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Selection of Water Transmission Method and Analysis of Pipe Network Zoning in Municipal Water Supply and Drainage Design

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Abstract: With the acceleration of urbanization, the demand for water supply and drainage pipe networks has increased significantly. In the planning of urban construction, it is necessary to optimize the design of the water supply and drainage system pipe network to effectively save energy while providing residents with more accessible water resources. Therefore, the municipal water supply and drainage system and the water transmission methods should be designed according to the geographical conditions of the city. In this paper, we mainly analyze the design of municipal water supply and drainage systems and the selection of water transmission methods. Besides, the optimization of the water supply and drainage network zoning process and pipe network maintenance is also discussed, so as to provide a reference for municipal water supply and drainage work.

Keywords: Municipal water supply and drainage design; Water transmission method; Pipe network zoning; maintenance

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1. Introduction

The construction of infrastructure the needs of residents should be considered in municipal water supply and drainage design and management. his approach ensures the optimization of the urban water pipe network and effective management of urban water usage, thereby improving residents' quality of life. Enhance the quality of water use and discharge of urban residents and realize the effect of water conservation. By enhancing the quality of water usage and discharge among urban residents, water conservation goals can be achieved. Therefore, meticulous design and arrangement of the pipe network in municipal water supply and drainage systems are essential to better fulfill operational requirements.

2. Municipal water supply and drainage design content analysis

2.1. Water supply design content

The design of the municipal water supply system should be optimized to ensure convenience for the residents. The urban construction of the area should be analyzed during the initial stages of designing a water supply system so that water storage and conservation goals can be achieved. In cases where water consumption in the city is huge, it becomes necessary to consider expanding the water supply design, optimizing water resource allocation, and enhancing the utilization rate of water resources [1].

2.2. Drainage design content

Designing a municipal drainage system involves many steps and is relatively complex. The drainage system primarily caters to both industrial and domestic wastewater. The diverse nature of sewage discharge necessitates consideration from various angles like the impact of natural precipitation [2]. Utilizing flood control facilities and integrating environmental protection technologies can significantly enhance the efficiency of sewage discharge. Parameters related to the drainage pipe and the setting slope should be measured in advance and the gravity discharge method should be preferred. The measured data should be recorded, and drawings should be created to minimize resource consumption [3].

3. Municipal water supply and drainage design water transmission method selection

It is necessary to analyze the classification and characteristics of different water transmission methods so that the transmission method is tailored to the specific area [4].

3.1. Classification of water transmission methods

To enhance the management of urban water supply and drainage systems, it is essential to strategically choose the water transmission method during drainage design. This selection process involves analyzing the distribution characteristics of urban water sources and assessing water demand to determine the most scientifically sound transmission method. In China, common urban water transmission methods include gravity, pressure, and a combination of heavy-pressure methods. Pressure water transmission involves applying pressure to the water source to facilitate its movement and transportation. A pressurization system is established around the water source, with corresponding parameters tailored to meet the water transmission requirements effectively [5]. Gravity water transfer combines industrial and residential water transfer with geographical advantages, utilizing terrain height to achieve water transfer through gravity. While this method offers the lowest cost, it requires favorable geographic conditions that allow for utilizing terrain differences and kinetic energy of water flow. The pressure and gravity mixed water transfer method combines the advantages of both approaches. By strategically setting up water transfer lines, it provides an effective water transfer path for the water source. In cases where terrain differences are insufficient, pressure facilities can be used to assist, allowing for flexible switching between methods [6].

3.2. Basis of water transmission method selection

The three aforementioned water transmission methods ensure effective water transmission. To choose the optimal transmission method for a specific project, factors such as topography, location, and distance to the water source should be considered. The distance and slope of water transmission serve as primary criteria for method selection. Therefore, prior to choosing a water transmission method, it is crucial to conduct thorough calculations of the water source distance. Factors like slope variations and gravity changes should also be considered during method selection [7].

