Original Research Article

Application of New Energy Natural Gas in Ship Engineering

Zhennan Yang, Liqun Pei, Jinsheng Zhu

Engineering College, Nanchang University of Technology, Jiangxi, China

ABSTRACT

Traditional ships are mainly diesel or gasoline as fuel, and diesel and gasoline are produced by the oil refining products. Oil is a non-renewable energy, human development step by step consumption of limited oil, while burning oil produced by the poisonous gas day and night to destroy the planet we live on. As the soaring oil prices and ecological deterioration, many ship-owners to the eyes of the gas to the above, the natural gas as a ship of fuel calls are getting higher and higher. The development of the technology has to get more attention by the industry itself. This paper mainly discusses the application of the new clean energy natural gas in ship engineering, and explains in detail the advantages and disadvantages of natural gas as a new energy source, the concrete application in ship power and the prospect of future energy shortage. As a new type of energy used in the ship is to solve the problem of power and China in the gas fuel as a ship power of the relevant provisions.

KEYWORDS: New energy natural, Gas ship, Power plant specification

1. The origin of natural gas powered ships

Norway as the LNG producer, in order to improve the Norwegian gas fuel technology and access to good environmental effects, in 1996 the Norwegian Parliament decided to build CNG and LNG as fuel for the two types of vehicles / passenger ferry. In 2000, the world's first ferry ship 'M / F Glutra', which was fueled by LNG, was completed by the Aker Shipyard. By using LNG fuel, the ship can reduce NOx emissions by 80%, the total cost is 30% higher than that of diesel fuel ferry, but shipyards and operators believe that due to the first application of new technology, the cost increase is within acceptable range. The

2. Advantages of natural gas powered ships

2.1. Environmental protection of natural gas

At present, oil and coal are the largest ship energy providers, while people use fuel to obtain energy, but also to the environment emissions of a large number of toxic gases, such as: carbon dioxide, Oxynitride, sulfur oxides, etc., where Oxynitride and Sulfur oxides are the main material of acid rain, and the large amount of carbon dioxide emissions also caused an increasingly serious greenhouse effect. As a result, reducing emissions of harmful gases in energy systems has become a key issue in improving the global environment.

At present, the national sailing ship emissions of nearly 1.2 billion tons of carbon dioxide gas per year, accounting for about six percent of global emissions. Oxynitrides and sulfur oxides account for 20 percent and 30 percent of global emissions, and marine fuel fuels are heavily polluting the oceans and the atmosphere. And the MEPC58, which was held in October 2008, passed the amendments to MARPOL Annex V1 to provide further requirements for the emission of air pollutants from ships. Revised from 1 January 2012 onwards, the sulfur content of the ship's fuel oil decreased from 4.5 per cent to 3.5 per cent and was estimated to be feasible by 2018 and gradually reduced to 1 per cent by 1 January 2020 of 0.5. The main component of natural gas is methane, is the nature of the lowest carbon molecules can exist fuel. Will naturally reduce to minus 160 degrees below its volume will be reduced by more than 600 times, conducive to storage and market supply. Natural gas does not contain any impurities, sulfur, mixtures and aromatics, the combustion products are not odor, no particles and residual ingredients, almost no pollution. Therefore, natural gas is a reliable new environmentally friendly fuel.

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2.2. Economies of natural gas powered ships

In 2000, the domestic diesel price of 2,000 yuan a ton, and by the first half of 2012, diesel prices are jumped to 9,000 yuan a ton, soaring oil prices greatly improved the owner's operating costs. At this time, natural gas as a low-cost environmental role appeared. Natural gas market prices are much lower than fuel prices, especially in the US and Europe. The same calorific value input, the price of natural gas relative to the fuel price is one quarter or one third. At present, the domestic price of natural gas and heavy oil prices due to the price mechanism, but with China as the world's largest importer, natural gas prices will be further reduced.

2.3. Safety of natural gas powered vessels

Natural gas is a cryogenic liquid, even when a leakage accident will soon be natural gasification, the density of light than the air, the leakage of gas will automatically overflow, will not produce water pollution, add a special smell, the natural gas leak can be timely be found. Natural gas burns higher than gasoline and diesel, instantly lighter than oil, easy to spread, easy to reach the explosion limit. From the use of security speaking, natural gas is much better than fuel.

