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Optimization of Line Cooldown Operations For Ship Readiness In Discharging and Loading on LNG

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Abstract: The use of Liquefied Natural Gas (LNG) as an alternative to fuel in the industrial and household sectors has increased rapidly along with the development of science and technology. LNG has an energy density equivalent to conventional fuel but with a lower environmental impact. Even so, the potential hazards of LNG vapor and low temperatures need to be aware of. Nonetheless, LNG has the advantage, such as the use of evaporation as a ship fuel or boil-off gas (BOG). The process of loading LNG to the ship involves several procedures, including cooling pipelines (line cooldown). Cooling pipelines before unloading LNG aims to avoid thermal stress that can damage the pipe. Planning and supervision of pipeline cooling operations become essential to achieve optimal temperature in the pipeline and prevent excessive heel use. Qualitative descriptive research methods are used by collecting data from library studies, documentation, observation, and interviews. In addressing the problem of cooling pipe, optimization of line cooldown operation and heel setting as fuel ship is the focus. The resulting conclusions involve the crew's understanding of valve function, the duration of the implementation of pipe cooling, the setting of the BOG amount, and the delivery of heel by the Charterer party to the ship. This study resulted in effective and efficient guidance in carrying out line cooldown operations and heel settings. With a better understanding of these factors, ships can optimally run the pipe cooling process, optimize the use of heel, and improve the efficiency of LNG use as a ship's fuel.

Keyword: Optimization, Line Cooldown, Liquefied Natural Gas.

INTRODUCTION

The use of Liquefied Natural Gas (LNG) as an alternative to fuel in the industrial and household sectors has increased rapidly along with the development of science and technology. LNG has an energy density equivalent to conventional fuel but with a lower environmental impact and makes advanced industrialized countries such as Japan, Korea, China the United States, and Taiwan choose to use it. LNG is a natural gas that has undergone an extreme cooling process to turn liquid. LNG distribution is done using LNG transport ships made of stainless steel to ensure the safety of ships, loads, and crew. However, since LNG includes dangerous payloads, good handling, and loading are required.

Even so, the potential hazards of LNG vapor and low temperatures need to be aware of. Nonetheless, LNG has the advantage, such as the use of evaporation as a ship fuel or boil-off gas (BOG). The process of loading and discharging LNG to the ship involves several procedures, including cooling pipelines (line cooldown) and cooling the tank (tank cooldown). Cooling pipelines before unloading LNG aims to avoid thermal stress that can damage the pipe. Planning and supervision of pipeline cooling operations become essential to achieve optimal temperature in the pipeline and prevent excessive heel use. Planning and supervision of pipe cooling operations becomes important to ensure optimal line cooldown process. The Chief Officer and Deck Gasman understanding of the pipe cooling process are also required. Evaluation of optimal cooling pipeline procedures on LNG EKAPUTRA 1 vessel is also the focus of the author, especially given the age of the ship's aging and the efficiency of the equipment used.

Scope of problem

1. Less optimal implementation of cooling operation on pipe
2. Not optimal use of Heel LNG used in the cooling process of pipe

Problem Formulation

1. Why is the implementation of cooling operations on pipe less optimal?
2. Why is the use of Heel LNG to be used in the pipe cooling process not optimal?

Purpose of the Paper

1. To find out and analyze the optimization of cooling operation on pipe
2. To find out and analyze the optimization use of Heel LNG used in the cooling process of pipe

Benefits of the Paper

1. Theoretical Benefits

   It is hoped that it can become a reference or literature to ship officer in the process of cooling pipeline and use of Heel LNG on LNG EKAPUTRA 1. It is expected to be useful input material to improve the officer and crew so that they are ready to face the next cooling operation on pipe.
2. Practical Benefits

   It can be taken into consideration by the ship officer in adopting policies related to the implementation of cooling operation on pipe in order to minimize not optimal the cooling operation on pipe and not optimal use of Heel LNG.

Theoretical Basis

1. Liquified Natural Gas

   Liquified Natural Gas or LNG according to [1] is a natural gas that has been liquefied through the cooling process to reach the temperature of -163°C at 1 atm pressure. LNG contains Methane (CH4) dominant with several other hydrocarbon gas mixtures such as Ethane (C2H6). LNG liquid conditions have a density of about half of the water density, with a reduction of volume of 1/600 compared to the gas conditions. A considerable volume compression is aimed at saving its loading space and efficiency of gas transport in liquid form for long distances.
2. Line Cooldown

   Line Cooldown according to [1] is cooling the pipelines before loading and discharging process into the tank to prevent the occurrence of very fast thermal pressure on the pipes, because this drastic temperature difference can cause damage to the pipes and harm the loading operation itself and target the line cooldown is cooling the pipe until under -100° C.
3. Heel

   Heel according to [4] is the amount of LNG in the load tank at the end of loading unloading. It is used to keep the cargo tank cool enough during the trip by circulating it

through the spraying device/Spray Nozzle. Heel can also be used as fuel during sailing. The remaining of this LNG is sent to the boiler to be burned. And in the application of Heel use on ships there is often excessive use and makes the load tank have no remaining cargo or Heel.

