system ie 1500 psi (std 2500 psi)
- Grease hose from the grease injector to the component's lubrication point is leaking
- Lubrication failure occurred at some lubrication points
- The occurrence of damage to the components of the pin, bushing, and torque rod LH
  a) Means of repair
     Replace the damaged grease hose
  b) How to prevent
     Do a test on the auto lube system to find out that the system is normal
  c) Analysis before and after the repair.

Figure 6 this grease pressure measurement is used to determine the performance of the displacement pump. When the pump is turned on, how much kPa is the pressure of the grease flowing.

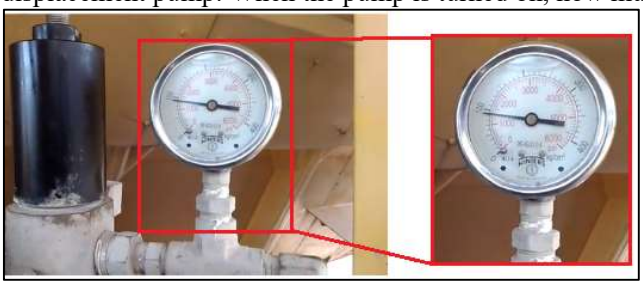

Figure 6. Measuring grease pressure on a displacement pump.

a b c

Figure 7. Condition of pins and bushings.

Figure 7 Pin and bushing in a dry state lacking Lubrication, (a) Lower Right Rear Suspension Pin and Bushing, (b) Left Lower Hoist Cylinder Pin and Bushing, (c) Right Steering Cylinder Pin and Bushing, Frame.

Figure 8 the auto lube system before the repair is carried out, the results of measuring the grease pressure when there is damage of 1500 psi which is caused by damage to the grease hose from the grease injector to the lubrication point so that the auto lube system becomes low pressure and results in lubrication failure which causes some pins and bushings to experience bad lubricating [1].

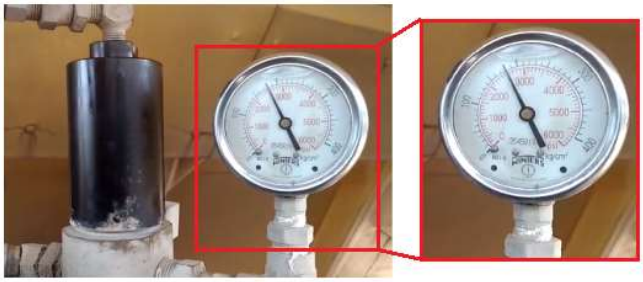

Figure 8. Measuring the grease pressure on the displacement pump after repairs.

Figure 9. Condition of wet pins and bushings.

Figure 9 excess lubrication (a) Right Lower Hoist Cylinder Pin and Bushing, (b) Lower Left Rear Suspension Pin and Bushing, (c) Left Side Torque Rod Pin and Bushing after repair. After the repair and testing process was carried out on the auto lube system, the results of the grease pressure measurement became standard, namely 2500 psi, and the conditions of the pins and bushings experienced good lubrication. Therefore, the auto lube system worked optimally and there was no lubrication failure.

3.3. Discussion.

3.3.1. Discussion of the maintenance performance of the dump truck unit brand K Type HD 1500-7.

Table 5. Data on the results of the calculation of the maintenance performance of the dump truck unit brand K Type HD 1500-7 Damage to the Frame Components.

No.	Month	MTBF (Hours)		MTTR (Hours)		PA (%)	
		Targets	Actual	Targets	Actual	Targets	Actual
1	Februari	100	355,8	4	9,625	96,00%	97,36%
2	Maret	100	360,7	4	16,142	96,00%	95,71%
3	April	100	342,4	4	14	96,00%	96,07%
Average totals		**100**	**352,9**	**4**	**5,388**	**96,00%**	**96,38%**

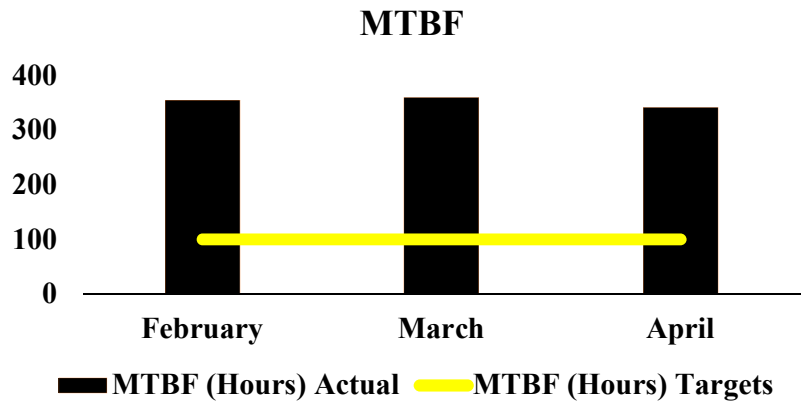

Figure 10. Graph of MTBF Calculation of HD1500-7 Dump Truck Unit (Feb-Apr 2022).

