Academic Journal of Science and Technology
ISSN: 2771-3032 | Vol. 6, No. 1, 2023

Research Progress of Sewage Treatment Technology in Small and Medium Sized Towns

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Abstract: A / O process, oxidation ditch process and other leading technologies used in China's cities, Europe and the United States and other developed countries have been proved to be effective water pollution control technologies. They have their own advantages and disadvantages, and their applicability is also different. However, for small and medium-sized urban sewage treatment plants, these methods may not be suitable. Therefore, for small and medium-sized urban sewage treatment plants, we should consider the problems of technology, management, investment and operation. Therefore, we should look for more convenient, simple operation, low investment and operation cost methods that are more suitable for small towns. In this paper, several common sewage treatment processes are compared to determine the type of sewage treatment process in small and medium-sized towns.

Keywords: Sewage disposal, A^2/O process, A/O process, Multi point cement membrane composite biological wastewater treatment process.

1. Introduction

Research direction of sewage treatment technology in small and medium-sized towns with the continuous improvement of people's attention to water environment protection, the government departments have put forward higher requirements for the water quality of sewage treatment plants, especially in recent years, the implementation of class I B and class I a standards in the discharge standard of pollutants for urban sewage treatment plants (GB18918-2002), The requirements of sewage treatment technology are also constantly improving. As the research direction of sewage treatment technology, it focuses on reducing energy consumption, improving effluent quality, reducing sludge volume, simplifying and reducing the volume of treatment structures, reducing land occupation, reducing infrastructure and operation costs, and improving management conditions. The research of new urban sewage treatment technology will turn the treated water and sludge into available resources, and make sewage treatment become a new industry of natural resources regeneration and utilization, which is one of the important ways to solve water pollution and rational use of water resources.

In recent years, China has accumulated rich experience in the design, operation and production construction of existing small sewage treatment plants. In addition, advanced and efficient unit technology should be adopted as far as possible to develop new and efficient small sewage treatment plants. Compared with the above-mentioned high-efficiency, advanced but high energy consumption technologies, the technologies with no energy consumption or low energy consumption should have broad market prospects.

2. Process Comparison

2.1. A/O and A^2/O proces

Both A/O and A^2/O are common processes in traditional activated sludge process. In the late 1980s and early 1990s, A/O process and A^2/O process were gradually applied in urban sewage treatment due to their better phosphorus and nitrogen removal effect, and became the mainstream.Since the 1990s, with the research and application of wastewater treatment process with nitrogen and phosphorus removal function, it has been found that A^2/O process has its own defects, that is, there are contradictions and competition among nitrifying bacteria, denitrifying bacteria and phosphorus accumulating bacteria in organic load, sludge age and carbon source demand, so it is difficult to obtain efficient removal of nitrogen and phosphorus in the same system at the same time, It hinders the application of biological phosphorus and nitrogen removal technology. Therefore, in order to solve these process contradictions, researchers have carried out a lot of research to improve the process, and developed inverted A^2/O, UCT, $A+A^2/O$ and other processes [1-2].

In particular, a lot of research has been carried out on inverted A^2/O, and the research on its principle, characteristics and operating parameters has been completed, and the production test has been carried out.The main advantages of A/O process are simple process and low construction cost; The denitrification reaction is sufficient. The disadvantage is to improve the denitrification capacity and increase the internal circulation ratio, so the operation cost will increase. The main advantage of A^2/O is that it can simultaneously remove nitrogen and phosphorus while removing organic matter through the alternate operation of anaerobic, anoxic and aerobic. The disadvantages are that the sludge return pump room must be set up, the investment is high and the process is complex; It is necessary to set up a separate secondary sedimentation tank, which covers a large area.

2.2. Oxidation ditch process

Oxidation ditch process is a new type of activated sludge process invented by Dutch engineers in the 1950s. Because of its simple structure and good treatment effect, it has attracted wide interest and attention from all over the world. Oxidation ditch has been widely valued in Europe and the United States, and its development speed is very fast. According to statistics,

up to 1977, more than 2000 pesville type oxidation ditches were put into operation in Western Europe. More than 800 Carrousel oxidation ditches invented by DHA company of the Netherlands have been put into operation all over the world.

Generally, the oxidation ditch process does not have a primary sedimentation tank. The process flow is relatively simple, the operation is flexible, the operation management is convenient, the operation cost is low, the sludge load is low, the BOD removal rate is high, and the nitrogen and phosphorus removal effect is good. The disadvantages are long residence time and large floor area.

2.3. SBR process

Sequencing batch process is an activated sludge wastewater treatment technology operated by intermittent aeration mode [3]. Different from the traditional wastewater treatment process, SBR technology adopts time division operation mode instead of space division operation mode, unstable biochemical reaction instead of steady biochemical reaction, and static ideal sedimentation instead of traditional dynamic sedimentation. In recent years, more than 600 SBR wastewater treatment plants have been built. As an economic, efficient and convenient wastewater treatment process, SBR process is suitable for small and medium-sized wastewater treatment, and has a very broad prospect. At present, CASS, ICEAS, MSBR, UNITANK and ASBR are widely used in urban sewage treatment of small and medium-sized towns.

