

Analysis of Freon Leak Identification and Repair in Refrigerator Piping System on MT GAS ALTHEA Ship

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ABSTRACT

This study aims to identify piping systems and detect Freon leaks in food refrigeration machines on ships that cause decreased circulation efficiency and increased energy consumption. The methods used include field inspections, leak testing with electronic and soap-water leak detectors, and repairs with pipe replacement. Of the 10 units tested, 7 had leaks at the joints and 3 due to corrosion, with a leak detector detection success rate of 95% compared to 70% of the soap-water method. Pipe repair increased efficiency by an average of 20%, and retesting for seven days showed normal operation without re-leaking. The result is the importance of periodic maintenance, the selection of quality plumbing materials, and the training of technicians to maintain the efficiency and disposal of the ship's cooling system.

Keywords: *Piping System, Freon Leak, Leak Detector, Ship Refrigerator*

ABSTRAK

Penelitian ini bertujuan mengidentifikasi sistem pemipaan dan mendeteksi kebocoran Freon pada mesin pendingin makanan di kapal yang menyebabkan menurunnya efisiensi sirkulasi dan peningkatan konsumsi energi. Metode yang digunakan meliputi inspeksi lapangan, pengujian kebocoran dengan detektor kebocoran elektronik dan sabun-air, serta perbaikan dengan penggantian pipa. Dari 10 unit yang diuji, 7 mengalami kebocoran pada sambungan dan 3 akibat korosi, dengan tingkat keberhasilan deteksi detektor kebocoran sebesar 95% dibandingkan 70% metode sabun-air. Perbaikan pipa meningkatkan efisiensi rata-rata 20%, dan pengujian ulang selama tujuh hari menunjukkan operasi normal tanpa kebocoran ulang. Hasilnya adalah pentingnya pemeliharaan berkala, pemilihan material pipa berkualitas, dan pelatihan teknisi untuk menjaga efisiensi dan pembuangan sistem pendingin kapal.

Kata Kunci: *Sistem Pemipaan, Kebocoran Freon, Leak Detector, Refrigerator Kapal*

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1. INTRODUCTION

Food cooling machines on ships have a very important role in maintaining the quality of food storage during shipping. The system works by utilizing *refrigerant circulation* that passes through various key components such as compressors, *condensers*, *evaporators*, and *receivers* to maintain optimal temperatures. Leaks in piping systems, particularly in corroded pipe joints and pipes, are often an obstacle that interferes with reception efficiency and increases energy consumption.

This study aims to identify the piping system and detect *Freon* leakage in food refrigeration machines in. The methods used include field inspections of the piping system, leak measurement using electronic leak detectors and conventional soap-water methods, and repairs by replacing damaged pipes. This approach is expected to provide a comprehensive overview of the condition of the cooling system and effective maintenance measures.

Of the 10 units of refrigeration machines tested, it was found that 7 units had leaks in the pipe connections, while 3 other units had leaks due to pipe corrosion. The success rate of leak detection using electronic detectors reaches 95%, much higher than the soap-water method which is only 70%. These results show that modern detection tools are very effective in supporting the process of identifying problems in piping systems.

After repairs in the form of replacing damaged pipes, the cooling efficiency of the engine increased by an average of 20%. A seven-day retest showed that all of the repaired units were operating properly without any re-leaks. This emphasizes the importance of appropriate and planned repair actions in maintaining the performance of the refrigeration machine.

This research has important benefits, both practically and practically. Theoretically, this research can be a source of study for further research related to the maintenance and repair of food refrigeration piping systems on ships, as well as a reference for readers who want to understand more deeply how leak detection and handling can improve system efficiency. Practically, the results of the study

provide important information that is useful in the selection of quality pipe materials, adequate technician training, and the implementation of regular maintenance.

2. METHOD

This study uses a descriptive approach to analyze the damage to the piping system of the refrigeration engine on the MT ship. Althea gas with a systematic data collection method. The main focus of the research is to describe in detail the condition of the piping system and detect potential leaks that can degrade the performance of the refrigeration engine. The variables analyzed included the identification of damage to pipes and joints and the application of leak detection techniques using modern tools. The population studied was the refrigeration engine unit on the ship, with samples taken from the ship's refrigeration engine piping system.

