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Analysis of Oil Leaking from Bowl on The LO Purifier Alfa Laval P626 at MV. SEAPEAK GLASGOW LNGC

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Abstract— **Lubrication oil purifiers are essential for the optimal performance and longevity of marine engines. On board the MV. SEAPEAK GLASGOW, we encountered an issue with the Alfa Laval purifier, where alarm A57 indicated an oil leak from the bowl, accompanied by a drop in PT4 pressure and reduced bowl speed. This investigation aimed to identify the root causes of the leakage and recommend maintenance strategies to prevent future occurences. Using a qualitative approach, we conducted onboard observations, interviews with the third engineer, and a review of maintenance records. A fishbone diagram analysis revealed several contributing factors, including wear on the water block filter, scale buildup on internal components, and a lack of understanding of maintenance procedures among the engineering staff. The findings underscored that neglecting structured maintenance schedules and inadequate routine monitoring resulted in system inefficiency. As a corrective measure, an auxiliary filtration system was installed to protect and reduce scale accumulation. To further mitigate these issues, we recommend aligning maintenance activities with the purifier's running hours and increasing the frequency of pressure checks. These actions will help minimise the risk of oil leaks and ensure consistent performance.**

Keywords—Lubrication Oil Alfa Laval P626, Oil Leaking from Bowl, Fishbone Diagram

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I. INTRODUCTION

Lubrication oil plays a role in the operation of diesel engines, particularly in marine applications. The purification process ensures high-quality lubrication oil by separating oil, water, and sludge through centrifugal action [1,45]. Centrifugal separators, including purifiers and clarifiers, are essential components in a marine engineering system to separate water and solid contaminants from fuel or lubrication oil based on density differences through centrifugal force. When contaminated oil is spun quickly inside a rotating bowl, heavier particles such as sludge and water are pushed to the outer wall. In contrast, lighter oil remains near the centre, enabling effective separation [39]. In contrast, clarifiers have a single outlet for pure oil, while purifiers have a separate outlet for both pure oil and separated water, which helps to improve operational efficiency [2].

Purifiers are typically divided into lube oil purifiers, which clean lubrication oil for the main engine to minimise wear and overheating [3,16]. Heavy fuel oil purifiers, which remove impurities from fuels like HFO and marine distillates, prevent combustion system damage [4,17]. Since operating engines generate heat, lubrication oil also acts as a coolant. Additionally, it prevents corrosion by forming a protective film that inhibits direct metal-to-metal contact [43].

During the initial starting phase, the electric current surges to its peak values before gradually decreasing and stabilising once the motor reaches its nominal speed or steady state condition. Upon pressing the start button, the purifier motor commences to rotate and reaches its maximum speed within five minutes, as indicated by the ammeter. Initially, the current spikes to 9-10A due to the heavy rotational load, then drops to around 5.5A as the rotation stabilises [5].

The water block activates the timed closing water sequence while the purifier speed reaches 7.000-9.000 RPM [6]. Low-pressure water enters the operating water ring, lifting the discharge slide and allowing the bowl to close. Subsequently, a specific volume of water from the water block forms a water seal inside the separator bowl, which prevents oil from leaking into the water outlet and maintains the stability of the interface during the separation process. Contaminated oil is then fed into the centre of the separator, where sludge and water are forced outward to the bowl's periphery. In contrast, clean oil is collected via the integrated paring disc. Excess water is discharged through the sludge outlet, and after a

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preset interval, displacement water is introduced to minimise oil loss during the sludge discharge cycle.

Meeting lubrication requirements through proper purification is essential for reliable ship operation. However, in practice, several issues can disrupt the purification process in the LO purifier, directly affecting the quality of the resulting lubrication oil. These disruptions may include component defects, operational errors due to rule violations, and component wear that reduces performance efficiency [7,18]. One of the primary issues encountered in the operation of a centrifugal purifier is the occurrence of oil leakage from the bowl. This leakage is commonly attributed to several interrelated mechanical and chemical factors. The most significant cause is the degradation of the PTFE sealing ring, which develops cracks due to thermal wear and material fatigue over time [8].