3. Disadvantages of natural gas powered ships

3.1. Natural gas fuel system bulky.

Natural gas storage tank fuel system occupies a large space, heavy weight, affecting the cargo volume. Natural gas storage tank volume, the space occupied by the traditional diesel fuel storage space about 4 times the weight of the latter is 1.5 times.

3.2. Natural gas fuel ship cost higher.

At present, the cost of natural gas fuel ship is higher than the traditional diesel fuel ship 5% -20%, will bring some cost pressure.

3.3. General rules for the lack of technical safety of natural gas fuels.

At present, only DNV has made the relevant classification standards for natural gas fuel ships, but most countries have not yet introduced relevant government regulations for technical standards such as LNG marine fuels

3.4. The initial cost of natural gas vessels is higher.

It is understood that the cost of an LNG storage tank will be a few million dollars, if the owner is only considered the cost of construction accounts, often discouraged. However, due to the increasingly stringent requirements for ship emissions, the Nordic countries such as Denmark and Neville have already had to start using LNG as fuel ferry, ro-ro ship, coastal garrison, LNG ship and platform supply ship.

3.5. Noise of natural gas powered ships

Modern marine diesel engine commonly used high pressure, the supercharger speed up to 20000rpm above the role of the air can produce severe high-frequency noise, diesel engine is the largest noise source; and diesel engine cylinder burning (burst pressure can be up to 20MPa), will also issue a strong noise; four-stroke diesel engine into the exhaust valve cycle of opening and closing, will issue a harsh percussion. Large-scale ocean-going vessels have higher technical standards and relevant specifications, and they are well equipped with soundproofing in the cabin. They are generally able to meet the requirements of China's 'Transport Ship Chamber Noise Standard' and 'Transport Ship Chamber Noise Measurement Method'. And small ships in the river using high-noise medium and high-speed diesel engine as a power plant, and there are many small boats without control room, the long-term exposure to high noise in the impact of the aircraft, the long run, severe hearing loss, physical and mental health cannot be guaranteed. However, natural gas turbine used in the gas turbine, in use, there are three main forms of noise: intake and exhaust noise, body radiation noise and structural noise. Under normal circumstances, the body radiation and structural noise than the diesel engine is small, but because it requires a large amount of air, so its intake and exhaust noise than the diesel engine.
4. Introduction of natural gas power plant

4.1. Steam Turbine

The steam turbine propulsion system consists mainly of boilers, steam turbines and gear reduction gears. Its working principle is that the steam generated by the boiler through the steam turbine to heat and pressure potential energy into kinetic energy to drive the turbine rotor rotation, the deceleration device driven by the propeller rotation, thus promoting the ship forward. Steam turbine occupies the mainstream of today's global LNG ship propulsion system. The main reason is that the LNG ship's speed is generally higher, the output power of the steam turbine is large, which can meet the requirements of the LNG ship to the high power propulsion system. High reliability, to meet the requirements of delivery timeliness; in the steam turbine system LNG evaporation steam or heavy oil can be used as fuel for the boiler, you can also use a certain proportion of mixed combustion, LNG evaporation steam can get very good The main propulsion system combined with the main boiler and the steam turbine effectively solves the problem of the safe use of the steam evaporator; the LNG is the most important and easy to use. Of the application technology for a long period of time only by a few developed countries to master, while the market for a long time in a state of oversupply, LNG prices lower, steam turbine system overall economy is better. While other main propulsion systems are relatively more or less technically bottlenecks and become an obstacle to LNG owners' propulsion systems. After several decades of development, the steam turbine system has to some extent become the standard power system for LNG ships.

4.2. Gas Turbine

In the LNG ship using gas turbine propulsion device, can be used mechanical or electric type. The gas turbine is lighter in weight, has no vibration, and can use dual fuel (using heavy oil as a backup fuel). Its inefficiency can be compensated to some extent through a combined cycle system. However, gas turbines have higher demands on power stations and gas pressures, which make installations more complex and costly.

