Jurnal Sains Teknologi Transportasi Maritim
Volume 7 No. 1. Mei 2025 pp.28-39
DOI: 10.51578/j.sitektransmar.v7i1.103
e-ISSN 2722-1679 p-ISSN 2684-9135

OVERHEATING OF THE L.O STANDBY PUMP ON THE MAIN ENGINE OF MT. KLAWOTONG

Agum Gymnastiar[1], Andy Wahyu Hermanto [2*], Mohammad Sapta Heriyawan[3]

[1,2,3]Semarang Maritime Polytechnic

Email: agum.gymnastiar842@gmail.com
*Email: andy@pip-semarang.ac.id
Email: hmsapta@pip-semarang.ac.id

(***Received***: 13-02-2025; ***Reviewed:*** 06-03-2025; ***Revised:*** 23-03-2025; ***Accepted:***15-04-2025; ***Published:*** 26-05-2025)

ABSTRACT

The main engine Lubricating Oil (LO) standby pump is crucial for smooth ship operations. Therefore, it is essential that this equipment is well-maintained. However, future problems can arise and disrupt ship operations if the maintenance schedule is not followed. The main engine lubrication system can be disrupted due to a damaged L.O standby pump, which can interfere with the smooth lubrication of the main engine. Based on field observation during a 12-month and 2-day sea project on board MT. Klawotong, the researcher experienced overheating of the L.O standby pump. When the ship entered bad weather on the voyage from Wayame to Tual, it disrupted the crew's comfort on board while working. The purpose of this research is to determine the causal factors, the impact of overheating on the pump, and efforts to prevent overheating of the L.O pump. This study uses a qualitative descriptive method by conducting interviews and direct field observations. Data analysis technique using SHEL (Software, Hardware, Environment and Liveware). By interviewing the Chief Engineer, 2nd Engineer, and 4th Engineer, this study states that overheating of the main engine L.O standby pump is caused by a damaged rubber coupling, a damaged oil seal, and abnormal vibration in the pump. The impact of these factors will reduce pump performance, reduce lubrication in the main engine, and reduce pump performance. Preventive measures can be done by implementing routine maintenance on the pump and cleaning the oil filter regularly. Cleaning dirt adhering to the oil filter using a brush, solar, and following the procedures correctly and properly.

Keywords: *LO Pump, Main engine, Overheat*

INTRODUCTION

World trade relies heavily on sea transportation. Ships, as the main means of transportation at sea, are essential for moving goods and people from one place to another by sea. In order for the ship to operate properly and according to plan, proper maintenance and management are needed (Bachtiar et al., 2021). In supporting the ship operation process, a good Maintenance management and practice are needed, so that the ship can run smoothly in its operation according to the plan determined by the Company (Mustain et al., 2019; Widiatmaka, 2018). Good ship operations cannot be separated from the condition of the main engine (Łosiewicz et al., 2022; Mishra et al., 2017). One of the keys to smooth engine operation is the optimal condition of the lubrication system. Lubrication serves as a reducer of friction between moving engine components (Ligier & Noel, 2015; Totten, 2017). Thus, wear on components can be reduced and engine life can be extended (Syahdanni & Sutantra, 2018).

When the researchers conducted sea practice on MT Klawotong, on Thursday, December 29, 2022, when the ship was on its way from Wayame to Tual, precisely in the waters of the Banda Sea at around 15.25 WIT, a smoke detector alarm in the engine room sounded due to smoke detected in the engine room, researchers and machinist 4 looked for the origin of the smoke, it was found that the smoke came from the Lubricating Oil (LO) standby pump main engine which probably loses pressure and causes high heat so that the LO pump is hot and burns the entire surface of the pump, after that the researcher and

*Corresponding Author

machinist 4 took action to reduce the main engine RPM to stop the engine, then the researcher reported to the superiors that there was damage to the L.O standby pump. Machinist 4 and the researcher took action to disassemble or remove the L.O stand by pump gear, it was found that there was damage to the pump shaft seal and damage to the rubber coupling.

This research focuses on the causes of overheating of the main engine (m/e) lubricating oil standby pump (L.O Standby pump) on board MT. Klawotong which resulted in disruption to pump operations. Specifically, this research aims to identify the factors that cause overheat, analyze the impact caused by this condition, and evaluate preventive measures that can be taken to avoid overheat on this important ship component.

