Research on Intelligent System Architecture of Urban Domestic Sewage Treatment

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Abstract. This paper studies and constructs an intelligent system of urban domestic sewage treatment, which consists of five modules, namely, 3d visualization simulation module based on data twin, key system operation and maintenance management platform, mobile data management platform; energy management module, security and warning module. The digitalization, networking and intelligence of municipal wastewater treatment have been realized, which improved the management level of urban domestic sewage treatment enterprises and reduced operating costs.

1. Introduction
With the rapid development of urbanization in China, the workload of urban domestic sewage treatment projects, daily maintenance, management and control has been increasing rapidly. Urban domestic sewage treatment enterprises are generally engaged in the construction, operation, maintenance and management of urban domestic sewage treatment and reclaimed water reuse facilities, as well as the daily operation and maintenance of sewage pipelines and auxiliary drainage facilities. The contradiction between the construction of new projects, the introduction of new equipment, the massive new data and the high-efficiency and low-cost operation and maintenance of unmanned or less humanized is deepening [1, 2]. Therefore, the construction of urban domestic sewage treatment intelligent system can realize the modularization and standardization of operation and maintenance, as well as the unified and standardized management of various sewage plants and pumping station pipe network. At the same time, it can realize efficient deployment of maintenance personnel to ensure stable operation of equipment and optimize existing process, thereby improving the quality and efficiency of enterprise operation and improving the comprehensive capacity of urban domestic sewage treatment.

2. System objectives and functions
The goal of the urban domestic sewage treatment intelligent system is to establish an intelligent collaborative coordination management and control platform, combining digital twins, expert systems, predictive models and urban domestic sewage treatment processes and equipment to realize visualization and intelligence of operation and maintenance, equipment information, energy, employees, and management of factory documents, etc.[2], and maximize the quality and efficiency of operational and the level of standardization management. The main functions include: 1) Intelligent and integrated management, basically realizing self-analysis and self-decision-making; 2) Inter-departmental work, improve the efficiency of work and decision-making; 3) Full-process operation and maintenance
management; 4) Reduce the number of process management staff; 5) Safety, alarm and equipment life cycle assessment.

3. System architecture research
The intelligent system of urban domestic sewage treatment mainly consists of five control units: 1) Visual 3D simulation module based on data twin; 2) Key system operation and maintenance management platform; 3) Mobile data management platform; 4) Energy management module; 5) Security and early warning module.

The system architecture has the following characteristics: 1) Highly integrated management information system. The system adopts advanced management concepts to improve and optimize the organization management and business processes of wastewater treatment enterprises; 2) Distributed business data model. Based on the characteristics of sewage treatment enterprises distributed in different regions of the city, a distributed layout mode matching the actual enterprise is established, and each enterprise is relatively independent; 3) Modular implementation framework; 4) Unified transmission network platform and unified software; 5) The stage is gradually launched step by step to achieve efficient use of people, money, goods and information.

3.1. Visual 3D simulation module based on data twin
The visual 3D simulation module based on data twin module of the intelligent system of urban domestic sewage treatment is a comprehensive information data system with physical simulation digital twin characteristics, which builds a large 3D model of urban domestic sewage treatment, combining real view, laboratory simulation and rapid navigation function, to realize the management of managers' operations and maintenance in 3D environment. Operations such as resource information management, employee immersive training, and spatial analysis and decision support in emergency situations.

3.2. Key system operation and maintenance management platform
For the key points of the entire urban domestic sewage treatment system, the testing of processes, equipment and materials shall be carried out. The key system operation and maintenance management platform is the core of the maintenance, management and maintenance of different professions and departments, which needs to be digital, uniform and consistent.

The key system operation and maintenance management platform mainly includes: 1) Key process management and control modules. In the operation process of the sewage treatment plant, all key processes are monitored and run simulation calculations, and the process-related online instruments are fully managed, organized, maintained and verified; 2) The equipment life cycle module. According to the characteristics of the equipment, such as mechanical characteristics, wearing parts, etc., the equipment is set to maintain according to a certain period. The system will automatically remind the person in charge of the plan to perform maintenance on time according to the set period, effectively reducing the failure rate and improving the operation level of the plant; 3) Integrated management module. Take a variety of resources and tools such as device documentation, engineering design data, maintenance history, real-time data, root cause analysis, and reliability-centric maintenance tools, work plans, or spare parts availability information; 4) Procurement management. The procurement work mainly provides various materials required for the production and management of sewage treatment enterprises; 5) Contract management. This part includes six functional parts: contract processing management, contract merging management, contract planning management, material transfer as contract management, contract quasi-issue management, contract tracking management; 6) Production planning management. According to the production contract and production forecast, the realization of the production target is specific and timed; 7) Inventory management. Collect and process the material requirements sent by the production management system of each enterprise, and query the inventory information of each enterprise; 8) Marketing management. Improve the evaluation and record of sales business from various aspects of finance, contract and information record, including: market management, sales contract management, sales measurement, sales inspection, business report,
etc. The sales contract is transmitted to the contract management module to generate the production contract; 9) Financial management. Introduce relevant financial data into the integrated management module to realize real-time interaction and timely sharing of financial management system data and enterprise information; 10) Human resource management. The relevant data is connected to the integrated management system to realize real-time interaction and timely sharing of human resources business data and information.

3.3. Mobile data management platform
A network-based mobile solution that supports global networked collaboration throughout the entire value chain of the plant. With the mobile solution, all project participants can quickly call enterprise-related information through the web server and mobile. Convenient and customized solutions for practical applications simplify collaboration and access to plant data and documentation, enabling organizations and engineers to quickly and easily access and use device-related information through web servers and mobiles. Universal browsers provide access to documents and data, simplifying the management and collaboration of data and documents.

3.4. Energy management module
At present, China's urban domestic sewage treatment enterprises urgently need to carry out energy optimization management in intelligent aeration and pumping station energy conservation [3], 1) Intelligent aeration optimization management. In order to effectively stabilize the effluent water quality and save operating costs, through the data acquisition, construction of simulation models, controller parameter tuning and other research work, establish APC precision aeration module and intelligent medication module; 2) Pump station energy-saving control system. This section includes the pump station operating energy efficiency prediction module, the pump group optimization module and the pump station operating energy efficiency predictable module to achieve predictable, manageable (critical process parameters such as pressure, flow, etc.) and minimum power consumption standards.

3.5. Security and early warning module
The safety and early warning modules of the urban sewage treatment intelligent system include: 1) Training and education management. The system obtains relevant personnel basic information, post information, various qualification certificates and training records from the human resource management system; 2) security inspection and alarm. According to the inspection category, the system separately manages and reports the separate alarms and corporate security records of sewage water quality. The inspection category is customized by the user; 3) security risk management. The system provides the function of registering defects, hidden dangers, such as equipment, environmental protection, security, etc., and the entry function of the notice of rectification of hidden dangers, and the attachments can be added; 4) Emergency plan drills. Assess emergency preparedness status. Arrange and calibrate materials, personnel and other relevant emergency plans, regularly prompt the drills and find defects and deficiencies in the implementation procedures; 5) Management of key parts. Manage key parts and locations of the company by category.

4. Conclusion
Compared with the traditional sewage treatment control system, the urban domestic sewage treatment intelligent system realizes the control room data twin simulation management, the integration of the whole system of sewage treatment process and equipment control, remote automatic monitoring and random monitoring, energy optimization and automatic warning. The system construction and operation costs have been greatly reduced, and the increasing demand of the sewage treatment market has been met, contributing to the optimization and upgrading of the sewage treatment industry, the construction of ecological civilization and the creation of green water and green mountains.
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