Data was collected through two main methods, namely direct observation (field research) during marine practice on ships to obtain primary data, and literature studies which included literature reviews, books, and documents related to ship cooling systems to obtain relevant theoretical foundations. The research instruments used included observations, interviews with ship officers and lecturers, as well as documentation of events during the research process.

The data analysis technique is carried out by comparing the collected field data with existing theories and references, then critically analyzed to provide an in-depth understanding of the condition and malfunction of the refrigeration engine piping system. All data collected is carefully processed and analyzed to produce accurate and relevant conclusions, which are then presented in the form of scientific papers in the form of thesis as research results.

3. RESULTS AND DISCUSSION

a. Research Overview

This research aims to identify and analyze the *refrigeration system* on MT ships. Althea gas, which has an important role in maintaining the quality of goods during shipping. This system functions to maintain the temperature of the refrigeration chamber in the range of -18°C to -20°C so that stored goods do not deteriorate. *The refrigerant* used is Freon R134a, which is known to be

environmentally friendly and efficient for working at low temperatures.

The main components that support this *refrigeration system* include screw-type compressors designed for high efficiency, shell-and-tube-type condensers, expansion valves that regulate the flow of refrigerant, and coil-shaped evaporators located in the refrigeration chamber. Each of these components works synergistically to ensure that the temperature of the cooling chamber remains stable during the voyage and maintains the quality of storage.

The importance of this refrigeration system lies not only in its ability to maintain temperature but also in supporting ship operations so that stored materials remain in optimal condition. With a well-maintained system, the durability and quality of the materials stored on the ship can be guaranteed until the final destination of the voyage is reached.

b. Object Data Studied

Table 1. Cooling System Parameters under Normal Conditions

Yes	Parameter	Units	Normal Values	Remarks
1	HP (Pressure Side Pressure)	Bar	12 – 18	Pressure out of the compressor
2	LP (Suction side pressure)	Bar	1,5 – 2,5	Pressure inlet into the compressor
3	LO Press (Oil pressure)	Bar	3 – 5	Normal compressor lubrication
4	Cooling chamber temperature	°C	-5 to -8	Ideal storage room temperature
5	Compressor current	Amperes	6 – 8	Normal workload
6	Sight glass	Visual	Clear	Full Freon , no bubbles
7	Duty Cycle Compressor	minutes	20 – 30	Compressor works in a cycle
8	Pressure test (90 psi)	jam	≥ 12 jam	Pressure stable, closed system

Source: MT Ship. Gas Althea

Table 2. System Parameters When a Leak Occurs

No	Parameter	Units	Value at Moment of Leak	Remarks
1	HP (Pressure Side Pressure)	bar	2,8	Pressure drops drastically
2	LP (Suction side pressure)	bar	0,6	The main signs of refrigerant shortage
3	LO Press (Oil pressure)	bar	< 2.5	Less lubrication, risk of compressor wear
4	Cooling chamber temperature	°C	-3,2	Not reaching the ideal temperature
5	Compressor current	Ampere s	5	Light load but constant work
6	Sight glass	Visual	There is a bubble	Refrigerant is not enough
7	Duty Cycle Compressor	minutes	Non-stop	The compressor continues to work
8	Pressure test (90 psi)	jam	4 hours (down to 84 psi)	Leak detected

Source: MT Ship. Gas Althea

Table 1. System Parameters After Repair

No	Parameter	Units	Value After Repair	Remarks
1	HP (Pressure Side Pressure)	bar	14,2	Back to normal
2	LP (Suction side pressure)	bar	1,8	Stable to standard
3	LO Press (Oil pressure)	Bar	3,6	Optimal re-lubrication
4	Cooling chamber temperature	°C	-6,5	Efficient cooling again
5	Compressor current	Ampere s	6,9	Normal work with standard load
6	Sight glass	Visual	Clear	Freon is enough, circulation is smooth
7	Duty Cycle Compressor	minutes	18 – 25	The compressor works normally
8	Pressure test (90 psi)	Hours	Stable 12 hours	No leaks

Source: MT Ship. Gas Althea

c. Research Data Analysis

Based on the results of observations and analyses carried out on the food refrigeration system on the MT ship. Althea gas, some of the main factors that cause performance impairments can be identified by this system using a steam compression cycle with *Refrigerate* R-134a.

