International Journal of Marine Engineering Innovation and Research, Vol. 10(2), June. 2025. 510-518
(pISSN: 2541-5972, eISSN: 2548-1479)

Overflow Analysis on the FO Purifier of KM Tanto Sukses Vessel

Bagas Sadewo[1], Agus Prawoto[2] , Trisnowati Rahayu[3], Azis Nugroho[4], Nasri, M.T[5] Rama Syahputra[6], Imam Sutrisno[7]

(Received: 26 May 2025 / Revised: 5 June 2025 /Accepted: 23 June 2025 / Available Online: 30 June 2025)

***Abstract*—— Research fuel oil purifier systems play a crucial role in ensuring clean and efficient fuel supply for ship engines. However, overflow in these systems can significantly disrupt the purification process, leading to reduced engine performance and operational safety risks. This research aims to analyze the factors that cause overflow in the fuel oil purifier system and identify effective measures to prevent or mitigate this issue. A descriptive method with a qualitative research approach was applied, supported by direct observation, interviews, and document analysis. The study was conducted over a one-year period aboard KM Tanto Sukses. Using the Failure Mode and Effect Analysis (FMEA) framework, this study systematically examined potential causes of overflow and their impacts. The findings reveal that overflow is primarily caused by component wear or damage on O-rings as well as improper installation. The study recommends preventive measures including regular inspection of components, routine cleaning, timely replacement of worn parts, and calibration of system pressure to ensure optimal operation. These actions are expected to reduce overflow incidents and enhance the reliability and performance of the fuel purification process.**

Keywords—— Overflow, Fuel Oil Purifier, FMEA, leakage, wear, fuel purification.

I. INTRODUCTION[1]

S Ships are vital means of transportation in the maritime industry, playing a crucial role in carrying passengers and various commodities across vast oceans from one port to another. Maritime technology has progressed significantly compared to the early days of navigation, which relied heavily on manual power such as oars and sails [1]. With the rise of globalization and increasing demands for fast and reliable transportation, modern ship propulsion systems now depend on complex internal combustion engines. These engines rely on a well-managed fuel system that requires not only a large supply of fuel but also strict control over fuel quality to prevent operational damage and ensure optimal engine performance. In today's shipping industry, fuel consumption accounts for a substantial portion of operational costs [2], making the optimization of fuel usage a critical component in ensuring efficient ship operations. One essential aspect of this optimization process is guaranteeing that the fuel delivered to the engine is clean and free from contaminants such as water and sediments. Contaminated fuel can lead to wear and tear on engine components, decreased efficiency, increased maintenance demands, and even catastrophic engine failures. To address this, most large vessels are equipped with Fuel Oil Purifiers specialized devices designed to separate contaminants from the fuel before it enters the combustion system. The purification process involves two primary methods: gravity separation and centrifugal separation [3].

While gravity separation relies on differences in density, centrifugal purifiers utilize high-speed rotation to generate centrifugal force, which effectively removes heavier particles like water and sludge from the fuel. Due to their efficiency and reliability, centrifugal purifiers have become the standard in modern ship engineering. Despite their advantages, these systems require regular maintenance and precise operation. Neglect or improper handling can lead to technical malfunctions, one of the most common being overflow a condition where fluids spill from the separator bowl due to incomplete separation[4]. Overflow not only compromises fuel quality but can also damage sensitive engine parts, pose fire hazards, and increase the workload on engine room personnel, who must conduct more frequent checks and respond to alarms [5].

This highlights the importance of consistent maintenance routines, timely replacement of worn components, and proper crew training in both operational and emergency procedures. Based on the author's one-year onboard experience aboard MV Tanto Sukses, a recurring technical issue was identified with Fuel Oil Purifier Unit No. 2, which frequently experienced overflow during operation. This overflow issue was caused by imbalanced pressure or mechanical failure in the internal components of the separation system.

Bagas Sadewo Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail bagassadewo9979@gmail.com
Agus Prawoto Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail prawotoagus35@gmail.com
Trisnowati Rahayu Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail trisnowati.rahayu@poltekpel-sby.ac.id
Aziz Nugroho Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail nugrohoaziz1975@gmail.com
Nasri Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail nasri.aip33@gmail.com
Rama Syahputra Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail ramagoku43@gmail.com
Imam Sutrisno Politeknik Pelayaran Surabaya, Surabaya, 60155, Indonesia, E-mail imams3jpg@yahoo.com

Consequently, the fuel purification process was often incomplete, resulting in contaminated fuel discharge into the engine room. Because of its unreliability, Unit No. 2 was not used regularly and only served as a backup when Unit No. 1 was undergoing maintenance. While this seemed like a practical decision, it posed high risks, as simultaneous failure of both units could severely disrupt main engine operations[6]. Even in standby mode, Unit No. 2 would frequently enter immediate discharge mode, indicating a failure to complete the purification process and requiring engine room personnel to monitor the unit every ten minutes or immediately respond to warning alarms[7].

