Analysis and Discussion on Operation Stability of Urban Sewage Treatment Plant

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Abstract: Based on the acceleration of the development of the national economy and the overall progress of urbanization, the discharge of domestic sewage has increased significantly, and the characteristics of domestic sewage within each city are significantly different. Therefore, the design and operational stability of urban sewage treatment plants are proposed higher requirements. In this case, the urban domestic sewage treatment plant should follow the basic principles of adapting measures to local conditions, taking into account the characteristics of domestic sewage drainage and water quality in different areas to ensure the rationality of the sewage treatment process design and the safer and more stable subsequent operations. Based on this, the article takes the urban domestic sewage treatment plant as the main research object, and focuses on the related content of its operational stability.

1. Introduction
Based on the rapid development of social economy, our domestic sewage treatment industry has achieved ideal results. According to the data survey results, the amount of domestic sewage discharged every day is 6.7 billion tons. In order to better meet the requirements of urban sewage treatment, it is necessary to build the sewage treatment plants in the later stage. Based on the massive construction of urban sewage treatment plants, it is necessary to study the treatment capacity and efficiency of urban sewage treatment plants. It can be seen that in-depth research and analysis of the operational stability of urban domestic sewage treatment plants have certain practical significance.

2. The status quo of urban domestic sewage treatment plants
In our country, it has not been long for the development of urban sewage treatment plants, and the initial research started in the early 1970s, which is significantly behind the developed countries in the same period[3]. Based on more than 40 years of in-depth discussion, drawing lessons from foreign advanced experience and theories, using new foreign sewage treatment processes, equipment and technologies, and applying activated sludge processes, we have applied the main land treatment method, A/O method, CASS method, A/B method, Oxidation Ditch, A2/O method, etc.

Among them, the activated sludge process is the most commonly used traditional sewage biological treatment method, and the development prospect of this technology is considerable. Through the application of the activated sludge method, the water quality and quantity can be effectively controlled, and the operation mode is more diversified. On the basis of setting up anoxic zone or anaerobic zone, the activated sludge method can give full play to various advantages such as phosphorus removal efficiency and biological nitrogen removal efficiency. At this stage, even if the domestic sewage treatment efficiency is significantly improved, the problem of eutrophication caused by the pollution of N and P elements frequently occurs and is difficult to effectively solve. When calculating the sludge...
age, that is, the average residence time of microorganisms in the biological treatment system, the formula is: 
\[ \theta_r = \frac{(X)_r}{(\Delta X/\Delta T)_r} \]. Because \( A^2/O \) process has both denitrification and phosphorus removal functions, compared with other simultaneous biological nitrogen and phosphorus removal treatment processes, its control operation is not cumbersome and the total hydraulic retention time is not long, the process structure is relatively simple, and the actual operating cost is not high. With the above advantages, it is widely used in the sewage treatment work of sewage treatment plants\(^2\). A sewage treatment plant chose to use the \( A^2/O \) process. In the operating conditions data from February to April 2019, it was found that the sludge age exceeded the normal range from the 11th week, and at the beginning of the second week from February to April 2020, the working condition parameters were abnormal, and the sludge volume was high and the load was low.

3. Analysis of operation and management problems of urban domestic sewage treatment plants

(1) The sludge disposal lacks rationality

The sludge produced during the actual operation of the municipal sewage treatment plant can be used for brick burning and other tasks, and the final disposal can also be completed by landfill or incineration. The most common disposal method is landfill. At this stage, in order to reduce the cost of treatment, many sewage treatment plants will discard the sludge at will when they have not yet processed it. Due to the high proportion of organic matter contained in the sludge, it is easy to deteriorate and decay, thereby forming a pungent odor. At the same time, the sludge contains heavy metals, parasite eggs, and pathogenic microorganisms, which will also pollute the ecological environment again.