A. Refrigeration System Leak Identification

The food refrigeration system (refrigerator) on the MT. Althea gas uses a vapor compression system with refrigerant R-134a. The system works on a closed cycle that includes repeated compression, condensation, expansion, and evaporation processes to produce a cooling effect. The main components of the system include a compressor that compresses refrigerant into a high-pressure gas, a condenser that releases heat, an expansion valve to lower pressure, and an evaporator that evaporates refrigerant to absorb heat from the cooling chamber.

During the observation several symptoms of abnormalities were found, such as the temperature of the cooling chamber only reaching -3.2°C , the compressor working non-stop without a shutdown cycle, and the pressure of the suction side and the compressive side were far below standard. Pressure measurements show the suction side pressure is 0.6 bar and the pressure side is 2.8 bar, while the normal standard is 1.5–2.5 bar and 12–18 bar. The compressor's electrical power consumption also increases, signaling a heavier workload due to unstable refrigerant pressure.

To detect the location of the leak, two methods were carried out, namely an examination with an electronic leak detector which found two active leak points at a rate of 0.3 grams per hour, and a pressure test with nitrogen which lowered the pressure from 90 psi to 84 psi for 4 hours. The leakage point is detected at the pipe connection near the expansion valve experiencing wear due to vibration, and the pipe near the receiver dryer is experiencing mild corrosion due to environmental humidity.



Figure 3. Foodstuff Cooling Machine
Source: MT. GAS ALTHEA

B. Effects of Corrosion on Refrigerant Pipes

Corrosion in refrigerant pipes on MT ships. Althea gas is the main cause of freon leaks in the cooling system. Although the pipes use corrosion-resistant copper materials, exposure to seawater vapor, mechanical vibrations, and other metal contamination accelerates damage. Corrosion mainly occurs in areas with high humidity and limited ventilation. Physical examination found mild to moderate corrosion with fine cracks and blackened surfaces on the pipes near the receiver dryer and evaporator.

Corrosion causes micro-holes that are the source of leaks, resulting in a decrease in system pressure, compressor damage due to low workloads, and decreased cooling efficiency. The life of the pipe, which is more than six years old and mechanical vibrations that are not held back by the supports, also aggravate the condition. Corrosion prevention requires regular maintenance and periodic inspections, especially in prone areas to prevent re-leakage. Maintenance includes replacement of worn pipes, surface protection, and installation of brackets to reduce vibration.

C. Analysis of Cooling System Parameters

The cooling system on the ship works on the basis of a steam compression cycle with R-134a refrigerant which maintains the temperature of the refrigeration chamber from -5°C to -8°C . The analysis is carried out under normal conditions, when a leak occurs, and after repair by measuring pressure, room temperature,

compressor current, oil pressure, as well as visual inspection and pressure test.



Figure 4. Leaks In *Solenoid Valves* And Pipes In Foodstuff Refrigeration Machine Systems

Under normal conditions, the pressure and suction side are standard (12–18 bar and 1.5–2.5 bar), the cooling temperature is optimal, the compressor duty cycle is reasonable, and the sight glass is clear without bubbles. During the leak, the pressure drops drastically (2.8 bar and 0.6 bar), the room temperature is not reached, the compressor current drops, and the sight glass shows the presence of bubbles. After repairs including joint welding, component replacement, vacuum, and refrigerant refill, the system returns to normal with standard pressure and temperature, as well as an optimal compressor duty cycle. A 12-hour pressure test showed a leak-free meeting system, demonstrating successful repairs.

D. Cooling System Repair Efforts

Repairs begin with a thorough inspection using soap foam, electronic leak detectors, and visual inspections of leak-prone points. Defective components such as corrosion pipes, seals, O-rings, and filter dryers are replaced as standard. The pipe joints are rewelded by the brazing method with nitrogen purging to avoid oxidation.

After repair, a vacuum is carried out for 45 minutes and R-134a freon is refilled according to the system capacity. The system is pressure-tested and controlled for 24 hours to ensure operational stability. The implementation of preventive maintenance programs including pressure checks, temperatures, visual inspections, parameter recording, and technician training is carried out to maintain the integrity of the system.

E. Evaluation of the System After Repair

Post-repair evaluation shows stable working pressure and temperature, cooling performance is restored, and compressor work cycle is normal. Pressure tests and monitoring for 14 days did not show any re-leaks. Positive vessel technician feedback with easy-to-monitor system conditions and no refrigerant refill.