Table 5 calculation of the maintenance performance of the dump truck unit obtained for the MTBF value, which increased from 355.8 hours to 360.7 hours, then decreased again to 342.4 hours, where the target MTBF value determined by PT X is 100 hours, where In Figure 10, a decrease in the value of MTBF has an impact on the reliability of a product which is not good and an increase in the value of MTBF, which has good reliability.

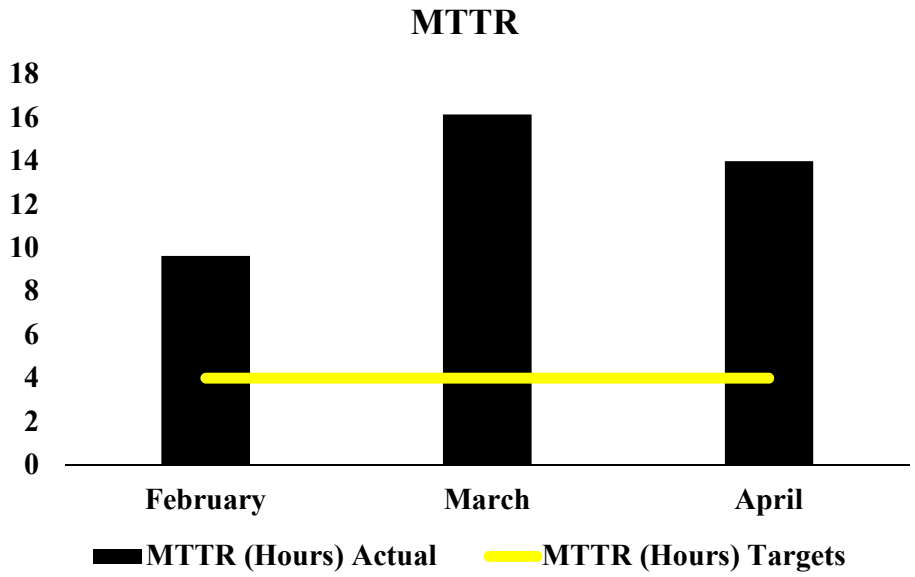

Figure 11. MTTR calculation graph for HD1500-7 Dump Truck Unit (Feb-Apr 2022).

Figure 11 MTTR values have increased from 9.625 hours, 16.142 hours, and 14 hours, where the target MTTR value determined by PT X is 4 hours. Therefore, the MTTR value which has decreased means the ability of a product because the breakdown can be completed effectively and efficiently.

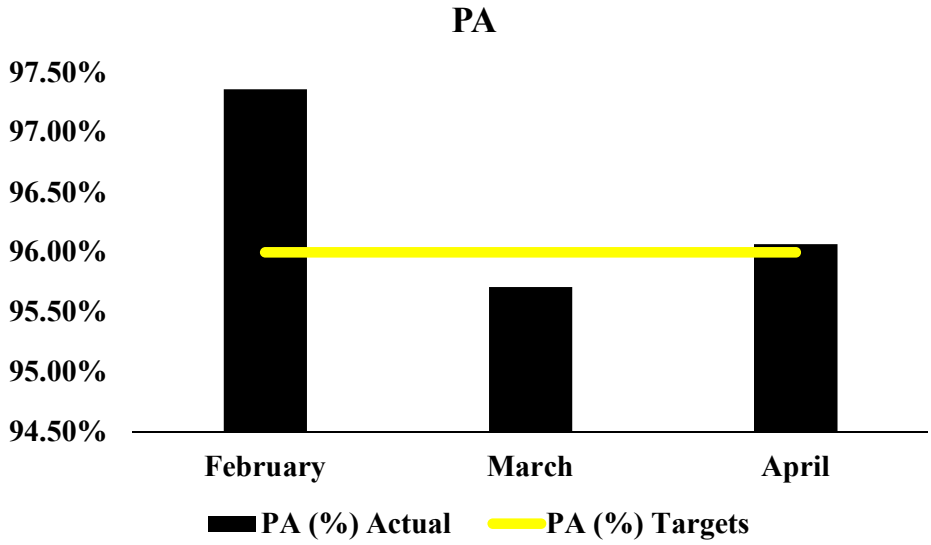

Figure 12. Graph of calculation of PA Dump Truck Unit HD1500-7 (Feb-Apr 2022).

