e-ISSN 3089-1248

Cargo Handling Method Due to Temperature Decrease in Para-Xylene Cargo During Winter on MT WOO DONG

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***Abstract*—This thesis is entitled "Cargo Handling Method Due to Temperature Decrease in Para-Xylene Cargo During Winter on the MT WOO DONG". The operation of tankers is very complex, requiring officers and crew to use safety equipment in accordance with the Ship Oil Pollution Emergency Plan (SOPEP) to carry out cargo operations and tank cleaning effectively. One of the special payloads of concern is Para-Xylene, an aromatic hydrocarbon that is generally derived from crude oil and is used in the production of polyester fabrics and PET plastic bottles. However, Para-Xylene has a freezing point of 13.2°C which is higher than other xylene isomers, thus posing challenges during payload operations, especially in cold weather conditions. Several incidents involving the handling of Para-Xylene cargo on the MT WOO DONG ship from December 18th, 2022 – December 26th, 2022 have been documented, due to problems such as cargo freezing in pipelines and valves, which caused operational delays. To address these challenges, proper planning, preparation, and execution of cargo operations are essential, including monitoring cargo temperatures, implementing warming measures, and ensuring collaboration between port personnel and ships. This study aims to analyze and propose a method of handling Para-Xylene cargo in cold weather conditions on the MT WOO DONG ship to prevent freezing incidents and optimize cargo operations efficiently.**

Keywords—Tanker, Para-Xylene, cargo operation, cold weather, freezing, safety meeting.

I. INTRODUCTION

Sending goods and services is a very important activity in community life, both among the general public, government, and industrial companies. Through waters, namely ships as delivery accommodation (DR. Hidayat, 2018). Ships also have the meaning of a vehicle for transporting passengers and goods at sea (rivers, etc.) made of wood or iron, with one or more masts, decks, driven by engines or sails. Ships are able to sail to transport large amounts of cargo and travel quite far at a relatively more affordable cost (In the Big Indonesian Dictionary or KBBI).

Technological developments are also taking place very quickly. In order to realize a better ship and goods service system, making it easier for users of sea transportation services to obtain fast, transparent and measurable services (Directorate General of Sea Transportation). Get to know the various types of ships according to their shape and the cargo they carry. Some types of tankers include Crude Oil Carriers, Black - Oil product Carriers, & Chemical & Oil Product Carriers. Chemical & Oil Product Carriers are tankers used to transport clean petroleum oil such as kerosene, gas-oil, RMS (Regular Mogas) and the like (G.S. Marton Fifth Edition (Tanker Operation Fourth Edition Book)).

The operation of tankers is very complex, where officers and crew are required to use safety equipment that has been adjusted based on the Ship Oil Pollution Emergency Plan (SOPEP) and are able to complete the implementation of loading operations and cleaning of cargo tanks effectively according to tank cleaning instructions to facilitate ship loading and unloading operations.

In accordance with the nature of the cargo, a chemical tanker cargo, especially the Para-Xylene cargo type. Para-Xylene, also called p-xylene, is an aromatic hydrocarbon that is usually obtained from crude oil sources. The chemical formula for paraxylene is C6H4(CH3)2 (One Solution Pertamina, 2023). For the manufacture of polyester fabrics and PET plastic bottles, this is one of the raw materials needed. Paraxylene belongs to the xylene family which consists of three isomers of dimethylbenzene (One Solution Pertamina, 2023). PX has a much higher freezing point than other xylene isomers (One Solution Pertamina, 2023). The boiling point and melting point of Para-Xylene are 138.35°C and 13.2°C, respectively (S-OIL MSDS Book). Therefore, if the air temperature is below freezing point, the temperature in the tank will decrease, causing the liquid in the tank to change form to solid (freeze). Then at the cargo operation stage, cargo handling becomes very important to avoid delays. There are several incidents that have occurred in handling Para-Xyelene cargo on the MT WOO DONG ship.

The cargo line is usually impassable by cargo because the cargo freezes during loading or unloading, usually because the cargo is blocked from entering the tank, especially in the pump side area (knowladgeofsea.com). In this case, there are several factors that must be considered when the Chief Officer performs the Sequence before the loading operation, so that it is correct and maintains the temperature so that the cargo remains melted and in normal condition.

The planning stage includes collecting information about the cargo to be loaded and the air temperature in the local area. The preparation stage includes preparing the steaming process, such as steaming hoses for heating in case of freezing on the line or valve, SOPEP (Ship Oil Pollution Emergency Plan) and adequate supporting personnel. The implementation stage includes the implementation of checking tanks by cargo surveyors, equipment for cargo operations by paying attention to existing safety procedures.