(2) The sewage treatment level needs to be improved

The development of urban sewage treatment in our country is not long. Even if the social and economic development speeds up, the construction of urban infrastructure is obviously delayed, making it difficult for the capacity of urban sewage treatment plants to meet actual needs. Most sewage treatment plants are in full load or overload operation state\(^3\). In addition, the domestic sewage treatment plants in most cities have not yet completed the upgrade and transformation, which makes it difficult to meet the requirements of national standards.

(3) Management methods are not scientific

Due to the relatively complicated cost of urban domestic sewage, the treatment process is also complicated, which directly increases the difficulty of the management of sewage treatment plants. For this reason, it is necessary for the management staff to have rich practical experience and professional quality. In addition, the sewage treatment construction system and operation management system in many regions have always followed the traditional model, which is mainly funded by government departments for construction and operation. However, sewage treatment is a public welfare undertaking, and in the long run, it will be prone to the phenomenon that sewage treatment plants cannot be built or cannot be operated.

4. Factors affecting the operation stability of urban domestic sewage treatment plants

Among the traditional biological sewage treatment methods, the activated sludge process is the most widely used and it has an ideal effect. Among them, in the application of activated sludge method, standing the mixed solution and sedimentation can effectively separate the activated sludge to achieve the purpose of purification\(^4\). Through microscope observation, it can be found that the brown flocculent sludge contains a lot of bacteria and fungi. The organic matter in the sewage is an important food for the metabolism and reproduction of the above microbial populations, so the organic matter content in the water is significantly reduced. After the biological flocculation and adsorption of the sludge flocculant, the colloid and other substances in the suspended state in the sewage can be effectively removed. The so-called activated sludge refers to the particle size of 200-1000 microns, which is similar to the grind flower shape. It is an indeterminate floc with ideal coagulation and
sedimentation properties. Under normal circumstances, the surface area of the flocs is relatively large, which is between 20-100cm³/ml, and micro-animals live inside or around. The mixed liquid of the aeration tank can ensure biological flocculation effectively separated from the sewage after entering the secondary settling tank. During the operation of the activated sludge method system in an urban sewage treatment plant, the main factors affecting its operational stability are hydraulic load, sludge age, return sludge concentration, sludge return ratio, sludge load, etc.\(^5\)

1. **Hydraulic load factor**
   The so-called hydraulic load refers specifically to sewage flow. Under normal circumstances, it is difficult to effectively control the change of sewage flow, and the local lifestyle and water collection area will have a certain degree of influence on the change of sewage plant flow. Normally, the highest peak is about 200% of the average flow, and the lowest value is about 50% of the average flow. Based on the change of seasons, the flow of sewage also shows fluctuations, and the flow is small in winter, and large in summer. In addition, the sewage flow will directly affect the operating effects of the secondary settling tank and aeration tank of the activated sludge process system. If the flow of sewage increases, the residence time of sewage in the aeration tank will be shortened, which will affect its water level, which is not conducive to the improvement of effluent water quality.

2. **Sludge age factor**
   During the actual operation of the activated sludge method system, the sludge age is also a very important parameter. Especially for biological treatment systems, the essence of sludge age refers to the time required to ensure that microorganisms complete their physiological metabolism and degrade organic matter. Through the selection of specific MLSS concentration and organic load, the sludge age can be determined. Therefore, the relationship between organic load and mud age is relatively close.

3. **Factors of returning sludge concentration and sludge returning ratio**
   The so-called return sludge concentration specifically refers to the functional relationship between the characteristics of activated sludge and the sludge return ratio. For the sludge in the mixed liquid, the return sludge is the main source, so there is a certain correlation between MLSS, the return sludge concentration and the sludge return ratio. If the return sludge concentration is the same, the return ratio of sludge will also increase when the MLSS concentration increases. In this case, the flow rate of the mixed liquid in the sedimentation tank will also increase. Therefore, the increase in the load of the secondary sedimentation tank will inevitably affect the actual sedimentation efficiency.

