Discussion on Urban Sewage Treatment Technology of Dalian

Ma Renjiao
Jilin Architectural University, China 130118

Abstract—Taking a sewage treatment project of Dalian for example, this paper studied the feasibility and characteristics of two sewage treatment technologies, analyzed the process, operation management and energy consumption, and determined the hydrolytic sedimentation tank - biological filter - V-Filter technology as the final solution of this project.

Keywords-Sewage Treatment; Technology; Feasibility

I. BACKGROUND

This project is constructed at Dalian. With estimated investment of CNY 140,000,000, the completed project has a daily treatment capacity of 100,000m3. The urban sewage quality indicators and effluent quality indicators are shown in the following.

The effluent quality of sewage treatment follows the Grade A defined by Discharge Standard of Pollutants for Municipal Wastewater Treatment Plant (GB18919-2002) in this project. The selection of sewage treatment technology is the key point for sewage treatment project. This paper compared the two alternative technologies A/A/O and hydrolytic sedimentation tank - biological filter - V-Filter.

Table 1 Quality Indicators

Quality Indicator	Sewage Quality (mg/l)	Effluent Quality (mg/l)
Chemical Oxygen Demand CODcr	350	50
Biochemical Oxygen Demand BOD5	200	10
Suspended Substance SS	220	10
Total Nitrogen TN	40	15
Ammonia Nitrogen NH3-N	30	5（8）
Phosphorus TP	3	0.5
PH	6～9	6～9

II. A/A/0 Technology

A/A/O is a typical technology removing phosphorus and nitrogen. The biological reactor is composed by anaerobic, anoxic, and aerobic segments. The facility involves primary sedimentation tank, primary sedimentation sludge pumping station, synchronization phosphorus and nitrogen removal A/A/O tank, secondary sedimentation tank, sludge return pumping station, flocculation tank with screen, flotation tank, blower room, etc.

The sewage treatment has higher requirements on the phosphorus removal. All return sludge and 10~30% sewage in A/A/O tank flow into the biological selector. Under the conditions of denitrification and 10-30% carbon source, the residual NO3-N in return sludge generates N2 by denitrification, which is directly discharged into the atmosphere. The mixture flows into the anaerobic tank with 70-90% sewage, the anoxic segment of synchronization phosphorus and nitrogen removal A/A/O tank, and then the aerobic segment. The phosphorus is transferred from the water to the sludge, and discharged from the system together with the residual sludge. By this way, the phosphorus is removed.

The A/A/O technology is featured by stable effluent quality, low energy consumption, and convenient operation management, etc. It can improve the density of activated sludge effectively up to 6000—8000mg/L, which is twice or three times higher than the traditional biological treatment. It realizes high treatment load and high removal rate of CODcr, BOD5, N, and P, with less sludge generated. However, the A/A/O technology has some defects. When the return sludge flows back to the anaerobic segment directly, a great quantity of nitrate carried also flows back, which will break the anaerobic state in the tank, and accordingly reduce the phosphorus removal effect. Additionally, the internal reflux increases the energy consumption of system and operation cost of sewage treatment.

III. Hydrolytic Sedimentation Tank - Biological Filter - V-Filter Technology

1) Hydrolytic Sedimentation Tank

Hydrolysis is a new technology of sewage treatment. The purpose is mainly to transform the organics that hardly decompose in the sewage into biodegradable organics in favor of subsequent aerobic treatment. In the sewage treatment, the hydrolysis rate of sludge is up to 25～35%. After sedimentation, the water content of sludge is low, and the sludge discharge is reduced.

As replacement of traditional primary sedimentation tank, the hydrolytic sedimentation tank in this project realizes the COD removal rate up to 10-35%, and SS up to 80-90%. The nitrification liquor partly returns to the hydrolysis tank. The mixture of backflushing wastewater sludge return and the nitrification liquor return play the role of denitrification. As a result, the hydrolytic sedimentation tank can remove TN by denitrification when removing BOD5, ensuring sufficient carbon source with TN removed. The return rate of nitrification liquor is 100%.