In addition, improper sealing of the bowl hood and sliding bowl can be attributed to pilot valve contamination. This issue often arises due to the acidic properties of freshwater used in the system and the buildup of dirt and scale that obstruct the pilot valve's operation [9]. When this occurs, internal pressure imbalance develops within the separator, allowing light liquid to escape through the sludge outlet or the bowl casing drain [10]. Suppose these mechanical faults are not promptly addressed. In that case, they can severely compromise the effectiveness of the oil purification process, ultimately diminishing the overall efficiency and reliability of the vessel's lubrication system. Other problems arise from an insufficient water supply, which prevents the bowl from sealing properly. The bowl spins extremely high speeds, producing strong centrifugal force [6]. An imbalance in hydrophore pressure and sealing wear, can trigger oil leaking from the bowl [9].

Previous studies have emphasised the importance of maintaining optimal performance of lubricating oil purifiers to support reliable engine operation on board ships. Oil leaking alarms are often triggered by several factors, including improper PT4 pressure caused by an overly open sliding discharge [11], which reduces the oil outlet pressure from the purifier. He also noted that a clogged oil strainer can further obstruct the lubricating oil flow, contributing to a drop in PT4 pressure. Similarly, [12] determined that the valve block water may get obstructed by dirt particles, mineral deposits, or corrosion, reducing oil outlet pressure and producing failures in the discharge and working slides. Meanwhile, [13] also observed that poor LO purifier performance produces excessive friction within engine components, reducing the engine's power efficiency.

A similar incident occurred aboard the MV. SEAPEAK GLASGOW during voyage, where oil leaking from the bowl triggered alarm A57. At the same time, the Alfa Laval P626 purifier experienced an automatic shutdown, while all ship generators were running at full capacity. This incident demonstrated the severe operational impact of oil leakage within the purifier system. If not addressed promptly, this oil leakage may contaminate the lubrication oil, resulting in engine damage and reduced operational efficiency. This study seeks to broaden the analysis by examining the role of the water block and scale deposits as key contributors to oil leaking from the bowl. Moreover, this research links these failures directly to back pressure valve PT4 deterioration, a consequence often overlooked in earlier works.

II. METHOD

This study employed a qualitative research approach aimed at examining and interpreting causal relationships between operational factors contributing to the oil leaking from the bowl issue in the Alfa Laval P626 lubrication oil purifier. The research was conducted during a one-year sea period from 2023 to 2024 aboard the MV. SEAPEAK GLASGOW, during which the researcher actively participated in engine room operations as an engine cadet. This hands-on involvement allowed direct observation of the equipment, maintenance procedures, and real-time troubleshooting activities, providing valuable insights into the technical and procedural challenges encountered during purifier operation.

A. Types and Sources of Data

The primary data sources for this study were obtained through direct field observations, operational logbooks, and semi-structured interviews with the third engineer responsible for the LO purifier system. Observational data included real-time monitoring of critical system parameters such as PT4 pressure, bowl speed, and water block performance. Secondary data were gathered through a literature review to support and contextualise the findings, including relevant journal articles, technical documentation, and the Alfa Laval P626 separator manual. These combined sources allowed for a thorough analysis of both practical and theoretical aspects of purifier operation and maintenance.

B. Data Analysis

A fishbone (Ishikawa) diagram was employed to methodically identify and classify the underlying causes of oil leaking into four main areas: man, machine, method, and material. At the same time, a typical fishbone diagram may include six or more categories such as environment and measurement. This study focused only on four, as they were the most relevant to the case under investigation. This analytical approach has demonstrated its effectiveness in enhancing operational efficiency and reducing repair costs by addressing recurring mechanical failures, particularly in equipment maintenance and manufacturing industries [14].

The collected data were subsequently analysed to assess the extent to which each factor contributed to the malfunction, along with the corresponding preventive measures. Analysis of Root cause analysis RCA has been extensively utilized across many sectors, including manufacturing, mechanical maintenance, healthcare, and quality control systems [15]. This method was selected for its strength in illustrating clear cause-and-effect relationships within a practical operational context, making it especially applicable to complex environments such as marine engine rooms.

III. Results and Discussion

A. Results

This research was conducted aboard the MV. SEAPEAK GLASGOW, with call sign C6DG2. The ship encountered a technical issue involving oil leaking from the bowl in the Alfa Laval P626 LO purifier unit. This malfunction had a direct impact on the performance of the ship's lubrication system. To provide a clearer technical overview, the following section presents the operational specifications of the Alfa Laval P626 LO purifier, based on the separator manual as a reference framework for the subsequent problem analysis.

During a one-year sea training period aboard the MV. SEAPEAK GLASGOW, a series of observations and performance monitoring were conducted on the Alfa Laval P626 LO purifier. Direct field observations revealed recurring operational disturbances from oil leaking from bowl.

