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Research on Anti-Corrosion Solutions for Simplification OCS Components

Li Shaopeng, Wang Guoliang, He Changhong

Institute of Electrification, China Railway Design Corporation, Tianjin, China

Email address:
liseanh@163.com (Li Shaopeng), wangguoliang@crdc.com (Wang Guoliang), hechanghong@crdc.com (He Changhong)

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Abstract: Simplification OCS equipment is a OCS equipment system with Chinese independent intellectual property rights. In recent years, more and more railroad projects have adopted this equipment system, which marks a big step forward in the process of China's OCS autonomy. However, its anti-corrosion process is not perfect, the current anti-corrosion measures are passivation, anodic oxidation and micro-arc oxidation three means, the anti-corrosion program is not mature. China's vast territory, the natural environment varies greatly from place to place, at the same time on the market a wide variety of anti-corrosion process, different projects, different locations using the anti-corrosion program is not uniform. This has a direct impact on both the manufacturing cost and the later maintenance cost. In this paper, through the service performance of existing parts, anti-corrosion measures to study the different forms of anti-corrosion process for the test, and ultimately achieve the purpose of unifying the anti-corrosion program of the Simplification OCS equipment. Propose anti-corrosion measures applicable to OCS equipment in different environments. Extend the service life of the equipment, improve the reliability of the contact network equipment and reduce the operation and maintenance cost while considering the economy. Realize the complementary improvement of Simplification OCS equipment technology system.

Keywords: Simplification OCS, Corrosion, Operation and Maintenance, Service Life, Reliability

1. Introduction

In the railroad projects that have been operated, the parts are exposed to the humid environment for many years, which is very easy to cause corrosion phenomenon. The traditional OCS equipment has many unreasonable anti-corrosion process design, which directly leads to the reduction of the service life of the parts. At the same time, the anticorrosion process of diversification, complexity in the OCS industry is not uniform, the same region, different projects using a large difference in the anticorrosion process is not uncommon.

This paper through the domestic and foreign part of the railroad project OCS parts service performance research, the current project used anti-corrosion technology research and comparison, combined with the latest anti-corrosion results of universities, manufacturers, research, and come up with the simplification OCS equipment anti-corrosion performance of the program, and in the line for testing, application. Improve the service performance of the equipment at the same time, improve the simplification OCS equipment technology accumulation, for the development of Chinese characteristics of the OCS technology and equipment to provide design ideas. [1-3].

2. Domestic Status

At present, the OCS steel parts generally use hot dip galvanizing process for anti-corrosion treatment, anti-corrosion process is more complex, and accompanied by the "three high" (high energy consumption, high pollution, high occupational hazards), and later can not be cut to deal with. Generally applicable to ordinary environmental railroads. But for the coast, high cold and high heat, windy areas, the durability of the performance will be significantly reduced, the harsh environment will accelerate its surface peeling, atomization, blackening, rust and so on. Aluminum alloy parts use passivation and other processes for anti-corrosion treatment, and later can be cut and processed, but the manufacturing cost is high [4, 5].

The corrosion of steel parts is very serious in coastal areas,

around chemical enterprises, tunnels and other regions where the air contains corrosive substances such as salt, alkali, acid and sulfur, as well as areas where high temperature and humidity change alternately. In the railroad lines built in the past, most of the OCS components use the more mature hot dip galvanizing anti-corrosion technology, which, compared with electroplating, chemical plating and other technologies, can obtain a thicker and dense plating layer as a protective coating, and its corrosion resistance fully meets the requirements for the use of the lines in ordinary areas [6].

The Lion Rock Tunnel of the Guangzhou-Shenzhen-Hong Kong Railway is located in the coastal area, which is humid all year round, with poor air circulation and dust accumulation, and all the OCS parts have been protected by the highest level 3 hot dip galvanizing corrosion protection. Before the line was opened for operation, the appearance of the parts was uniform and bright, but after 2 years of operation, the parts showed serious corrosion, and the mechanical and electrical performance was greatly reduced, which posed a more serious safety risk.