Figure 12 the PA value has decreased from 97.36%, 95.71%, and 96.07%, where the target PA value determined by PT X is 96.00%. Therefore, an increase in PA value means that the availability of a product can be relied upon because it increases productivity without any breakdown problems in a product.

Due to the lengthy repair process, poor maintenance performance brought on by auto lube system damage will result in a reduction in the number of operational hours for the unit. Many tasks require more than one day, such as waiting for replacement parts and other repair procedures, such as line boring, which might take longer than one working day.

3.3.2. Discussion of the calculation of the working power of the Graco Dyna-Star Hydraulic Reciprocating Pump and Pump.

A reciprocating (oil) pump with a measurement pressure equal to standard pressure, or 400 psi, has an internal power (Watts) of 537.81 according to the calculations. The measurement findings show that the displacement (grease) pump pressure is 1500 psi with a power of 58.67 Watts and the standard displacement (grease) pump pressure is 2500 psi with a working power of 163.29 Watts.

3.3.3. Discussion of the Dump Truck Unit Auto lube System Brand K Type HD 1500-7.

The auto lube system of the dump truck unit brand K type HD 1500-7 can be seen in how the lubrication pump works are divided into 2 (two), namely how the hydraulic or oil circuit works and how the grease circuit works [18]. Where the working standard for oil is 400 psi and the standard working pressure for grease on the auto lube unit dump truck HD 1500-7 system is 2500 psi, if the system pressure reaches 2500 psi then the pressure switch will send a signal to the controller to cut off the signal to the solenoid valve pump that the pressure the system has been reached, if the pressure in the system does not reach 2500 psi as long as the solenoid valve pump is active and the pressure switch does not send a signal to the controller, the controller will detect that the auto lube system is in an abnormal condition or error [16].

There are some reasons why the grease pressure in the auto lube system is below the required 2500 psi, including air trapped in the grease pump supply line, leaking grease supply lines, faulty vent valves, and broken grease pumps [2]. If such occurs, the auto lube system may not function properly or may experience an error condition. Due to improper lubrication, the pin, bushing, and torque rod parts may be damaged when the auto lube system is in an error condition or an abnormal condition. This is because many dump truck operators are unaware that the auto lube system is in an abnormal condition [1][18].

3 CONCLUSION

The results reached following investigation and discussion is: 1) Based on calculations of the HD 1500-7 dump truck unit's maintenance performance for the period of February to April 2022, it was determined that the MTBF, or the average amount of time between damage and subsequent damage, was 352.9 hours. The mean time to repair the damage, or MTTR, is 5.388 hours. In PA, 96.38% of the necessary tools and replacement components are readily available. Therefore, the unit's maintenance performance may be impacted by the lubrication failure. 2) A pressure of 400 psi results in a working power of 537.81 Watts from the Graco Dyna-Star hydraulic reciprocating pump and pump. While the usual pressure for a grease pump is 2500 psi, which produces a power of 163.29 Watts, the displacement pump (grease) has a measuring pressure of 1500 psi and generates 58.67 Watts of power. Therefore, the pressure exerted on the auto lube system is either impractical or dangerous. If the working pressure on the system is below standard pressure then the system is in an abnormal condition and an error will occur. The auto lube system of the dump truck unit brand K type HD 1500-7 has a working pressure of 2500 psi for the discharge (grease) pump and 400 psi for the reciprocating (oil) pump.

REFERENCE

[1] Rasma and H. Basri, “Analisa Service Brake Malfunction pada Unit Dump Truck (HD) 1500-7,” *Semin. Nas. Sains dan Teknol.*, pp. 1–7, 2019.

[2] Wilarso, A. Domodite, H. Sholih, and Mujiarto, “Analysis of SOS Results for Engine Lubricants Contaminated by the Fuel in the 3516 TA Diesel Engine Generator Set,” *J. Phys. Conf. Ser.*, vol. 1764, no. 1, 2021, doi: 10.1088/1742-6596/1764/1/012172.

