

Design and Operation of Municipal Rain and Sewage United Pumping Station

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Abstract: In the process of designing a municipal rainwater and sewage pumping station, it is necessary to accurately grasp the design points, reasonably determine the scale of the rainwater and sewage pumping station, scientifically select the location and layout, and select materials reasonably. After completing the process design of the municipal rainwater and sewage pumping station and putting it into operation, in order to ensure the normal and stable operation of the pumping station, it is necessary to focus on strengthening the operation and management of diving equipment, cleaning equipment, and electromechanical equipment. The author analyzes the key points and specific design path of the process design of municipal rainwater and sewage pumping stations, and puts forward effective strategies for operation management, hoping to contribute to the scientific design and stable operation of municipal rainwater and sewage pumping stations.

Keywords: Municipal administration; Rainwater and sewage united pumping stations; Design path; Operation management

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1. Introduction

In view of rapid urbanization and industrialization, people have been paying more and more attention to water conservation and reuse. Relevant government departments in our country have also increased their investment in water environment governance. The construction of municipal rainwater and sewage pumping stations plays a very important role in the rational allocation of urban water resources, water supply and drainage, and water transfer and supply. To maximize the value of municipal rainwater and sewage pumping stations, it is necessary to do a good job in designing and strengthening the operation and management of pumping stations.

2. Key points of process design for municipal rainwater and sewage pumping station

(1) Determining the scale of the rainwater and sewage pumping stations

When designing a rainwater and sewage pumping station, it is necessary to conduct an in-depth investigation of the upstream and downstream of the pumping station and collect data related to rainwater and sewage pipe network to determine the pipe diameter and elevation of the pipe network. The flow rate and head of the pumping station can then be determined. At the same time, the discharge flow of rainwater and sewage in the service area of the pumping station is also calculated. The future growth of sewage discharge is predicted according to the development of the area covered by the pumping stations and the overall planning of the city. An appropriate return period is selected according to the location of the pumping station, to calculate the storm rainfall in the service area. The scale of the

rainwater and sewage pumping station the can then be determined based on the prediction of the sewage discharge and the rainstorm within the service range of the pumping station.

(2) Scientific site selection and layout

The municipal rainwater and sewage pumping station is an important infrastructure in the city, and the location of the pumping station is very critical. When selecting the location of the pumping station, it is necessary to conduct a comprehensive analysis of the existing urban municipal drainage network layout, buried depth, and planning of municipal land resources. In addition, it is also necessary to comprehensively consider the environmental benefits the pumping station can bring. When selecting the location and designing the layout of the pumping station, it is important to not only meet the needs of the urban infrastructure, but also to minimize the adverse impact on the urban environment and residents. Besides, it is also necessary to ensure that the layout of the pumping station is conducive to future operation management and maintenance.

(3) Reasonable choice of materials

The quality of sewage water is poor and somewhat corrosive. Therefore, when designing municipal rainwater and sewage pumping stations, it is necessary to choose high-quality, strong corrosion-resistant materials. Moreover, during the construction of the pumping station, the quality and corrosion resistance of the materials must be strictly tested to ensure that the selected materials meet the requirements of the pumping station.

3. The process of designing a municipal rainwater and sewage pumping station

(1) Determining the type of pumping station

There are some differences in terms of the sewage characteristics of the supporting pipe network, hydrological conditions, and operation management requirements for different types of pump stations. According to relevant surveys and studies, there are two main types of sewage pumping stations, one is dry pumping station and the other is wet pumping station. In terms of structure, a wet pumping station is relatively simpler; in terms of investment, a wet pumping station not only has strong corrosion resistance, but also relatively low investment costs, and in some comparative, and it can also operate stably in harsh environments. Because of the many advantages of wet pumping stations, it is becoming increasingly popular. On the other hand, dry pumping stations are easy to repair and maintain, and it is highly adaptable. When designing a municipal rainwater and sewage pumping station, it is necessary to choose the most suitable pumping station form according to the relevant needs.

(2) Ventilation design of municipal rain and sewage pumping stations

The pumping station and the grille are prone to pollution, thus causing odors. Therefore, when designing the pumping station, it is necessary to pay attention to the odor control of pumping stations. Proper ventilation can prevent odors forming in the pumping stations, so as to ensure the service life and performance of the equipment while preventing the odor from affecting the management personnel and the surrounding environment. With the continuous development of society, people are paying more and more attention to energy conservation. Therefore, it is important to utilize natural ventilation, and plants that absorb odors can also be planted for better deodorization.