To investigate the root causes and systematically identify the technical issues involved, a combination of visual inspections, operational data logging, and troubleshooting based on the engine room logbook was carried out. These observations formed the primary basis for the cause-and-effect analysis presented in this study. The results of the inspections and maintenance of the Alfa Laval P626 LO purifier are summarized in the following tables.

Table 1.
Operating Data

Description	Value	Unit
Bowl speed, synchronous		
-50 Hz	11912	r/min
-60 Hz	11885	r/min
Motor speed, synchronous		
-50 Hz	3000	r/min
-60 Hz	3600	r/min
Maximum allowed speed	12150	r/min

Source: Alfa Laval P626 Separator Manual

Table 2.
MEDIA INLET / OUTLET DATA

Pressure	
Oil inlet	Max. 2 bar at separator inlet
Oil outlet	Maximal. 2.5 bar
Sludge outlet from separator	Without pressure
Sludge outlet from sludge pump	Max. 5 Bar at 6 bar air pressure
Separated water	Max. 4 bar (if not diverted into sludge outlet)

Source: Alfa Laval P626 Separator Manual

Table 3.
OPERATING WATER DATA

Auxiliary System	
Operating water flow S 831, S 836, S 841, S 846, S 936, S 937, S 946, S 947	SV 10: 1.61 l/m SV 15: 11 l/m SV 16: 2.8 l/m
Operating water flow P 635, P636	SV 10: 15 l/m SV 15: 11 l/m SV 16: 2.8 l/m
Pressure	2-8 bar

Source: Alfa Laval P626 Separator Manual

The inspection results of the LO purifier revealed several conditions that impacted the overall performance of the machinery. A visual inspection of the lubricant oil purifier system, including the purifier and heater system, indicated a decrease in purifier RPM speed it shown in Table 5. This condition may reduce the operational efficiency of the LO purifier.

TABLE 4.
TROUBLESHOOTING DATA OF ALFA LAVAL P626

Date of Troubleshooting	Water Block (bar)	PT4 (bar)	Bowl Speed (RPM)	Remarks
25-Jul-24	3	0.5	7290	Abnormal
31-Jul-24	4	0.9	9812	Abnormal
5-Aug-24	3.6	0.6	8095	Abnormal
15-Aug-24	2	0.1	6211	Abnormal

Additionally, an inspection of the water block filter revealed significant scale buildup, causing restricted water flow. During the examination of the inlet and outlet pressure, a drop in outlet pressure (PT4) was also recorded, which ultimately triggered the “oil leaking from bowl” alarm, according to the troubleshooting data presented in Table 4.

Daily logbook entries revealed a significant discrepancy between the normal bowl speed and the speed recorded during the malfunction. Under normal conditions, the bowl should rotate at 12.150 r/min; however, during the incident, the lowest recorded speed dropped to 6.211 r/min, with bowl speed showing fluctuating behavior over the last month. The water block flow rate during the oil leaking incident fell to a minimum of 2 bar, whereas the normal operating range is around 5 bar. Furthermore, the regulating valve pressure (PT4) dropped to as low as 0.1 bar during the trouble event, while it ranges from 1.8 to 2.5 bar under normal conditions.

To better understand with the “oil leaking from bowl” issue on the Alfa Laval P626 LO purifier, a semi-structured interview was conducted with the third engineer of the MV. SEAPEAK GLASGOW, who is responsible for the operation of the Alfa Laval P626 LO purifier. The following five key questions were posed, and the response are summarized below:

1. What causes the LO purifier’s alarm “oil leaking from bowl” to activate?
2. What factors contribute to oil leaking from bowl?
3. How does the water block flow obstruction impact the LO purifier?
4. What causes poor water flow from the water block system?
5. What maintenance and repair actions can prevent oil from leaking from the bowl on the LO purifier?

Figure. 1. Low Pressure of PT4

TABLE 5.
VISUAL INSPECTION

No	Inspection	Results
1.	Visual inspection of LO purifier, LO purifier system, and heater system	A decrease in purifier RPM speed was observed
2.	Inspection of pressure (inlet and outlet)	A drop in outlet pressure (PT4) was recorded
3.	Inspection of bowl purifier	Scale buildup was found on the discharge slide and operating slide
4.	Inspection of water block filter	Scale deposits were identified

The engineer confirmed that the primary cause of the “oil leaking from bowl” issue was the water block filter or solenoid valve blockage due to scale build up, as illustrated in Figures 2 and 3. This obstruction disrupted the formation of the closing water seal, resulting in a malfunction of the bowl and triggering alarm A57.

