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Analysis of Lubricating Oil Pressure Decrease in the Generator Engine on Board MT. Anargya I

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Abstract

This study aims to analyze the causes of lubricating oil pressure decrease in the generator engine on board MT. Anargya I and to identify appropriate solutions to resolve the issue. The primary problem identified was a drop in oil pressure from the normal operating parameter of 3.6 bar to 2.1 bar on January 21, 2022, while the vessel was sailing from Balikpapan to Batam. The research employed a descriptive qualitative approach using data collection techniques including direct observation, interviews with engineering officers, and documentation study. Analysis was conducted using the fishbone (Ishikawa) diagram method to systematically map the cause-and-effect relationships of the pressure decline phenomenon. The findings revealed two principal causes: first, the fracture of the piston cooling nozzle on cylinder number 2, which was attributed to the use of a plastic material component (part number 3007517) instead of the copper material specified in the engine manual book (BP1115); second, the clogging of the lubricating oil filter by accumulated metal wear particles generated from friction between internal engine components. The study concludes that strict adherence to manufacturer specifications for spare parts procurement and implementation of a systematic preventive maintenance schedule for the lubrication system are essential to prevent recurrence of similar failures.

Keywords: *generator engine, lubricating oil pressure, piston cooling nozzle, oil filter, fishbone analysis*

I. INTRODUCTION

The generator engine serves as the primary electrical power source on board merchant vessels, providing essential energy for auxiliary machinery operations, navigation systems, communication equipment, and safety installations. The continuous and reliable operation of the generator is therefore critical to the overall safety and operational efficiency of the vessel. Among the various subsystems that support generator performance, the lubrication system holds a particularly vital role, as it functions to reduce friction between moving components, dissipate heat from high-temperature areas, prevent corrosion on metal surfaces, and seal the clearances between pistons and cylinder liners.

The lubrication system operates by circulating oil under a specified pressure to all critical engine components. A decrease in lubricating oil pressure below the manufacturer's recommended operating range can result in inadequate oil supply to bearing surfaces, accelerated wear, overheating, and potentially catastrophic engine failure. In the maritime context, such failures can lead to vessel blackout conditions, which pose significant risks to navigational safety, crew welfare, and environmental protection.

On January 21, 2022, while MT. Anargya I, an oil tanker operated by PT. Maritim Indo Trans, was sailing from Balikpapan to Batam, a low-pressure alarm was triggered on generator number 2. The engine control room parameters indicated a pressure drop from 3.6 bar to 2.1 bar. This reading was significantly below the normal operating range of 2.4–3.1 bar specified in the Cummins KCM-II A engine manual. If left unaddressed, this condition could lead to severe damage to internal engine components and a complete power failure.

Based on the background described above, this research was conducted to identify and analyze the root causes of the lubricating oil pressure decrease in the generator engine on board MT. Anargya I and to propose corrective and preventive measures to mitigate future occurrences of similar problems. The study addresses two primary research questions: (1) What are the factors causing the lubricating oil pressure decrease in the generator engine? and (2) What corrective actions should be implemented to restore and maintain the oil pressure within the normal operating range?

II. LITERATURE REVIEW

A. Lubricating Oil System in Marine Diesel Engines

The lubricating oil system in marine diesel engines is designed to supply clean oil at a specified pressure and temperature to all moving parts that require lubrication. According to Woodyard (2009), the primary functions of lubricating oil include reducing friction and wear between surfaces in relative motion, cooling components by carrying away heat, cleaning internal surfaces by flushing away combustion residues and wear particles, and providing a sealing film between pistons and cylinder liners. The system typically comprises a sump or oil carter, oil pumps (gear-type or screw-type), filters (full-flow and bypass types), coolers, and distribution galleries.

B. Oil Pressure Parameters and Monitoring

Lubricating oil pressure is one of the most critical operational parameters monitored in diesel engine operation. The manufacturer specifies a normal operating pressure range for each engine model. For the Cummins KCM-II A series generator, the normal oil pressure range is 2.4–3.1 bar at rated speed. Any deviation from this range triggers an alarm system, and a further decrease to the critical low level initiates an automatic engine shutdown to prevent catastrophic damage. Regular monitoring of oil pressure, temperature, and quality is essential for early detection of potential lubrication system failures.