4.3. Compound Turbine Unit

The compound turbine unit (i.e., the gas turbine engine 10 steam turbine engine) is used to produce steam turbines while using steam turbines to burn steam. The fuel efficiency of this engine is better than that of a typical steam turbine, and the exhaust gas is the same as the steam turbine engine and is cleaner. The disadvantage is the need for high quality petroleum fuels and cannot be combusted with steam. The future may also be considered in conjunction with the electric propulsion device. From environmental factors to consider the future may be the use of such a propulsion system.

4.4. Dual fuel power propulsion

The development of dual-fuel engines (fuel and steam) has made it possible to make efficient use of vaporized fuels, which have evolved from heavy oil diesel engines. So the dual fuel engine propulsion device is also a modern LNG ship with a strong competitive choice. The dual fuel engine is a specially engineered internal combustion engine that can burn LNG vapor and fuel directly, with both high pressure and low pressure. The low-pressure dual-fuel diesel engine can pump the vaporized LNG gas on the ship at a lower pressure (about 4 bar / cm2), and the low pressure double fuel diesel engine can inject the LNG gas injected into the combustion chamber. The Jet gets into the combustion chamber, burning under light oil ignition. The former uses of high-pressure LNG pipeline leakage risk, the latter need additional configuration of the ignition device. According to the relevant information, in the Norwegian offshore project, in the small LNG ship propulsion system has a direct use of dual-fuel engine as the main propulsion device, but the system needs and evaporative steam oxidation device supporting the use. Compared with the conventional power plant, the use of this dual-fuel engine not only to maximize the use of steam fuel, but also greatly reduces the fuel consumption and operating costs, can save fuel 20% to 30%, improve the efficiency of the engine. On a 135,000-cubic-meter LNG ship, MAN B ‘u0026 W Diesel Engine Company compared the steam turbine with heavy oil to a dual-fuel engine with heavy oil and natural gas, which costs about $ 2.5 million a year for ship-owners. At the same time, dual-fuel engine has a very low emissions, the nitrogen oxide emissions is only equivalent to ordinary diesel 1/10, carbon dioxide emissions are quite low. Since the dual fuel engine can be operated alternately in both the gaseous fuel and the liquid fuel mode, and the two modes are automatically switched, the engine does not stop running when the gaseous fuel supply is stopped but is automatically switched to the liquid fuel mode. With the continuous development of marine power plant, dual fuel engine with its use of two kinds of fuel, light weight, lower manufacturing costs, etc. will become the future LNG owners of the propulsion device is an important choice.
5. China's natural gas fuel power ship specifications

With the increasing use of natural gas in ships, the 'Natural Gas Fuel Power Vessel Code' was released. It is based on the CCS 'Gas Fuel Power Boat Inspection Guide' (2011), based on CCS 'natural gas fuel power ship key technology research', 'marine LNG fuel tank structure key technology research' and other research results and a large number of practical research Results, in accordance with the target type standard (GBS) and risk assessment concept developed for the natural gas fuel for the steel specifications.

Relative to the 2011 version of the 'Guide' the main changes in this specification are:

(1) On the basis of 'Guide', adjust the specification structure from the point of view of ease of use, and add the technical requirements of the four key products of the gas tank, the gas fuel engine, the electronic control system and the heat exchanger 4 as the 4 Appendix.

(2) Revise some of the contents of the original guide, increase the requirements of the gas tank connection, the piping test, the gas valve unit, the storage area in the semi-enclosed space, the layout of the air supply pipe valve, Tank space, the cabin air supply system, the gas fuel engine functional requirements and other content has been adjusted.

(3) The new gas fuel filling, natural gas standard filling the relevant technical requirements.

(4) The risk analysis concept throughout the specification has always been the new failure mode and impact analysis (FMEA) requirements.