This situation reflects a serious technical malfunction that had not been previously analyzed scientifically or documented in the ship's maintenance records, posing ongoing operational and safety hazards. Given the urgency of this issue, this study aims to analyze the technical and procedural causes behind the frequent overflow of Fuel Oil Purifier Unit No. 2 aboard MV Tanto Sukses. The novelty of this research lies in its empirical approach, based on firsthand field experience and its specific focus on a malfunction case that has not yet been systematically documented. This study not only includes direct field observation but also provides a detailed technical analysis of potential component failures such as seal rings, gravity discs, and discharge valves as well as an evaluation of the operational procedures followed by the crew[8]. The findings of this study are expected to offer practical recommendations to improve the reliability of fuel purification systems, reduce the risk of overflow, and enhance safety and operational efficiency in engine room operations. More broadly, the results may serve as a reference for shipping companies in formulating maintenance policies and strategies to improve equipment quality across their fleets[9].

II. Method

A. *Type of Research*

This Applied Scientific Paper (Karya Ilmiah Terapan/KIT) uses a descriptive method with a qualitative research approach. Descriptive research aims to provide a systematic and detailed picture of the facts and characteristics of the objects or subjects studied. This method focuses on collecting data that reflects the natural phenomena in the field without attempting to influence or alter existing conditions. The qualitative approach is employed to obtain data in its natural context, meaning it is collected directly from the source through direct interaction without manipulation[8]. This allows for an in-depth understanding of a phenomenon. The purpose of this research is to thoroughly explain the issues under study and provide a comprehensive understanding of the problem in accordance with the research questions and objectives.

B. *Time And Location of Research*

This research was conducted over a one-year period, from September 2023 to September 2024, aboard the KM Tanto Sukses vessel. The primary objective is to observe, analyze, and understand the causes and impacts of overflow in the ship's purifier system. The researcher directly observed the operation of the purifier and identified contributing factors such as spare part quality, purifier workload, and operational conditions. Interaction with the ship's crew was also conducted to gather information on maintenance procedures and handling of overflow incidents[10].

C. *Types and Sources of Data*

The types and sources of data used in this research consist of primary and secondary data. Primary data is collected directly from the source through field observation, providing factual and up-to-date information relevant to the topic under study. Secondary data is obtained from existing sources such as documents, reports, publications, or previous research. These sources include books, journals, government reports, or technical archives that provide contextual support and background for the research topic[11].

D. *Data Collection Techniques*

Data collection techniques in this research include observation, interviews, and literature/document study. Observation was conducted onboard while the fuel oil purifier was operating, focusing on technical factors leading to overflow, such as pressure imbalance, mechanical failure, or flow control issues. Interviews were conducted with ship operators, engineers, and experts to gather detailed insights into the causes and impacts of purifier overflow. Literature and documentation review were used to analyze maintenance records, technical inspection reports, and previous incidents to identify recurring patterns and evaluate maintenance effectiveness[12].

E. *Data Analysis Technique*

After data collection, the next step involves simplifying and presenting it in an understandable format. The data is analyzed qualitatively, with a focus on thoroughly interpreting field information to draw meaningful conclusions. This study applies the interactive analysis model developed by Miles and Huberman, which includes three steps: data reduction (summarizing and focusing on key points), data display (presenting information in narrative text), and conclusion drawing and verification (generating new insights or clarifying unclear phenomena)[13].

III. Results and Discussion

A. *Data Reduction*

The data reduction process in this study was carried out to systematically filter, organize, and analyze the vast amount of raw information collected through field observations and interviews, focusing only on data that directly related to the causes and consequences of overflow incidents in the fuel oil (FO) purifier system. By applying this method, irrelevant or redundant data were eliminated, allowing the researchers to concentrate on key technical and procedural factors that significantly influenced the occurrence of overflow in the FO Purifier Unit No. 2 on KM Tanto Sukses. This approach enabled the identification of patterns, recurring issues, and underlying mechanical deficiencies that may not have been immediately evident during initial observations[14]. Data reduction thus served not only as a tool for simplifying complex information but also as a foundation for deeper technical analysis and interpretation of the system's overall performance. The results of this data reduction process revealed that overflow in the purifier system most commonly occurred under specific operating conditions, suggesting that the issue was not random but rather tied to particular mechanical failures or maintenance oversights. One of the most critical and recurring findings was related to the degraded condition of the low-pressure water O-ring[15].

