Study on Risk Precaution Measures for LNG Fuel-powered Ship in Pontoon Filling Station

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Abstract. In recent years, with the adjustment of the national energy structure and the issuance of relevant guidance documents by the Ministry of Transport, China's Inland River LNG fuel-powered ships have developed rapidly, and LNG PONTOON filling stations have been successively constructed. However, China still lacks the safety of inland barge filling stations. Related procedures such as operations, this paper analyzes the related safety risks of the LNG inland barge refueling station, and proposes the safety management and technical measures that need to be taken when carrying out LNG refueling operations.

Introduction

In China, the promotion of natural gas application is an important part of the national energy structure adjustment, liquefied natural gas (LNG), as one of the most valuable and high quality energy has a bright future in the application of marine power energy. Internationally, Norway is the first country in the world to use LNG as a marine fuel, according to the Norwegian classification society; there are currently 58 LNG power vessels in Norway. In recent years, the rapid development of LNG ships in China, the Ministry of Transport in October 2013 issued a "Ministry of Transport and transport industry to promote the use of liquefied natural gas" guidance, September 2014 issued the "Ministry of Transport and transport industry application of liquefied natural gas pilot demonstration work Implementation Plan" notice ", The pilot work of LNG fuel-powered boats and filling stations in inland waters such as the Yangtze River has been fully rolled out. In the Environment of environmental protection, the application of LNG on ships will be more and more extensive. According to DNV GL Statistics, by 2020, the global LNG fuel ships will reach thousands of new orders, 2025 global LNG fuel ships will reach 3200. In view of the good development prospect of LNG fuel vessels, the European Union plans to accelerate the layout of LNG filling stations, and the layout planning of LNG replenishment stations is being carried out in China.

At present, the mode of filling the LNG fuel-powered ship can be divided into the whole replacement of gas fuel tank, the filling scheme of tanker, the filling scheme of shore station, the filling scheme of filling ship and the scheme of barge filling, and the different filling modes adapt to different demands. The barge filling scheme is suitable for inland waters with large change of water level during flood period and dry season. At the same time, lighter relatively fixed, conducive to risk control. The barge-filling scheme is more suitable for the water level change of China's Yangtze River and Zhu Jiang River, which belongs to the typical filling mode. At present, China's inland river has been built LNG fuel power ship filling station a total of four, mainly distributed in the Yangtze River basin, Guangxi Xi Jiang Waters. Of the four filling stations, three are barge-filling modes.

The fuel filling operation of LNG ships is the most important part of LNG ship transportation, and it is also the most easily occurring stage of the accident. Because LNG has the characteristics of inflammable, explosive and cryogenic, and the environment of filling operation is relatively complex, the safety of LNG filling operation cannot be neglected. and the relevant safety operation standard is still blank at home at present. Therefore, this paper takes the barge-filling model as the research object, carries out the research on the risk precaution measures of raising safety operation, in order to solve the safety problems in the filling operation of China LNG fuel-powered ship, and provide scientific basis for improving the safety level of filling station operation.
Risk Factors Analysis

Because the ship replenishment LNG fuel must operate in the port, while the navigable conditions in the Inland river port are more complicated than that of the sea and the coastal port, such as the safe distance between ships and the radius of maneuver, etc. Compared with the coastal port ships, the Inland river port ships the density is big, the ship enters and the port channel is narrow, and the Inland River LNG ship tonnage is relatively small, the draught is shallow, the wind area is relatively big, the ship operation performance is relatively poor, the LNG ship carries on the filling operation the safety hidden danger In addition to the ship replenishment of LNG fuel operations, the need for the port management department, mooring personnel, crew, tug Crew, filling personnel, firefighters, the various assistance, due to people's unsafe behavior caused accident probability than the car raise is much greater.

From the point of view of security system engineering, this paper analyzes and identifies the existence and distribution of risk sources, and systematically identifies the risk factors from the aspects of technology, personnel, management and environment.