6. Status of natural gas powered ships in the global market

In the global marine gas development status, natural gas as a marine fuel in the global scope of the low degree of penetration, only a few sporadic countries in a few ferry, cruise ships and other fixed-point transport of ships with natural gas as a marine fuel, Most of the world's marine natural gas applications are concentrated in Norway. Natural gas carriers are mostly diesel and BOG dual power systems, the propulsion system without exception are steam turbine power plant. At present, more than 300 LNGCs and BOG are used as fuel for steam turbines.

However, the LNG fuel economy advantage is driving the development of marine LNG. The state of crude oil supply, oil prices remain high, while the international LNG prices in 2009 after the sharp decline in oil prices and natural gas prices between the gap is growing, from the fuel costs and other economic considerations, burning LNG than burning diesel cost The

At the same time, the international ship emission standards will promote the rapid development of marine LNG. In recent years, the International Maritime Organization (IMO) has strengthened mandatory provisions for marine ship emissions, and if countries have implemented mandatory emission regulations for IMO, most of the world's vessels for offshore trade will use LNG after 5-10 years as a marine fuel. Future LNG marine fuel international market development focus area is the Baltic region, the North Sea and the Mediterranean region.

At present, the international LNG fuel ship power system mainly by Wärtsilä, MAN, Rolls-Royce and Mitsubishi Heavy Industries four companies, including Wärtsilä and MAN to dual-fuel engine-based, and Rawls Royce and Mitsubishi Heavy Industries to gas engine.

LNG hull manufacturing, Japan and South Korea as the main origin. Mitsubishi Heavy Industries is the supplier of many LNG fuel ships, the Japanese merchant ship Mitsui announced in 2009 the use of LNG fuel 'ISHIN-II' design concept of ferry, Daewoo Shipbuilding and Marine Company is currently developing large-scale container with LNG fuel Ship, the company and MAN are working together to develop ME-GI engines and DSME high pressure cryogenic fuel supply systems for 14,000TEU container ships.

7. Development of natural gas powered ships in China

At present, the domestic use of marine natural gas is basically in the blank area, China's inland waterway fuel to diesel power, LNG fuel has not yet applied to the marine field, but the past two years, some of the LNG industry technology companies have tried to LNG marine fuel as LNG industry The future development of an important direction, there are a variety of models of the mainstream diesel engine has been carried out bench test, and through the relevant departments of the relevant departments of the identification of acceptance, proved the technical and economic feasibility. In addition, under the government's 'energy-saving emission reduction' policy guidelines, the riverboat converted LNG fuel will become the focus of development.

From the development trend, on the one hand, the future of China's inland river LNG ship number will grow rapidly. China's inland waterway is rich in resources, with large and small Natural River more than 5800, the river total length of 430,000 km, the huge demand for inland waterways. In the context of energy saving and emission reduction,
it is of great practical significance to develop river LNG vessels to prevent and control ship pollution on the basis of increasing LNG receiving stations. It is expected that over the past three years, there will be more than 50,000 ships to be converted, directly driving the value of energy equipment up to 26 billion yuan in the market increment.

On the other hand, the state is to increase capital investment to promote the development of inland waterway, LNG shipbuilding constitute a strong support. Ministry of Transport Deputy Minister Xu Zuyuan said, 'Twelfth Five-Year Plan' period, the central government will arrange 45 billion yuan of financial funds to increase the channel to support the security system and the central and western regions of the port and other capital investment, while arranging 5 billion yuan financial guidance funds, Promote the standardization of river ship type and structural adjustment of capacity. This means that the 'second five' inland shipping investment than the 'Eleventh Five-Year' period increased by 2.7 times, an increase of record highs.