1. Main Engine

The main engine is the main engine used to generate the propulsion of the ship, usually in the form of a large diesel engine designed to drive the ship's propeller or generate the power needed in the ship's system. This main engine is often part of a thermodynamic system that plays a role in converting thermal energy into mechanical energy (Bejan, 2016; Struchtrup, 2014).

Figure 1. Lubricating Oil Standby pump on board of MT. Klawotong
Source : Researcher's documentation (2023)

2. Definition of LO Standby pump

Lubricating oil reserve pump (L.O Standby Pump) is an important supporting equipment in the ship's main engine lubrication system (Dionysiou et al., 2022; Nitonye, 2017), Lubricating oil reserve pump (L.O standby pump) is an important component in the ship engine lubrication system. This pump is designed to keep the oil pressure stable, especially when the engine is operating at low speed. The working principle of this pump generally uses interlocking teeth to pump oil. The backup pump will activate automatically when the oil pressure reaches a certain threshold and will stop working when the pressure returns to normal (Da Rosa & Frisoli, 2024; Takacs, 2017). With a backup pump, the reliability of the engine lubrication system can be improved, resulting in longer engine life.

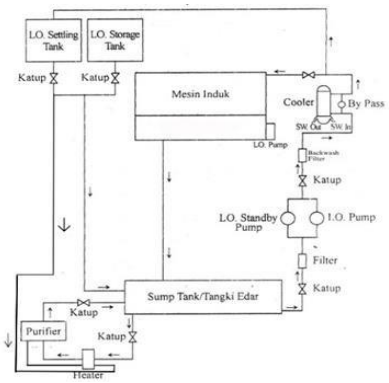

Figure 2. LO Piping diagram (Anton, 2021)

The lubrication system in Figure 2 is a closed system in which lubricating oil circulates continuously. The filtered and cooled lubricating oil is pumped to the engine to provide optimal lubrication. Afterwards, the oil returns to the main tank for cleaning and recycling, ensuring optimal engine performance.

3. Working system of L.O Standby pump

The way the L.O standby pump works is the same as the gear pump, there are two types of gear pumps, namely internal gear pumps and external gear pumps (Sinaga & Nurtjahyo, 2023; Smith et al., 2016). The following is an explanation:

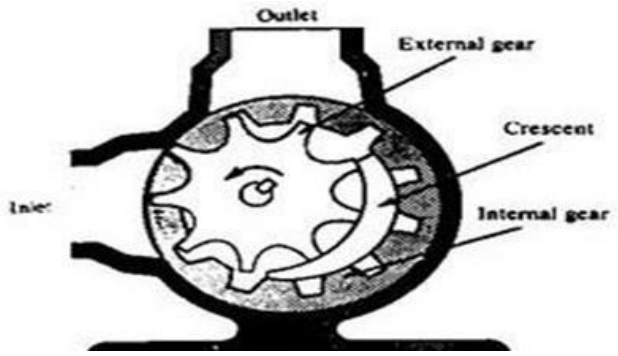

Figure 3. Internal gear pump (internal gear pump)
(Crane et al., 2023; Wolansky & Akers, 1990)

a. The inner gear pump uses two interlocking gears. Fluid enters through the gap between the rotor and idler, then gets trapped between the teeth. As the teeth rotate, the fluid is pushed out through the outlet.

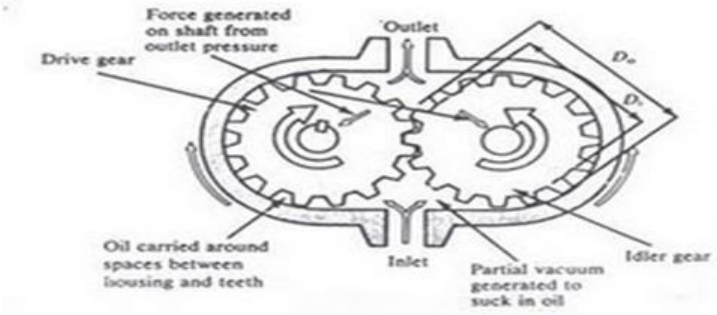

Figure 4. Outer gear pump
(Wolansky & Akers, 1990)

b. The outer gear pump uses two gears that rotate in opposite directions. Fluid enters these cavities and is then carried out by the rotating teeth. The fewer the number of teeth and the faster the rotation of the gears, the more fluid can be pumped.

4. Overheat

Overheat in lube pumps occurs when mechanical components in the pump, such as bearings or seals, generate excessive heat due to high friction or inadequate lubrication (Merkle, 2014; Rajora & Dixit, 2013). While the definition of overheat in the context of engineering thermodynamics refers to a condition in which a working fluid (for example, water vapor) is heated higher than its boiling point temperature at a certain pressure (Borgnakke & Sonntag, 2020).

