



# Factors Causing an Increase in the Main Engine's Cooler Fresh Water Temperature KMP. Port Link III

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**Abstract :** This study examines the factors causing the increase in the fresh water cooler (FWC) temperature of the main engine on the KMP Port Link III. The FWC cooling system plays a crucial role in maintaining a stable and efficient engine operating temperature. However, temperature increases exceeding the optimal operating limit can pose a risk of serious engine damage. The objective of this study was to identify the primary causes of the FWC temperature increase and evaluate the effectiveness of maintenance measures in reducing system temperature. Data collection was carried out through direct onboard observation, recording temperature data before and after maintenance, and technical analysis of cooling system components. Data were obtained through temperature measurements at the FWC outlet and engine cylinders, as well as inspections of the sea chest, strainer, freshwater pump, and coolant capillary tube. The results showed that blockages in the strainer and capillary tube, decreased pump pressure, and insufficient cooling water volume were the primary factors causing the freshwater temperature to rise to 80°C. After maintenance measures, such as cleaning and refilling the cooling water, the temperature was successfully reduced to the normal range of 51–54°C. This study emphasizes the importance of routine and systematic cooling system maintenance to maintain optimal main engine performance and prevent operational disruptions.

**Keywords :** Fresh Water Cooler, Cooling, Temperature, Routine Maintenance

## 1. INTRODUCTION

The main engine is one of the most critical components in ship operations because it functions as the primary propulsion system that ensures vessel mobility and operational reliability. In marine diesel engines, maintaining the engine operating temperature within the allowable range is essential to achieving optimal combustion efficiency, reducing fuel consumption, and preventing premature component failure [1]. Excessive engine temperature can lead to overheating, increased thermal stress, lubrication failure, and severe mechanical damage, ultimately affecting ship safety and operational continuity [2].

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One of the most important supporting systems in marine diesel engines is the cooling system. The cooling system is responsible for absorbing and dissipating the heat generated during the combustion process in the engine cylinders [3]. Marine diesel engines generally use a centralized cooling system consisting of freshwater and seawater circuits. In this system, the Fresh Water Cooler (FWC) acts as a heat exchanger that transfers heat from the freshwater cooling circuit to seawater before the freshwater is recirculated into the engine [4]. Therefore, the performance of the FWC significantly influences engine temperature stability and overall machinery efficiency.

During engine operation, combustion temperatures inside the cylinder chamber can reach 600°C–800°C, while combustion pressure may exceed 30–40 kg/cm<sup>2</sup> [5]. Without an effective cooling system, these extreme conditions may cause thermal expansion, cylinder liner wear, piston seizure, and even catastrophic engine failure [6]. Consequently, maintaining the efficiency of the FWC and associated cooling components is essential to ensuring safe and sustainable ship operations.

In practice, cooling system disturbances frequently occur on merchant vessels, especially those operating continuously under high engine loads. One of the most common problems is the increase in freshwater cooling temperature beyond the normal operating range [7]. Several factors may contribute to this condition, including blockage in the sea chest or strainer, fouling inside heat exchanger tubes, inadequate seawater circulation, reduced pump performance, leakage in the cooling system, and insufficient cooling water volume [8]. These issues can reduce heat transfer efficiency and cause abnormal increases in engine temperature.

Research conducted by Tjahjono et al. showed that cooling system failure is one of the dominant causes of marine diesel engine malfunction and contributes significantly to engine downtime [9]. Similarly, the Marine Engineering Review reported that approximately 35% of failures in merchant ship propulsion systems are related to cooling system problems, with a large proportion associated with inefficient heat exchange in freshwater cooling systems [10]. These findings indicate that the cooling system requires continuous monitoring and systematic maintenance to ensure operational reliability.

Routine maintenance plays a crucial role in maintaining cooling system performance. Preventive maintenance measures such as cleaning strainers, inspecting pump pressure, flushing cooling pipelines, and replacing damaged components can significantly improve cooling efficiency and reduce the risk of overheating [11]. According to Gunarin, proper maintenance management is essential for maintaining stable engine temperatures and extending engine service life [12]. Inadequate maintenance not only reduces engine reliability but also increases operational costs due to unexpected repairs and fuel inefficiency [13].

The advancement of marine engineering technology has encouraged the implementation of more effective cooling system monitoring methods. Several studies have highlighted the importance of temperature monitoring and predictive maintenance approaches in detecting abnormalities before major damage occurs [14]. Real-time monitoring of freshwater outlet temperatures and seawater circulation conditions can help engineers identify performance degradation in cooling system components at an early stage [15].

