Discussion on Key Technologies for Sewage Treatment in Municipal Water Supply and Drainage Design

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Abstract: In recent years, with the rapid growth of urban agglomeration population, the municipal water supply and drainage system has a large pressure. Sewage treatment contributes significantly to urban water resource recycling and the maintenance of urban water environment quality. Conventional sewage treatment technologies are struggling to satisfy the stringent environmental standards. This paper studies the significance of sewage disposal in municipal water supply and drainage design, proposes major technology for sewage treatment and optimization strategy — building stormwater and separate sewage use treatment system, reasonable planning and designing of sewage disposal, optimal pipeline network design program, intelligent monitoring methods as well as improving the cleanliness of sewage disposal engineer to efficiently promote urban water resources recycling use supported by sustainable development.

1. Introduction

Municipal Water Supply and Drainage System is an important part of urban infrastructure. The sewage treatment technologies applied in its design are influenced and influenced by the use and protection of urban water resources, together determining the quality of the entire urban ecological environment. The rational and efficient technical methods of sewage treatment technologies provide the means for removing pollutants in municipal water supply and drainage design, so that treated water can be recycled, alleviating the shortage of urban water resources. Therefore, the application paths of sewage treatment technologies should be deeply explored in urban water supply and drainage design in order to promote the simultaneous improvement of efficiency and quality for the treatment.

2. Importance of Enhancing Sewage Treatment in Municipal Water Supply and Drainage Projects

2.1 Protecting Water Resources

Water is the lifeblood of urban development. In particular, under the prospect of rapid development of urbanization, effective sewage treatment is helpful to safeguard water resources in municipal water supply and drainage projects. The efficient treatment of sewage involves the use of scientific technologies that eliminate various contaminants from water so that treated effluent can be recycled for various applications or is safe enough for reuse, providing the city with non-potable clean and potable water supplies [1]. At the same time, sewage treatment is a prerequisite for ecological balance. This will strengthen sewage process capacity in municipal capital works, mitigating the impact of waste water on ecosystems and allowing rivers, lakes or other water bodies to maintain a suitable ecological environment. Moreover, improved sewage treatment can reduce water shortages in urban areas. Deep-treated wastewater is applied in urban greening and road cleaning and other fields, considerably enhancing the utilization efficiency of water resources. It is an essential guarantee for the sustainable development of cities and an important means to protect water resource security.

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2.2 Improving the Ecological Environment

Advanced sewage treatment methods and a sound pipeline network for municipal water supply projects (drainage) enable the collection and centralized governance of sewage, as well as removing harmful substances from allocated recycling standards to minimize pollution to urban natural water systems and establish conditions beneficial for subsequent recycling of water resources. Moreover, sewage treatment technologies can efficiently address greenhouse gases generated by the degradation of organic substrate in wastewater, blocking ways for these gases to contaminate air environment and hence better safeguard soil and air quality. Besides, improvement of sewage treatment helps cities attract investors and tourists with clean water bodies and good ecological environment, which not only improves the overall image and ecological quality of cities but also promotes urban ecological environment improvement from various aspects.

2.3 Promoting Urban Green Development

Municipal water supply and drainage projects sewage treatment technology is an important way to promote the green development urban environment. Municipal projects collect and treat sewage through centralized means, while reducing harmful substances in wastewater, allowing all treated water quality to meet discharge standards. A good water resource environment can attract more investment and is the foundation to vigorously develop the tourism industry. Clean water bodies and beautiful ecological environment can also make cities more attractive, promote the high-quality development of related green industries, and provide a material foundation for the cultivation of urban economy in greenness and sustainability.

3. Key Sewage Treatment Technologies in Municipal Water Supply and Drainage Design

3.1 Variable Frequency Water Pump Control Technology

The variable frequency water pump control technology is one of the important supporting technologies in sewage treatment of municipal water supply and drainage projects, which greatly improves the treatment efficiency and energy saving effect. That technology allows for the real-time monitoring of sewage flow. The flow data is continuously collected by the high-precision flow sensors mounted in the sewage pipelines and then uploaded to the control center. The pump frequency is calculated by the control center according to predetermined flow parameters [2]. Variable frequency pump control technology also has soft start function. It can realize smooth regulation of voltage and frequency in start-up and shut down process, avoiding the large current impact produced by traditional pump startup, reducing its impact on power grid. This technology mainly revolves across the application of AC variable frequency speed regulation. The frequency converter is set up on the pump motor which changes the power supply phase to achieve stepless regulation otherwise. It improves process control accuracy, stability and ensures the liquid level in chamber or sludge return flow in biochemical tank is always in a reasonable range. This allows subsequent treatment units to function in a stable and efficient manner, maximising final effluent quality.

