

Study on the application of natural gas to inland and coastal ships in China

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Abstract: In order to promote the green and low-carbon development of ships and promote shipping energy conservation and emission reduction. This paper systematically combed the development of liquefied natural gas (LNG) powered ships in China's inland ships, deeply studied and analyzed the development characteristics of China's new LNG powered ships and reconstructed LNG powered ships, so as to provided reference experience and lay a foundation for China to continue to promote the application of LNG in the water transportation industry in the future.

Key words: Ship; liquified natural gas; newly build; reconstruction; LNG.

1 Introduction

Strengthening the construction of ecological civilization is an important content for the CPC Central Committee to comprehensively promote the overall layout of "five in one" and the strategic layout of "four comprehensives" in the new era. The nineteen Party Congress made clear arrangements for speeding up the construction of ecological civilization and building transport power. In April 2018, general secretary Xi Jinping made an important speech when he inspected the Yangtze River. He stressed that the development of the Yangtze River Economic Belt should be placed in an overwhelming position to restore the Yangtze River's ecological environment. LNG is a clean energy that the state gives priority to promoting. The opinions of the CPC Central Committee and the State Council on Comprehensively Strengthening Ecological and environmental protection and resolutely fighting a tough battle of pollution prevention and control issued by the CPC Central Committee and the State Council and the three-year action plan for winning the blue sky defense war put forward the promotion of natural gas clean energy ships as a key task. The promotion and application of LNG in water transportation industry is the need of developing green transportation and building ecological civilization. It is an effective measure to realize energy conservation and emission reduction, transformation and upgrading and optimize energy consumption structure in water transportation industry. In order to thoroughly implement the spirit of the 18th CPC National Congress, take the scientific outlook on development as the guidance, adhere to the basic national policies of saving resources and protecting the environment, and focus on optimizing the

energy consumption structure and reducing emissions in the water transportation industry, the Ministry of transport issued the guiding opinions on promoting the application of liquefied natural gas in the water transportation industry in 2013, Take the promotion and application of LNG as an important starting point for energy conservation, emission reduction and ecological civilization construction of water transportation industry, accelerate the pace of green water transportation construction, and promote the comprehensive, coordinated and sustainable development of water transportation[1]. In 2018, the CPC Central Committee and the State Council issued the opinions on Comprehensively Strengthening Ecological and environmental protection and resolutely fighting the battle of pollution prevention and control, which clearly proposed to "encourage the promotion and use of clean energy ships". The Ministry of transport also issued the implementation opinions on Comprehensively Strengthening Ecological and environmental protection and resolutely fighting the battle of pollution prevention and control, which proposed to "promote the construction and transformation of LNG powered ships and electric ships"[2]. In 2019, the Ministry of transport issued the guiding opinions on accelerating the use of shore power and promoting the application of LNG ships on the Yangtze River trunk line, and proposed to accelerate the promotion of LNG ship application on the Yangtze River trunk line[3-5]. In September 2020, President Xi Jinping announced at the seventy-fifth general debate of the UN General Assembly that China's carbon dioxide emissions will reach a peak by 2030, and strive to achieve carbon neutralization by 2060. Since then, local governments along the river have also issued a series of policies and

measures to support the application of LNG powered ships, and the promotion of LNG in the water transportation industry has been gradually launched.

2 Analysis on the development status of LNG power ship market

As of December 2019, according to the incomplete statistics of our institute, there are 284 LNG powered ships in China, including dry bulk carriers, container ships, port tugs, LNG carriers, official ships, tourist passenger ships, etc.[6]. Among them, 157 LNG powered transport ships (1 LNG electric propulsion), 4 port tugs and 2 inland river LNG transport ships are newly built; One official ship, one tourist ship and one teaching ship. A total of 118 LNG powered ships were reconstructed, 72 were reconstructed by means of overall renewal of power system, and 46 LNG powered ships were reconstructed directly on the original ship engine.

3 New LNG powered ship in inland river

Since April 2014, the Ministry of Finance and the Ministry of transport issued the measures for the management of inland ship type standardization subsidy funds to give financial subsidies to new LNG powered ships. According to incomplete statistics of the Water Transportation Research Institute of the Ministry of transport, up to now, there are 157 new LNG powered ships in China, including 154 LNG powered demonstration ships and 3 non demonstration ships.

1) Ship type

The newly-built LNG power demonstration ships in China are mainly ordinary dry bulk carriers, including 146 general dry cargo ships, bulk cargo ships and multi-purpose ships, accounting for 94.8% of the newly-built LNG power demonstration ships in China, and the rest are container ships, distribution ships and self unloading sand ships.