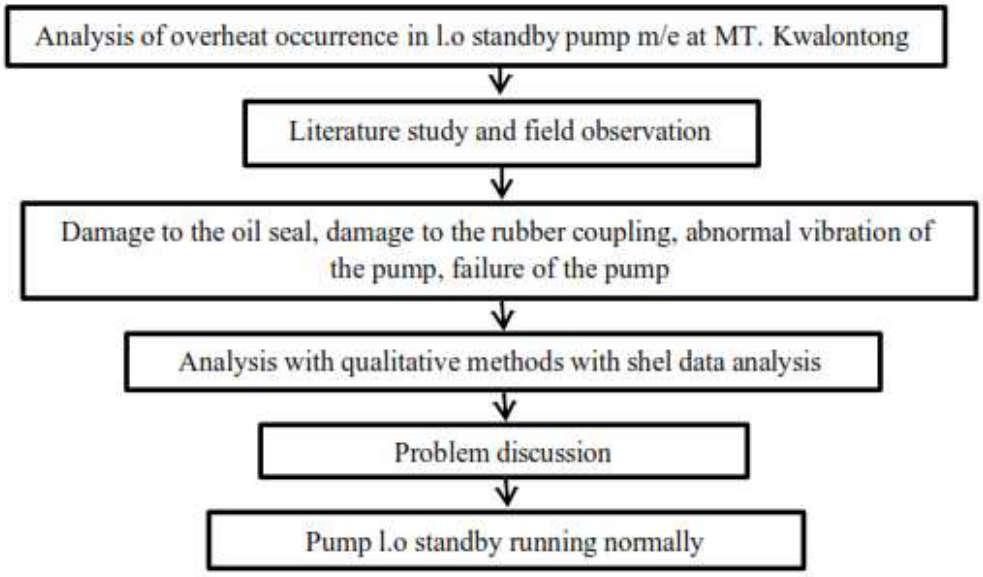

Figure 5. Research framework

METHOD

This research adopts a qualitative approach to explore in-depth understanding of the problems with the L.O Standby pump on the product tanker MT. Klawotong. Based on the philosophy of postpositivism, this research places the researcher as the main instrument in collecting and analyzing data (Maksimovic & Evtimov, 2023; Tamminen & Poucher, 2020). Through qualitative methods, researchers attempt to reveal the meaning behind the phenomena that occur, such as social interactions, attitudes, and perceptions of crew members related to pump performance (Panhwar et al., 2017). The choice of this qualitative method is believed to be very relevant to the dynamic and complex field conditions, allowing researchers to obtain a more holistic and in-depth picture.

This research was conducted intensively for one full year, starting from October 2022 to October 2023. The research location was set directly on board the product tanker MT. Klawotong owned by PT Pertamina (Persero). The selection of the time and place of this research is based on the aim of applying the theory that has been studied directly to real conditions in the field and collecting primary data relevant to the problem under study. In addition, this research period also coincided with the researcher's Field Work Practice (PKL) period, thus allowing researchers to be actively involved in ship operational activities and interact directly with the crew.

To obtain comprehensive and accurate data, this research relied on several main data sources. First, the researcher conducted direct interactions with crew members who have in-depth experience and knowledge of the L.O Standby pump. In-depth interviews were conducted to explore information related to the causes of the problem, the impacts caused, and the efforts that have been made to overcome the problem. Second, the researcher conducted participatory observation to directly observe the pumping process and the interaction between the crew and the equipment. This participatory observation allowed the researcher to obtain richer and more contextualized data. Finally, the researcher analyzed various related documents, such as maintenance manuals, maintenance reports, and logbook records, to obtain additional information that supported the data analysis.

The research adopted a multi-source data approach to ensure the depth and accuracy of the results obtained. The researcher actively engaged in direct interactions with crew members who have a deep understanding of the L.O Standby pump. Through in-depth interviews, the researcher information on the root causes of the problem, the impact caused by the pump damage, and the efforts that have been

made to overcome the problem. In addition, the researcher also conducted participatory observation to directly observe the pump working process and the interaction between the crew and the equipment. This participatory approach allowed the researcher to obtain richer and more contextualized data, as well as gain a deeper understanding of the situation in the field. As a complement, the researcher also analyzed various related documents, such as maintenance manuals, maintenance reports, and logbook records, to obtain additional information that could support data analysis. The combination of these various data sources is expected to provide a comprehensive picture of the problems with the L.O Standby pump.