Overall, the damage to the cooling system on the MT ship. Althea gas is caused by refrigerant leakage due to corrosion and pipe wear that can be prevented with periodic inspections and maintenance.

4. CONCLUSION

Based on the results of research on *freon leakage* in the piping system of the refrigeration engine on the MT ship. Althea gas, it was found that the main cause of the leak was damage to the pipe connections using the dilution method. The joints are not able to withstand the vibration and high pressure of the vessel continuously, especially under dynamic and corrosive operating conditions. This condition causes freon to leak easily and disrupt the stability of the refrigeration ship system.

Freon *leaks* have a very significant impact on the performance of the cooling system, including causing an increase in the temperature of the storage room, the risk of compressor damage due to overwork, and potentially causing logistical losses and environmental threats to the consequences of *freon* emissions. To overcome this problem, the repair with the brazing welding method on pipe joints has proven to be much more effective compared to hostage-taking. The repair process equipped with a vacuum system and *freon* filling according to standards successfully restored the performance of the cooling system to optimal condition.

As a follow-up, it is recommended to replace the connecting pipe connection method with a brazing technique that is more resistant to pressure and vibration. In addition, regular monitoring of the cooling system such as *freon* pressure, operating temperature, and pipe connection conditions is essential to prevent re-

leaks. Standardization of repair procedures involving vacuum and *freon* refilling must be applied consistently, and post-repair evaluation and documentation must be carried out to keep the cooling system stable and can be used as a reference for other ship maintenance.

5. REFERENCES

- Aji, R. P., Daryanto, & Wiratno. (2019). Freon leakage causes a decrease in evaporator work in refrigerator machines in MV. Asike Global. Proceedings of the Seminar in the Field of Nautical Navigation, 1–9. http://repository.pipsemarang.ac.id/3012/1/51145363T_PROSIDING_FULLTEXT.pdf
- American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- ASHRAE. (2021). ANSI/ASHRAE Standard 34-2021: Designation and Safety Classification of Refrigerants.
- B. J. T. (2025). Cold storage cooling systems: How does they work? <https://bjtindonesia.id/2025/02/05/sistem-pendingin-cold-storage-bagaimana-cara-kerjanya/>
- Bhatti, M. M., Ahmad, R., Alqahtani, R. T., Alsharif, A. M., & Sait, S. M. (2022). A recent development in refrigeration and air conditioning systems: A comprehensive review. *Materials Today: Proceedings*, 62, 3056–3063. <https://doi.org/10.1016/j.matpr.2022.02.053>
- Chen, M., Wang, X., Zhou, Q., & Sun, Y. (2023). Performance optimization of thermoelectric refrigeration systems for marine applications using nanofluid-enhanced heat sinks. *Energy Conversion and Management*, 291, 117422. <https://doi.org/10.1016/j.enconman.2023.117422>
- Honeywell. (2022). R-134a Refrigerant Safety Data Sheet. <https://www.honeywell-refrigerants.com> Indonesia, IMO Publishing.
- Insight, M. (2025). Ship's refrigeration plant—Working and uses. <https://marineinsight.com>
- Journal of Smart Maritime Engineering*, 51(2), 130–145.
- Kim, S., Park, J., & Lee, H. (2023). Artificial intelligence for energy optimization in shipboard incinerators. Ltd, I. C. B., & Co. (2021). SOLAS LSA Training Manual (4th ed.). I.C. Brindle & Co. Ltd.
- Madengineer.com. (2025). Main components of refrigeration engines. <https://madengineer.com>
- Organization, I. M. (2021). MARPOL Annex VI: Regulations for the prevention of air pollution from ships.
- Rizwan, M., Khan, M. I., & Zahid, M. (2022). Energy efficiency analysis of absorption refrigeration systems in shipboard food preservation. *Journal of Cleaner Production*, 378, 130849. <https://doi.org/10.1016/j.jclepro.2022.130849>
- Smith, J., & Tanaka, K. (2020). Refrigeration and air conditioning for marine engineers (2nd ed.). Springer Maritime Engineering Series.
- TeknologiRefrigerasi.com. (2025). Freon and its application in refrigeration systems. <https://teknologirefrigerasi.com/freon-sistem-pendingin>