Periodic checking & recording of cargo temperatures on the Cargo Monitoring System is required, as well as good cooperation between the port and the ship. Meanwhile, the ship must provide the necessary tools and materials for carrying out cargo operations. Because if the cargo tank and cargo line freeze, the loading process will be stopped and will result in delays in the ship's cargo operations. If this happens, the ship must make a LoP (Letter of Protest).

Therefore, to prevent freezing from occurring, an analysis of the incident is carried out, then Steaming activities are carried out in accordance with those stated in the book The International Code of the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk and Cargo Manual Book at MT WOO DONG.

The primary objectives of this research are:

1) What causes the temperature monitoring system in the cargo monitoring system to be suboptimal, resulting in a significant decrease in the temperature of the cargo?

2) What causes the loading and unloading process to be hampered by frozen cargo?

This research is significant for several reasons. First, To find the cause of the suboptimal temperature monitoring system in the cargo monitoring system temperature in the cargo monitoring system which resulted in a significant decrease in cargo temperature. Second, To find the cause of the delay in the loading & unloading process due to frozen cargo. The results of the research are to increase knowledge about Chemical carriers, especially cargo handling during the winter. and can be used as input for the ship and the office so that the Para-Xylene cargo operation process runs smoothly and efficiently.

II. Literature Review

A. Cargo Handling

According to Arso Martopo and Soergiyanto in their book "Cargo Handling", "cargo handling" is a term in shipping that refers to the way of loading and unloading cargo from and to the ship in such a way that it complies with the five principles of cargo handling. The first principle of cargo handling on a ship is to protect the ship in relation to cargo distribution. Cargo must be distributed vertically and longitudinally as much as possible.

a) Vertical cargo distribution: This is related to the stability of the ship. If cargo is too much concentrated above, it will have low stability and a sloping condition. If the grain is concentrated too much below, it will have excessive stability and stiffness.

b) Longitudinal grain distribution: This distribution is related to trim problems, and can also cause sagging or hogging. Trim is the distance between the front and rear grain.

B. Para-Xylene

Paraxylene or 1,4 dimerthylbenzener is a colorless, low-flammability, liquid-phase aromatic hydrocarbon compound. Paraxylene is one of the xylenes that can be converted into purified terephtalic acid (PTA) and dimerthyl terephthalate which are often used as raw materials for Polyether Terephthalate (PeT) and terephtalic acid (TPA) (Cherm et al.,). Storage of Paraxylene and toluene products must be in tightly sealed tanks and sealed until ready to be used or distributed. Avoid raw material and product tanks from sparks or sparks (Perrtamina, n.d.2023). In the industrial world, this material is very much needed as a raw material for product refining materials. Para-Xylene (PX) is a C8 aromatic compound that is used exclusively as an intermediate raw material for the production of polyesters via pure terephthalic acid (PTA) or dimeryl terephthalate (DMT). PX is one of the most widely used aromatic compounds and contributes almost 86% of the total demand for blended xylenes, as well as global fermented demand in 2021 (Chemical Erconomics Handbook, 2022). Para-Xylenes are widely distributed in the world, attached to Figure 2.1 which presents a graph of PX consumption in 2021. The chemical formula of paraxylene is C6H4(CH3)2 (Oner Solurtion Pertamina, 2023). For the production of polyester fabrics and PErT plastic bottles, this is one of the raw materials needed. Paraxylene belongs to the family of xylenes consisting of three dimerylbenzene isomers (Oner Solurtion Pertamina, 2023). PX has a much higher melting point than other xylene isomers (Oner Solurtion Pertamina, 2023). The boiling point and melting point of Para-Xylene are 138.35°C and 13.2°C respectively (S-OIL MSDS Book).

C. Cargo Pump

According to (ISGINTT Safety Guide Second edition, 2023) Cargo pump rooms must be equipped with a permanent gas detection system that automatically indicates the presence of explosive gases or lack of oxygen through sensors. immediate reduction and which triggers visual and audible alarms when the gas concentration has reached 10% of the lower explosion limit. The sensors of this system must be placed in a suitable position at the bottom and are located under the Deck.

