Research on Marine Structure and Ship Anticorrosion Technology

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Abstract: As one of the basic projects of national economic construction, shipbuilding and ocean engineering is of great significance to China's economic construction and development. Marine engineering equipment has the characteristics of high technology, high input, high output, high added value and high risk, and it also requires high safety and reliability. Metal materials are mainly used in ship and ocean engineering structures. Corrosion protection measures must be taken for metal materials that have been in service for a long time in such a highly corrosive environment as the marine environment. As far as offshore engineering structures and ships are concerned, the salinity of the marine environment is high, and offshore engineering structures and ships will stay in the marine environment for a long time, which will cause corrosion to them. This is a key issue to be considered in the development of offshore engineering. In recent years, various new technologies emerge in endlessly, which also poses new challenges to the anti-corrosion technology of ship and ocean engineering. Based on this, this paper focuses on analyzing the current situation of marine engineering structures and ship corrosion, and further expounds the trend and related measures of marine engineering structures and ship corrosion prevention.

1. Introduction

It is the treasure of marine human resources, the important place of national security and the frontier of scientific investigation. The area of the ocean is huge, and more than 80% of the earth's surface is ocean[1]. In the long history of human development, the resources and shipping value in the ocean have been developed and utilized by people. It can be said that the economic benefits created by the ocean at present have great influence on the development of the world and have become one of the important industries[2]. Marine transportation is an important driving force for the development of international trade. Although the speed of marine transportation is relatively slow, marine transportation has incomparable advantages over other transportation. At the same time, offshore operation platform is the key link to develop offshore oil and natural gas, and offshore wind power equipment enables Qingjie energy to provide services for human beings. Therefore, the ocean brings huge output benefits to mankind[3]. Because of the unique environmental characteristics of the ocean, the related equipment is extremely vulnerable to corrosion during construction. The salt content of seawater is extremely high, the seawater contains sufficient oxygen, and a large number of microorganisms exist, which further aggravates the corrosion phenomenon[4]. Therefore, it is extremely important to innovate the anti-corrosion technology for ships and ocean engineering.

At present, China's economic development and scientific and technological level are constantly improving, and marine engineering development has received extensive attention, which is one of the problems faced by coastal cities in marine development and rational use[5]. The vast majority of marine structures and production facilities are made of steel. These steel products are always in the marine atmospheric area filled with salt mist, or the splash area impacted by tides and waves. In such a harsh marine environment, the corrosion rate of metal is many times faster than that of land[6]. At present, the corrosion of ships and engineering structures is the biggest obstacle to the development of marine resources. Many basic equipment and facilities are scrapped due to corrosion, which is the most important reason for the damage of offshore equipment[7]. At present, China's corrosion losses far exceed those of developed countries. Therefore, improving the

corrosion resistance of marine engineering structures and ships is a problem that needs deep consideration in marine development and utilization[8]. In order to further reduce the corrosion of offshore engineering structures and ships, it is necessary to improve the durability and safety of enterprises; In the process, strong corrosion-resistant materials can be selected to replace the existing materials, so as to improve the level of marine development and utilization. Based on this, this paper explores the marine engineering structure and ship anti-corrosion technology.

2. Corrosion status of marine structures and ships

2.1. Complex marine environment

The overall environment of the ocean is relatively harsh, and the seawater contains a lot of hidden components, including salt, oxygen, microorganisms and so on. These are hotbeds of corrosion to offshore engineering structures and ships, which will further accelerate the corrosion degree of various building materials[9]. From the perspective of corrosion rating, marine corrosion is also an extremely serious type. The droplets in seawater contain sodium chloride, which will cause corrosion of offshore engineering structures and ships within 200m of the coast. It can be seen that the engineering structures and ships working at sea for a long time will be greatly corroded. In addition, in the same marine environment, the corrosion resistance and corrosion characteristics of various steels are quite different. The equipment has been in the marine climate environment for a long time, tested by severe conditions such as high temperature, high humidity, high salt, strong wind and rainfall, and some coastal areas will be affected by high and low temperature difference. In this context, improving the corrosion resistance of marine engineering is an important content of marine resources development. In order to effectively reduce corrosion and improve the durability of marine engineering structures and ships, we should develop good and excellent corrosion-resistant materials to improve the actual level of marine development. Ocean engineering is a relatively large engineering operation, and there are many factors affecting corrosiveness in its construction environment. From the point of view of the following steel structure, it can be classified into four categories according to the characteristics of different construction environments. Mainly reflected in: (1) Sea mud area. (2) Seawater immersion area. (3) splash zone. (4) Marine atmospheric area.