C. Piston Cooling Nozzle Function and Specifications

The piston cooling nozzle is a component installed in the engine block that directs a jet of lubricating oil onto the underside of the piston crown. This oil spray serves to dissipate the intense heat absorbed by the piston during combustion, thereby preventing thermal distortion, seizure, and ring groove degradation. According to the Cummins Operation and Maintenance Manual, the piston cooling nozzle for the KCM-II A engine series must be manufactured from copper-based alloy material as specified under part reference BP1115, which possesses superior heat resistance and fatigue strength properties compared to substitute materials.

D. Fishbone (Ishikawa) Diagram Analysis

The fishbone diagram, also known as the Ishikawa or cause-and-effect diagram, is a quality management tool developed by Kaoru Ishikawa in the 1960s. This analytical method provides a structured approach to identifying potential causes of a specific problem by categorizing them into major groups, typically including Man, Machine, Method, Material, and Environment. The diagram is widely used in marine engineering troubleshooting to systematically analyze complex machinery failures and identify root causes for corrective action planning.

III. RESEARCH METHODOLOGY

This research was conducted during the sea practice (Prala) period on board MT. Anargya I for approximately 11 months. The specific research location was the engine room of the oil tanker vessel owned by PT. Maritim Indo Trans. The study adopted a descriptive qualitative approach to comprehensively analyze the phenomenon of lubricating oil pressure decrease in the generator engine.

A. Data Collection Techniques

Primary data were obtained through two methods: first, direct observation of engine components, including physical inspection of the piston cooling nozzle and lubricating oil filter; second, structured interviews with the Second Engineer who was responsible for the generator maintenance and operation during the incident. Secondary data were collected from the engine manufacturer's manual book, the vessel's planned maintenance system records, and company damage reports. The combination of primary and secondary data sources ensured triangulation and enhanced the reliability of research findings.

B. Data Analysis Method

The collected data were analyzed using the fishbone (Ishikawa) diagram method. This technique was selected due to its effectiveness in systematically organizing and visualizing the cause-and-effect relationships associated with complex engineering problems. The analysis categorized the identified causes into the standard fishbone categories of Man, Machine, Material, Method, and Environment, enabling a comprehensive root cause analysis that informed the development of corrective and preventive recommendations.

IV. RESULTS AND DISCUSSION

A. Analysis of Piston Cooling Nozzle Fracture

Physical inspection conducted on the generator number 2 revealed that the piston cooling nozzle installed on cylinder number 2 had fractured at its tip section. A detailed examination of the failed component yielded two significant findings that directly contributed to the lubricating oil pressure decrease.

First, the material of the installed piston cooling nozzle was found to be non-compliant with the manufacturer's specifications. The fractured component was made of plastic material bearing part number 3007517, whereas the instruction manual book (reference BP1115) explicitly specifies that the piston cooling nozzle must be fabricated from copper-based alloy material. The use of an inappropriate material resulted in premature fatigue failure under the operational stress and thermal conditions within the engine cylinder, as plastic materials possess significantly lower heat resistance and mechanical strength compared to the specified copper alloy.

Second, the fracture created an unintended leakage path in the oil circuit. As the nozzle tip broke off, lubricating oil that was supposed to be directed onto the piston crown in a controlled jet was instead lost through the fracture point. The magnitude of the pressure decrease was directly proportional to the size of the leakage opening. The larger the leakage at the fractured nozzle, the smaller the oil flow pressure available to the remaining components in the lubrication circuit, thereby causing a systemic pressure drop throughout the engine's oil system.

Table 1. Lubricating Oil Pressure Comparison Data

Parameter	Normal Range	Incident Reading	Deviation
Oil Pressure (bar)	2.4 – 3.1	2.1	–0.3 below min.
Pre-Incident Pressure (bar)	3.6 (operating)	2.1 (alarm)	–1.5
Nozzle Material (Specified)	Copper alloy (BP1115)	Plastic (3007517)	Non-compliant

Source: Engine Control Room Data and Manual Book, MT. Anargya I (2022)

B. Analysis of Lubricating Oil Filter Clogging

Upon disassembly and inspection of the lubricating oil filter assembly, a substantial accumulation of contaminants was discovered adhering to the filter element surfaces. The contaminant material was identified as fine metal wear particles, commonly referred to as metallic debris or swarf, which had been generated through the abrasive and adhesive wear mechanisms occurring between the engine's internal moving components during normal and abnormal operation.

The contamination originated from two primary sources. First, the normal wear process between metal surfaces in relative motion, including piston rings against cylinder liners, crankshaft journals against bearing shells, and camshaft lobes against tappet surfaces, continuously generates microscopic metallic particles that become suspended in the circulating oil. Second, the abnormal wear resulting from the piston cooling nozzle fracture and subsequent thermal stress on cylinder number 2 components accelerated the generation of metallic debris beyond the filter's design capacity.