In the technology, the suspended substances of sewage are removed by sedimentation, filter and absorption. When the sewage containing impurities flows through filtering medium with certain porosity, the suspended substances are caught on the medium surface or internal pore. The process is called sedimentation. Additionally, the attached microbial in the filter tank has certain function of absorption, by which some suspended substances are transformed to sludge and then removed.

2) DN Biological Filter +CN Biological Aerated Filter

DN biological filter + CN biological aerated filter is a technology of pre-denitrification biological filter. The sewage flows into the DN filter (denitrification filter) and then the CN filter (nitrification filter). The effluent of CN filter flows back to the hydrolytic sedimentation tank and denitrification filter. As the nitrification filter transforms NH3-N into NO3-N, in the return, the denitrifying bacterium utilizes the organic matters in the inflow as electron donor and NH3-N as electron acceptor to transfer the electron (oxidation-reduction reaction). The nitrogen is transformed to gaseous and discharged to the atmosphere finally.

3) V-Filter

V-filter is a gravity sand filter. The technology is characterized by short hydraulic detention time, less land occupation, low energy consumption, good treatment efficiency, stable effluent quality, etc.

Hydrolytic sedimentation tank is characterized by improving the sedimentation and denitrification performance, improving the TN removal efficiency, and reducing the water content of sludge discharged from the sedimentation tank. The biological aerated filter is characterized by high treatment load, strong risk resistance capacity, short commissioning time, better effluent quality, etc. By combination with technologies as above, V-filter is characterized by less land occupation, better effluent quality, low investment and operation cost, and simple flowchart. It is the optimal technology till now.

IV. CONCLUSION

As the hydrolytic sedimentation tank - biological filter - V-Filter technology realizes higher treatment efficiency, low investment and operation cost, low-temperature adaptability, land occupation saving, as well as simple operation and maintenance, it is determined the sewage treatment technology for this project. The comparison between the two technologies is shown in the following Table 2.

Table 2 Comparison of Sewage Treatment Technologies

Item	Biological Filter	A/A/O Intermediate Layer
Features	High treatment load, strong risk resistance capacity, short commissioning time, low water content of sludge discharged, stable treatment efficiency; low operation cost; air supply by blower, high utilization rate of oxygen by aeration of monocular air diffuser; deep tank, high requirement on foundation and construction	Blower for oxygen supply and velocity maintenance; shallow tank convenient for construction; sludge bulking possible, and biological selector is needed; large open area, largely affected by the low-temperature environment
Operation Management	Systematic management, low operation cost	Less equipment, simple and convenient management
Equipment	Relatively more types and quantity of equipment, higher requirements on maintenance	Single type and less quantity of equipment, simple maintenance
Power Consumption	0.3 degree /m3 sewage	0.355degree /m3 sewage
Land Occupation	Actual land occupation of 3.2ha	Actual land occupation of 5.4ha

REFERENCES

[1]CHANG Chun-Li, WANG Kai-Jun; The Academic Research of Biology Denitrogenation for Sewage and the New Progress in Construction Practice [J]. Municipal Administration and Technology 1, 2005, 7（1）: 21-23

[2] SHAO Lin-Guang. Cause of Operation Water Quality Far Lower than Design in Southern Urban Sewage Treatment Plants and Countermeasures. Water Supply and Drainage, 1999, 25(2): 11-13

[3]BAN Fu-Chen; LIU Ming-Xiu; LI Ya-Feng; ZHANG Ji-Ku; Approach to the Utilization of Sludge from Municipal Sewage Treatment Plants [J]. Environmental Science and Management,2006,36（5）: 50-53

[4]HUANG Chun; Application of improved A2O Technology in Sewage Treatment in Cold Regions [J]. Environmental Science and Management, 2010,35（4）: 119-120

[5]ZHU Wen-Ting; YAN Ling. Hydrolysis(acidification)—Aerobic Biological Treatment Process. Urban Environment & Urban Ecology, 2000, 2(5) : 43-48