Additionally, the weakened condition of the motor contributed to a reduction in bowl speed, particularly during the feed process when sufficient centrifugal force is crucial for effective separation. These mechanical issues directly compromised the performance of the LO purifier.

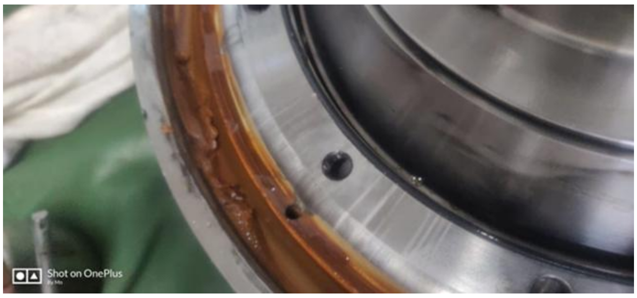

Figure. 2. Scale at Operating Slide

Figure. 3. Scale at Water Block Filter

Supporting insights from the interview further revealed that improper valve sequencing, worn sealing components such as O-rings and gaskets, and irregular monitoring of PT4 pressure exacerbated the problem. These factors contributed to system instability, affecting the bowl's ability to maintain proper sealing and interface position during operation. Collectively, these conditions led to decreased purification efficiency and a higher risk of unplanned shutdowns, emphasizing the need for preventive maintenance and routine inspection protocols.

To improve the performance of the LO purifier, the 3rd engineer carried out maintenance on several components, focusing on the bowl purifier parts. The As water block filter was replaced as part of the corrective measures, and chemical cleaning was conducted using Metal Brite HD Figure 4. This cleaning process was selected due to the presence of phosphoric acid in the solution, which is specifically formulated to remove scale, light rust, and oxide deposits from metal surfaces caused by water contamination in the water block or residual oil. All components requiring maintenance and cleaning were soaked in the chemical solution for 30 to 60 minutes.

B. *DISCUSSION*

a. *Analysis*

The investigation into the oil leaking from the Alfa Laval P626 LO purifier bowl aboard the MV. SEAPEAK GLASGOW reveals a complex interaction between mechanical, human, procedural, and material-related factors. Root cause analysis using the fishbone (Ishikawa) diagram, Figure 5, was instrumental in categorizing these causes into four key domains.

Figure. 4. Immersing the Components

From the machine-related perspective, performance deficiencies in critical components such as the water block and the bowl contributed significantly to operational instability. Specifically, improper sealing and imbalance in the bowl rotation were noted, which are vital for maintaining centrifugal efficiency during purification. Observations also recorded fluctuating bowl speeds and declining back pressure valve (PT4), further compromised the purification process.

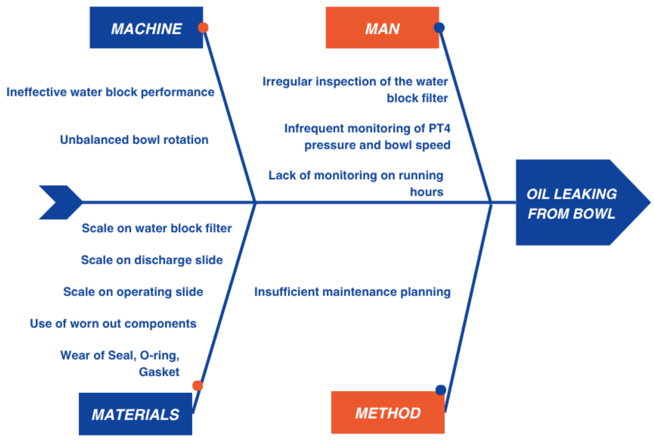

Figure. 5. Fishbone Diagram

Material-related degradation was prominent in scale accumulation on components such as the water block filter, discharge slide, and operating slide. Additionally, wear of essential sealing elements such as O-rings, gaskets, and seals was evident. These deteriorations, caused by extended use beyond recommended running hours, directly reduced system reliability and increased the likelihood of leakage.

From a human factor standpoint, the study identified lapses in operation discipline, particularly the failure to perform routine inspections and monitoring. Interviews with the 3rd engineer indicated that checks on PT4 pressure, bowl speed, and water block conditions were infrequent. The absence of structured monitoring practices allowed minor inefficiencies to escalate into critical failures, ultimately triggering alarm A57, "oil leaking from bowl".