3. Status Abroad

In the early days of German wrist arm construction, galvanized steel tubes were used for the wrist arm tubes and malleable cast iron hot-dipped in galvanized corrosion protection was used for the connecting parts. By the mid-1980s, in order to improve the corrosion resistance of OCS parts, aluminum alloy began to be widely used. Aluminum has good corrosion resistance, and its surface generates a thick oxide layer, which can be regenerated when subjected to mechanical damage, so its protective function will not be lost. At the same time, aluminum's electrical conductivity and heat transfer capacity is 10 times and 2 times that of steel, so it is more resistant to short circuits [7].

In Japan, an integral steel wrist arm structure is used, with fewer connections in the structure, and the corrosion protection scheme is hot-dipped galvanized [8].

In the steel wrist arm system of the French railway, the supporting structure is made of square steel, and the connecting parts are made of high-strength and large plasticity copper alloy parts, which ensures the safety, reliability and stability of the OCS parts. Copper alloy and steel wrist arm connection has good electrical coupling, no need for electrical connection line connection between the positioner and the support; the connection parts adopt metal type copper alloy casting process. The most important characteristics of aluminum bronze is high strength, good elongation, very good corrosion resistance, excellent electrical properties, no need for conductive wires in the connection, no treatment or protection, good wear resistance. France's alloy smelting and casting technology is very developed, positioning wire clamps with boltless structure, the use of bronze alloy casting process, with high strength, high elongation, good fatigue resistance, good electrical conductivity, good corrosion resistance.

4. Research on Anti-Corrosion Programs

In the steel wrist arm system of the French railway, the supporting structure is made of square steel, and the connecting parts are made of high-strength and large plasticity copper alloy parts, which ensures the safety, reliability and stability of the OCS parts. Copper alloy and steel wrist arm connection has good electrical coupling, no need for electrical connection line connection between the positioner and the support; the connection parts adopt metal type copper alloy casting process. The most important characteristics of aluminum bronze is high strength, good elongation, very good corrosion resistance, excellent electrical properties, no need for conductive wires in the connection, no treatment or protection, good wear resistance. France's alloy smelting and casting technology is very developed, positioning wire clamps with boltless structure, the use of bronze alloy casting process, with high strength, high elongation, good fatigue resistance, good electrical conductivity, good corrosion resistance.

The materials of existing OCS parts are mainly divided into steel, aluminum alloy, copper alloy, etc. Steel and aluminum alloy are mainly used for wrist arm, pillar and base parts, while copper alloy is mainly used for wire clips and wires. This paper discusses a variety of anticorrosion solutions, and researches the optimal anticorrosion solutions for the parts.

(1) Multi-alloy co-infiltration anti-corrosion process

Multiple co-infiltration is a variety of elements of the active atoms adsorbed on the surface of the metal material, in the process of parts processing through the interfacial reaction and diffusion penetration into the material, the formation of intermetallic compounds on the surface of the metal material infiltration, which contains a variety of elements of the infiltration layer [9].

Table 1. *Comparison of hardness (HV0.05) of Q235 and 45# steels before and after multiple co-infiltration.*

Model	Q235	45#
Before	120-140	220-260
After	350-450	550-650

Multiple co-infiltration penetration layer of chemical composition and organizational structure with the base material is completely different, can significantly improve the parts surface wear resistance and mechanical properties. As can be seen from Table 1, the hardness of the surface of the parts treated by the multiple co-infiltration process for the untreated 2-3 times, superior wear resistance. Table 2 is the comparison of mechanical indexes of steel parts in multiple co-infiltration, and all mechanical properties have been improved. The most important thing is that the multiple co-penetration is the multiple non-metallic elements penetrate into the internal parts, basically does not increase the thickness of the parts, eliminating the need to increase the thickness of the coating must be reconsidered because of the other parts of the tolerance of the trouble with the coating and eliminates the coating can be attached to the surface of the parts of the concerns of the firm. In addition, multi-dimensional co-infiltration can also be combined with other processes to

further improve the parts of corrosion, fatigue and wear resistance, and can also change the color of the parts appearance [10].