(3) Grid design of municipal rainwater and sewage pumping station

Judging from the actual operation of municipal rainwater and sewage pumping stations, there are still some deficiencies in the grid design, which are listed in **Table 1**.

Table 1. Deficiencies in the grille design of municipal rainwater and sewage pumping stations

Design problem	Main hazard
(1) No lifting hoist	Affects future development and maintenance
(2) In order to reduce cost, the equipment between the grille and the water inlet gate are directly exposed to the environment	The equipment is exposed to wind and rain and shine for a long time, which makes it prone to corrosion and odor.
(3) No automatic detection and alarm equipment	Harmful gases cannot be detected.
(4) The rotary grille decontamination machine can only salvage hemp rope, cloth strips, etc.	Large objects like wooden blocks cannot be salvaged and need to be removed manually, which increases the workload of the operation and management personnel.

For this reason, when designing the grille of a municipal rainwater sewage pumping station, it is necessary to select the grille strictly according to the requirements and standards of the pumping station for sewage treatment. The types of grilles mainly include coarse grille and fine grille. Generally speaking, sewage treatment plants are designed with coarse grilles, and reasonable adjustments will be made according to the water level of the area where they are located. For this reason, when designing the grille, it is necessary to install a liquid level gauge near the grille to measure the water level in real time. Once the water level difference exceeds 0.2 m, the grille will be automatically activated for slag discharge ^[1].

(4) Sump design for combined pumping station of municipal rainwater and sewage

The main function of the sump in the rainwater and sewage pumping station is to adjust the water inflow. Through the reasonable design of the sump, the normal and stable operation of the submersible pump unit can be ensured. Therefore, the design of the sump is very important ^[2]. If the capacity of the sump is too large, it will lead to serious siltation in the sump, which will cost a lot to resolve the issue. However, if the capacity of the sump is too small, it would be difficult to meet the demand for water regulation. Therefore, it is important to design a sump with a suitable capacity. The final capacity of the sump should also be able to adapt to changing water volumes. The capacity of the sump should be designed according to the actual flow of the water inlet pipe, the pumping capacity of the water pump, the number of starts and stops, and whether the capacity of the sump can be adjusted by the water inlet pipe. The capacity of the sump should be minimized to save construction and operation costs and reduce the deposition and corrosion of debris in the sump. Based on the equation of a self-controlled pumping station: $V_{min} = T_{min}Q_4$, the minimum volume is directly proportional to the minimum work cycle of the pump. The water pumps in the pumping station are operated according to a certain order, and the order of the water pump operations corresponds to the capacity adjustment of the water pumps. To ensure that the capacity of the selected sump conforms to the minimum capacity, it is also necessary to comprehensively analyze the plane layout of the pumping station and the characteristics of the upper space structure.

In addition, several points need to be paid attention to when designing the sump.

- (i) The type of water pump should be reasonably selected to ensure that it not only has good energy saving performance, but also easily maintained.
- (ii) An isolation wall and an electric isolation gate should be placed in the middle of the sump so that the pumping station can still operate normally in the event of an abnormal situation ^[3]. When the isolation gate is closed, the sump transforms into two smaller sumps, which form a unified production system when the isolation valve is open.
- (iii) The operating platform of the pumping station should be placed on the ground to avoid leakage.

4. Operation of municipal rainwater and sewage pumping stations

4.1. Management of diving equipment

Immersible pumps are often used in municipal rain and sewage united pump stations. There are various types of diving equipment installed in the pumping station. Usually, the current of the equipment set in the middle is higher than that of the equipment set at the sides, and the current value may exceed 50%. If the equipment on both sides starts first, and the equipment in the middle cannot start normally. This means that the water inlet and outlet parameters of the pump station are not suitable. When the water outlet system on both sides of the pumping station fails, the water resistance value will increase significantly, which results in a high voltage, leading to power outages. There are many types of problems with mid-position devices, which is described below.