D. Cargo Heating

Many cargo oils have high melting points and high viscosities, so they must be heated and kept warm throughout the process to avoid their natural cooling. There are limitations in heating and insulating cargo oils, especially because of the very different environmental gradients. Therefore, to reduce operating costs and reduce environmental pollution, the implementation of appropriate heating and insulation plans is very important. Currently, the insulation and heating of cargo oil is largely based on crew experience. To prevent delays in shipping, many crews

overheat the crude oil (Chenlong Shern ICAMIM, 2021). Heaters are usually designed to increase the temperature of refrigerated propane from -45°C to -5°C; however, it is important to note that in cargo lanes where this temperature increase can be achieved, it can be significantly reduced in cold water areas. Under such conditions only a very slow escape lane is possible and when the water temperature drops below 5°C it becomes increasingly difficult to use water as a heater. Cargo Drawings are presented in ISGINTT Safety Guidelines for Shipbuilding (2023)

E. Cargo Control Room

Quoted from SIGTTO, 2020 (Recommendations for Dersigning Cargo Control Rooms, Edition 2020), the Cargo Control Room has been developed using the best information currently available, intended purely as a guideline for use at the user's own risk. A Cargo Monitoring System is a system used to monitor the level and condition of cargo. This system is more complicated than the ballast monitoring system. In addition to the cargo control, we can also know about the cargo flow and IG pressure in the cargo tank. This system also uses an electric sensor. We can see the display of the system's main control monitor in the CCR (Cargo Control Room). All valves for controlling weight and cargo are also controlled from here. (Arier Bakhtiar, 2021)
Mernurrurt Abhisherk (2018) The Cargo Control Room (CCR) is one of the parts where the main control operates the unloading and unloading of oil on a tanker. The CCR should be located above the main pump room so that it can see the top of the oil tank well. In addition, the place of goods control must have a fairly large space for the location of the control equipment and its equipment. The Cargo Control Room at MT WOO DONG is located in the front Accommodation Deck. From inside the Cargo Control Room, we can see the conditions outside and pipes such as bypasses above the oil tanks and can also monitor the activities of the crew on the deck. The smoothness of the oil unloading process on the tanker, especially at MT WOO DONG, also depends on the operation of the officers in the Cargo Control Room.

F. Tank Cleaning

Tank Clearing is the cleaning of the remains of goods carried by a tanker ship that has entered the shipyard for repair or maintenance. (Wahyur Baskoro, 2011:16). According to the Standard Training and Certification of Watchkeeping (STCW) Code B Chapter-V Section B - V/I, tanker personnel must undergo training on board and, if necessary, training on shore to meet the requirements and experience in handling and knowledge of the properties of oil fuels, fuel procedures and fuel room preparation. To avoid fire, chemical additives may be used with water flushing not exceeding 60 °C. If the water flushing temperature is higher than 60 °C, the flushing must be stopped. The gas concentration must exceed 35% of the hazard threshold. Cleaning tank (Tank Clearing), is done when replacing the thread and the inspection is carried out by the surveyor before the cargo thread is carried out. (Chapter 9: 2010)

III. METHODOLOGY

The research method used is the descriptive curative method and the multifaceted approach, namely one of the research methods used to describe and explain social or cultural phenomena in detail and in depth through data collection in the form of texts, images, sounds, and direct observations. Descriptive curative research aims to understand and describe social or cultural phenomena in a broader and more complex context. This is achieved through data analysis from field research and the use of measurement tools such as theories related to the problem being studied. Curatorial descriptive research analyzes the behavior and written or spoken words of individuals Lerxy J. (Molerong (2020: 213)). Urnturk examines the hypothesis that suggests that there is or is not a relationship between dura variables or more. This relationship can be causal, namely the relationship between dura variables mutually (Anas Surdijono (2023: 17))

The objective is to explore how maritime institutions innovate their training practices, and how collaboration among stakeholders contributes to this transformation.

A. Research Design

The publication of this research was conducted using a descriptive curricular method and did not use population, sample, and sampling techniques, but used interview, observation, and documentation techniques. There were incidents that occurred during the implementation of sea practice on the MT WOO DONG ship, then recorded as research materials accompanied by documentation on the ship.

B. Research Setting and Participants

The place of research and observation was on the MT WOO DONG ship, owned by a shipping company from Korea, namely WOOLIM MARINE. CO. LTD. With a subsidiary of PT BUSAN JAKARTA MARINE as the managing director from Indonesia.