Despite the importance of the freshwater cooling system, studies specifically discussing the causes of increased Fresh Water Cooler temperatures on Indonesian ferry

vessels remain limited. Most previous studies focus generally on marine engine performance without detailed analysis of the operational and maintenance factors influencing FWC effectiveness. Therefore, this study aims to analyze the factors causing the increase in Fresh Water Cooler temperature on the main engine of KMP Port Link III and evaluate the effectiveness of maintenance measures in restoring normal operating conditions. The findings of this study are expected to contribute to improving cooling system maintenance practices and enhancing the operational reliability of marine diesel engines in ferry transportation services.

## 2. METHODOLOGY

### Data Collection Methods

**Primary Data** The data to be collected in this study includes information on the inlet and outlet temperatures of the Fresh Water Cooler, as well as the outlet temperatures of each cylinder in the main engine. This data serves as an important indicator in analyzing the efficiency of the cooling system and detecting potential abnormal temperature increases in engine components. **Secondary Data** Secondary data is information not obtained directly from the field but rather gathered through various written sources such as reference books, scientific journals, ship technical documents, official websites, and previous research results related to this research topic.

### Data Collection Techniques

In preparing this Mandatory Working Paper, complete, valid, and accountable data and information are required to be processed into an accurate and representative picture. To support the field data processing process, a theoretical basis is also required as a reference in compiling this paper. Therefore, the author implemented several data collection methods.

### Data Analysis Techniques

The data obtained in this study will be analyzed by comparing the temperatures at the inlet and outlet of the fresh water cooler, as well as the temperature in the main engine cylinder cooling system before and after maintenance. This comparative analysis aims to identify the extent to which the cooling system affects the performance of the main engine on board the KMP Port Link III and to provide an overview of the effectiveness of the cooling system after maintenance.

## 3. DISCUSSION

This research was conducted during the author's sea practice (PRALA) on board the KMP Port Link III, which is managed by PT ASDP Indonesia Ferry (Persero), the primary operator responsible for managing the ship's operational activities. The author chose the title "Factors Causing an Increase in Fresh Water Cooler Temperature on the Main Engine of KMP Port Link III" due to frequent problems with the ship's Fresh Water Cooler, which could potentially cause the main engine to overheat and reduce its performance. In collecting data, the author used direct observation while on board to obtain accurate information consistent with actual conditions in the field. The maintenance process aims to ensure the cooling system continues to operate optimally according to user expectations. Before carrying out maintenance, the author first identified common problems with the Fresh Water Cooler system, then analyzed them

and sought the best solutions. Some of the problems frequently encountered with the Fresh Water Cooler system include the following.

According to (Hidayat, 2019), a sea chest is a device connected to seawater attached to the inside of a ship's hull plate below the waterline. It is used to channel seawater into the ship to meet the seawater system's needs. There are two sea chests: one positioned slightly higher (standard high sea chest) and the other slightly lower (standard low seachest). Between the sea chests, a filter is installed as a place to collect dirt that comes with the sea water sucked by the pump. A clogged filter can result in reduced suction pressure from the pump which results in the role of sea water not being optimal in cooling fresh water and the dirt can cause the cooler to become dirty so that the fresh water cooling does not work optimally. This clogged filter is caused by the growth of moss and shellfish that cover the small holes in the filter. The way to overcome this is to clean the filter after passing through river water and use a good zinc anode. Therefore, regular maintenance and cleaning are very necessary so that the filter function continues to run optimally and does not interfere with the flow of cooling water to the main system.

The impeller in a centrifugal pump is a pump component whose primary function is to suck up water. If the impeller is damaged or worn, the pump's performance in sucking up fresh water will be less than optimal, resulting in decreased pump pressure. The resulting decrease in pump pressure results in less than optimal fresh water flow to the fresh water cooler system (main engine cooling water) in the fresh water cooler (Hidayat, 2019). This decrease in pump pressure can be caused by worn-out gaskets that require replacement.

Dirt carried by seawater is often not completely filtered at the beginning of the filtration system. This is caused by the holes in the seawater filter being too large, allowing small particles such as fine silt and marine organism remains to pass through. As a result, this dirt can potentially enter the capillary tube and block the coolant flow. This blockage will certainly hinder the overall circulation of the coolant and directly impact the performance of the main engine cooling system.