Table 2. *Comparison of mechanical properties of Q235 material parts before and after treatment by multiple co-infiltration process.*

No.	Yield strength MPa		Tensile strength MPa		Bending strength MPa	
	Before	After	Before	After	Before	After
1	255.3	399.0	386.2	506.3	575.4	860.9
2	269.4	384.3	370.4	486.7	568.2	882.5
3	191.3	307.4	315.4	436.7	431.8	712.6
4	216.5	284.9	339.8	472.9	439.8	748.2
Average	233.1	276.4	352.9	475.6	505.6	801.1

The wear resistance and corrosion resistance of steel parts treated by multiple co-infiltration process are stronger than that of hot-dip galvanized parts, and meet the relevant requirements of the current iron standard. After experiments, steel multi-dimensional co-infiltration process will not cause environmental pollution, is an ideal measure to replace hot dip galvanizing.

(2) Galvanizing anti-corrosion process

Galvanizing process is a corrosion prevention method in which zinc active atoms are infiltrated into the surface of steel through thermal diffusion movement to form a protective layer of zinc-iron alloy to prevent corrosion on the surface of the component [11].

Galvanizing process has much higher corrosion resistance than hot-dip galvanized parts. The thickness of the galvanized layer is uniform and can be precisely controlled, and the abrasion resistance is better than that of hot-dip galvanized parts. The thickness of the galvanized layer can be estimated by multiplying the corrosion rate of the galvanized layer in the corresponding environment with the design life of the product. When the thickness of the galvanized layer reaches 100 μm or more, the process ensures that the corrosion resistance of the steel parts of the OCS in the harshest industrial corrosive environments reaches about 20 years. In addition, the galvanizing process does not cause environmental pollution and is therefore an ideal anti-corrosion alternative to hot dip galvanizing [12, 13].

(3) Micro-arc oxidizing anti-corrosion process

Micro-arc oxidation process is based on ordinary anodic oxidation, the use of arc light discharge, enhance and activate the reaction on the anode, in aluminum, magnesium, titanium and other metals and their alloy materials on the surface of the workpiece to form a high-quality strengthened ceramic film method [14].

From the test [15], it can be seen that the corrosion resistance and abrasion resistance of the micro-arc oxidation process is better than the existing passivation and anodic oxidation process, which can improve the corrosion resistance of aluminum alloy parts of the OCS in a higher place [16]. Micro-arc oxidation process has no environmental pollution, although the cost is higher, but it can eliminate the cost and workload of the later maintenance and repair, it is an ideal alternative to passivation and anodic oxidation of aluminum alloy parts anti-corrosion process, especially for the tunnel and the tunnel mouth near the ocean or serious corrosion of the industrial environment.

5. Conclusion

The simplification OCS system is available in steel and aluminum alloy. In view of the above test results, for the inland climate is relatively dry, the pollution of the general railroad projects, it is recommended that the steel parts of the anti-corrosion program using galvanized process. For coastal, environmentally polluted areas using galvanizing and multi-dimensional co-infiltration process, the anti-corrosion effect of this program and the surface wear resistance of parts are better than hot dip galvanizing, and the environmental pollution of both smaller, can be considered as an alternative to the traditional hot dip galvanizing corrosion protection process.

For the aluminum alloy wrist arm system corrosion, taking into account the structural shape of the parts, processing technology and manufacturing costs of the common impact, for the general inland areas, it is recommended that tubular parts, such as flat sloping wrist arm using a relatively cheap and mature passivation treatment, forging parts, such as wrist arm connector anodic oxidation treatment. Due to the micro-arc oxidation process of wear resistance, corrosion resistance are better than passivation, anodizing, but considering its high cost, can be used as a pilot or in the marine environment, serious pollution in the region.

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Biography

Li Shaopeng, Born in 1988, Male, Engineer of China Railway Design Corporation. Graduated in June 2014, Southwest Jiaotong University, Mechanical Design and Theory, Master of Engineering.