The methodological shortcomings were center around the suboptimal implementation of the planned maintenance system. While the PMS is designed to provide scheduled guidance on component inspection and replacement based on running hours, its inconsistent application on board rendered it ineffective. The engineer acknowledged that preventive maintenance was often deferred due to the vessel's tight sailing schedule, especially for components such as the water block filter and the bowl assembly. Consequently, components operated far beyond their intended lifespan, resulting in scale formation, pressure imbalance, and mechanical failure.

b. Implication

In response, the ship's engineering team adopted a preventive intervention by installing an additional water filter unit upstream of the water block. This filter serves as a pre-filtration mechanism, shown in Figure 6, capturing solid particles and impurities carried in the water supply before they reach the purifier components. It also helps stabilise water pressure, protects internal components like solenoid valve, and supports more reliable purifier operation. Although minor, this solution reflects an effective preventive maintenance, aligning with the fishbone diagram's findings by directly addressing key root causes such as material contamination and insufficient water quality management.

The engineering solution on MV. SEAPEAK GLASGOW shows that simple, targeted changes, like adding a water pre-filter, can greatly improve performance when they are part of a full preventive maintenance plan. These actions show a shift from a reactive to a proactive maintenance culture, which shows how important it is for people and system design to ensure that machines stay reliable for a long time.

This study uses the fishbone (Ishikawa) diagram in a new way to examine oil leaks in a marine centrifugal lubrication oil purifier. This method is often used in manufacturing and processing, but not so much in maritime engineering. Using this method to determine what's wrong with the Alfa Laval P626 purifier gives us a systematic way to find the root causes in a complicated maritime setting.

The study showed that the breakdown was caused by several factors, including mechanical issues, material wear and tear, human mistakes, and problems with the way things were done. This all-encompassing view goes against the usual tendency to focus on individual technical failures and instead suggests a systems-thinking approach to fixing and troubleshooting maritime equipment.

Figure. 6. Installation of a New Water Filter

A practical new idea was adding a custom water filter before the purifier's water block. Some industrial systems have auxiliary filtration, but adding it to marine lubricating oil purifiers as a retrofit to cut down on scale buildup and pressure changes is a cheap and effective way to fix the problem. This intervention directly addresses important problems found in the fishbone analysis, such as contaminated materials and poor water quality. It also shows how small changes to the design can greatly improve reliability and ease of maintenance.

This study also stresses the need for a broader shift toward a proactive maintenance culture. The auxiliary filter not only lowered the immediate risk but also made engineering staff more aware, especially when it came to regularly checking operational parameters. These methods are in line with the principles of condition-based and reliability-center maintenance, which are becoming increasingly important in modern ship operations that are limited by a tight schedule and a small number of crew members.

This case study provides a framework for other boats with similar problems with their purifiers. This method shows how structured root cause analysis and direct technical interventions can make maritime equipment last longer, be safer to use, and work better overall in the engine room by using data-driven preventative strategies.

In summary, the engineering response aboard the MV. SEAPEAK GLASGOW illustrates how relatively simple yet targeted modifications, such as implementing a water pre filter, can produce substantial performance improvements when integrated within a broader preventive maintenance framework. These actions reflect a shift from reactive to proactive maintenance culture, underscoring the importance of both human diligence and system design in ensuring long-term machinery reliability.

IV. CONCLUSION

This study focused on the key reasons behind oil leakage from the Alfa Laval LO purifier on the MV. SEAPEAK GLASGOW. It highlighted several issues, including low PT4 pressure, inconsistent bowl speed, and scale buildup on internal parts. The root cause analysis revealed that these problems stemmed from not following maintenance schedules and a lack of understanding of the maintenance procedures among the engineering team. To tackle these issues, an auxiliary water filter was introduced to help minimize scale buildup, ensuring that the flow direction was correct and simplifying maintenance tasks. One of the standout aspects of this research was using a fishbone diagram, which effectively identified multiple root causes. Additionally, logbook entries and discussions with personnel provided further support for these findings. However, it is worth noting that this examination was confined to just one type of purifier on a single vessel. Future research could benefit from looking into a broader range of machinery and vessels. To promote reliable purifier performance and prevent similar issues from arising, it is recommended that auxiliary filtration systems be integrated into regular preventive maintenance. Furthermore, cartridge replacements should be synchronized with actual contamination levels. Lastly, it is crucial to enhance the skills of engineers through focused training and awareness initiatives.

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