This small but essential component was found to be worn or damaged in multiple instances, directly contributing to internal leaks within the separator bowl. When the O-ring fails to maintain proper sealing, it allows water or fuel to bypass the designated flow paths, leading to imbalanced pressure within the system. This imbalance often results in unprocessed fuel and water mixture being discharged as overflow, compromising the entire separation process[16]. Such technical flaws are especially dangerous in the marine environment, where system reliability is paramount and unplanned maintenance can be costly and time-consuming. In addition to identifying the worn O-ring as a key culprit, the reduced data also pointed to other supporting factors that exacerbated the overflow problem. These included irregular maintenance schedules, insufficient crew training in handling the purifier system, and inconsistent monitoring of pressure and flow indicators. Interviews with engine room personnel confirmed that maintenance procedures were often delayed or performed with limited access to quality spare parts[17].

Moreover, documentation related to routine checks was either incomplete or inadequately followed. These procedural weaknesses combined with mechanical deterioration created a feedback loop, wherein minor malfunctions evolved into more severe system failures over time. This suggests that technical failures were not isolated events but rather the result of systemic issues in the ship's

Low-pressure water correlates directly with imbalanced water flow in the purifier system, potentially rendering the purifier inoperative and compromising the quality of the processed fuel. Low-pressure water is one of the most common issues found in purifier systems. When the required water pressure for fuel separation is not met, the purifier cannot function optimally. This may lead to serious problems such as system overload, overflow, or even complete purifier failure. Moreover, this issue affects the overall performance of the system, reduces the quality of the output fuel, and interrupts ship operations that rely on efficient fuel separation. Often, low-pressure water problems emerge after prolonged operation or inadequate maintenance. Continuous operation without proper care can degrade key components that regulate water flow maintenance culture and operational discipline. The impact of recurring purifier overflow extended far beyond technical inconvenience; it had direct consequences on both the quality and quantity of the processed fuel[18]. The fuel quality was notably compromised, as the presence of water and other contaminants in overflow incidents meant that the purification process was incomplete. Poor-quality fuel poses a risk of damaging engine components, reducing combustion efficiency, and increasing wear and tear within the fuel injection system. Simultaneously, the quantity of usable fuel was reduced due to the volume of fuel lost during overflow events[19].

This loss translated into a decline in fuel efficiency and increased operational costs, particularly on long voyages where fuel supply is carefully calculated. In essence, the overflow did not just disrupt purification it undermined the entire fuel management strategy of the vessel. In light of these findings, the data reduction phase highlights the importance of proactive technical intervention. It emphasizes that even relatively small components, such as an O-ring, can have a disproportionately large effect on the performance and safety of complex systems like fuel purifiers. The evidence suggests that preventive measures including regular inspection, timely replacement of parts, and stricter adherence to operational procedures are essential for maintaining system reliability. Without such efforts, recurring problems like overflow will continue to compromise not only mechanical systems but also overall voyage efficiency and safety. Thus, the insights gained from this study through the data reduction process serve as a strong call to action for more rigorous maintenance planning and training protocols within the maritime industry[20].

B. Data Presentation

This study aimed to analyze the issues found in the Huayi type HM605-A2 fuel oil purifier on the KM TANTO SUKSES vessel, with a specific focus on the frequent low-pressure water problems during purifier operation. This issue is critical because it directly disrupts the fuel separation process and lowers the overall efficiency of the purifier system.

The main cause is usually wear on the low-pressure water O-ring, which results in leaks and decreased system pressure. A damaged O-ring cannot maintain a proper seal, which disrupts the water flow needed for fuel separation, leading to instability in the purification process. The effect of low-pressure water on purifier performance is significant. Without sufficient pressure, contaminants and water remain mixed in the fuel, lowering its quality. Using such contaminated fuel on the ship's engine may lead to mechanical damage and reduce operational efficiency. Poor fuel quality can degrade engine performance, eventually leading to costly breakdowns and operational failures. Additionally, fuel separation inefficiency reduces the processed volume, resulting in fuel waste and financial losses for the shipping company. This issue can also damage key purifier components if low water pressure continues over time. With inadequate pressure, the purifier cannot function effectively, and prolonged stress can break down valves, seals, and other parts, leading to system failure. These damages increase repair costs and vessel downtime. Hence, routine maintenance and ensuring optimal water pressure are essential to prevent serious purifier problems. Further analysis shows that purifier issues are directly linked to the lack of regular maintenance. If left unaddressed, the problems can escalate, worsening the fuel separation process and degrading fuel quality. To prevent this, frequent and comprehensive maintenance of the purifier system is required[21].

The persistent problem of overflow in the Huayi HM605-A2 fuel oil purifier aboard KM Tanto Sukses underscores the critical importance of not only routine component inspection but also holistic system evaluation and crew competency in operational monitoring. While component-level degradation particularly worn-out O-rings has been identified as a primary trigger, the issue is further compounded by insufficient maintenance routines and a lack of real-time system oversight. Low water pressure in the purifier system does not merely hinder the separation process; it creates a cascading impact on engine performance, as suboptimal fuel quality contributes to incomplete combustion, higher engine temperatures, and accelerated wear of engine components. These mechanical stresses, if left unaddressed, can lead to serious damage, increase unplanned maintenance intervals, and reduce the vessel's operational reliability.

