Concrete Corrosion Mechanism and Durability Design of Municipal Sewerage

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Abstract. In recent years, with the rapid development of urbanization, urban sewage pipe has become an important infrastructure, which plays a significant role in urban ecological security and social production development. Based on the investigation and analysis of concrete corrosion of sewage pipe in a certain city, the indoor simulated corrosion test is carried out, and the durability design method of sewage pipe concrete is put forward. Research findings show that the main cause of concrete corrosion failure in sewage pipe is sulfate erosion, and the modification of pipe concrete by mineral admixture and polypropylene fiber can effectively improve the durability of pipe concrete in sewage corrosion environment.

1.Introduction
Urban sewage pipe is an important infrastructure, which plays an important role in urban ecological security and social production development. With the rapid development of social economy and urbanization, urban water consumption and sewage discharge are increasing, and the composition of sewage is becoming more and more complex, which will undoubtedly aggravate the sewage corrosion of pipeline concrete[1]. In the urban drainage system, the investment of drainage pipe network is large, which accounts for about 60% of the total investment, while the corresponding sewage pipe network project has a strong sense of concealment, which results in a large cost of maintenance, and in the process of maintenance, Underground pipe problems, will also bring serious pollution to the city. This brings about pipeline durability degradation, service life shortening and other problems. Because the sewer pipe is buried underground, its durability problem is often ignored. If it is not paid attention to, it will bring great social and economic losses and ecological environment pollution. Based on this, it is very important to analyze the corrosion problem of sewage pipe network and realize the perfect implementation of detection and repair technology to reduce the cost input of maintenance sewage pipe network and ensure the safe operation of sewage pipe network[2].

2.Characteristics of concrete corrosion in sewer pipe
In order to further clarify the main factors of concrete corrosion deterioration in sewage pipes. The cement stone was extracted from the concrete of the sewage pipe and processed into the sample needed for the SEM test. The microstructure and composition of the sample were analyzed by JSM-7500F scanning electronic microscope. The hydration products in concrete reacted with erosive ions in sewage to form expansive products, which are mainly distributed in the pores, gaps and interface areas of concrete. With the accumulation of corrosion products and the increase of expansion stress, the microcracks in concrete increase, the adhesion between slurry and aggregate decreases, and
the concrete will appear crisp and spalling. The number of needle crystals in concrete pores is large and the individual erosion products are large. After erosion, a large number of short columnar erosion products are interlaced in the pores of concrete, accompanied by microcracks at the edge of the pores. A large number of short columnar crystals can also be observed in the interface area (ITZ) of mortar and aggregate in concrete. This short columnar crystal is gypsum, like ettringite, which is a typical erosion product of concrete during sulfate erosion[3].

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3.1. External corrosion resistant coating
Coating is the most basic and necessary measure for pipeline anticorrosion. Most of the anticorrosive coating materials of oil field main gathering pipeline are single layer fused epoxy powder (polyethylene, epoxy resin, phenolic resin), three layer polyethylene(epoxy powder, polymer adhesive, polyethylene layer), and the anticorrosive coating of non main pipeline is petroleum asphalt material. Currently, the double-layer fused epoxy powder has been developed to improve the mechanical properties of single-layer fused epoxy powder. Through the investigation and analysis of the application of these anticorrosive coatings abroad, the anticorrosive coatings of double layer fused epoxy powder are highly evaluated, followed by fused epoxy powder anticorrosive coatings and three layers of polyethylene anticorrosive coatings.

3.2. Sewerage Repair Technology
In the process of pipeline repair, two methods can be used---excavation or non-excavation, but based on the advantage that non-excavation repair technology can protect the road surface, avoid the impact on traffic and reduce the cost input while ensuring the normal drainage of sewage pipe network, it is suggested to adopt non-excavation technology to implement pipe network repair. In this process, the corresponding repair decision support system can be used to ensure the generation of scientific repair decision, and then to ensure the scientific and efficient implementation of repair technology. In the process of practical practice, it is necessary to carry out daily inspection records as the basis, and then analyze and evaluate the possible impact of the corresponding sewer in the event of damage. At the same time, the corrosion of sewage detection, and the actual situation of the pipeline evaluation. Finally, on the basis of scientific prediction of pipeline effectiveness probability, the corresponding optimization model of planned repair time is built to guide the scientific selection of repair technology. It lays a solid technical foundation for the scientific detection and efficient repair of urban sewage pipes[4].