8. Natural gas power ship in the future development prospects

The Lloyd's Register (GL) is currently studying the feasibility of using liquefied natural gas (LNG) as a marine fuel. A member of the board said that taking into account the required volume of LNG storage tanks, large ocean-going container ships are unlikely to fuel LNG, but for small-scale feeder vessels operating in the Baltic region, LNG is fuel more feasible. Although container ships using this new fuel will be more expensive than conventional fuel container ships, the former has lower fuel costs and fewer emissions. 'The natural gas propulsion system will be one of the main contributors to future green shipping,' said Bernard A. Nne, general manager of the ship's department. 'The use of natural gas as a ship has the advantage of reducing pollution emissions,' the French classification society said. Natural gas supply is abundant and has a price advantage compared to low sulfur content fuels. We have been studying the possibility of retrofitting existing vessels. 'According to GL, two 1,500 TEU container ships with LNG and heavy oil fuel are expected each year. The income for the owner will be $200,000 lower than the latter. This is because the volume of LNG storage tank is larger, resulting in the former carrying less than the latter about 3%. However, with the increasingly stringent regulations on ship emission reductions, the latter is more due to the cost of carbon dioxide emissions. According to this calculation, the shipowners, the use of these two kinds of fuel ship operating income is basically the same. Based on the above analysis, GL predicted that by 2012, LNG-fueled container ships would appear in the Baltic area where ship emission control was severe. At a World Gas Forum held in northern Europe, the company learned that under the relevant convention, the Nordic would promote the use of LNG marine fuel systems to protect the marine environment. Hamworth company official said, LNG fuel system can improve the ship's economy and environmental protection, reduce its operating costs and storage costs. By 2015, nearly a thousand ships in the Nordic region will stop using diesel, change their natural gas as fuel, and thereafter the new ships operating in this area will also install LNG fuel systems. It is predicted that the Nordic market demand for the system will reach hundreds of units each year. Wu goods Fang said that the use of natural gas to replace diesel, the fuel cost is expected to reduce about 1/3. 'The global shipping industry has the potential to achieve 30% reduction in emissions by 2030,' said Remi. Eriksen, Executive Vice President of DNV (Det Norske Veritas), said: 'The most effective measure is to use LNG as fuel. The Nordic countries, such as Denmark, Norway and other Nordic countries, have begun to use LNG as fuel ferry, ro-ro ship, coast guard ship, LNG ship and platform supply ship, which shows that with the global demand for gas emissions more and more The higher the higher.

9. Natural gas power ship development problems

9.1. Reconstruction of existing fleet and natural gas storage infrastructure is lacking

First of all, the biggest obstacle is the construction of supporting infrastructure, because most of the port natural gas supply facilities are not matched, although the natural gas supply is not difficult, but the port has not established a complete and practical supporting system, as the current car filling station plaque Lack of control of the popularity of gas vehicles, natural gas on the use of the ship has also received constraints. The construction of natural gas supporting infrastructure involves the planning and layout of the port, which requires the planning and cooperation between the government and the government and the government.

9.2. Natural gas fuel tank life is still weak

At present, natural gas as the fuel of the ship's highest endurance capacity is low, studies have shown that natural gas power ship's maximum battery life is only 22 days, up to ocean long-distance transport requirements. The reason is that the size of the fuel tank of the ship is large, but it can be placed on the ship at random, and the volume of the natural gas storage tank is small, but the system is complicated and the layout is difficult. The installation of the cylindrical natural gas storage tank will also lose part of the transportation space. This is a great difficulty for the design and alteration of the ship.
9.3. There is no uniform standard for natural gas technology, and there is a difference between the various classification societies.

In view of these problems, first of all, we should increase the 'oil to gas' efforts to strive for faster popularization of this technology; Secondly, faster research and development 'Note barge' and other new technologies, The government needs to increase LNG infrastructure construction and increase investment in this area.

10. Conclusion

From the technical development of natural gas fuel ship itself, LNG storage, transportation, supply, safety and other aspects of ordinary diesel ships have a greater change, involving LNG gas tank, power plant and fuel supply are all LNG fuel Ship design considerations include, in addition to evaporative gas, valves and piping systems, control systems and other content. LNG industry can be described as a great potential for development and with greater uncertainty in the emerging industries, at this stage has not yet achieved a wide range of promotion and application. At present, the main factors that affect the rapid development of LNG fuel ships include the lack of infrastructure, the constraints of shipbuilding technology, the lag of standardized development, the obvious advantages of natural gas prices compared with the advantages of oil prices, the different attitudes of governments and the public's understanding of natural gas, so the future needs of a wide range of joint efforts to solve

References

2. Qian Bozhang. Oil and Gas Technology and Citation. Science Press.