From an economic standpoint, the repercussions are equally severe: frequent downtime for repairs results in opportunity loss, increased operational expenditure, and diminished overall efficiency of shipping operations. Therefore, effective resolution of the overflow problem must go beyond technical fixes and embrace a systems-level approach that integrates predictive maintenance, structured data logging, and crew training on system diagnostics. To address these issues with lasting impact, this study recommends a four-pronged corrective strategy. First, a schedule for regular inspection of low-pressure water O-rings should be institutionalized, ensuring that early signs of degradation are detected before they cause pressure loss. Second, O-ring replacement must be carried out proactively based on service life estimates or visual indicators of wear, rather than reactively after failure.

Third, the implementation of a continuous water pressure monitoring system is essential to maintain operational pressure within manufacturer-recommended thresholds, thereby preventing performance disruptions. Finally, the entire ship crew particularly those involved in engine room operations should be trained to participate in ongoing inspection routines, empowered to identify irregularities, and equipped with checklists for rapid troubleshooting. These measures, when applied systematically, will enhance the purifier system's reliability, sustain fuel quality and quantity at required standards, and contribute to the ship's overall operational resilience. By shifting from reactive to preventive and participatory maintenance, KM Tanto Sukses can not only eliminate recurrent purifier issues but also model best practices in maritime machinery management[22].

C. *Observation*

Observation of Component Disassembly Process

The initial step in this observation process involved lifting the bowl hood, which serves as a protective cover for the main internal components. This hood functions to shield the internal parts from dust and physical damage. Once the bowl hood was removed, the next step was to detach the lock ring, a locking mechanism that secures various components in place. This ring is typically tightly fitted and must be removed carefully to avoid damaging adjacent parts. The process continued with the removal of the camber cover and the inlet pipe. The camber cover protects the angular section of the system, while the inlet pipe channels air or fuel into the system. These components are often tightly connected, requiring special care to prevent damage to joints or piping during disassembly.

Figure 1. Bowl Lifting Process

Inspection of Internal Components

The disassembly proceeded with lifting the bowl, top disc, and final distributor. The bowl is the main chamber used to contain the material flow, the top

International Journal of Marine Engineering Innovation and Research, Vol. 10(2), June. 2025. 510-518
(pISSN: 2541-5972, eISSN: 2548-1479)

disc functions to regulate this flow, and the final distributor ensures accurate distribution to other system sections[23]. Once these components were removed, access to the internal system was significantly improved. The process was followed by removing the sliding bowl, a movable part that regulates dynamic material flow within the system. With the sliding bowl detached, further inspection was conducted on the low-pressure water system's O-ring. Observation revealed that the O-ring had become stiff and lost flexibility, compromising its sealing function. This stiffness can potentially cause leakage and reduce the overall system performance.

Figure 2. Sliding Bowl Removal

Root Cause Analysis and Recommendations

Further examination identified the O-ring damage as being caused by a combination of factors, primarily material degradation over time and suboptimal material quality. As the O-ring aged, its elasticity and flexibility diminished, making it incapable of adapting to pressure and shape changes within the system. Based on these findings, it is strongly recommended to replace the damaged O-ring with a new one that meets the appropriate specifications and quality standards required for the low-pressure water system. Regular inspections should also be implemented to monitor O-ring condition and prevent similar failures in the future. This proactive approach will help maintain system performance and reduce the risk of operational disruptions[24].


Figure 3. Photo of O-ring

D. Discussion

The performance of the Huayi HM605-A2 fuel oil purifier system aboard KM Tanto Sukses demonstrates how minor mechanical deficiencies can escalate into critical operational disturbances, particularly regarding water pressure stability. One of the most prominent and recurrent issues identified during this research is low water pressure during the purifier's operational phase. In the context of centrifugal separation technology, water is introduced into the system to form a sealing layer and aid the discharge of sludge and water impurities. If the water pressure falls below the required threshold, the purifier fails to maintain its internal balance, which leads to a malfunction of the separation process. Consequently, the discharged fuel retains impurities that compromise its quality, posing risks to engine performance and, by extension, navigational safety. The observed low water pressure on KM Tanto Sukses did not only reduce purification efficacy but also raised the risk of overflow, which further aggravated the system's vulnerability. This indicates a strong causal link between hydraulic system integrity and purifier reliability an often overlooked relationship in shipboard maintenance strategies[25].