The data that has been collected is then analyzed using qualitative analysis methods. Specifically, this study used the SHEL analysis model to identify the factors that cause overheating in L.O standby pumps. This SHEL model analyzes the problem from four perspectives: software (procedures), hardware (physical components), environment (environment), and liveware (people). To ensure the validity of the data, the researcher used the triangulation technique. This technique involves comparing data from various sources, such as observations, interviews, and documentation. The aim is to ensure that the conclusions drawn from this research are reliable.

Triangulation was used in this research as an attempt to verify the validity of the data. By comparing data from literature studies and documentation with the results of direct observation, researchers aim to obtain a more comprehensive and accurate picture of the phenomenon under study.

Triangulation is a technique used to test the truth of data by collecting data from various sources (for example, interviews, observations, documents) and using various methods (for example, content analysis, comparison). By comparing these data, researchers can increase confidence in the results of their research.

RESULT AND DISCUSSION

1. RESULTS

a. Research Object

This research was conducted on the product tanker MT. Klawotong, a vessel carrying fuel oil that uses diesel engines as its main propulsion. The ship is equipped with an L.O standby pump to support the engine lubrication system. The research took place over a period of 12 month and 2 days. During the voyage from Wayame to Tual on April 12, 2023, damage was found on the rubber coupling of the MT. Klawotong's L.O standby pump. The damage was in the form of cracks and wear on the rubber coupling gear side (wing). This damage has the potential to disrupt the pump's performance and impact the main engine lubrication. To address this issue, temporary action was taken by replacing the damaged rubber coupling with a new one. However, after a while, similar damage recurred. Further inspection revealed that the main cause of the damage was misalignment between the L.O pump coupling and the electric motor coupling. This condition caused excessive load on the rubber coupling, causing it to break quickly. In addition, cracks were also found in the
L.O pump coupling casing. This damage was exacerbated by the lack of a strong foundation to support the pump, causing the pump to become unstable and easily shift. As a temporary solution, emergency repairs were carried out on the coupling casing by welding it. However, due to the special material of the casing, the welding results were not perfect. For more permanent repairs, it is recommended to take the damaged coupling casing to an onshore workshop. Meanwhile, the rubber coupling that is still usable is reinstalled to save on spare parts usage.

b. Findings

Observations showed that there was an overheating problem on the lubricating oil (L.O standby pump) on the MT. Klawotong ship. Based on the results of participatory observation in the field, researchers successfully identified a number of factors that contributed to the occurrence of the overheat phenomenon in the L.O standby pump, as follows:

a) Damaged rubber coupling

The rubber coupling serves as a connector between two shafts that can absorb vibrations generated by the engine. With this ability, it can prevent excessive vibration, if the rubber coupling is damaged,it can damage other components.

Figure 6. Damage to the rubber coupling Source: Researcher's documentation (2023)

b) Damage to the oil seal

The oil seal is an important component of the pump that functions to prevent leakage or transfer of liquid between two parts of the machine that move relative to each other. If the oil seal is damaged, it will cause leakage.

Figure 7. Damage to the oil seal Researcher's documentation (2023)

This research involved interviews with several sources who have knowledge and authority related to the events discussed. The first interview was conducted with Mr. Untung Sidodadi, Chief Engineer of the MT. Klawotong ship, who explained that the L.O standby pump functions as an auxiliary device to increase pressure at low RPM, with operation influenced by pressure and main engine rotation. The initial symptoms of overheating in this pump can be seen from abnormal vibrations and a decrease in performance detected by the pump thermometer. To overcome this, the first step is to turn off the system and ensure the area is safe, then check the pipe connections for leaks, and if found, the pipe will be disassembled and welded. The next step is to check the pump to find the cause of overheating, which is often caused by abnormal vibrations in the L.O standby pump. The advice given is to carry out routine maintenance and periodic inspections and maintain the operating environment so that it is not extreme. The next interview with Mr. Amron H Nainggolan, 2nd Engineer of the MT. Klawotong ship, revealed that overheating in the pump can be caused by damage to components such as the oil seal or rubber coupling, as well as abnormal vibrations in the pump. Technical, non-technical factors, and human error also play a role. Meanwhile, Mr. Rizky Hermanto, 4th Engineer of the MT. Klawotong ship, added that damage to the rubber coupling due to misalignment with the pump, as well as damage to the oil seal and abnormal vibrations, are also the main causes of overheating. The impact is a decrease in pump performance, which can result in suboptimal engine lubrication and high financial losses. To prevent this, routine maintenance, monitoring of pump temperature, and implementation of correct operating procedures are highly recommended.