METHOD

This research uses a qualitative descriptive research method. According to [5] Qualitative descriptive method are research methods used to identify the value of self-definite variables, either one or more (independent), without making comparisons or connecting them with other variables, while emphasizing the quality or most important aspect of a good or service. This most important aspect can be the meaning behind events, phenomena, and social symptoms that can be used as valuable lessons for the development of the concept of theory. Research using data collection method from library studies according manual book from ship, documentation that use during operation, observation during line cooldown operation, and interviews to the Chief Officer as the responsible of Line Cooldown operation.

1. Data Collection Techniques

   In this research the authors used data source. In carrying out this study the author obtains a source of data which is obtained both directly and indirectly, by searching and collecting data which certainly relates to the problems taken by the author. The data obtained by the author to write this description is primary data and secondary data. Primary data obtained from data collection techniques that can be done by observation and interview. And secondary data that the authors get is a previous library study.

   a. Primary Data

      Primary Data is data obtained directly by researchers from original or first-party sources, like observation. The Observation by the author when the Chief Officer performs the line cooldown and involves the author to participate in the implementation process. Accompanied by Deck Gasman Author is introduced with valve on board that relates to the process of line cooldown. After several times the authors follow the line cool down activities, the authors find that there are some things in their less optimal implementation, so the authors raise the issue into a description.

   b. Secondary Data

      Secondary Data is data obtained by researchers indirectly through intermediary media, the author collects through reference manual books on board and other data sources like library studies. Data collection technique is reluctant to conduct buzz library research collecting theories from reference books, belonging to the ship SS. EKAPUTRA 1 and Jakarta's Library of High School of Shipping Sciences. The example of the book is International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), Instruction Manual for Cargo Handling (GC - 15), Society of International Gas Tanker & Terminal Operators (SIGTTO).

2. Data Collection Techniques

   The data collection technique used is to search for data and collect data related to problems according to the description title. The data obtained is conducted by direct research at the field or the authors follow activities related to this research directly and also conduct interviews with several officers on board the ship related to the cargo. Here are the methods used to collect data:

   a. Observation

      According to [2] Observation it is direct observation by using a specific format according to the needs of the researcher. To make it easier to observe, special scenarios are required that have been compiled before by researchers. The Observation was made by the author, when the ship did the Ballast Voyage or Laden Voyage, more precisely

when the ship was 1 day before the berthing at Port and a few hours before the End of Passage (EOP) when the ship entered the port. It is in this situation that the Chief Officer will cool the pipe. The author begins an observation by following Deck Gasman to the local site. Here the author observes the top dome area where the entire cargo operation runs here. The author observes from any valve that must be operated open or close the valve which is aimed at cooling the pipeline. This activity is done to obtain data during the pipe cooling operation and as a comparison of some previous data.

b. Interview

According to [5] Interview is a meeting of two people to exchange information and ideas through question answers so that they can be constructed meaning in a particular topic. This is to get information orally with the aim of obtaining data that can explain the research problem. The assessment of conducting direct interview activities with the officer in charge of the research problem, the Chief Officer holds responsibility for the cargo operation. This interview is non-formal because it is done with the continuation of the cooling operation and lasts almost as long as the author performs marine practice.

c. Documentation

According to [3] Documentation is a systematic process from collecting to managing data that generates a collection of documents. Documentation can be in the form of writing, drawing, or monumental works of a person. On this documentary data collection technique, researchers collect and write or report in the form of quotations about a number of documents reported in the study. Techniques conducted by researchers by reading and reviewing documents related to problems. By reading and scanning documents in the archives, the files on the ship and this is concrete data that can provide complete and accountable information. The document used is Ship Particular, Deck/Engine Abstract Log, Custody Transfer Measurement (CTM) Data Sheet, and Line Cooldown Record.The research method contains the type of research, sample and population or research subjects, time and place of research, instruments, procedures, and research techniques, as well as other matters relating to the method of research. This section can be divided into several sub-chapters, but no numbering is necessary.

RESULTS AND DISCUSSION

The analysis here discusses the description of data on matters related to the problems raised in this study, providing deeper and more relevant discussions and explanations to the data of the author's findings when undergoing practice on LNG EKAPUTRA 1 vessels with the procedures and conditions that should be so that you can find the cause of the problem. In addition, the authors also present problems and evaluate the problem solving so that they get concrete solutions.