The advantages of SBR are the integration of regulating tank, aeration tank and sedimentation tank, no need of sludge return system, small occupation area and strong resistance to impact load. The disadvantages are full automatic control, high investment, relatively complex management and high idle rate of equipment.

2.4. Blake Technology

Its core technology is biolake biochemical tank [4]. The suspended chain aerator is installed in the biolake biochemical tank. During operation, the aerator swings back and forth along the flow direction, and at the same time, it fills oxygen into the water. Multiple anoxic zones and aerobic zones are formed alternately in the aeration tank, which is called multi-stage A / O process. The advantages of block process are high oxygen utilization rate, high sludge concentration and high load by using floating mobile aeration chain; The disadvantages are high investment and high damage rate of aeration chain [5].

Table 1. Comparison of common sewage treatment processes in small town sewage treatment plants

technology	advantage	disadvantage
A/O process	The process is simple, the construction cost is low, and the denitrification reaction is sufficient	Therefore, the operating cost will be increased
A^2/O process	Through the alternate operation of anaerobic, anoxic and aerobic, it can simultaneously remove nitrogen and phosphorus while removing organic matter	Improve the ability of nitrogen removal, increase the internal circulation ratio,Improve the ability of nitrogen removal, increase the internal circulation ratio,
SBR process	It integrates regulating tank, aeration tank and sedimentation tank, and does not need sludge return system. It occupies a small area and has strong anti shock load capacity	Full automatic control, high investment, relatively complex management, high idle rate of equipment, poor effect of nitrogen and phosphorus removal
Oxidation ditch process	The sludge load is low. The removal rate of BOD is high and the effect of nitrogen and phosphorus removal is good.	The residence time is long and the floor area is large

The research of sludge membrane composite biological treatment system has a history of more than 20 years in foreign countries. This process is a composite process of activated sludge and biofilm, which integrates the activated sludge process and biofilm process in the same tank, and its function is to prolong the sludge age. The process is to put suspended materials into the activated sludge aeration tank to make microbial growth carrier. The activated sludge and biofilm formed a comprehensive wastewater treatment microbial system to remove the organic pollution in the water. Due to the addition of fillers, the mechanism and efficiency of wastewater treatment are greatly changed.In this system, the basic environment for the survival of microorganisms changes from the original gas-liquid two-phase to gas-liquid-solid three-phase, which creates more abundant forms of existence for microorganisms and forms a more complex complex complex ecosystem. The biofilm on the surface of the carrier and the suspended sludge in the liquid phase work together to play their own degradation advantages. Under the same sludge load, the process is more compact, economical and efficient[6].In the composite system, due to the effect of aeration, the microorganisms in suspended state and attached state on the packing surface are in aerobic state, which are mainly composed of heterotrophic bacteria, nitrifying bacteria and nitrifying bacteria. These bacteria can remove organic matter and oxidize ammonia nitrogen to nitrite nitrogen and nitrate nitrogen. From the aerobic zone on the surface of the packing to the inside of the packing, due to the influence of oxygen transfer, the intermediate facultative zone and the internal anaerobic zone are formed, and facultative denitrifying bacteria exist, which can transform nitrate nitrogen into nitrogen to remove total nitrogen.From the above analysis, it can be seen that it is an economic and efficient way to transform the traditional activated sludge process with composite biological treatment system. At the same time, organic matter is used as the resource of biofilm growth, so that a large number of active organisms in the biological pool are also increased, so as to improve the impact

resistance of the whole system. Aiming at the problems existing in the conventional biological nitrogen and phosphorus removal process, it decomposes the factors that affect and restrict the nitrification and denitrification of nitrogen removal, so that different bacteria grow in their respective optimal environmental conditions, Therefore, the denitrification and biochemical effects can be optimized at the same time, and the controllability of the process is enhanced.In the process of operation, the ability of deoxidation and phosphorus removal can be improved by adjusting the system parameters, and the water quality index of the effluent can be improved. Because of the increase of biomass in liquid phase, the removal efficiency of organic matter is improved[7] .Compared with the conventional activated sludge process, the sludge membrane composite biological process also has the advantages of short hydraulic retention time of aeration tank, good effluent quality of post sedimentation tank, high removal rate of SS, BOD, COD and ammonia nitrogen, less excess sludge, low treatment, disposal and operation maintenance costs[8].

A multi-stage A/O treatment system is set up in the multi-point cement membrane composite biological wastewater treatment process. The carbon source in each stage of A/O system is supplemented by the way of point feeding. After the sewage enters the first aeration section, the ammonia nitrogen in the water is rapidly "replaced" into nitrate nitrogen, and the nitrate nitrogen content increases rapidly, while the ammonia nitrogen content decreases; After entering the second non aeration section, due to the introduction of some raw water, denitrifying bacteria use the carbon source in the raw water for denitrification to remove nitrogen in the sewage. Whether denitrification is complete or not depends largely on the carbon source. In the multi-stage A/O system, multi-point influent is used, that is, part of the raw water is introduced into the non aeration section of each stage, so as to ensure the carbon content in the wastewater and complete the nitrification reaction. The multi-point cement membrane composite biological wastewater treatment process has the following advantages:

(1) Increase the MLSS of sludge concentration in the reactor.