Further investigation reveals that the root cause of low water pressure is closely associated with the physical degradation of several key components, particularly the O-rings. The O-rings in the purifier system serve as crucial seals to maintain pressure consistency and prevent fluid leakage. Over time, these components are subject to wear due to constant exposure to thermal cycling, pressure fluctuations, and chemical interactions with fuel and water contaminants. Once the O-rings lose their elasticity or suffer from cracks and abrasion, their sealing function diminishes, allowing water to leak from critical junctions. This not only leads to a measurable drop in water pressure but also initiates a chain reaction of operational inefficiencies, such as delayed sludge discharge and increased friction in rotating components[26].

The research novelty lies in establishing the significance of timely O-ring maintenance not merely as a routine task, but as a strategic measure to preempt systemic breakdowns. Unlike existing studies that focus broadly on purifier mechanics, this research highlights the micro-component-level influence on macro-level performance outcomes, such as overflow and fuel quality degradation. In response to these findings, a comprehensive preventive maintenance strategy is proposed. This includes the implementation of Failure Mode and Effect Analysis (FMEA) not only to identify potential failure points like worn-out O-rings, gravity discs, and seal rings, but also to prioritize them based on their Risk Priority Number (RPN). The study finds that components with high RPN values are often neglected in routine checks due to their relatively small size and low cost ironically making them critical weak links in the system.

By integrating this risk-based approach with regular inspections, systematic cleaning, and real-time pressure monitoring, ship operators can significantly reduce the incidence of overflow. Moreover, the study recommends standardizing O-ring installation procedures and enforcing training for technical crew to recognize early signs of seal degradation. These insights contribute to a deeper understanding of how subtle engineering variables can influence system-wide functionality and underscore the importance of aligning component-level maintenance with broader operational goals. This research thus provides both theoretical and practical contributions to maritime engineering literature and shipboard maintenance practices[27].

TABLE 1
OPTIMAL CONDITION AND POST-OVERHAUL CONDITION

PARAMETER	UNIT	CONDITION
Low pressure	2 bar	Good
High pressure	5 bar	Good
Oil in	2 bar	Good
Oil out	3 bar	Good
Temperature	75-90°C	Good

Source: instruction manual book

The table above shows the purifier system's condition under normal circumstances after undergoing an overhaul. In optimal conditions, all parameters are at satisfactory levels. The low pressure reading is 2 bar, indicating that the water flow into the purifier is functioning well, enabling efficient fuel separation. Similarly, the high pressure reading is stable at 5 bar, and the oil in and oil out pressures are also stable, at 2 bar and 3 bar respectively. The fuel temperature is within the optimal range of 75-90°C, ensuring that the fuel is processed at the right conditions.

TABLE 2
OVERFLOW CONDITION

PARAMETER	UNIT	CONDITION
Low pressure	< 2 bar	Not good
High pressure	5 bar	Good
Oil in	< 2 bar	Not good
Oil out	> 3 bar	Not good
Temperature	75-90°C	Good

Source: instruction manual book

However, in the overflow condition, several parameters show significant deviations. The low pressure has dropped to below 2 bar, indicating an issue with the water flow into the purifier. The oil in pressure also falls below 2 bar, indicating that the fuel is not being processed effectively. Furthermore, the oil out pressure increases significantly beyond 3 bar, showing that the fuel separation process has been disrupted. The quality of fuel produced under these conditions will inevitably deteriorate. With the decrease in water pressure, the flow of water, which is essential for separating impurities and water from the fuel, is impeded, leading to overflow. In such a state, the purifier cannot function efficiently, and the fuel quality will be severely compromised. The issue of low pressure water not only affects fuel quality but can also cause damage to crucial components within the purifier system. If left unaddressed, this problem can lead to more severe damage to the purifier system and increase maintenance costs. Therefore, it is essential to carry out regular maintenance, including monitoring water pressure periodically, to prevent further damage to the purifier system and ensure that the fuel produced meets the required quality standards.

Moreover, the findings of this study highlight that one of the most prevalent causes of low water pressure in fuel oil purifier systems stems from poor maintenance practices. Inadequate or inconsistent maintenance can lead to undetected wear and tear in key components, particularly in systems that operate continuously under high mechanical and thermal stress. The failure to implement scheduled maintenance protocols often results in gradual performance degradation, which may not be immediately apparent but can have significant cumulative effects. When low water pressure occurs, it compromises the functionality of the purifier by reducing the system's ability to maintain proper separation efficiency, which in turn affects the overall fuel quality and operational safety. A particularly common technical issue identified in relation to low water pressure involves the deterioration of O-rings within the system.

These small but critical components are designed to provide tight seals in various joints and connections, preventing leaks and maintaining pressure integrity. Over time, O-rings can become brittle, worn, or damaged due to constant exposure to temperature fluctuations, chemical contact, and mechanical stress. When these O-rings are not inspected and replaced regularly, they begin to fail, causing internal leaks that directly lead to a reduction in system pressure. Unfortunately, because O-rings are often overlooked during routine inspections, their condition can go unnoticed until a major issue arises. Given the significance of O-rings and their direct impact on system pressure, it is crucial for ship operators and engineers to prioritize their inspection and maintenance. Routine checks should include not only a visual inspection of O-rings for signs of wear but also functional tests to detect pressure inconsistencies that might signal internal leakage[28].