2.2. Ship corrosion problem

In addition to marine engineering structures, ships are prone to corrosion when they run in the ocean for a long time because of their huge and complex structures. The corroded parts include ship hull, superstructure, ballast tank, etc. The specific corrosion types and corrosion characteristics of each part are also very different due to the different contact time with seawater[10]. Besides seawater erosion, the influence of wave erosion and biological adhesion on the hull corrosion should also be considered. Under the influence of spray splash and sunlight exposure, the hull in the water area is in a corrosive environment with sufficient oxygen supply, alternating wet and dry, and the impact of floating objects causes serious corrosion. China has a long coastline, and there are many seaports and docks along the coast. At the same time, on the basis of the rapid development of marine resources, the submarine pipeline and transportation industry is also showing a rapid development trend, and the number of corroded marine engineering structures and ships is increasing. Among them, the treatment methods of metals and concrete which are susceptible to corrosion are imperfect, and they are hard to bear the invasion of the ocean, and then easily damaged. Figure 1 shows the corrosion velocity of different marine corrosion environment zones.

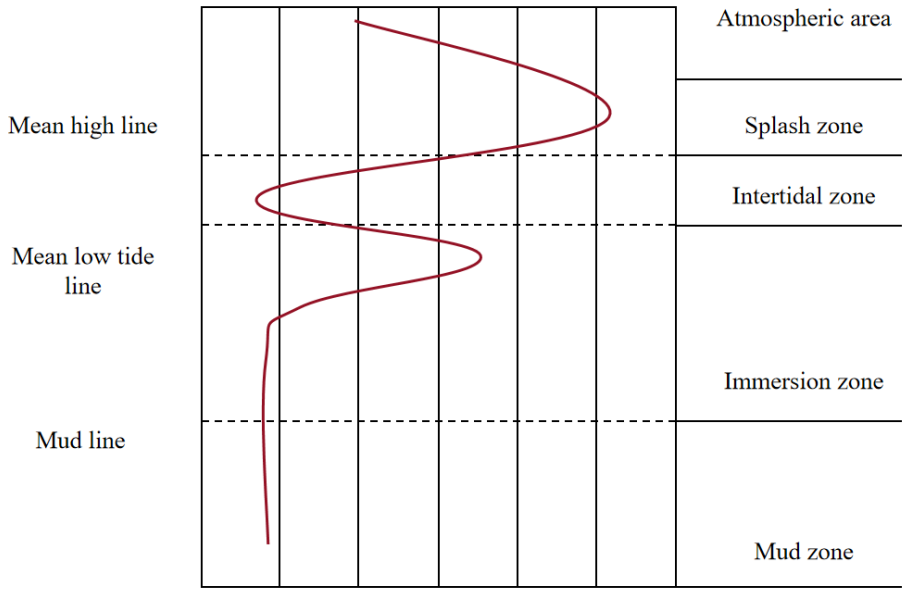

Figure 1 Corrosion velocity map of different marine corrosion environment zones

At present, the amount of equipment invested by China in offshore oil and gas development platforms, ship transportation, submarine pipelines and other industries is increasing, and most of the materials are made of concrete and metal. If the methods to prevent marine corrosion are not in place, serious corrosion phenomena and economic losses will occur in a short time, and even equipment will be scrapped. In addition, the common corrosion problem in marine security system engineering is that the anti-corrosion performance of supporting equipment is poor, that is, in the same time, the cameras and other sensors are in good condition, and the supporting rod body, box body and cable joint are seriously corroded, which leads to their failure to work normally.

3. Anti-corrosion technology of ships

3.1. Coating technology in spray area

In a sense, the innovation and improvement of anti-corrosion technology is extremely important in ship and ocean engineering. The sea contains extremely high salt, and the salt content of spray is also extremely high. If metal materials such as steel structures of ships are splashed by spray for a long time, it will cause corrosion of offshore engineering structures and ships. In order to effectively reduce the corrosion of steel structure in splash zone, coating anti-corrosion technology can be used to effectively cut off and isolate various corrosive media, so as to ensure that the salt of spray will not cause corrosion to offshore engineering structures and ships. In addition to appropriately increasing the thickness of steel, steel structures in tidal range and splash area usually adopt coating or covering neoprene and Monel alloy for external surface protection, and at the same time, aluminum alloy sacrificial anode is used for cathodic protection. This part is the most difficult area for corrosion prevention due to seawater corrosion and the effects of ice, waves and currents. Japan's research on this aspect is leading. It has made corrosion-resistant and coated Monel alloy, which has strong corrosion resistance. In the process of continuous optimization and adjustment, it has formed an industrial development trend. China learned from many foreign experiences, and at the same time, according to its own actual situation, it completed the anti-corrosion work of spray splash area, which promoted the development of coating technology of marine spray splash in an all-round way. Among them, oxidation polymerization coating anticorrosion technology is used in demonstration projects of special-shaped structures such as bolts and flanges, cables and waterproof sleeves of bridges, welding parts in wind power atmosphere, etc., and China has realized the underwater construction without relying on Japan's independent use of this technology. In addition, material modification and surface treatment, comprehensive electrochemical protection, effective use of corrosion inhibitors and other anti-corrosion methods have been comprehensively innovated

in ships and marine engineering structures, and outstanding results have been achieved.