Description Data

Preparation in loading on board LNG Carrier is carried out with several stages of preparation, one of which is the process of cooling the ship pipe. Where in the cooling operation of this pipe has an important role in maintaining the condition of the pipe in order to reach the desired temperature so that it can be said pipe in the state of Ready to Load. Ready to Load is the state of the pipeline of the ship that is at least temperature -100˚ C, there are several crews involved in the process of cooling pipeline, among others Chief Officer, Junior 1st Engineer, Deck Gasman, and Engine Gasman. Then the ship remains given Heel for cooling, and also fuel, a Chief Officer should be at least possible to leave Heel in the

loading tank to avoid excessive evaporation when the ship anchors or other possibilities that when the tank receives his new charge will be mixed with the remainder of the old charge.

Analysis Data

In doing the cooling operation of this pipe must certainly have knowledge and experience in doing so. Technical, weather, residual charge and also final conditions will greatly affect the cooling operation of the pipe. Because the purpose of this operation is to keep the pipe temperature in the predetermined condition of -100˚C so that it can be said Ready to Load. Maximization of the use of heel should also pay attention to the remaining end of the charge in the tank, as this will affect the composition of the existing will be incorporated with the new LNG. From the data set on the journey, the following analysis obtained by the author is:

1. Less optimal implementation of cooling operation on pipe

   Less understanding of the crew which in the implementation of the valve opening by Deck Gasman while helping the Chief Officer occurred in the form of valve opening so that the pressure to push LNG from Spray Line to Liquid Line is too small, this resulted in the cooling process of the pipe not maximal. Deck Gasman also did not ask back to ensure the orders received were done in accordance with the direction of the Chief Officer. And the implementation of line cool down operation that only for a short time will result in rapid rise in temperature or heat up temperature on the pipe before unloading operation is done.
2. Not optimal use of Heel LNG used in the cooling process of pipe

   Limited number of Heel given by the Charterer to the ship, causing limited implementation of line cool down operations and cool down tanks, so the Chief Officer cannot do the line cool down longer before arriving at the port of loading and unloading ships. And if the Heel of a charge tank is depleted will cause the Dead Heel or the remaining charge inside the charge tank cannot be used because it is not left or depleted. And Less precisely the officer responsible for accounting for the amount of BOG produced and also consumed by the boiler is not balanced between vapor produced by Forcing Vaporizer and vapor in the loading tank. To balance the resulting vapor, the Chief Officer will use the vapor in the charge tank as fuel for Boiler. The setting of the amount of BOG will also affect the existing fuel ship because if the ship cannot channel the needs of the BOG that the Boiler wants, then the ship must change the mode of fuel use from Gas Burning to Dual Burning which will use the fuel of the ship, which is Fuel Oil along with the BOG that is on board.

HUMOLCO	Operation Procedures			OP 71-31	Ver. 7.0
	Line Cooldown Monitoring			Rev. 00 18-Mar-2019	Page 1 of 1
Approved: Heru Prasetyo K.	Proposed: M. Yasin	Timing: Pre-operation	Report: NIL	Retention: 3 years	

Vessel	LNG EKAPUTRA 1	Voy. No	711 B	Prepared by,
Date	06 - 07 MAY 2022	Port	TANGGUH LNG TERMINAL	<signature>

Time	Liquid Header Press. (KPa)	Liquid Header Temp Fore (°C)	Liquid Header Temp Aft (°C)	Liquid X-Over Fore Press (KPa)	Liquid X-Over Fore Temp (°C)	Liquid X-Over Aft Press (KPa)	Liquid X-Over Aft Temp (°C)	Condition of Spray Pump No. 1 Current (Amps)	Load (%)	Dis. Pres. (KPa)	Dis. V/V (%)	Tank No. 3 Press (KPa)	Boiler Gas Flow (Kg/Hr)	RPM	Remarks
1500	17.5	31.4	31.5	18.2	31.0	18.1	29.3	27.21	–	307.1	45.2	5.28	2003	65.2	
1520	19.6	-2.8	19.8	19.9	-40.3	19.7	-63.4	24.81	–	293.5	43.7	5.47	2897	65.1	
1600	30.1	-30.1	-12.5	30.4	-70.4	30.2	-82.7	24.35	–	308.4	43.1	11.37	2894	65.1	
1620	40.6	-70.5	-50.7	40.5	-95.3	40.7	-98.7	–	–	–	0	13.98	2301	65.1	
0350	16.3	-2.6	6.8	16.7	-63.2	16.6	-58.2	24.74	–	231.1	47.3	8.61	528	0	
0430	46.5	-30.4	-23.4	47.4	-79.5	47.3	-64.2	26.64	–	268.9	49.2	9.83	846	6.1	
0500	47.4	-35.4	-60.2	48.2	-98.6	48.3	-97.3	–	–	–	0	5.89	887	0	