4. **Sludge load factor**
   The so-called sludge load specifically refers to the amount of organic matter per unit weight of sludge in the biochemical system within a unit time, and generally uses $\text{kgBOD}_5/(\text{kgMLSS·d})$ as the unit. In practice, the sludge load will directly affect the efficiency of sewage treatment. Combining specific experience, it can be known that the design value of sludge load should not exceed 0.5 under the condition of higher requirements for treatment efficiency. If certain requirements are put forward for nitrification in the process of sewage treatment, the design value can be set to 0.15 $\text{kgBOD}_5/(\text{kgMLSS·d})$. If you want to reduce the volume of the aeration tank, you should choose to use a higher load, that is, set the sludge load design value to exceed 1.0 $\text{kgBOD}_5/(\text{kgMLSS·d})$. Even if the high sludge load can reduce the actual volume of the aeration tank, it is easy to significantly increase the amount of remaining sludge, which will adversely affect the initial water quality.

5. **Stable operation strategy of urban domestic sewage treatment plant**

1. **Emphasize the importance of sludge treatment**
   For urban sewage treatment plants, the most important task is to treat sewage and its sludge. However, at the current stage, the sewage treatment plant's ability to treat sludge is relatively weak, so relevant staff must pay more attention to this work, and appropriately increase supervision to prevent unreasonable sludge disposal from causing secondary pollution to the ecological environment. If the city has strong economic and technical capabilities, it can purchase sludge nitrification or sludge thickening and other treatment facilities to ensure its operation is in a stable state\(^6\). If the city's economic and technical capabilities are underdeveloped, the selected sewage treatment process should
minimize the amount of sludge produced, and use economic means to ensure the stability of the sludge.

(2) Optimization of sewage treatment infrastructure
In the process of optimizing sewage treatment facilities, technological transformation methods should be adopted rationally, or advanced technology and equipment should be used. At the same time, the sewage treatment plant should arrange for more professional staff to be responsible for maintaining the facilities and equipment. As an operator, his own experience and professional quality level will have a direct impact on the stability of the operation of the sewage treatment plant. In this case, the sewage treatment plant must regularly organize staff to participate in skill training to ensure that its operational capabilities and professional qualities are improved, and the sewage plant effluent discharge effect is enhanced.

(3) Expansion of investment channels
Currently, the construction of many urban sewage treatment plants is mainly based on government investment and is responsible for the construction of supporting facilities. In this case, government departments have always played an important role, restricting the sustainable development of urban sewage treatment business to a certain extent, and affecting the efficiency of sewage treatment. To this end, based on the guidance of market mechanisms, competition mechanisms should be introduced, and existing investment models should be transformed, so as to achieve the goal of enterpriseization and diversification of investment entities, and ultimately achieve the goal of market-oriented operation and management. The effective expansion of investment channels for urban sewage treatment plants can also ease the financial pressure of government departments and effectively improve the efficiency of sewage treatment.

(4) Strengthen the supervision of the operation of sewage treatment plants
The online monitoring system should be installed in the urban sewage treatment plant, and while operating with the environmental protection department, actively carry out system maintenance work to make the data transmission more real-time. At the same time, it is necessary to record the original data in detail and implement the filing work. Necessary punishment measures should be taken for sewage plants whose effluent stability is not strong and does not meet standards, or whose operating efficiency is not ideal. In addition, a system should be established to link the allocation of sewage operating costs and the rate of effluent compliance. Once the effluent does not meet the standards, the environmental protection department should submit certification materials to the financial department and the financial department should reduce its operating costs.

6. Conclusion
In summary, the rationalization of urban sewage treatment plant planning and design and the stability of operation will have a direct impact on the regional development of the city. Sewage treatment plant is an important component of municipal engineering, so it is necessary to form a deep understanding of its key operating indicators. Only in this way can we reasonably take emergency measures when an emergency occurs in the indicator. During the design period, comprehensive consideration should be given to the later operation method and urban development plan to ensure that the selected sewage treatment process is compatible with the drainage characteristics of this area, effectively reducing the later operation and management costs and enhancing the city's municipal functions.

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