3.2. Coating technology can isolate the attack of corrosive components.

In the application of anti-corrosion technology, it is one of the effective means to realize coating anti-corrosion by coating. To carry out anti-corrosion coating work is to use marine anti-fouling coating and anti-corrosion coating to carry out anti-corrosion. Marine anticorrosive coatings mainly include those applied to steel structure and non-steel structure. Non-anti-corrosion coating for steel structure is the necessary anti-corrosion work for concrete structure, which is carried out according to the material characteristics and structural characteristics of concrete. Anti-corrosion coating mainly refers to coating materials on the cut surface to be protected, so that the surface can be isolated from the surrounding corrosive media, and then a covering layer can be formed to protect the safety and stability of the structure, thus achieving the anti-corrosion effect. Marine anti-corrosion coatings include shop primer, anti-rust coating, anti-fouling coating on ship bottom, ballast tank coating, oil tank coating, offshore oil platform coating, coastal bridge protection coating and related industrial equipment protection coating. The amount of marine anticorrosive coatings is large, and 40,000 ~ 50,000 liters of coatings are needed for every 10,000 tons of ships. The types of anti-corrosion coatings are mainly divided into silicone resin coatings, epoxy coatings and polyurethane anti-corrosion coatings, among which epoxy coatings are widely used in the anti-corrosion treatment of offshore engineering structures. Anticorrosive coating is a special material with excellent electrical insulation and water resistance, which can adapt to the complex environment of the seabed. The coating can form strong adhesive force with the corrosion-resistant structural surface, can prevent different types of chemical damage, and has mechanical strength, which can achieve better protection effect. The anti-corrosion life of the coating mainly depends on the quality of steel surface treatment. Generally, rust removal is required to reach nearly white metal level, that is, there is no rust on the steel surface with naked eyes. Secondly, long-acting heavy-duty anticorrosive coatings suitable for different requirements should be selected. The so-called long-acting heavy-duty anticorrosive coating refers to high solid content, thick paint film and long protection life. Table 1 shows the types and proportions of heavy-duty anticorrosive coatings in China.

Table 1 Types and proportions of heavy-duty anticorrosive coatings

Coating	Proportion
Epoxy	32%~38%
Polyurethanes	23%~28%
Zinc rich primer	11 %o~17%
Acrylic	11%o~16%
Chlorinated rubber	11 %~ 16%
Fluorocarbon	3.3%~6.6%
Polysiloxane	1.1%~2.1%
Others	1.2%~2.2%

Basically, ships and marine engineering structures are built on marine pipelines and steel piles, which increases the invasion and corrosion of marine fouling organisms. The corrosion caused by biofouling is very serious, and it is also a common type of corrosion. Therefore, in the application of anti-corrosion technology, anti-corrosion can be achieved by using anti-fouling coatings. Anti-fouling paint is a special kind of marine paint, whose main purpose is to prevent marine organisms from adhering to and fouling marine structures, and to keep the bottom of ships or marine structures smooth and clean. Through the use of antifouling coatings, the material surfaces of various marine buildings and ships can be relatively smooth and clean, so as to avoid being attached by benthic organisms, reduce the pollution to structures and hulls, and improve the safety. At present, the service life of antifouling coatings has been improved, but research and development are still needed to improve the performance and service life of antifouling materials, and environmental protection should be realized without polluting the environment.

4. Conclusions

With the progress of materials science, in the engineering field of developing, producing and applying metallic materials, inorganic nonmetallic materials, polymer materials and composite materials, the characteristics of materials can be manufactured according to human needs. There are many marine weather-resistant materials, among which titanium alloy and aluminum alloy used in aviation industry are better choices. Corrosion-resistant metal materials can reduce the reaction rate of electrochemical corrosion by adjusting the chemical element composition, microstructure and the properties of corrosion product films in metal materials, thus significantly improving the corrosion resistance of metal materials. Steel should be the core construction material for marine engineering structures, and the importance of improving the corrosion resistance of steel materials should be recognized. As far as the application of ships in the development of offshore engineering structures is concerned, their components are mainly metal and concrete. Therefore, in order to effectively improve the corrosion resistance of metal, it is necessary to effectively adjust the chemical elements of metal, and on this basis, change the onlooker's structure of metal, so as to reduce the electrochemical corrosion area and reaction speed, and then improve the corrosion resistance of metal materials. Anti-corrosion measures for marine structures and ships mainly include anti-corrosion coating, anti-corrosion materials, coating anti-corrosion and electrochemical protection. It should be noted that besides applying these anti-corrosion measures, it is also necessary to construct perfect anti-corrosion technology, regularly check the corrosion situation and anti-corrosion effect, and regularly maintain facilities and equipment, so as to promote the sustainable development of offshore engineering structures and ships.

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