3.3. Anti-corrosion lining
Lining type anticorrosion design can adopt lining PE, lining HDPE, lining FRP, lining PVC and other materials. The anticorrosion performance of lining material determines the anticorrosion performance of the whole concrete pipeline. Lining anticorrosive materials usually have excellent corrosion resistance, adhesion to concrete pipes, and high elasticity. The lining anticorrosion and pipe are prefabricated, and the inner wall of the concrete pipe is embedded mechanically by special anchor nail, which is not easy to fall off. The mechanism of anticorrosive lining is: first, the lining material insulates the direct contact between the sewage corrosion material and the concrete pipe, effectively prevents the corrosion liquid from infiltrating into the reinforced concrete pipe; secondly, the low roughness of the lining material reduces the accumulation of silt in the pipe and the corrosion of microorganism to the inner wall. However, in the process of field construction, it may cause damage to the anticorrosive sheet of the inner wall of the pipe, so the corresponding measures should be taken to protect the finished product.

3.4. Active introduction of new technologies and equipment
Traditional welding technology and welding equipment can not meet the requirements of future oil
field mining, so it is highly necessary to speed up the introduction of new technology and new equipment to improve the welding construction of oil field pipeline in order to effectively improve the welding quality of oil field pipeline. Traditional welding equipment should be updated to ensure that welding operations can be carried out in an increasingly complex environment. At the same time, we should strengthen the management, maintenance, inspection and regular inspection of the existing welding equipment. Secondly, the use of new welding technology can also strengthen the welding quality of oil field pipelines, introduce high technology to facilitate the collation and storage of various construction data, and strengthen the data management work can improve the construction efficiency[5]. Strengthen the construction of communication staff, actively introduce talents, and improve the scientific research level of staff through various channels. To encourage the staff to overcome difficulties and innovate the existing welding technology, so that the welding seam of pipeline welding is beautiful and burr free, and thus can meet the requirements of oil field crude oil transportation.Oil field mining units should increase their investment in new technology development and equipment renewal, pay attention to digital and intelligent construction, and make use of the most advanced welding technology for welding operations.

3.5. Test methods
The corrosion of sewer concrete is a complex physical and chemical process, and the deterioration of its material properties is often the result of the coupling of many factors. In the actual environment, the middle area of the inner wall of the pipeline is often the most corroded area. This is because the sewage flow in the pipeline changes at all times, the inner wall of the pipeline will suffer from dry and wet circulation. Therefore, the experiment will adopt the soaking system of dry and wet circulation to simulate the actual working condition of sewer pipe. In the sulfate corrosion test of concrete, some researchers have adopted the test system of soaking and drying cycle. Although this method can accelerate corrosion, high temperature drying will affect the deterioration of concrete and the formation of corrosion products. Therefore, this experiment will use natural soaking 7 d natural drying 8 d, and altogether 15d as a cycle.

3.6. Corrosion inhibitors
Adding corrosion inhibitor is an important and feasible anticorrosion method. At present, imidazoline corrosion inhibitors are used in oil fields, which have good inhibition effect on acid corrosion media such as H2S,CO2,HCl. However, the synergistic effect of composite corrosion inhibitor is better than that of single corrosion inhibitor. The screening results of corrosion inhibitor of petroleum associated gas in oil field show that the corrosion inhibition rate of Tiancheng chemical corrosion inhibitor combined with Shenyang Zhongke corrosion inhibitor can reach more than 90%. Blind selection of corrosion inhibitors may reduce the anticorrosion effect and accelerate pipeline corrosion. Therefore, suitable corrosion inhibitors should be selected according to the specific environment of oil field sewage pipes[6]. In the actual system, the concentration of corrosion inhibitor should be adjusted according to the specific flow rate to achieve the best corrosion inhibition effect.

3.7. Cathodic protection
The sewage pipe reduces the corrosion speed and degree of the anode by applying the current at the cathode. There are two main methods of cathodic protection: sacrificial anode method and forced current method. The function of protecting sewage system is achieved by sacrificing anode. If the soil or water contains sulfate reducing bacteria and the concentration is more than 0.5, the power protection needs to reach below-950 mA.h, effectively prevent the loss of cathode current, and install insulation device at the inlet and outlet of the pipeline.

3.8. Organic paint
According to different organic materials, organic coatings include epoxy coatings, polyurethane coatings, polyurea elastomer coatings, acrylic latex paint, fluorine resin coatings, silicone resin
coatings, glass scale coatings, etc. Among them, the most common anticorrosive materials used in municipal concrete sewage conveying pipes are polyurethane coatings[7].

4. Conclusion
In the urban sewage pipe network, aiming at the corrosion problem caused by the water-free in the sewage to the concrete of the pipe network, and a series of effects on other pipe networks, groundwater and soil in the city after the leakage of the pipe network due to corrosion, it is urgent to realize the scientific and standardized implementation of the sewage pipe network repair and detection technology in order to ensure the safe, reliable and efficient operation of the urban sewage pipe network.

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