	Tank No.1 Volume (m³)	Tank No.1 Avg Temp (°C)	Tank No.2 Volume (m³)	Tank No.2 Avg Temp (°C)	Tank No.3 Volume (m³)	Tank No.3 Avg Temp (°C)	Tank No.4 Volume (m³)	Tank No.4 Avg Temp (°C)	Tank No.5 Volume (m³)	Tank No.5 Avg Temp (°C)	Total Volume (m³)	Quantity LNG used (m³)
Start					149	-159.3						
Stop					23	-159.5						126

Source: Research Results

Figure 1. Operation Procedures Data

From the figure 1, the data is obtained as follows: Line Cooldown is done in 2 sessions, and each session takes about 1-2 hours, and the total cooling time is only 2 hours 40 minutes. The amount of Heel Consumption required for Line Cooldown operation for 2 hours 40 minutes is 126 m3. And if more than 3 hours will eat more Heel. Liquid Header & Liquid Crossover temperature on front and rear pipe that does not meet the desired temperature to perform load unloading process of -100° C. RPM, gas flow, total heel consumption when cooling pipe as the basis for viewing the use of Boil of Gas and Heel LNG during the Line Cooldown process.

Problem Solving

The following problem solving is intended only for the operation of pipe cooling, which every trip always has problems in operation even if it is just a problem or a small obstacle. Here the author provides an alternative to problem solving that could happen to every single Line Cool Down.

1. Problem Solving to Less optimal implementation of cooling operation on pipe

   To carry out a better Line Cooldown operation is to do Meeting with the involved crew and ask if there are any obstacles in the implementation later, if the find of an obstacle then the Chief Officer immediately finishes it. Because on board for the task of a Deck Gasman turns every month so to get better is to familiarize Cargo Line, Spray Line and all related to cargo operations to reduce the errors that will occur. And when implementation of Line Cool Down is expected to check the temperature of the cooled pipe and also against the valve involved in Line Cooldown operation so as not to return errors during operation it lasts and causes no desired temperature during Line Cooldown operation until the loss of many Heel in the load tank.
2. Problem Solving to Not optimal use of Heel LNG used in the cooling process of pipe

   Determine the RPM to be used during sailing and determine the amount of BOG used. Back in using high RPM then the amount of BOG will also be greater, the amount of BOG demand by Boiler depends on the number of Heel available. Chief Officer must be able to customize a cruise plan with Master and Chief Engineer in order to find the right solution in the existing conditions. Determination of RPM will also affect the use of fuel aboard the ship, which is pressured for its use. With the determination of RPM, the Chief Officer can make a better plan ahead and will be applied during the Tank Cooldown process to Line Cooldown before the port load or unload port.This section contains data (in brief form), data analysis, and interpretation of the results. Results can be presented in tables or graphs to clarify the results verbally because sometimes the display of an illustration is more complete and informative than the display in narrative form.

This section must answer the problems or research hypotheses that have been formulated previously.

CONCLUSION

From the results of analysis and discussion of the problems that researchers found during their time in SS. EKAPUTRA 1 is especially the problem that occurs when Voyage 711B comes to conclusions in the form of effective and efficient ways of implementing Line Cool Down. The conclusion can be found that the author describes the results of research and analysis of Line Cool Down Operation, specialized in the implementation and arrangement of Heel as a ship fuel 1. Optimal implementation of cooling operation on pipeline is caused by: a) Understanding the crew in knowing the function of each Valve operated b) The duration of the operation of the cooling of the pipe performed on the charge pipe. 2. Optimal use of Heel during pipe cooling operation is due to several factors: a) Heel provided by the Charterer to

the ship which will severely limit the Chief Officer to perform Line Cool Down. b) Setting the amount of BOG so that the amount of consumption of Vapor produced by Heel.

Suggestion

1. Training to the crew of the ship while on land.
2. Provide knowledge to ship officers, especially Chief Officer about the operation of the implementation of Line Cooldown
3. Implementing or Familiarization of Gasman Decks
4. Performing Cooldown Line for a minimum of 3 hours in one operation
5. Coordinate with Charterer party for Heel to be given by the ship, which is to request more from the count
6. Meet with Charterer about the schedule of the ship so that at the time of determination of the ship's RPM by the ship is obtained lower RPM for the use of lower Boil of Gas consumption
7. Asking Heel more than the total Chief Officer count to the party Charterer
8. Determine RPM and how much LNG steam consumption is needed for fuel adjust to the load tank pressure condition.

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