C. Data Collection Methods

Complete and responsible data and information must be studied and presented to provide a helpful picture and understanding. For good results in this writing, data analysis is needed to clarify the problem material. In this case, data collection uses the following methods:

- Observation: observation is a procedure for collecting data by directly observing the object being studied. Data is obtained by conducting observations through primary data, secondary data, and secondary data obtained from other sources. In addition, this type of information can be more reliable, objective and responsible, because the researcher is directly involved and participates in the situation. (Arikunto, 2022).
- Interview: an interview is a question and answer session with someone (official, etc.) to ask for information or opinions about a particular matter, such as being written in a newspaper, broadcast on the radio, or shown on television. (KBBI, 2018).

- Documentation: Documentation is " Documentation is a record of events that have already passed. Documentation can be in the form of written texts, images, or monumental works from someone. Documentation that clashes with written documents, for example diaries, life histories (life historians), biographical stories, policy regulations". (Sugiyono, 2019).

D. Data Analysis

Data analysis in this study uses an interactive approach model developed by Millers and Hurberrman. Data analysis can be started from formulating and explaining the problem. The steps involved in the observation area and continue until the publication of the research results (Sugiyono, 2016). Data analysis is the process of systematically searching for and sorting data obtained from interviews, field notes and other materials (Sugiyono, 2016).

The steps involved in thematic analysis are:

- Data Collection: The researcher collects data through observation and interviews. The data collected through observation is related to the unloading process on the MT Woo Dong ship.
- Data Reduction: the process of summarizing, choosing the main thing, focusing on the important things, looking for terms and patterns and eliminating unnecessary things.
- Data Display: Presentation of data in curricular research is carried out in the form of brief descriptions, charts and relationships between categories and collecting information that has been structured in an integrated and easy-to-understand manner.
- Conclusion Drawing / Verification: the conclusions drawn at the initial stage are supported by valid and consistent evidence when re-examining the data collection stage, so that the conclusions drawn are credible conclusions.

IV. FINDINGS AND DISCUSSION

A. Findings

The temperature monitoring system in the cargo monitoring system is not optimal, resulting in a significant decrease in temperature.

At that time, MT Woo Dong carried out a shipping process based on the Voyager Instruction. The ship will carry out a voyage carrying cargo to be unloaded at one of the ports in Dalian, China, namely HENGLI No. 6 Terminal on the initial plan of December 25, 2022. Carrying a Para-Xylene cargo of ± 10,500 MT.

When the cargo has been unloaded with the stowage plan on the ship, it has become the full responsibility of the Captain or as a representative of the Chief Security Officer (CSO) of the company on board. However, if there is a delay caused by various things on board the ship, it will be a loss that has an impact on the company. This is stated in the International Convention for the Regulation of Certification of Rulers of Law Relating to Bills of Loading and Protocol of Signatories which explains the responsibilities of the shipper as follows:

- Making the ship seaworthy
- Manning and quipping the ship with shipyard

ACKNOWLEDGMENT *(Heading 5)*

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

Preparing the oil chamber, refrigeration chamber and coolant section of the ship during the first inspection to monitor the oil condition in the Cargo Control Room on December 24, 2022, there was a failure where the low temperature in oil tank number 6 had reached 28°C where Para-Xylene would crystallize at a temperature <28°C and the boiling point and melting point were 138.35°C and 13.2°C respectively (S-OIL MSDS Book). This was caused by the collision between the ship with trim by astern conditions and the steaming action on the condenser resulted in the mixing of water from the condensation on the heating coil in tank number 6. Thus, Muralim I immediately carried out a series of actions on the implementation of Cargo Heater by draining the heating coil and carrying out communication with the cooling room which immediately reduced the surpply cargo heater bar by 45% and then became 80%. So that the temperature slowly returned to normal or not less than 28°C.

- *Loading and unloading was hampered by frozen cargo :* When departing from Daesan, Korea to Dalian, China, there was a snowstorm along the East China Sea waters which resulted in significant changes in the weather with air temperatures reaching -8°C. The ship arrived in Dalian, China on December 24, 2022, which required the ship to dock at the terminal temporarily. Then on December 25, 2022, after receiving information about the docking from the agent via email, the ship carried out the shifting process through HENGLI No.6 Terminal to delay the unloading process. After the docking process was completed, Muralim I carried out a safety inspection with the crew to ensure that all plans would run according to plan. After the Surrveryor carried out a tank inspection assisted by 2nd officer and then the tank was ready to carry out the unloading of the deck. Where the heavy snow storm and low air pressure caused a reduction in the pipes on the deck. When the unloading process had begun. At the time of 3rd Officer's watch, the water level was 0600 liters - 1200 liters. At 0610 lt purkurl when wanting to carry out a change in the tank unloading sequence from tank number 1 to tank number 5, the cargo liner in tank number 5 experienced a reduction caused by the reduced oil so that the oil unloading operation was stopped for approximately 30 minutes, calculated from 0610 lt - 0640 lt. When they found out about the incident, Muralim I and Bosurn carried out a streaming action by using a hose on the reduced cargo liner. The

incident was recorded in the MT Woo Dong deck log book which read, "Ther cargo freeze on cargo liner number 5 & cargo operation temporary stopped".

