Analysis of Difficulties and Suggestions for Developing Ship LNG Bunkering Stations in China

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Abstract. The ship LNG bunkering station is the basis and premise for the promotion of LNG fuelled ships. As a new thing, there are more difficulties in current construction and operation in China. This paper analyzes the development status and industry difficulties of ship LNG bunkering stations, and proposes countermeasures to promote the development of China's ship LNG bunkering station.

1. Introduction
The promotion of the use of liquefied natural gas (LNG) for ships is an important part of the water transport industry to implement the ecological civilization of the Chinese government and to build a beautiful China, and to reduce the pollution and emission of ships and ports. In 2017, the 13 ministries, such as the China Development and Reform Commission, the Ministry of transportation and transportation, the Ministry of housing and construction, the State Energy Bureau and other ministries and commissions, jointly issued the opinion on speeding up the use of natural gas, proposed to speed up the large-scale and efficient scientific use of natural gas in transportation and other fields, and will promote the development of natural gas vehicles as a key point for the implementation of traffic fuel upgrading workers. The LNG bunkering station is the basis and prerequisite for the promotion and application of LNG in the water transportation industry. Through the study and analysis of the difficulties in the development of the Chinese ship's LNG bunkering station and the relevant countermeasures and suggestions, this paper can provide decision-making suggestions for the development of the industry.

2. The development status of Chinese ship LNG bunkering station

2.1. Characteristics of Chinese ship's LNG bunkering station
China's ship LNG bunkering stations are currently mainly used in inland waters, including shore-based bunkering station and Pontoon bunkering station. Among them, the shore-based bunkering station refers to the LNG bunkering station of the LNG storage tank located in the dock land; The pontoon bunkering station is also called LNG bunkering barge, which means that the LNG storage tank is located on the barge.
As of June 2018, China has built 19 ship LNG bunkering stations, covering the main waters such as the Yangtze River trunk line, the Beijing-Hangzhou Canal, the Xijiang shipping trunk line and the Yangtze River Delta water network. Among them, the Yangtze River trunk line, the Xijiang shipping trunk line and other areas with large annual water level drop are mainly Pontoon bunkering station. While the water level of the Beijing-Hangzhou Grand Canal, the Yangtze River Delta and the Pearl River Delta are relatively stable, the shore-based bunkering station is the main type of station.

Figure 3. Distribution characteristics of Ship LNG bunkering stations in China
Table 1. The characteristics and applicability of Chinese ship LNG bunkering station

| Type                     | Advantage                                      | Shortcomings                                                                                   | Applicable navigable waters of China |
|--------------------------|------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------|
| Shore based type bunkering station | (1) Small investment in construction. (2) Small impact on navigable waters. | (1) It occupies the resources of the coastline. (2) The construction examination and approval procedures are complex in China. (3) It is not suitable for the waters with large annual water level drop. | the Beijing-Hangzhou Canal, and the Yangtze River Delta water network. |
| Pontoon bunkering station | (1) It can adapt to the change of water level drop. (2) The shoreline resources can be saved. | (1) The construction cost is high; it is only suitable for wide water area. (2) Some bunkering stations need to supply LNG through water. | the Yangtze River trunk line and the Xijiang shipping trunk line |

2.2. The policy environment of Chinese ship's LNG bunkering station

2.2.1. China has set up the layout plan of the LNG bunkering stations. China's ship LNG bunkering stations layout planning includes two levels: National Planning and local planning. At the national level, in 2017, the Ministry of transportation issued the layout scheme for the liquefied natural gas bunkering terminal of the Xijiang River shipping trunk line of the Yangtze River trunk line (2017 - 2025). The 74 LNG bunkering terminals were arranged in the Yangtze main line, the Beijing-Hangzhou canal, the Xijiang shipping trunk line, and so on. At the local level, in order to guide the development of LNG bunkering stations in the province, the provinces have speed up the layout planning of LNG bunkering stations in the province. At present, Jiangsu, Anhui, Jiangxi, Guangxi and other provinces have combined the actual situation of each province to introduce the location planning of LNG bunkering stations in the province. Hunan, Hubei, Chongqing, Zhejiang, Guangdong and other provinces have also been working on the layout planning of LNG bunkering stations.

Table 2. Layout planning of ship LNG bunkering station in China

| Issuing unit                  | File name                                                                 |
|-------------------------------|---------------------------------------------------------------------------|
| Ministry of transportation of China | 《Layout plan for LNG bunkering wharf of Yangtze River trunk line, Beijing Hangzhou canal, Xijiang River main line (2017 - 2025)》 |
| Anhui Province                | 《Notice on doing well in the construction of LNG infrastructure》           |
| Jiangsu provincial            | 《Special planning for development of inland river LNG bunkering stations in Jiangsu》 |
| Jiangxi Province              | 《Layout planning of Jiangxi liquefied natural gas (LNG) water bunkering station》 |
| Guangxi Province              | 《Layout planning of Guangxi Xijiang golden waterway water bunkering station (2012-2030)》 |

2.2.2. The standard system of China's ship LNG bunkering station has been formed. The relevant standard specifications for pontoon LNG bunkering stations have been basically improved. Since 2014, the Ministry of transportation has issued the Provisional Regulations for the safety supervision and
management of the water liquefied natural gas bunkering station, the guide for the operation of the fuel injection of liquefied natural gas, and a complete set of specifications for the bunkering of liquefied natural gas pontoon and the specification for the bunkering of liquefied natural gas fuel, which has promoted the formation of a more perfect Standard system for ship bunkering stations. The relevant standards and regulations for shore based ship LNG bunkering stations have been preliminarily formed. In the design of bunkering terminal, the Ministry of transport issued the code for design of liquefied natural gas bunkering wharves in 2016. In addition, the national code for design of liquefied natural gas gas bunkering stations will be completed soon.