2. DISCUSSION

This section discusses the results of the data analysis that has been carried out. The first step in finding a solution to a problem is to identify the cause and learn how to deal with it to prevent overheating of the L.O standby pump. Overheating in the L.O standby pump requires special attention because it can disrupt the smooth operation of the MT. Klawotong ship's voyage. In this

study, the researcher explains the factors that contribute to overheating, the impacts caused, and how to prevent it using the SHEL (Software, Hardware, Environment, Liveware) method. These factors are explained separately to facilitate data analysis, and the researcher also includes relevant problem formulations.

Tabel 1. SHEL Observation

Observed Factors	**Problems Encountered**
Software	Lack of Pump Maintenance
Hardware	1) Damaged Rubber Coupling 2) Damaged Oil Seal 3) Abnormal Pump Vibration
Environment	Dirty Oil Filter

Tabel 2. SHEL Analisis

No	**Description**	
	Data Analysis	**Analysis Results**
1.	Problem identification	The investigation into the L.O. (Lubricating Oil) standby pump on the main engine of the MT. Klawotong began with an examination of the signs and symptoms indicating component failure. The primary cause of overheating in the L.O. standby pump was identified as a combination of factors: a dirty oil filter restricting oil flow, a damaged oil seal leading to potential leaks and reduced lubrication, and a faulty rubber coupling causing misalignment and decreased pump efficiency. Additionally, a general lack of proper maintenance contributed to the overall deterioration of the pump's components. The impact of this overheating resulted in diminished pump performance, potentially compromising the lubrication of critical engine parts, and led to financial losses for the company due to necessary part replacements and repairs. To prevent future occurrences of overheating, the implemented solutions included replacing the oil seal and rubber coupling to restore proper pump function, as well as cleaning the oil filter to ensure adequate oil flow and prevent restrictions. These measures, combined with a commitment to more diligent maintenance practices, aim to optimize the performance and longevity of the L.O. standby pump
2.	Data Collecting	The data collected includes all forms of information needed and can support and facilitate the process of identifying the root cause of the damage that occurred to the LO Standby Pump. During the observation process, researchers found that the pump vibrated abnormally during operation. The initial suspicion of the problem was the rubber coupling and oil seal that had been damaged. This greatly affected the performance of the LO Standby Pump.

3.	Analyzing Data	Data analysis was conducted to identify the causes of damage through information gathered from observation, documentation, and interviews. During the observation process, the following causes of the problem were identified: 1. Damaged Rubber Coupling Damage to this component can have an impact on other components, which can disrupt the pump's performance. To avoid increasingly fatal events on the rubber coupling, it is necessary to carry out maintenance that pays attention to the operating hours of the rubber coupling. 2. Damaged Oil Seal A damaged oil seal can cause leaks in the pump. This can lead to reduced lubrication, overheating, and potential damage to other components. 3. Lack of Pump Maintenance Damage to the rubber coupling and oil seal is caused by running hour factors that have exceeded the limit. So it is necessary to carry out maintenance in accordance with the PMS (Planned Maintenance System) to avoid damage.
		4. Dirty Oil Filter The loss of viscosity or viscosity causes damage to the components. Where dirty oil causes a buildup of dirt on the filter and produces suboptimal lubrication. This can accelerate wear and tear on pump components.
4.	Defining Root Cause	The main causes of damage problems that occur in the LO Standby Pump serve as the basis for determining risk factors that can be one of the causes of damage to the LO Standby Pump components. This is determined based on the collected data that has been analyzed and then described as a formulation of the main root causes of the damage that occurred. 1. Damaged rubber coupling, which reduces pump performance. 2. Damaged oil seal, which causes leaks in the pump. 3. Dirty oil filter, which causes suboptimal lubrication.
5.	Identifying Corrective Actions	The actions that can be taken as a form of effective repair and prevention strategies to overcome or minimize the causes of damage. In this case, the ship's crew made repairs to restore the pump's performance by: 1. Replacing the damaged rubber coupling, so that the pump can return to normal operation without excessive vibration. 2. Replacing the damaged oil seal, so that no leaks occur in the pump. 4. Cleaning the dirty oil filter to optimize lubrication on the machinery. 5. Carrying out maintenance in accordance with PMS (Planned Maintenance System) and paying attention to the operating hours of each machine so as to minimize damage to the machinery