The progressive accumulation of these metallic particles on the filter element created an increasing flow restriction within the oil circuit. As the effective filtration area decreased due to clogging, the pressure differential across the filter increased, and the volume of oil reaching the downstream engine components was progressively reduced. This flow restriction, combined with the oil leakage at the fractured piston cooling nozzle, compounded the overall pressure decrease observed at the engine control room instrumentation.

C. Fishbone Diagram Analysis Results

The fishbone diagram analysis identified contributing factors across multiple categories. Under the Machine category, the primary causes were the piston cooling nozzle fracture and filter clogging. The Material category revealed the use of non-specification spare parts as a critical contributing factor. The Man category identified insufficient crew awareness regarding the importance of material verification during spare parts installation. The Method category highlighted gaps in the planned maintenance system, specifically inadequate frequency of filter inspection and oil quality testing. Finally, the Environment category noted the harsh operating conditions of the engine room, including elevated temperatures and vibration levels, which accelerated material fatigue on the substandard plastic nozzle component.

V. CONCLUSION

Based on the analysis and discussion presented in this study, the following conclusions and recommendations are drawn regarding the lubricating oil pressure decrease in the generator engine on board MT. Anargya I.

The decrease in lubricating oil pressure on the generator engine was caused by two interrelated factors. The first factor was the fracture of the piston cooling nozzle on cylinder number 2, which was directly attributable to the use of a plastic material component that did not conform to the copper alloy specification prescribed in the engine manufacturer's instruction manual. The second factor was the clogging of the lubricating oil filter element by accumulated metal wear particles that had been generated through friction between internal engine components and were not removed through timely filter maintenance.

Several recommendations are proposed to prevent the recurrence of similar incidents. First, the vessel's spare parts management system should be strengthened to ensure that all procurement requests to the company headquarters include precise part number specifications in accordance with the instruction manual book, and a verification procedure should be implemented prior to installation to confirm material compliance. Second, the engine department crew must adhere strictly to the scheduled preventive maintenance program, which includes regular inspection and cleaning of the lubricating oil filter and routine oil quality testing on the carter oil before generator startup. Third, enhanced communication and coordination among engineering officers should be established to ensure that all corrective maintenance actions are performed comprehensively and in a timely manner.

REFERENCES

[1] D. Woodyard, Pounder's Marine Diesel Engines and Gas Turbines, 9th ed. Oxford: Butterworth-Heinemann, 2009.

[2] H. Kuiken, Diesel Engines for Ship Propulsion and Power Plants. Onnen: Target Global Energy Training, 2012.

[3] K. Ishikawa, Introduction to Quality Control. Tokyo: 3A Corporation, 1990.

[4] Cummins Inc., Operation and Maintenance Manual: K-Series Diesel Engines. Columbus, IN: Cummins Inc., 2018.

[5] R. L. Mott, Applied Fluid Mechanics, 6th ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006.

[6] International Maritime Organization, International Safety Management Code (ISM Code), 4th ed. London: IMO Publishing, 2018.

[7] International Maritime Organization, SOLAS: International Convention for the Safety of Life at Sea, Consolidated ed. London: IMO Publishing, 2020.

[8] S. K. Friedlander, Smoke, Dust, and Haze: Fundamentals of Aerosol Dynamics, 2nd ed. New York: Oxford University Press, 2000.

[9] J. Sugiyono, Metode Penelitian Kuantitatif, Kualitatif, dan R&D. Bandung: Alfabeta, 2017.

[10] D. R. Stinson and R. E. McFadden, Lubricating Oil Analysis for Marine Applications. Houston: Gulf Professional Publishing, 2015.

[11] American Bureau of Shipping (ABS), Guidance Notes on Equipment Condition Monitoring Techniques. Houston: ABS, 2016.

[12] Badan Klasifikasi Indonesia, Rules for Classification and Construction of Seagoing Ships, Vol. III: Machinery Installations. Jakarta: BKI, 2019.

[13] T. Lamb, Ship Design and Construction, Vol. 2. Jersey City, NJ: SNAME, 2004.

[14] M. J. Neale, The Tribology Handbook, 2nd ed. Oxford: Butterworth-Heinemann, 2001.

[15] PT. Maritim Indo Trans, Vessel Particulars and Machinery Data Sheet: MT. Anargya I. Jakarta: PT. Maritim Indo Trans, 2020.