4.1.1. Waste clogging

The accumulation of sundries in the water inlet and outlet pipes can damage the components of the equipment and cause failures, or lead to high current and voltage. Therefore, it is necessary to deal with the waste accumulated in the water inlet and outlet pipes regularly.

4.1.2. Loss of power to sewerage

Most of the equipment in the pump station is a submersible pump unit and an axial flow pump unit. Among them, the submersible unit is in the water for a long time, and it will vibrate violently when in use, with a relatively large amplitude, which makes it prone to wear and tear and electrical damage, where circuits often fail to function properly. If this condition is ignored when starting the equipment, it will lead to failure problems of the drainage equipment. Therefore, when operating and managing diving equipment, it is necessary carefully investigate hidden dangers to ensure the normal operation of water supply and drainage equipment ^[4].

4.1.3. Loss of water vapor

Through daily inspections, it was found that the immersible pumps were worn out during operation, some axial flow units had been severely damaged, and the water vapor loss exceeded 50%. If this issue is not resolved, it will cause serious damage to the equipment. Therefore, it is important to inspect the equipment's operation status and make sure that the equipment is operating normally.

(1) Cleaning equipment operation management

The main function of the cleaning equipment of the municipal rainwater sewage pumping station is to prevent waste from entering the pipeline and prevent water supply and drainage equipment failures ^[5]. In terms of cleaning equipment, some local brands and foreign brands have better performance but are expensive. Although some ordinary domestic brands are relatively cheaper, their quality cannot be guaranteed. If the cleaning equipment lacks good power system protection, it will fail frequently ^[6]. Therefore, we must strengthen the operation and management of cleaning equipment. On one hand, we must choose appropriate cleaning equipment according to the actual situation. On the other hand, we must clean the pipelines more frequently and observe the accumulation of waste in the pipeline to ensure that the waste can be cleaned up in time ^[7].

(2) Operation management of electromechanical equipment

The number of electromechanical equipment in the municipal rainwater sewage pumping station is increasing year by year, and the equipment has been continuously perfected and are becoming increasingly reliable. However, there are some frequently encountered faults in the operation of municipal rainwater and sewage pumping stations.

The first problem is that the electrical connection points of electromechanical equipment are continuously heated. When the equipment operates for long periods of time, heat will be generated, the contact surface of the connection point will continue to shrink, and electrical corrosion will occur. If this problem is not resolved, the equipment will be damaged. Therefore, it is necessary to inspect the operation of electromechanical equipment frequently in order to identify and deal with the problems found in time.

The second problem is that the electrical values of electromechanical equipment does not necessarily conform to conventional requirements. After an electromechanical equipment has been in operation for some time, the voltage and current values may suddenly increase or decrease^[8]. Therefore, it is necessary to set the electrical values for electromechanical equipment. Once the current and voltage fluctuate, the circuit will be automatically protected, which significantly reduces the occurrence of power outages. For this reason, the operation and management personnel must do a good job in the daily inspection, so as to prevent safety accidents.

With the continuous development of science and technology, the operation of pumping stations is becoming increasingly automated, and the management concept and methods have become more and more advanced^[9]. To this end, through the establishment of an automatic operation management system, all the electromechanical equipment in the pumping station can be incorporated into the system. With the help of computer technology, network technology, measurement and control technology, and industrial control technology, a management and control system integrating communication, control and management can be built to realize automatic management and control. For example: A municipal rain and sewage united pumping station adopts a distributed electromechanical equipment operation management and control system. The components of the system mainly include the information layer, the field control layer, and the monitoring layer. A control room is used to monitor the various electromechanical equipment in the pumping station in real time^[10]. There are usually two ways to control electromechanical equipment: manual and automatic. Each electromechanical equipment is equipped with a local control box with a manual and automatic switch. At the same time, in order to fully connect the pumping station to the sewage treatment plant, it is necessary to ensure that the operation of the electromechanical equipment is consistent with the sewage treatment plant, so as to coordinate the operation of pumping stations and sewage treatment plants.

5. Conclusion

In conclusion, when designing a municipal rainwater and sewage pumping station, it is necessary to reduce the investment and construction cost of the pumping station as much as possible while ensuring the efficiency of the pumping station. At the same time, it is necessary to comprehensively consider the convenience of subsequent operation and management, in order to maximize the value of the pump station.

Disclosure statement

The author declares no conflict of interest.

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