Kurniawan & Wirawan, (2022) said that the lubrication system is a support system for the main engine/main drive of a ship. The main engine runs for 24 hours non-stop and all the time sailing so that its support system must function at all times. The problem that occurs in this case is that the automatic panel will activate the 1st pump, and if it is moved to the 2nd pump, the pump is running but only 1 minute later the auto switch to pump 1 again, after observations and several trials and analyzing the system, the root of the problem can be found, namely not in the electrical system but in the mechanical components. The method used in solving this problem is a case study and literature review. The conclusion obtained is that a system cannot stand alone, be it mechanical or electrical, it is closely related to other components

The damage of electro motor oil max pump on the main engine at KM. Dharma Kartika IX because of pumps is mostly as a driver, conveyor, press machine, elevator and others (Hendrawan et al., 2021). The most widely used induction motor because the induction machine is strong, sturdy and easy to maintain and the efficiency at power is quite high. Problems that often occur in every electro motor are mechanical damage such as over-current, mechanical failure, low insulation resistance, lack of lubrication, excessive vibration,

misalignment, motor age and other factors in induction motor operation, Data obtained through direct observation field research on the object under study. The research was conducted by observation at KM. Dharma Kartika IX. Based on the results of the study, damage to electro motor components is caused by several things including excessive current, mechanical damage, low insulation resistance and excess heat

Both research articles have similarities in discussing problems related to damage to the main engine operating support system on ships, such as lubricating pumps and induction motors, which play an important role in maintaining engine performance so that it continues to run smoothly. The analysis methods used in these three studies are also similar, namely through observation, case analysis, and the use of damage cause analysis methods such as Fishbone Analysis and Fault Tree Analysis. In addition, all three highlight the importance of maintenance in accordance with standards and manual procedures as a preventive measure. However, the difference lies in the specific focus of each articles that Kurniawan & Wirawan (2022) emphasize more on the problem of unwanted auto switches in the lubrication system for the main engine, while Hendrawan et al., (2021) focus on damage to the electro motor oil pump in the main engine due to various mechanical and electrical factors.

a. Causes of Overheating in the L.O. Standby Pump M/E on MT. Klawotong

An analysis using the SHEL model allows us to systematically break down the various elements that contribute to the problem of imperfect injector atomization. This model adopts a multidisciplinary approach, considering aspects such as software design, hardware conditions, work environment, and operator characteristics.

Software is the digital guide that governs the system, while the lack of maintenance on the L.O. standby pump is a major issue found. Maintenance aims to ensure that equipment and auxiliary machinery continue to function properly in the long term and prevent damage that may occur. Damage to the rubber coupling and oil seal is not only caused by the negligence of the crew or watch officers but is also influenced by the age of the machine and spare parts that do not meet manufacturer standards or are not original. This factor affects the performance of the L.O. standby pump. On the MT. Klawotong, the crew did not carry out maintenance according to the procedures in the PMS, and sometimes maintenance is neglected due to delays in work. This delay has the potential to cause new problems in the future. If maintenance of the L.O. standby pump is delayed, new problems can arise that require handling. Problems that arise due to lack of maintenance can be overcome by proper division of tasks in urgent situations. After problems occur in the performance of the exhaust valve, the Chief Engineer will instruct the responsible engineer to continue carrying out tasks in accordance with applicable PMS procedures, even in urgent conditions.

Hardware is the physical and non-human element of a system or device. Several factors that can cause overheating in the L.O. Standby pump on the main engine are as follows:

1) Damage to the rubber coupling: The rubber coupling is a component that connects two shafts and functions to absorb vibrations generated by the machine. This ability prevents excessive vibration that can damage other components. If the rubber coupling is damaged, it can affect the performance of the pump and potentially cause more serious problems. Therefore, during operating hours, the engineer must check the condition of the rubber coupling during maintenance.
2) Damage to the oil seal: The oil seal is an important component of the pump that functions to prevent leakage or transfer of fluid between two parts of the machine that move relative to each other. If the oil seal is damaged, it can cause leakage that impacts the performance of the pump.
3) Abnormal vibration on the pump: Vibration is a reciprocating motion that occurs near the equilibrium point, with the amount of energy received affecting the level of vibration. One way to evaluate whether a tool is functioning properly is to monitor its vibration. On the L.O. standby pump, the vibrations that appear can provide clues about the condition of the pump. If the pump is functioning normally, the resulting vibrations and noise will be smooth. Conversely, abnormal vibrations can cause excessive pressure on the pump components, which eventually damages other parts and interferes with its performance.