(1) The risk of the medium

Because LNG is a liquid hydrocarbon mixture, the -162℃ of cryogenic liquid, its vapor and air mixture explosion limit concentration is 5%-15% (volume percentage). In the process of transporting and storing materials, if you accidentally generate a lot of static electricity or get a heavy impact, fires and explosions can occur. And at standard atmospheric pressure with very low temperature, LNG leakage after the gasification of cold vapor clouds and the failure to gasification of liquids, will cause frostbite to the human body, low-temperature burning and other serious damage, but also to the filling machine, add car, storage tank, LNG high-pressure plunger pump, submersible pump and other filling equipment caused damage, at the same time, LNG on human health is also a hazard, because its extremely low oxygen content easily causes the human body to suffocate. Therefore, LNG has the characteristics of fire explosion and low temperature, and it has the asphyxia to human.

(2) The danger of installation facilities

From the point of view of the installation of LNG filling station, the key equipment’s, such as LNG tank, LNG tanker, cryogenic pump, unloading hose and LNG filling machine, have certain danger. Due to the flammable and explosive characteristics of LNG, the uneven subsidence of tank foundation will have serious effect on the stability of tank. The deformation, corrosion perforation and weld cracking of the tank can cause the vacuum to be destroyed and the adiabatic performance reduced, resulting in the low temperature cryogenic liquefied gas which is heated and gasification, which leads to the explosion of pressure in the tank. A large number of LNG leakage, so LNG tanks, and tankers have a greater risk. The biggest danger of cryogenic pump is that the seal failure causes a large amount of leakage of dangerous material, and it is formed in the range of explosion limit with air and the explosion accident occurs in the ignition source. Unloading Hose easy aging, at the interface due to long-term wear and tear may lead to seal lax, and even due to the discharge of severe shock and burst. These will produce LNG leaks.

Risk analysis of pipeline facilities. The risk of pipeline facilities involved in LNG filling include cooling failure, liquid-shock phenomenon, bog and "intermittent spring" phenomenon and the influence of two-phase flow. In which the cooling failure refers to the failure of the pipe vacuum, and so on, the pipeline insulation performance is decreased, the inner pressure of the tube is increased rapidly, and the risk of leakage or explosion increases. The liquid-hammer phenomenon is the liquid-hammer phenomenon caused by the large fluctuation of pressure in the pipeline. Fluid strikes generally cause a strong vibration of the piping system.

BOG, "intermittent spring" phenomenon and two-phase flow are derived from the pipeline may produce steam to make the tube pressure sudden, or gas-liquid two-phase fluid in the pipeline to increase the pressure in the pipe to create a safety hazard.

(3) Environmental factor analysis

Environmental factors include natural environment, social environment and working environment. For the natural environment should focus on the meteorological conditions, climate disasters,
geological hazards, fire and environmental pollution, especially in the inland waters, the number of ships, River has a certain flow rate, in the filling operation when the safety of the ship berthing and connection by the natural environment has a greater impact, the social environment harm mainly manifests in the third party destruction, the illegal and the malicious destruction, the work environment mainly manifests in to raises the battlefield environmental hygiene request, does not have the stagnant water and the waste weeds, and is clear smoke-free fire (for example cigarette butts, static electricity and so on).

(4) Ship factor analysis
The ship structure, technical condition, and the suitability of the two ships are the key factors which affect the safety operation of the filling vessel. If the ship age is too large, the ship equipment aging, the ship structure is unreasonable, the filling ship and the loading ship's suitability is poor, will increase the operation safety risk. Transformation of inland LNG ships in the filling operation in particular, it is necessary to pay attention to the risk of the ship's own factors, at the same time considering the ship is affected by the hydrological instability, in the raising of the ship to prevent the impact of the collision damage, LNG leakage, etc.

(5) Personnel factor analysis
With the development of equipment technology, the proportion of personnel operating accidents is highlighted. According to the relevant accident statistics at home and abroad, many accidents in petroleum and petrochemical industry are caused by the poor consciousness of safety and environmental protection of the operators, the lack of sense of responsibility, the illegal operations and the Operation errors. Filling station related operator’s improper operation or error, safety awareness, lack of professional knowledge or experience, personnel overworked and so on are important potential security risks, especially the Inland river ships relative to the coastal ship operators relative to the quality of the relatively low, and risk of accidents is greater because of the possible operation errors.