Table 1 Types of new LNG power demonstration ships

Ship type	Quantity
General dry cargo ship	69
Bulk cargo ship	43
Multipurpose ship	34
Container ship	6
Distributed dual-purpose ship	1
Self unloading sand ship	1
Total	154

2) Tonnage structure

The measures for the administration of subsidies for inland river ship type Standardization (CJ No. 2014-61) issued by the Ministry of Finance and the Ministry of communications stipulates that the tonnage of newly-built LNG power demonstration ships shall not be less than 400 gross tons. According to statistics, the tonnage (deadweight tons) of newly-built LNG power

demonstration ships are mainly 500-1500 tons. See the following table and figure for details.

Table 2 Tonnage (DWT) distribution of new LNG power demonstration ships

Tonnage	Quantity	Tonnage	Quantity
500-1000	99	2500-3000	6
1000-1500	29	3000-4000	7
1500-2000	11	6000 以上	2

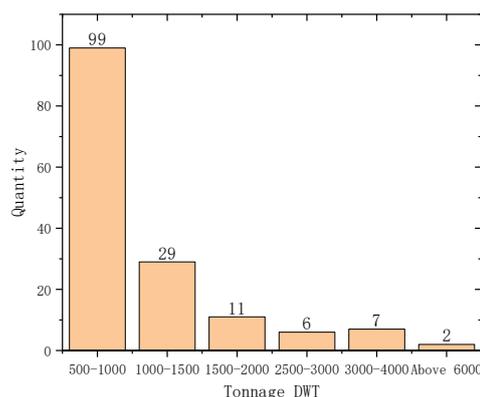


Fig. 1 Tonnage (DWT) of new LNG power demonstration ship

3) Regional distribution

According to statistics, China's new LNG power demonstration ships are mainly distributed in Shanghai, Jiangsu and Guangxi, including 90 in Shanghai, 24 in Jiangsu and 26 in Guangxi. The specific distribution is shown in the following table and figure.

Table 3 Regional distribution of new LNG power demonstration ships

Region	Quantity	Region	Quantity
Shanghai	90	Chongqing	2
Guangxi	26	Hubei	2
Jiangsu	24	Guizhou	2
Guangdong	4	Anhui	2
		Shandong	2

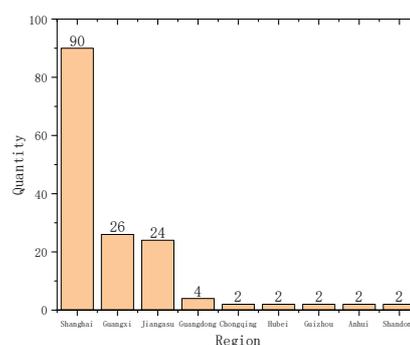


Fig. 2 Regional distribution of new LNG power demonstration ship

3 Power system update LNG powered ship

In order to encourage existing ships to use clean energy and promote the supply side structural reform of the shipbuilding industry, in 2016, the Ministry of Finance issued a supplementary notice on the measures for the administration of subsidies for ship scrapping, dismantling and ship type Standardization (finance [2016] No. 418), which adjusted the subsidy policy for LNG powered ships, The original subsidy for newly-built LNG powered demonstration ship is adjusted to the subsidy for the reconstruction of LNG powered demonstration ship by overall renewal of power system^{[7] [8]}. Up to now, according to the incomplete statistics of the Water Transportation Research Institute of the Ministry of transport, 72 LNG powered ships have been reconstructed by the overall renewal of the power system, including 71 demonstration ships.

1) Ship type

According to statistics, the LNG power demonstration ships reconstructed by the overall renewal of power system mainly include dry cargo ships, dry bulk cargo ships, cement tank ships and container ships, of which dry cargo ships are the main, dry bulk cargo ships and cement tank ships are the second, and container ships are the least. See the figure below for details.

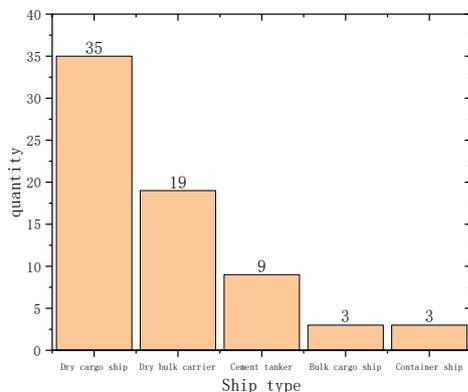


Fig. 3 Type of LNG power demonstration ship reconstructed by overall renewal of power system

2) Regional distribution

Jiangsu Province is the most active Province in responding to the national development of green water transportation. Among the 71 LNG powered demonstration ships that have been reconstructed by adopting the overall renewal of the power system of the existing ships in China, there are 68 in Jiangsu, accounting for 95.77%; The remaining three ships are two in Chongqing and one in Wuhan, Hubei. See the table below for details.