Factors that affect overheating in the LO Standby Pump Main Engine in terms of the environment are dirty oil filters. When carrying out a sea project from Wayame to Tual, the ship experienced extreme weather with waves reaching 3 meters, which caused the oil in the sump tank to shake and mix with

sediment and mud deposits. This causes the oil to become dirty, with a specific gravity of 0.83 kg/m3 and containing small particles. The dirt results in the loss of viscosity or oil thickness, which can ultimately damage components. This dirty oil also causes a buildup of dirt on the filter, so lubrication is not optimal. Therefore, it is important to maintain the cleanliness of the oil so that its performance remains optimal.

b. Impacts of Overheating on the L.O. Standby Pump M/E on MT. Klawotong

1) Decreased pump performance

Overheating in the L.O. standby pump on the main engine can cause a decrease in pump performance where the pump when running normally the thermometer is 4kg/m2 but when the pump experiences overheating or heat becomes 3kg/m2 which can experience a decrease in lubricant viscosity, which can reduce the effectiveness of lubrication in the form of a protective layer between moving components. Excessively thin lubricant is not able to withstand mechanical loads. This causes damage to the pump components.

2) Financial loss

Overheating in the L.O. standby pump that is not immediately addressed can result in damage to expensive engine components. The cost of replacing spare parts, and labor to repair or replace the constantly damaged rubber coupling and oil seal can result in financial losses and related components can be very large. If there is damage to the pump before it spreads to other components, immediate repairs should be carried out to avoid excessive replacement with increasing costs of spare parts replacement.

c. Efforts to Prevent Overheating in the L.O. Standby Pump M/E on MT. Klawotong

Routine maintenance is carried out once a week by checking its physical condition and cleaning it from dirt or particles that may be attached. Be sure to clean the parts exposed to fluids, and replace or clean the filter if necessary. In managing engine maintenance, all activities carried out, including visual inspections, must be properly recorded. Whether it is routine maintenance or major repairs, well-managed records are essential to ensure the availability of quality spare parts needed.

Monitoring the temperature and pressure of the L.O. standby pump is an important step to prevent overheating or overpressure which can reduce pump performance. Parts that are worn or damaged can interfere with pump performance and increase the risk of failure. Carry out regular inspections of spare parts such as oil seals, rubber couplings, bearings, or gears and replace them immediately following correct operating procedures.

CONCLUSION

Based on the research and discussion, the researcher can draw the following conclusions. Firstly the factors causing overheat in the L.O standby pump related to software factors are: lack of pump maintenance, damaged rubber coupling, damaged oil seal, abnormal vibration in the pump, and dirty oil filter. Secondly, the impacts of overheat in the L.O standby pump are decreased pump performance and financial loss. For the last is the efforts to prevent overheat in the L.O standby pump are routine maintenance on the pump, checking the temperature and pressure of the pump, checking and replacing damaged spare parts, and following the correct operational procedures.

ACKNOWLEDGEMENTS

The researcher would like to express his sincere gratitude to the leaders and all crew members of Pertamina International Shipping (PIS) for providing a valuable opportunity to carry out field work practices and research on board the ship. Gratitude is also extended to the supervising lecturers at PIP Semarang for their guidance and support during the research process.

REFERENCES

Anton, P. U. (2021). Perawatan Sistem Pelumasan Mesin Induk di Kapal SPOB MARY UPP Kelas III Juwana. *KARYA TULIS*.

Bachtiar, A. I., Marimin, M., Adrianto, L., & Bura, R. O. (2021). Strategi peningkatan daya saing industri perkapalan (shipbuilding industry). *Jurnal Aplikasi Bisnis Dan Manajemen (JABM)*, *7*(1), 121.

Bejan, A. (2016). *Advanced engineering thermodynamics*. John Wiley & Sons.

Borgnakke, C., & Sonntag, R. E. (2020). *Fundamentals of thermodynamics*. John Wiley & Sons.

Crane, D., Mitsubishi, T., Wirawan, Y. B., Purnomo, B., & Kurniawan, R. D. (2023). *Jurnal Teknik Elektro dan Informatika ANALISA KERUSAKAN HYDRAULIC PUMP TIPE ROTARI VANE PADA*. *5*(1), 110–121.

Da Rosa, L., & Frisoli, C. (2024). Pumping and Compression Stations of Pipelines. In *Handbook of Pipeline Engineering* (pp. 889–937). Springer.