Table 1. Outlet temperature of each cylinder of the right main engine after maintenance.

Time	Temperature Outlet							
	08.00-12.00	64	66	67	65	61	65	63
12.00-16.00	67	67	66	67	61	65	64	74
16.00-20.00	65	67	66	64	63	66	65	74
20.00-00.00	65	65	65	64	64	64	63	73

Source: KMP Port Link III, 2025

This discussion identifies and analyzes several technical factors contributing to the rising temperature in the main engine cooling system, which directly affects the operational performance of KMP Port Link III. The first major factor is the decreased pressure of the cooling water pump, which plays a vital role in maintaining the stability of the engine's operating temperature. Observations show that when the pump pressure

drops below the standard of 3.0 kg/cm<sup>2</sup>, the flow rate of cooling water decreases, leading to reduced heat absorption. This decline is primarily caused by insufficient cooling water volume, scaling on the impeller, bearing damage, or general wear of internal components. Such mechanical degradation results in inefficient circulation, causing an increase in the temperature of the cylinder liner, cylinder head, and exhaust valve. If left unresolved, this condition may escalate into severe overheating and eventual engine failure.

Another critical aspect identified is the insufficient cooling water volume in the system. Cooling water functions as the primary medium for heat transfer between engine components and the fresh water cooler. When its volume is inadequate, the heat generated by the engine cannot be effectively absorbed, resulting in elevated temperatures within the system. The shortage of cooling water may stem from leaks in the piping system, improperly opened valves, or evaporation during prolonged voyages under high-temperature operations. Consequently, reduced coolant circulation disrupts the thermal balance of the engine and lowers overall cooling efficiency, underscoring the need for consistent monitoring of the system's hydraulic integrity.

In addition to pressure and volume issues, the study also found that the fresh water cooler (FWC) temperature did not meet operational standards. Data from field measurements indicated that the FWC inlet temperature ranged from 58 °C to 63 °C, while the outlet temperature of the right main engine cylinder reached 83 °C to 85 °C. This condition signifies that the heat absorption process inside the cooler is not functioning optimally. One of the main causes is the blockage of capillary tubes by sludge, sand, or marine debris carried by seawater. When these particles accumulate, they restrict seawater flow and increase back pressure, thereby reducing the effectiveness of the heat exchange process. This problem is often linked to malfunctioning seawater strainers or filters that fail to trap fine contaminants before they reach the cooler.

Furthermore, a decrease in seawater pump pressure also significantly contributes to poor FWC performance. Reduced seawater pressure limits the flow through the capillary tubes, lowering the system's convective heat transfer rate between the fresh water and seawater. Over time, mineral deposits and scale buildup further narrow the internal passageways of the tubes, worsening the situation. In thermodynamic terms, this degradation diminishes the overall heat exchange coefficient, preventing the cooling system from maintaining the fresh water temperature within its operational threshold. Regular inspection, cleaning of capillary tubes, and maintenance of both seawater and freshwater pumps are therefore essential to sustain optimal cooling performance and prevent overheating of the main engine.

#### **4. CONCLUSION**

This study found that the increase in the fresh water cooler (FWC) temperature in the main engine of KMP Port Link III was caused by three main factors. First, the accumulation of dirt in the sea chest and strainer impeded the flow of seawater to the FWC. Second, the pressure of the freshwater pump decreased due to impeller damage, bearing wear, and insufficient cooling water volume. Third, the blockage of the FWC capillary tube by sludge and scale disrupted the heat transfer process. As a result of

these disturbances, the freshwater temperature rose above 80°C, posing a risk of main engine overheating.

After maintenance actions such as cleaning the filters, boosting the cooler, adding cooling water, and repairing the pump, the freshwater temperature returned to normal within the range of 51–54°C. These corrective measures proved effective in stabilizing the cooling system temperature and restoring engine performance. Furthermore, proper maintenance has been shown to prevent potential damage to vital engine components and improve the overall operational efficiency of the vessel.

Therefore, routine maintenance and periodic inspection of the cooling system are essential to ensure stable main engine operating temperatures. Scheduled activities such as cleaning the sea chest and seawater filters every 1–2 weeks, monthly inspections of the freshwater pump and capillary tubes, and prompt repairs when abnormalities are detected can maintain optimal cooling efficiency. These preventive measures not only minimize the risk of overheating but also extend engine lifespan and support the vessel's safe and efficient operations.

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