B. Discussion

- *Conduct a safety meeting before or after carrying out loading and unloading activities:* By implementing safety monitoring, it is expected to optimize crew performance with knowledge of standard operating procedures when the meeting is carried out. The work will be more coordinated and planned. As with implementing monitoring, the officer in charge will plan handling effectively and efficiently by recording it on the Cargo Monitoring System. This system has a sensor installed in the cargo room, where the measurement results are burned to the Monitor. This method must be carried out periodically for no more than 1 hour. Because if the terrserburt recording is done with a relatively long time interval, the decrease in the temperature of the steam will be very significant.
- *Implementation of the cargo heating process :* The implementation of cargo heating is important to be carried out on the para xylene steam, considering that the terrserburt steam reduction point is 13.8°C. This process is also effective, because it can reduce the risk of failure, such as reduction in pipes and steam tanks. Preparing cargo heating is carried out to produce hot steam. One way to implement it is by heating the inlet heating valve and outlet heating valve according to the temperature conditions in each steam tank.

However, in its implementation, tank number 6 often mixes the remaining water on the heating coil liner. This is related to the drain process to drain the remaining water, so that the hot water that passes through will enter optimally and the temperature returns to normal. Later it can also be used through the streaming hose to be used on valves or liners that are clogged due to the threads being left for too long, considering the low external air temperature conditions. Then the occurrence of reduction in stripping liner number 5 which resulted in a delay in the unloading process and the valve was carried out by streaming using a streaming hose where the use of this streaming consumes wasteful fresh water which can be minimized by not delaying the stripping process. because the delay or method carried out at MT Woo Dong causes the valve to reduce in several stripping pipes. Therefore, by carrying out the stripping process immediately when the valve in the tank system starts to run out is very effective because it allows the valve that has passed to continue to flow and there is no sedimentation that causes reduction.

V. CONCLUSION

Significant temperature drop is caused by the temperature monitoring system in the cargo monitoring system is not optimal. Handling of this cargo focuses on the cargo temperature monitoring process and the heating process on the cargo. During the trip, the circulation of hot steam in the cargo tank must be carried out. Then, during the transportation, if the cargo temperature has approached its crystallization point, which is 28 ° C, then the drain process must be carried out on the heating coil so that the unloading and loading processes run according to plan.

Safety monitoring is also carried out from and by the Cargo Monitoring Coil to all crews, so that efficient handling planning is carried out by recording it in the Cargo Monitoring System. This method must be carried out periodically for no more than 1 hour. Because if the recording is carried out with a relatively long time interval, the decrease in the pressure temperature will be very significant. Extreme weather conditions and poor supporting equipment are the causes of suboptimal pressure handling processes. In order to avoid delays in the unloading and pressure process, a streaming / cargo handling process is carried out. This will indeed consume an excessive amount of fresh water, but this method is effective against the Paraxylene pressure treatment. As happened in MT Woo Dong, where the damage to the cargo liner, especially the stripping liner number 5, was carried out by the stripping process directly without delaying the stripping operation.

A. Recommendations

- *Coordination before loading*: the company must coordinate with the ship's party (in this case the Master as the Chief Security Officer (CSO)) first before receiving the certificate for damage that requires the attention of the course, such as the Para-xylene.
- *Coordinated planning:* The Chief Officer must make a coordinated plan by carrying out the surhur checking process periodically with a time that is not too long or not more than 1 hour, using several supporting tools on board, such as the Cargo Monitoring System, temperature gauge and sournding piper. In addition, checking the supporting tools for handling the surhur must be carried out regularly, carrying out operations on the Para-xylene surhur and must be checked properly as a whole, if it is damaged, repairs must be carried out as soon as possible.
- *Understanding the characteristics of the cargo:* all crew members must know the procedural characteristics of the cargo to be shipped through safety inspection and reading the manual provided on board the ship, such as the Material Safety Data Sheet (MSDS).

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