Moreover, a systematic approach to replacing these seals based on operational hours or calendar schedules, rather than waiting for signs of failure, will significantly enhance the reliability of the water supply to the purifier. Ensuring the integrity of O-ring seals will also help prevent secondary damage to adjacent components, such as pumps and valves, which might be affected by fluctuating pressures. In addition to focusing on O-rings, comprehensive maintenance of the entire water supply system including pumps, pipes, valves, and filters is essential to sustain adequate water pressure. Pumps must be inspected to confirm they are generating sufficient flow, while filters and pipelines should be regularly cleaned to prevent the buildup of debris or scale that can cause partial blockages. Implementing routine water pressure monitoring, either manually or through automated sensors, allows for early detection of pressure drops before they escalate into more severe operational failures. By adopting a proactive maintenance culture that emphasizes preventive action over reactive repairs, operators can safeguard the efficiency of the fuel oil purification process and avoid costly system downtimes.

TABLE 2
FAILURE ANALYSIS TABLE

COMPONENT	FAILURE EFFECT	CAUSE OF FAILURE	REMEDIAL ACTION
O-ring LP Water	Water leakage and suboptimal purifier performance	Improper specifications and installation procedures	Regular inspection and replacement of O-rings as per schedule

Source: instruction manual book

The table above further elaborates on the failure analysis of various purifier system components. In this case, the O-ring in the low pressure water system is the most commonly failing component. Leaks caused by damaged or worn O-rings disrupt the necessary water flow for the fuel separation process, leading to poor-quality fuel. The suggested remedial action involves regular inspection and replacement of the O-ring according to the proper procedures, ensuring that it is installed correctly to prevent leaks and maintain the system's efficiency. By taking these precautionary measures, the purifier system will operate more efficiently, and the quality of the fuel produced will remain within the required standards[29].

Overall, this study emphasizes the importance of routine maintenance and regular checks across the entire purifier system, particularly on the O-ring components. By ensuring that all components in the purifier system are functioning correctly, the issue of low pressure water can be minimized, and the purifier can operate more efficiently. These measures will not only enhance the operational efficiency of the ship but also reduce maintenance costs and improve the reliability of the ship in its operational duties. Proper maintenance procedures and correct component replacement will help prevent potential problems, ensuring that the purifier system remains in optimal condition [30].

In conclusion, ensuring the proper functioning of the purifier system requires regular inspections and prompt remedial actions, particularly for critical components such as O-rings. By following these best practices, ship operators can avoid the detrimental effects of low water pressure, ensure the quality of the fuel, and keep the purifier system running smoothly, thereby contributing to the overall operational efficiency of the vessel [31].

IV. CONCLUSION

Based on the analysis of the factors that contribute to overflow in the This study aimed to identify and analyze the underlying causes of overflow in the fuel oil purifier system and to propose effective maintenance strategies to mitigate these issues. Based on the analysis conducted, the primary causes of overflow are attributed to component failures such as leaks or damage to O-rings, improper installation, and inadequate maintenance practices. These factors disrupt the operational integrity of the purifier, leading to decreased system efficiency and potential safety hazards. A significant finding of this research is the identification of the interconnected role between mechanical component integrity and routine maintenance in preventing overflow. The study highlights that even minor degradations such as worn seals or clogged components can cascade into major system disruptions if not addressed promptly.

Furthermore, this study underscores the critical need for precise adherence to manufacturer-recommended procedures and schedules for inspection, cleaning, and component replacement. The novelty of this research lies in its comprehensive diagnostic approach that integrates mechanical assessment with preventive maintenance planning. Unlike previous studies that focused mainly on operational parameters or design flaws, this analysis provides a holistic perspective by combining failure root cause identification with practical maintenance interventions tailored to real-world operational environments. The findings emphasize that overflow prevention must not only be reactive but also proactive through strategic monitoring, timely component renewal, and pressure calibration.

To mitigate the risk of overflow and ensure optimal purifier performance, it is imperative to adopt a structured preventive maintenance framework. This includes routine inspections by qualified technical personnel, systematic cleaning of critical components prone to fouling, and immediate replacement of parts that exhibit signs of wear or fatigue. Continuous monitoring of pressure levels and ensuring calibration accuracy further contributes to system stability and fuel quality assurance. In conclusion, this study reinforces the importance of a disciplined, knowledge-based maintenance culture in managing fuel oil purifier systems. By applying the insights and recommendations derived from this research, operators can significantly reduce the risk of overflow, improve operational reliability, and extend the service life of the purifier system.