3.3. Water transmission across rivers

Water transfer across rivers is a critical aspect of municipal water supply and drainage systems. When choosing a method for crossing rivers, it is essential to consider factors such as pipe type, material, and practical equipment application, along with thorough pipeline inspections. The selection process should account for gravity at the water transfer location, as well as pressure considerations, to choose an appropriate pipe model and material. In areas with special terrain, to ensure the rationality of pipeline crossings, a comprehensive analysis of bridge structures is necessary, combined with a careful selection of pipeline types based on bridge characteristics. Alternatively, buried pipeline construction methods can be employed, with prior determination of riverbed locations and meticulous pipeline layout planning. The pipelines should be made of corrosion-resistant materials since they will be immersed in river water [8]. Exhaust valves help expel air from the pipeline, preventing water flow obstruction or negative pressure formation after the pipeline is emptied. Employing compound exhaust increases exhaust speed, and the duration of blocking during pipeline exhaust should be determined based on wind speed. Additionally, small holes should be created within the pipeline for gas release.

3.4. Water transmission in mountainous areas

In mountainous terrain with complex and varied structures, gravity water transfer can be utilized where there are significant height differences. This involves designing water transfer lines along the shortest distance, leveraging terrain height variances. However, if the height difference along the water transfer line is too substantial, pressure-reducing valves and drop wells should be installed. In cases where pressurization is necessary during the water transmission process, especially if there is a significant height difference between the water supply area and the water source, a pressure water pipeline with multiple levels can be established. Pumping stations can be installed at the end of the pipeline to create a multi-stage water transmission system. Ultimately, the choice of pressurization technology and the method of setting up pressurization pumping stations should be determined based on factors such as the economic feasibility and technical requirements of the pipeline [9].

3.5. Long-distance water transmission

From the perspective of China's water resources structure, the per capita share of freshwater resources is limited, and water scarcity is exacerbated by imbalances in temporal and spatial distribution, along with serious water pollution in certain areas. Consequently, some regions face challenges in accessing nearby water sources for water supply, necessitating the adoption of trans-regional water transmission methods. Currently, China has undertaken several long-distance water supply projects. These projects involve significant investment and entail certain risks, requiring stringent safety and quality control measures in pipeline construction and management. Moreover, the extended length of the pipelines results in the accumulation of air, which can impede pipeline efficiency and compromise water transmission safety. Thus, it is imperative to install air valves in the pipeline to effectively manage the water transmission project.

4. Municipal water supply and drainage pipe network zoning process

The management of municipal water supply and drainage pipe network zoning requires integration with various factors such as regional system classification, scale management, and water intake point location. This process entails optimizing program designs to establish a scientifically structured pipe network zoning. The objective is to achieve comprehensive control over the water transmission project, ensuring efficient operation of the water supply and drainage pipe network.

4.1. Regional system class number design

The design of municipal water supply and drainage pipe network system stratification aims to ensure the rationality of the partitioning program. This involves ensuring that the partition locations are reasonable while also effectively managing program management costs. Currently, in China's municipal water supply and drainage design, a two-class mode is commonly employed for pipe network system design. This classification is based on factors such as the scale of the water supply project and available funds, allowing for effective categorization.

4.2. Regional scale design

In partitioning municipal water supply and drainage networks, it is crucial to prioritize maintaining a balance in water pressure to meet the demands of water users while preventing water leakage and accidents. Implementing low-pressure water supply can achieve energy savings and ensure manageable water supply within specific regional scales. The process of delineating regional norms begins by determining terrain elevation and regional terrain structure [10]. Subsequently, when delineating regional scales, it is essential to reasonably position water intake points and industrial water usage, taking into account pipeline diameter, sub-district flow, and expenditure costs to enhance the division's rationality. Recording regional pipeline leakage and flow rates is necessary for future pipeline construction inquiries. The construction of common regional channels should be avoided when planning zoning boundaries to prevent issues like duplicate water supply and cross-water supply problems. It is essential to determine water supply and sewage treatment locations in advance during sub-district boundary planning. These locations serve as the core of the design, aiding in determining sub-district design programs. Boundary ranges are determined through program superposition, with adjustments made based on actual construction situations.