[3] Sugiharjo and Wilarso, “ANALISIS KEGAGALAN REM HINO FG 235 DENGAN MENGGUNAKAN METODE FISHBONE ANALISIS,” *TEKNOSAINS J. Sains, Teknol. dan Inform.*, vol. 8, no. 1, 2021, doi: 10.37373/tekno.v8i1.74.

[4] Z. A. Yusuf, “Analisa Perawatan Berbasis Resiko Pada Sistem Pelumas Km. Lambelu,” *J. Ris.*

dan Teknol. Kelaut., vol. 14, no. 1, pp. 129–140, 2016.

[5] I. B. Dharmawan, M. I. Marsal, P. N. Balikpapan, and K. Balikpapan, "P-30 Analisa Pemanfaatan Limbah B3 Pelumas Oli Bekas Sebagai Alternatif Pelumas Padat (Grease) Analysis of Utilization Toxic and Hazardous Waste Lubricant Oil As a Solid Alternative Lubricant (Grease)," pp. 209–216, 2021.

[6] W. Arso, B. Idiyanto, and F. Azharul, "Meningkatkan Kualitas Water Pump Engine Type SAA6D170E-5 Dengan Perbaikan Proses Assembly Water Pump," *J. Mech. Eng. Manuf. Mater. Energy*, vol. 6, no. 01, pp. 56–69, 2022, doi: 10.31289/jmemme.v6i1.6763.

[7] F. Mode, E. Analysis, P. Unit, S. Alat, and K. Selatan, "ISSN : 1963-6590 (Print) ISSN : 2442-2630 (Online)," 2010.

[8] E. Febriyanti, B. Besar, and T. Kekuatan, "Analisa Kerusakan Connecting Rod Pada," vol. 12, no. 3, pp. 214–219, 2010.

[9] M. . Toha, R. Nofwanda, and R. Busyaf, "Analisis Efisiensi Kerja dan Produktivitas Pengangkutan Batubara Sistem Shovel – Dump Truck," *Pertambangan*, vol. 5, no. 4, pp. 23–27, 2019.

[10] P. Studi, S. Teknik, J. T. Sipil, F. Teknik, and D. H. Dani, "ANALISA PERBANDINGAN PRODUKTIVITAS ALAT BERAT DUM TRUCK TIPE A , B DAN C PADA PROYEK KONSTRUKSI Firdaus Firman Fauzi Abstrak," pp. 1–7.

[11] K. Kusnadi and T. Taryana, "Usulan Waktu Penggantian Optimum Komponen Mesin Gas Engine (Prechamber Gas Valve) Dengan Model Age-Based Replacement Di Pt. Xyz," *J. Teknol.*, vol. 8, no. 1, p. 45, 2016, doi: 10.24853/jurtek.8.1.45-52.

[12] H. Basri, E. Diniardi, and A. I. Ramadhan, "Optimasi Desain Dimensi Silinder Arm Pada Hydraulic Excavator Pc 1250-7," no. November 2016, pp. 1–7, 1990.

[13] M. Arifanto and E. Santoso, "Politeknik manufaktur astra," vol. 10, no. 8, pp. 1–9, 2015.

[14] Y. Setiawannie, N. Marikena, and S. Sania Putri, "Penentuan Umur Dump Truck Dengan Metode Optimal Replacement Interval Di Cv. X," *JiTEKH*, vol. 9, no. 2, pp. 65–73, 2021, doi: 10.35447/jitekh.v9i2.422.

[15] N. Rahman and A. Hendrawan, "Service Accuracy pada Preventive Maintenance Terhadap Mechanical Availability Unit Off Highway Truck," *J. POROS Tek.*, vol. Volume 6, no. 1, p. No. 1, Juni 2014 : 1-54, 2014.

[16] I. Arifin, "Analisis Sistem Kendali Dua Posisi Pada Solenoid Valve Untuk Produk Biogas Control and Monitoring (Common-Bigot) From Animal Waste," *Inject. Indones. J. Vocat. Mech. Eng.*, vol. 1, no. 2, pp. 47–57, 2021, doi: 10.58466/injection.v1i2.131.

[17] M. S. N. J. Jagad, N. P. E. Utami, and D. K. Pratiwi, "Analisis Kerusakan pada Chain Link Apron Feeder," *J. Rekayasa Mesin*, vol. 21, no. 2, pp. 61–66, 2021, doi: 10.36706/jrm.v21i2.140.

[18] H. Purwono, "Perancangan Special Tool Remove and Install Hoist Cylinder Pada Unit Dump Truck Hd 1500-7," vol. 17, no. D, pp. 1–10, 2018.