3. Main problems restricting the development of LNG bunkering stations in China

3.1. Construction examination and approval procedure is not clear
The construction and operation of the LNG bunkering station of ships involves many departments such as reform, housing, port, maritime, water conservancy, fire fighting and land. As a new thing, the examination and approval procedures and management subjects are not clear. Although some provinces, such as Jiangsu Province, have issued guidance documents to guide the construction of the LNG bunkering stations in the province, there are still some construction approval issues in the implementation process, and even some of the already built LNG bunkering stations cannot be put into operation. At present, 19 LNG bunkering stations have been built in China, but only 3 have been put into trial operation, which greatly restricts the application of LNG in the water transport industry.

3.2. It is difficult to locate the shore line of the bunkering station
The LNG bunkering station of the ship belongs to the gas facility. According to the regulations on the management of urban gas, the site should be located in accordance with the urban gas planning of the district. However, the current planning of the bunkering stations of the ship is mostly issued by the transportation and energy departments, such as the notice on the construction of the infrastructure construction of the water liquefied natural gas in Anhui province.is issued by The Energy Bureau of Huizhou province, the layout plan of the water bunkering station of Jiangxi liquefied natural gas (LNG) in Jiangxi province is issued by the Jiangxi transportation hall. Because the layout planning of the LNG bunkering stations is not taken into consideration in the regional gas planning, the site selection of the LNG bunkering stations in these areas is difficult to be audited by the gas management department. As a result, some LNG bunkering pontoons do not have appropriate berth shoreline to be put into operation. Some shore based bunkering stations are difficult to pass through the planning of relevant departments and do not qualify for operation. However, In some provinces, such as Jiangsu and Guangxi Province, the housing construction departments of Jiangsu and Guangxi jointly issued the layout plan of the water bunkering stations for the liquefied natural gas (LNG), "the layout plan of the Guangxi Xijiang golden waterway water bunkering stations (2012-2030)" , and the LNG bunkering stations in these areas are pushed into the work relatively smoothly. China's 3 LNG bunkering stations, which have been put into trial operation, are also concentrated in these two provinces.

3.3. The LNG bunkering station currently operated in China has poor economy
According to the survey, the construction of a five grade shore based bunkering station on the Beijing Hangzhou canal (Tank capacity less than 120 cubic meters) requires about 15 million, while the Yangtze main line has a total investment of about 45 million Yuan for the construction of a grade three pontoon bunkering station (Tank capacity 500 cubic meters). According to the estimated yield of 40%, the investment recovery period of the LNG bunkering station is about 10 years. According to the investigation, the first LNG bunkering pontoon "seaport star 01" in China (cost about 45 million Yuan) has only completed about 1423 tons of shipping LNG fuel since it was put into operation in September 2013. The annual yield is less than 2%, and the company is in a state of long-term loss. Due to the small demand for bunkering in the initial stage of the promotion, the economy of the bunkering station
was not obvious, and some enterprises also slowed down the construction speed of the bunkering stations, or were in a wait-and-see state.

4. Conclusions

4.1. Define the main body of management and approval procedures for construction of LNG bunkering stations
With the construction of ecological civilization and the implementation of the adjustment of energy consumption structure, the government departments of transportation, development, energy, finance and other government departments have issued policies to encourage the use of clean energy such as natural gas for ships, but there is no coordination mechanism among various departments, and no resultant force has been formed. It is suggested that the Chinese government establish a coordination mechanism from the national level, and make clear the management subject of each link of the LNG bunkering station and the procedure of construction and approval to jointly promote the application of the ship's LNG bunkering stations.

4.2. The government management departments should mutually recognize the layout plans of the LNG bunkering stations of the provinces that have been issued
In view of the difficulties in the current location of the shore line of the LNG bunkering station in China, it is suggested that the Ministry of development, housing and transportation in China should work together to study the layout plan of the regional bunkering stations or the layout planning of the LNG bunkering stations which has been approved by each other, in order to promote the formation of a perfect network layout of the ship's LNG network.

4.3. The government should encourage the construction of LNG bunkering stations by means of financial subsidies.
Since China is in the initial stage of promoting the application of LNG in the water transportation industry, the economy of the shipping LNG bunkering station is weak. It is suggested that the government departments of China's transportation, finance and other government should study and formulate the economic encouragement policy of the ship's LNG bunkering station, and speed up the investment and construction of the ship LNG bunkering stations through the guidance of funds.

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