Table 4 Regional distribution of reconstructed LNG power demonstration ships in the overall renewal mode of power system

Ship type	Quantity
Jiangsu	68
Chongqing	2
Hubei	1

3) Tonnage structure

In the supplementary notice of the Ministry of Finance on the measures for the administration of subsidies for ship scrapping, dismantling and ship type Standardization (finance [2016] No. 418), it is stipulated that the existing ships shall be reconstructed into LNG powered demonstration ships by means of overall power system renewal, and the ship tonnage shall not be less than 400 gross tons. According to statistics, the tonnage (deadweight tons) of the reconstructed LNG powered demonstration ships are concentrated in 500-2000 tons. See the following table and figure for details.

Table 5 Tonnage (DWT) of LNG power demonstration ship for overall renewal and reconstruction of power system

Tonnage	Quantity	Tonnage	Quantity
500-1000	26	2000-2500	6
1000-1500	17	2500-3000	3
1500-2000	16	4000-6000	3

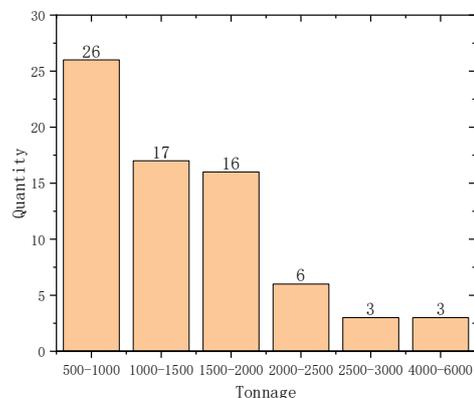


Fig. 4 Tonnage (DWT) of LNG power demonstration ship after overall renewal and reconstruction of power system

4) Ship age distribution

In the supplementary notice of the Ministry of Finance on the measures for the administration of subsidy funds for ship scrapping, dismantling and ship type Standardization (finance [2016] No. 418), it is stipulated that the existing ships shall be reconstructed into LNG powered demonstration ships by means of overall power system renewal, and the ship age must be within 10 years (inclusive). Therefore, the ship age of the reconstructed LNG powered demonstration ships is generally small, concentrated in 3-5 years and 7-8 years. See the following table and figure for details.

Table 6 Age distribution of LNG power demonstration ship reconstructed by overall renewal of power system

Ship age / year	Quantity	Ship age / year	Quantity
1	3	6	6
2	10	7	11
3	10	8	11
4	11	9	1
5	7	10	1

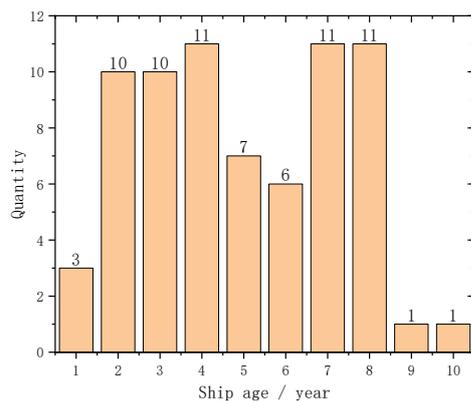


Fig. 5 Age of LNG power demonstration ship reconstructed by overall renewal of power system

4 Summary

According to the above analysis, it can be seen that the development of LNG powered ships in China is dominated by new construction and the combination of reconstruction and reconstruction; Ship tonnage is relatively small; The ship age is relatively small; The economically developed areas have the characteristics of relatively rapid development, and the overall development is relatively slow. In order to further implement China's policies on energy conservation and emission reduction, the development of new energy and clean energy, and accelerate the realization of the dual carbon goal of China's shipping industry, it is suggested that China give relevant support policies in promoting the application of LNG in the water transportation industry:

- 1) Introduce the continuation policy of financial subsidies, give certain financial subsidies to new LNG and reconstructed LNG powered ships, and improve the enthusiasm of ship owners to use LNG;
- 2) Improve the network of LNG filling facilities to ensure the operation safety of LNG powered ships;
- 3) Strengthen the supervision on the use of fuel oil by ships and establish a good LNG market application environment.

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