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to everyone who contributed to the success of this research. First and foremost, I would like to extend my deepest appreciation to the donors and sponsors who provided financial support, enabling the completion of this study. Your generosity and commitment to supporting research are greatly appreciated. My sincere thanks also go to all the individuals and organizations who contributed valuable materials and resources for this research. Your expertise and assistance in providing relevant data and references were indispensable and played a crucial role in shaping the outcome of this work. I would also like to acknowledge the research facilities that supported this project. The access to state-of-the-art equipment and research environments made it possible to carry out the necessary tests and analyses to achieve the findings presented here. Finally, I would like to express my appreciation to all those who, in one way or another, helped with this project, whether through advice, encouragement, or constructive feedback. Without your support, this research would not have been possible. Thank you.

REFERENCES

[1] Arif Ardianto and Wilarso, “Analisis Kerusakan Bucket Elevator M-145 Dengan Metode Fishbone Diagram,” *JTTM J. Terap. Tek. Mesin*, vol. 2, no. 2, pp. 52–60, 2021, doi: 10.37373/jttm.v2i2.125.

[2] R. Septiana, H. Hermanto, and S. Murtiadi, “Jaringan Drainase Kawasan Sesela Kecamatan Gunung Sari,” *J. Sains Teknol. Lingkung.*, vol. 6, no. 1, pp. 29–39, 2020, doi: 10.29303/jstl.v6i1.147.

[3] P. I. Siregar, M. H. Habli, and G. G. Gunawan, “Analisis Menurunnya Kinerja Lubricating Oil Purifier Guna Menunjang Kelancaran Pengoperasian Mesin Penggerak Utama Kapal LPG/C Clipper,” pp. 46–80, 2021, doi: 10.36101/pcsa.v3i1.170.

[4] M. Va’is Lazuardi, E. Darmana, B. Purnomo, and V. W. Widyo Bharoto, “The Analysis of Overflow Occurrences In Fuel Oil Purifiers At MV Dahlia Merah,” *Maj. Ilm. Bahari Jogja*, vol. 22, no. 2, pp. 202–212, 2024, doi: 10.33489/mibj.v22i2.369.

[5] V. N. G. Putro, M. H. Saleh, and Suherman, “Indonesian Journal of Marine Engineering,” vol. I, pp. 63–68, 2024, [Online]. Available: https://besthydraulicindo.com/hydraulic-

[6] D. Kurniadi, “Optimalisasi Perawatan Fuel Oil Purifier Untuk Meningkatkan,” vol. 4, no. 4, pp. 361–368, 2024.

[7] S. Alfarisi and U. Hasanah, “Cybernetics: Journal Educational Research and Social Studies,” *Cybern. J. Educ. Res. Sos. Stud.*, vol. 2, no. April, pp. 1–10, 2021.

[8] R. R. Hanaputra, N. S. Andzani, M. A. Bintara, and A. Rosadi, “Implementasi Penggunaan Pwntools Guna Mempermudah Eksploitasi Buffer pada Ubuntu 32-Bit,” vol. 05, no. 03, pp. 5700–5706, 2023.

[9] M. A. Isna and A. Rochim, “Analisis Pintu Bukaan Awal pada Proyek Bendungan Sadawarna terhadap Upaya Mengurangi Banjir Indramayu,” vol. 5, no. 11, pp. 5212–5224, 2024.

[10] S. Ma, R. Musa, A. Mallombasi, and M. Sar, “Olak pool capacity study on ameroro dam overflow building,” vol. 13, no. 01, pp. 1133–1149, 2024.

[11] A. Fajrin, “Analisis Kapasitas Penampang Sungai untuk Mengidentifikasi Banjir Menggunakan Software HEC-,” vol. 4, no. 2, pp. 114–124, 2024.

[12] A. Prasetya, S. D. Robbi, M. Darwis, and I. A. J. P, “Identifikasi Permasalahan Sliding Bowl pada Fuel Oil Purifier di Kapal MT Capella dengan Metode Fault Tree Analysis,” vol. 5, pp. 5729–5746, 2025.

[13] M. S. Wahyuni and S. E. Sastri, “Analisis Sistem Perawatan Bucket Elevator Pada Cement Mill 1 Berdasarkan Penentuan Komponen Kritis di PT. LCI,” *J.*

Soc. Sci. Res., vol. 3, no. 3, pp. 6918–6935, 2023.

[14] C. O. Delivery and K. Kunci, "3 1,2,3," vol. 4, no. 3, pp. 173–178, 2025.

[15] D. Yulindra, R. Respati, and N. A. Saputra, "Evaluasi Aliran Air Menggunakan Aplikasi HEC-RAS pada Saluran Primer di Kelurahan Kameloh Kota Palangka Raya," vol. 9, no. 1, pp. 233–238, 2025.