Dionysiou, K., Bolbot, V., & Theotokatos, G. (2022). A functional model-based approach for ship systems safety and reliability analysis: Application to a cruise ship lubricating oil system. *Proceedings of the Institution of Mechanical Engineers, Part M: Journal of Engineering for the Maritime Environment*, *236*(1), 228–244.

Hendrawan, A., Siswadi, S., & Al Khomsi, R. A. A. (2021). Penyebab Kerusakan Electro Motor Oil Max Pump pada Mesin Induk di KM. Dharma Kartika IX. *Jurnal Saintara Vol*, *5*(2).

Kurniawan, R. D., & Wirawan, Y. B. (2022). Studi Kasus Terjadinya Auto Switch yang Tidak Diinginkan pada Pompa Sistem Minyak Pelumas untuk Main Engine. *Marine Science and Technology Journal*, *2*(2), 75–81.

Ligier, J.-L., & Noel, B. (2015). Friction reduction and reliability for engines bearings. *Lubricants*, *3*(3), 569–596.

Łosiewicz, Z., Mironiuk, W., Cioch, W., Sendek-Matysiak, E., & Homik, W. (2022). Application of Generator-Electric Motor System for Emergency Propulsion of a Vessel in the Event of Loss of the Full Serviceability of the Diesel Main Engine. *Energies*, *15*(8), 2833.

Maksimovic, J., & Evtimov, J. (2023). Positivism and post-positivism as the basis of quantitative research in pedagogy. *Research in Pedagogy*, *13*(1), 208–218.

Merkle, T. (2014). *Damages on pumps and systems: The handbook for the operation of centrifugal pumps*. Elsevier.

Mishra, C. S., Ali, F., Adam, S., Tesfariam, A., Yemane, A., Amanuel, H., Teklemariam, U., & Alem, Y. (2017). Study of the causes of engine failure in ship and maintenance required to prevent engine failure. *International Journal of Contemporary Research and Review*, *8*(7), 20218–20241.

Mustain, I., Hidayat, T., & Abdurohman. (2019). Metode Perawatan Sistem Pelumasan Untuk Menunjang Kinerja Motor Induk Di Atas Kapal KM. DJO Pada PT. DHARMA BAHARI RIAU. *Jurnal Sains Teknologi Transportasi Maritim*, *1*(1), 19–26. https://doi.org/https://doi.org/10.51578/j.sitektransmar.v1i1.9

Nitonye, S. (2017). Design Calculation for Equipment and Components Specification of Lubricating Oil System of a Tug Boat. *International Journal of Advances in Engineering & Technology*, *10*(3), 449.

Panhwar, A. H., Ansari, S., & Shah, A. A. (2017). Post-positivism: An effective paradigm for social and educational research. *International Research Journal of Arts and Humanities*, *45*(45), 253–259.

Rajora, R., & Dixit, H. K. (2013). Effect of lube oil temperature on turbine shaft vibration. *International*

Journal of Mechanical Engineering and Robotics Research (IJMERR), *2*(2), 324–334.

Sinaga, M., & Nurtjahyo, H. (2023). Analisa Total Productive Maintenance (Tpm) Pada Mesin Diesel Jembio P-215. *Jurnal Kajian Teknik Mesin*, *8*(2), 1–10.

Smith, D. W., Crawford, J., & Moore, P. S. (2016). *Marine auxiliary machinery*. Elsevier.

Struchtrup, H. (2014). *Thermodynamics and energy conversion* (Vol. 8). Springer.

Syahdanni, L. R. A., & Sutantra, I. N. (2018). Studi eksperimen pengaruh temperatur dan viskositas pelumas terhadap performa kendaraan transmisi manual (Honda Sonic 150R). *Jurnal Teknik ITS*, *7*(2), E61–E66.

Takacs, G. (2017). *Electrical submersible pumps manual: design, operations, and maintenance*. Gulf professional publishing.

Tamminen, K. A., & Poucher, Z. A. (2020). Research philosophies. In *The Routledge international encyclopedia of sport and exercise psychology* (pp. 535–549). Routledge.

Totten, G. E. (2017). *Friction, lubrication, and wear technology*. ASM international.

Widiatmaka, P. (2018). *Manajemen Perawatan dan Perbaikan Kapal*. PIP Semarang.

Wolansky, W., & Akers, A. (1990). *Modern Hydraulics*. Mc Graw Hill Book, New York.