3.2 Vortex Grit Chamber Technology

It is a core pretreatment unit in municipal water supply and drainage sewage treatment, with the advantages of high grit removal efficiency and low energy consumption. And in the process of applying, vortex grit chamber technology can use mechanical drive or water flow rotation to generate a centrifugal force field to separate grit and organic matter from sewage. Wastewater usually is tangentially put into the tank and then the turbine acts on them to form spiral flow. The central upward flow carries organic matter in all directions. Another major benefit of this methodology is good impact load resistance, it can maintain steady grit removal efficiency under flow variation by ±30%. It is one of the most important technical means for achieving fine operation of municipal sewage treatment.

3.3 Oxidation Treatment Technology

Oxidation treatment technology is one of the core technical methods in municipal water supply and drainage sewage treatment. Its basic process is to degrade organic matter by severe oxidation, supplemented with decolorization and deodorization. Electrocatalysis oxidation technology is one of the key technologies in treating phenol-containing wastewater. Wet catalytic oxidation technology is able to convert sewage organic matter into carbon dioxide and water, therefore it has the advantages of high efficiency and low energy consumption, which can provide a more flexible technical selection for municipal water supply & drainage sewage treatment.

4 Optimization Strategies for Sewage Treatment in Municipal Water Supply and Drainage Design

4.1 Constructing Separate Stormwater and Sewage Treatment Systems

In the municipal water supply and drainage projects, sewage treatment is to be carried out by building separate stormwater and sewage treatment systems. Using GIS geographic information systems and pipeline detection technologies, the existing underground combined sewer network should draw a three-dimensional model, accurately displaying the mixed junction points of stormwater and sewage as well as illegal sewage discharge outlets. Peaiming in China, municipal water supply and drainage projects should build IoT monitoring equipment and digital twin technology to form smart drainage integrated platform. At key nodes, deploy flow meters and water quality sensors to monitor indicators (such as COD and SS) in real-time, using machine learning algorithms to predict the operational status of the pipeline network. Technologies like pipeline robots, water quality/quantity monitoring devices utilize to dig deep into the reality of the state of drainage network, accurately locate stormwater and sewage mixing or misconnection points, and assess health status and drainage capacity. Transition to separate systems should be prioritized in areas with extreme mixing and sensitive waters. After rain it would be critical that the water runoff from buildings roofs, squares and roads drained separately in to the natural bodies of water or rainwater utilization facilities near by. Implement the sponge city concept by promoting source facilities such as permeable pavements and sunken green spaces to decrease total runoff volume and pollution load. Moreover, successful separate system conversion depends on strong policies and regulations and widespread public support. Governments should also introduce relevant regulations that clarify the responsibilities and obligations of property owners, developers, and residents for the separation of stormwater and sewage; restrict illegal discharge behaviors; explain the significance of separation in improving the living environment to community residents as well as encourage community residents involved in supervision maintenance. The aim of this is to prevent the misconnections, (through getting rid of washing machine discharge into storm drains) at source in order achieve the overall goal of avoiding misattachment and increasing rainwater resource utilization [3].

4.2 Conducting Proper Planning and Design for Sewage Treatment

Well-planned and designed sewage treatment in municipal water supply and drainage projects is essential for improving treatment efficiency as well as urban water environment quality. At the first phase of project planning, carry out comprehensive research on the size and distribution of urban population and habits of water consumption; understand effluent discharge situations for relevant industrial enterprises; and keep abreast of operation status regarding existing sewage treatment installations. Further clarification of the characteristics and variation patterns of sewage water quality and quantity through in-depth analysis of this data as a solid basis for subsequent planning. Sewage treatment also needs to estimate how much sewage will be generated in the future based on survey data to determine the construction scale of sanitation plant. No more oversized scales wasting resources, or undersized ones not delivering results. Sewage water with complex water quality, high treatment requirements can choose biological treatment + advanced treatment process. As for the sewage treatment, priority should be given to planned flexibility and expandability so

that some space can be reserved for future facility upgrades and process enhancements according to the actual situation. The whole planning process must impose the relevant municipal departments to take comprehensive consideration of appropriate urban development factors, use various models for medium-to-long-term time prediction. Avoid design is too ahead of its time or backward. Also, process selection is the heart of planning and design. Compare and select technologically mature processes with low energy consumption and material consumption. Proactively promote new low-carbon hydrogen energy-saving technology represented by anaerobic ammonium oxidation (anammox), aerobic granule sludge, etc. The site selection and design of sewage treatment facilities must be fully compatible with the surrounding environment to create a truly efficient, low-carbon and future-oriented sewage treatment systems for the city.