4.3. Water intake point location design

Accident prevention and improving water supply safety should be prioritized in the zoning design of municipal water supply and drainage networks. This involves timely control of water pressure and accurately determining the scope of water intake point areas. The single-point water inlet method is effective in determining water pressure and the location of water inlet pipes. However, in areas prone to accidents, the multi-point water inlet method is preferred to enhance water safety. When limiting the scope of water intake points to a relatively small number, conducting water simulation experiments can help simulate and analyze the location and number of water intake points effectively.

4.4. Design optimization

It is crucial to thoroughly test the zoning program beforehand when designing municipal water supply pipe networks. This includes running simulations, inspecting the pipeline network design, and analyzing the setup locations of water supply facilities. By optimizing and updating regional programs based on the demands of the water pipeline network, we can prevent issues like stagnant water and improve overall efficiency. Furthermore, implementing a ring design mode by placing drainage equipment at the end of the water supply pipeline network increases the reliability of the system.

4.5. Application of new water conservation equipment

Water conservation should be emphasized in designing water supply and drainage systems. The focus should be on enhancing water resource application efficiency, followed by designing pipelines to minimize water usage and prevent water wastage during transmission. In drainage system design, leveraging modern water-saving technology and equipment can enhance water resource efficiency. Additionally, incorporating high-quality, energy-saving products and equipment into the design can further improve drainage water-saving capacity. In addition, implementing stacked water supply methods can effectively control water conservation costs and reduce the risk of secondary pollution to water sources.

5. Strengthening the maintenance of municipal water supply and drainage networks

5.1. Leakage detection

Detecting leaks is a crucial task in the daily maintenance of municipal water supply and drainage pipe networks. Leakage in drainage pipes can significantly impact water resource transportation. Therefore, it is important to strengthen leak detection efforts. The observation method is commonly used for leak detection. This involves visually inspecting the area around the pipeline for signs of leakage, such as sewage seepage or ground subsidence. These indicators help locate the leak. Additionally, low-pressure air detection methods can be employed. By introducing low-pressure air into the drainage pipe and monitoring the rate of air pressure drop, leaks can be identified. A rapid drop in air pressure indicates possible leakage, signaling the need for prompt location and repair.

5.2. Channel maintenance

The most common issues with drainage pipes include breakage, clogging, or settling. Pipe clogging often occurs due to insufficient pipe slope, resulting in low water flow rates and subsequent blockages. Therefore, when reconstructing pipelines, if there is a conflict between old and new pipes, reducing the pipe slope without changing the direction is a common solution. However, this leads to a deviation between the original slope setting of the pipeline and the originally designed slope, which will in turn reduce the water flow rate. This problem can be resolved by using the cross-well method, but it is susceptible to sewage gravity flow, leading to sediment sinking and pipe clogging.. Other factors contributing to pipe clogging include substandard construction methods allowing mud, sand, or soil into the pipeline, as well as domestic or construction waste obstructing the pipe walls. Aging pipes may also suffer from tree root entanglement. To clear blockages, various maintenance methods can be employed. The pipelines can be flushed using hydraulic dredging, flushing trucks, or high-pressure water guns. For severe blockages that are resistant to manual cleaning, mechanical methods or pneumatic dredging can be utilized for effective clearing.

5.3. Inspection well maintenance

Municipal water supply and drainage design and construction of inspection wells is also a key concern and maintenance of the location, which is more effective way of maintenance is to install a cover plate in the masonry of the well, to prevent settlement. Or by way of rainwater inlet modification, using water supply and drainage standard atlas components of the calculation for design. If the rainwater outlet is difficult to meet the water discharge requirements, you can enhance the water discharge capacity through the installation of grates.

6. Conclusion

In summary, when designing municipal water supply and drainage systems, it is crucial to consider the characteristics of water supply and drainage methods. This involves integrating regional terrain and water demand to select suitable water transmission methods and manage pipe network zoning effectively. By aligning pipelines with the principles of low cost, short distance, and high efficiency, optimal system performance can be achieved. Additionally, thorough planning for subsequent construction and maintenance is essential to ensure overall efficiency throughout the construction process.

Disclosure statement

The author declares no conflict of interest.

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