(2) The sludge sedimentation coefficient SVI is reduced and sludge bulking is inhibited or slowed down.

(3) The contradiction of sludge age between nitrogen and phosphorus removal was solved.

(4) Improve the treatment effect of refractory pollutants.

(5) The production of sludge is reduced and the cost of sludge treatment is reduced[9-12].

3. Determination of Wastewater Treatment Process

3.1. Process selection principle

The process selection of the sewage treatment plant should be based on the idea of suiting measures to local conditions, being technically feasible and economically reasonable. On the premise of ensuring the sewage treatment effect and stable operation, the project cost and operation cost should be the most economical and reasonable. At the same time, the process scheme should be simple in operation, small in land occupation and energy consumption, and less in sludge volume[13].

3.2. Process comparison and selection

By 2011, 38 small town sewage treatment plants have been built and put into use in Heilongjiang Province, of which 13 adopt Cass technology, 7 adopt A/O technology, 4 adopt BAF technology, 3 adopt A^2/O technology, and the remaining 12 adopt SBR, activated sludge, MBR, multi-stage filtration, constructed wetland and other treatment methods. It can be seen that CASS process has been widely used in small and medium-sized wastewater treatment plants in Heilongjiang Province in recent years. According to the current situation of wastewater treatment process at home and abroad, combined with the local actual situation, CASS process and multi-point cement membrane composite biological treatment process are selected for comparative analysis.

3.3. CASS process and its problems

Cass is developed on the basis of SBR. CASS process integrates reaction, precipitation, drainage and function. The degradation of pollutants is a plug flow process in time, while microorganisms are in the periodic changes of aerobic, anoxic and anaerobic, so as to achieve the removal of pollutants.

The advantages of CASS process are that it does not need to set up sludge return system, occupies a small area, and has strong resistance to impact load. The disadvantages are mainly high automation requirements, high investment, relatively complex management, and high idle rate of equipment. After years of operation, CASS process often has some problems:

(1) When the influent load changes greatly, the utilization ratio of the reaction tank varies greatly. The water level of the wastewater treatment plant will exceed the upper limit at the peak, the wastewater treatment load will be too large, and the pollutant removal rate will be reduced. On the contrary, when the influent is small, the wastewater treatment load is low, and the reaction tank can not be fully utilized. The non-uniformity of influent load has a great influence on the treatment effect and effluent quality, especially in winter. The wastewater discharge in scenic spots is periodic, and the water quantity changes greatly. Therefore, it will have great defects to choose CASS process.

(2) The influent disturbance in the sedimentation period affects the effluent quality. All the reaction stages of CASS process, including sedimentation, are completed in one tank, which requires high automatic control and complicated operation and management. Moreover, the sedimentation of reaction tank is completed under ideal conditions, and the effect of sedimentation effluent is often poor in actual operation.

(3) It is difficult to improve the efficiency of phosphorus removal. The phosphorus release process of sludge in biological selector is greatly affected by the concentration of nitrate nitrogen in the reflux mixture, so it is difficult to continue to improve the phosphorus removal efficiency in CASS process system.

(4) The total nitrogen removal efficiency is low. Due to the insufficient aeration time of CASS process, the digestion is not complete, resulting in low nitrogen removal efficiency[14].

3.4. Multi point feeding cement membrane composite biological technology

The multi-point cement membrane composite biological wastewater treatment process is a combination of biofilm and

activated sludge. The multi-stage A/O treatment system is set in the multi-point cement membrane composite biological wastewater treatment process. The carbon source in each stage of A/O system is supplemented by the way of point feeding. After the sewage enters the first aeration section, the ammonia nitrogen in the water is rapidly "replaced" into nitrate nitrogen, and the nitrate nitrogen content increases rapidly, while the ammonia nitrogen content decreases; After entering the second non aeration section, due to the introduction of some raw water, denitrifying bacteria use the carbon source in the raw water for denitrification to remove nitrogen in the sewage[15].

Characteristics and advantages of multi-point cement membrane composite biological sewage treatment system: ① multi-stage anoxic and aerobic biochemical reaction, the sewage is in the anoxic aerobic repeated alternating environment, so as to achieve the purpose of nitrogen removal. ② The multi-point influent mode was used to supplement carbon source for denitrification. The organic matter of wastewater in anoxic tank reacts in anoxic tank, and denitrifying bacteria can remove nitrogen. In the process of operation, the water quantity of each point can be adjusted according to the water quality of the site until the operation effect of the whole system is the best.

4. Conclusion

To sum up, the multi-point cement membrane composite biological sewage treatment system has the advantages of high nitrogen and phosphorus removal effect, simple operation and management, strong impact resistance and low investment, and is suitable for sewage treatment in northeast cold area. The multi-point cement membrane composite biological sewage treatment system is determined as the main process of the sewage treatment plant.

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