(6) Management factor analysis
The safety behavior of the operator plays an important role in the safety management of the LNG filling station. The important factors that trigger the production process, equipment potential danger and harmful accidents are often the personnel's illegal operation, the safety management rules and regulations are not perfect, and the safety management system is not implemented, which is one of the factors that cause the illegal operation and lead to the safety accident.

Precaution Measure
Through the analysis of the risk factors of the LNG fuel power ship in the Inland River barge filling station in the aspects of medium, device, ship, personnel, environment and management, the paper puts forward the corresponding safety technical measures, and points out that the safety management and personnel operation are the key factors which affect the safe operation of the station. The safety management of LNG inland barge filling station should be done well, the main risk should be controlled consciously and the safe operation of the filling station should be ensured.

(1) Establishment of safety production related norms, systems, etc.
The industry should promulgate the safe operation and emergency precaution standard of the LNG fuel power ship's inland barge filling station as soon as possible, the filling station should establish and perfect the regulations of safety production responsibility system. According to the domestic and foreign LNG characteristics and related operation regulations, as well as the production requirements of the filling station, including the surrounding environment characteristics of the filling station and the characteristics of the loading ship, the corresponding safety operation rules and safety management system are established, at least the safety operation rules, the safety management system and the emergency plan are set up at the filling station, and put on the security procedures and requirements in the prominent position of

(2) Sound Security Organization and division of responsibilities
To establish and improve the safety operation and emergency precaution procedures of the LNG fuel power ship's inland barge filling station, filling station should be formulated "post responsibility
System”, the responsibility to implement to people, filling station webmaster generally for safety first responsible person, filling station operators, should be equipped with special (and) full-time staff. Each position must have clear security responsibilities. All filling station personnel must receive professional technical training, after the examination qualified to obtain the corresponding qualification can work. The operator of the LNG filling station must undergo the following forensics training: gas cylinder filling personnel must undergo the local municipal quality and technical Supervision Department of the gas bottle filling operation training, and obtain the gas bottle filling operation certificate; Pressure vessel safety management personnel and operators must undergo the local municipal quality and technical Supervision Department of special Equipment Operations training, and obtain the corresponding special equipment operation personnel certificate.

(3) Timely inspection and maintenance of equipment safety
In the above safety risk analysis, the related equipment and facilities of LNG fuel power ship inland barge filling station are affected by LNG characteristics, may burst, overflow, burning, explosion and other hazards, so in the daily work, the equipment used before, in and after meticulous inspection, the accident prevention, and timely treatment of all leaks. At the same time, according to the phenomenon of hydraulic shock, BOG, "intermittent spring" phenomena and two-phase flow effects, etc. to develop a preventive solution, filling stations should establish a safety inspection system for the operating environment, facilities, equipment, fire equipment, electrical and other security checks.

(4) Set warning signs and operator safety requirements
Filling station should be set up safety warning signs and signs, warning signs to be clear, fire equipment to be intact and effective. Add stations are strictly prohibited fireworks, filling, unloading and other operating sites are prohibited to overhaul vehicles. In lightning, lightning frequently, cannot be raised, unloading and other operations, operators in the operation, must wear antifreeze gloves, protective masks, anti-static clothing, such as labor protection supplies. The filling station shall take effective measures to stop unsafe behaviors of people, vehicles and passengers who come to the air, including prohibiting open fire, prohibiting smoking, prohibiting the use of mobile phones, and so on. In addition, the filling station should formulate and implement the safety education system and enhance the safety precaution consciousness.

For fire prevention, leak prevention, flood prevention and other contingency plans, need to conduct regular drills, and gradually set up a professional safety and health management system.

(5) To develop the key problems of safety operation measures
According to the safety risk analysis of the LNG fuel power ship's inland barge filling station, the paper should make a separate processing method table for the common faults of the key equipment of the LNG filling station, including the equipment name, common faults, treatment methods, etc., such as "common failure and treatment method of LNG tank", "Common faults and treatment methods of LNG gas-adding machines ","Common faults and treatment methods of LNG submersible pump", "Common faults and treatment methods of LNG cryogenic safety valve", "Common faults and treatment methods of LNG cryogenic ball valves", and the safety disposal methods and safety operation of the operators, regular training and intensive training, etc.

References
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