4.3 Optimizing Pipeline Network Design Schemes

It is well known that the design schemes of pipeline networks in municipal water supply and drainage sewage treatment systems directly affect sewage collection efficiency and treatment costs, and belong to scientific problems. Wastewater pipeline network layout should follow urban spatial planning and sewage discharge characteristics, using the concept of zoning grading and piecemeal separation to divide the service area into multiple independent drainage zone. An independent outlet needs to be assigned to each zone and matched with a corresponding treatment scale. Set up 3D simulation of pipeline network model on GIS platform, simulate sewage flow change in thick and thin under rainfall intensity condition, dynamically adjust pipeline route and burial depth, try to avoid the construction conflict of underground utility pipes and building foundation. Using CFD Technology optimization of pipeline profile design could be realized in this aspect where we can control maximum flowing velocity and self-cleaning capabilitity of the minimum flow velocity. For long-distance transmission pipes, adoption of new pipe materials such as ductile iron pipes and HDPE steel strip reinforced pipe can be promoted to maintain pump operating efficiency near the optimal working point. Top level planning is the key for optimizing pipeline network design in municipal projects. Employ advanced hydraulic modeling tools to perform detailed simulation calculation to optimize pipe diameter, slope and laying depth with the aim of keeping pipeline network running stably at full load in dry weather and flood season. In addition, the design of pipeline network should adopt a combination of gray infrastructure (pipes) and green facilities to decrease runoff volume and pollution load at source, release the impact on pipeline transport and discharge, recharge groundwater and realize simultaneous improvement in environmental benefits as well as economic benefits. Conceptual stage should break the traditional construction cost model focused solely on, life-cycle cost analysis, total analysis of design, construction and operation etc. processes of design and build a modern drainage pipeline network system that is efficient and reliable to providereliance for urban sustainable development.

4.4 Adopting Intelligent Monitoring Measures

Municipal water supply and drainage sewage treatment, various types of sensors will be deployed at the node to establish intelligent monitoring measures. Water quality sensors are used for real-time monitoring of water key indicators such as COD and BOD, accurately grasping the changes in water quality. Real-time flow sensors and pressure sensors are installed to collect sewage flow, liquid level height and pipeline pressure in real time, form a monitoring network covering the whole process of sewage treatment, provide rich data reference for its intelligent control. The relevant departments should also establish an intelligent monitoring platform that covers data collection, transmission, and analysis,deeply mine and analyze massive monitoring data to quickly detect potential security problems such as water quality fluctuations [4]. Therefore, the construction of a digital twin model for sewage treatment is also very necessary based on this. It is able to simulate and test different operation schemes in virtual space, which can provide scientific decision-making support for process modification, capacity expansion and standards upgrading and reduce the cost of trial and error. Additionally, the final aim of intelligent supervision in municipal sewage treatment is establishing closed-loop management. So that in the actual supervision process, through to support mobile operation and maintenance APPs push key data, early warning

information and equipment status is used for managers of mobile terminal by means of control the project operation status at any time anywhere to improve management efficiency significantly.

4.5 Continuously Improving Sewage Treatment Infrastructure

Urban sewage treatment of municipal water supply and drainage projects, should continue to improve the infrastructure and through urban development planning and population growth trends for scientific and reasonable forward-looking planning. In new development regions, plan ahead for supporting sewage treatment facilities. For old urban areas, analyze the gap between existing facilities and future demand, two-phase renovation and upgrade plans were developed. Municipal projects need to actively introduce advanced sewage treatment technologies and processes, carry out technological transformations of existing treatment facilities, phase out aging equipment in a timely manner, adopt intelligent control systems that can monitor remote equipment supervision at the same time, reduce operation costs and operational risks. Sewage treatment infrastructure is also required to actively broaden financing sources. In addition to the financial investment of government funds laid a solid foundation, increasing social capital to participate in sewage treatment infrastructure construction and operation.To guarantee for these facilities continued improvement. At the same time, the ongoing upgrade and optimization of infrastructure be adapted to that of Peak Carbon Dioxide Emissions and Carbon Neutrality new requirements in a timely manner system planning and accurate investment. On infrastructure renovation, it is necessary to adhere to the long-term development perspective, integrate demand such as response to climate change and new pollutant standards into planning, so as to ensure that infrastructure can deliver, maximum value of system operation and good environmental benefits.

5. Conclusion

To sum up, more efforts on sewage treatment shall be put into municipal water supply and drainage project, which is also a effective way to improve the urban wastewater treatment level and safeguard people's living quality. Managers can optimize sewage treatment, build separate storm water and sewage treatment systems, conduct normal planning and design of sewage treatment, optimize existing pipeline network design schemes, adopt intelligent monitoring measures, continuously upgrade and improve sewage treatment infrastructure to reflect the maximum application value of sewage treatment technology.

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