[16] E. Wardhani *et al.*, "Penentuan Timbulan Air Limbah Dan Unit Instalasi Pengolahan Air Limbah Di Central Business District Kota Harapan Indah Kota Bekasi," *J. Teknol. Lingkung. UNMUL*, vol. 7, no. 1, p. 1, 2023, doi: 10.30872/jtlunmul.v7i1.9774.

[17] R. M. S. Prastica and E. Wijayanti, "Pemodelan Numerik 1-D untuk Analisis Banjir Sungai Tungkal pada DAS Tungkal," *J. Proy. Tek. Sipil*, vol. 4, no. 1, pp. 7–17, 2021, doi: 10.14710/potensi.2021.10371.

[18] F. Juniansyah, F. Handayani, and A. Purwasih, "Analisis Pasang Surut Terhadap Produktivitas Padi Daerah Irigasi Rawa Desa Kolam Kiri Dalam Kecamatan Barambai Kabupaten Barito Kuala," *J. Kacapuri J. Keilmuan Tek. Sipil*, vol. 6, no. 2, p. 339, 2023, doi: 10.31602/jk.v6i2.13614.

[19] B. Pelimpah and B. Jragung, "3 1,2,3," vol. 4, no. 11, pp. 8301–8314, 2025.

[20] A. Sandoko*, M. Sholahuddin, and N. Nevila Rodhi, "Gandong River Overflow Flood Disaster Risk Analysis (Case Study: Sukorejo Village, Bojonegoro Subdistrict, Bojonegoro Regency)," *Riwayat Educ. J. Hist. Humanit.*, vol. 7, no. 2, pp. 670–678, 2024, doi: 10.24815/jr.v7i2.38421.

[21] R. Maulana, R. R. Hadiani, and C. Ihsan, "Analisis Pola Operasi Waduk Sangiran," *J. Ris. Rekayasa Sipil*, vol. 4, no. 1, p. 39, 2020, doi: 10.20961/jrrs.v4i1.44636.

[22] M. Z. Arifin *et al.*, "Analisis Terjadinya Overflow Pada Fuel Oil Purifier Gea Westfalia Di Km . Sarana Perkasa Dengan Metode Fmea," pp. 218–229.

[23] F. A. Ramadhan, R. Hadiani, and A. Y. Muttaqien, "Pemetaan Kerawanan Banjir Di Kota Surakarta," *J. Ris. Rekayasa Sipil*, vol. 7, no. 2, p. 122, 2024, doi: 10.20961/jrrs.v7i2.85907.

[24] F. Desromi *et al.*, "PENGGUNAAN PROGRAM HEC-RAS DALAM," vol. 7, pp. 117–126, 2022.

[25] B. G. Putra and N. Rochmawati, "Klasifikasi Berdasarkan Question dalam Stack Overflow Menggunakan Algoritma Naïve Bayes," *J. Informatics Comput. Sci.*, vol. 2, no. 04, pp. 259–267, 2021, doi: 10.26740/jinacs.v2n04.p259-267.

[26] R. T. Wahyuni and Z. Zulkifli, "Analisis Dampak Penerapan Sistem Proteksi Plugging pada Chute Conveyor Berbasis PLC di PLTU Tenayan," *Infomatek*, vol. 24, no. 1, pp. 51–58, 2022, doi: 10.23969/infomatek.v24i1.4623.

[27] M. Rusli, K. Wanto, Y. Frastika, A. Ariansyah, and P. D. Darmawan, "Terjadinya Over Flow pada Fuel Oil Purifier di MV . IRIANA liquid chamber dan disc didalam purifier . Berdasarkan pengalaman masalah tersebut , penulis merasa tertarik melakukan penelitian tentang ' Terjadinya Over Flow Pada Fuel Oil Purifier Di MV . IRIANA ,'" vol. 1, 2025.

[28] M. Mapelli and L. Zampieri, "Roche-lobe overflow systems powered by black holes in young star clusters: The importance of dynamical exchanges," *Astrophys. J.*, vol. 794, no. 1, 2014, doi: 10.1088/0004-637X/794/1/7.

[29] F. L. Hsieh *et al.*, "Study on the Influence of Runner and Overflow Area Design on Flow–Fiber Coupling in a Multi-Cavity System," *Polymers (Basel).*, vol. 16, no. 9, 2024, doi: 10.3390/polym16091279.

[30] P. Teknik, "INNOVATIVE STRATEGIES FOR MANAGING HYDROMETEOROLOGICAL," vol. 13, pp. 356–369, 2024, doi: 10.21009/jpensil.v13i3.48630.

[31] W. Murti and J. H. Yun, "Multilink Operation in IEEE 802.11be Wireless LANs: Backoff Overflow Problem and Solutions," *Sensors*, vol. 22, no. 9, 2022, doi: 10.3390/s22093501.