

The Application of Orbal Oxidation Ditch Process Analysis and Discussion in Laixi Sewage Treatment Plant

Wang Xin

Laixi Wastewater Treatment Management Office
 Laixi, Qingdao, China

Abstract: The study take a brief introduction of the basic situation and design features of the sewage plant. And it analyzes the actual operation inlet, outlet index, process parameters and removal rate. It makes a conclusion about the technology characteristics in the actual operation and some of our everyday experience and practices.

Keywords: Orbal Oxidation Ditch Process; Application in Sewage Treatment Plant; Analysis and Discussion

1. Introduction

Laixi sewage treatment plant is urban sewage treatment plant which put into operation earlier, own an area of 189.5 acres. And it mainly deal with urban sewage and industrial wastewater, serving an area of 26 square kilometers, serving a population of 240,000, the treated effluent discharged into agricultural irrigation three sub-dry engineering, and finally by the T-Bay into the sea. Project scale of processing 120000 tons/day, construction by stages, the first phase of 20000 tons/day in December 1998 completed and put into operation; The second phase of 20000 tons/day in October 2000, completed and put into operation; Three phase of 40000 tons/day was completed and put into production in November 2007. Now the total processing capacity of 80000 tons/day, daily processing 75000 tons of sewage, each period are stable operation, water success rate above 99%.

Laixi sewage treatment plant industrial waste water accounts for about 50% and sanitary about 50% of the influent wastewater, effluent sewage perform level 1 B effluent standards of "urban sewage treatment plant pollutant discharge standards" (GB18918-2002), using with denitrification capability Orbal oxidation ditch biological treatment processes. Design of inlet and outlet water quality are shown in Table 1, the sewage treatment plant process is shown in Figure 1.

Table 1. Sewage Treatment Plant Design in and out of the Water Quality

Project	CODcr	BOD5	SS	NH4+-N
Design the in water quality	≤725	≤270	≤340	≤28
Design of the out water quality	≤60	≤20	≤20	≤8 (15)

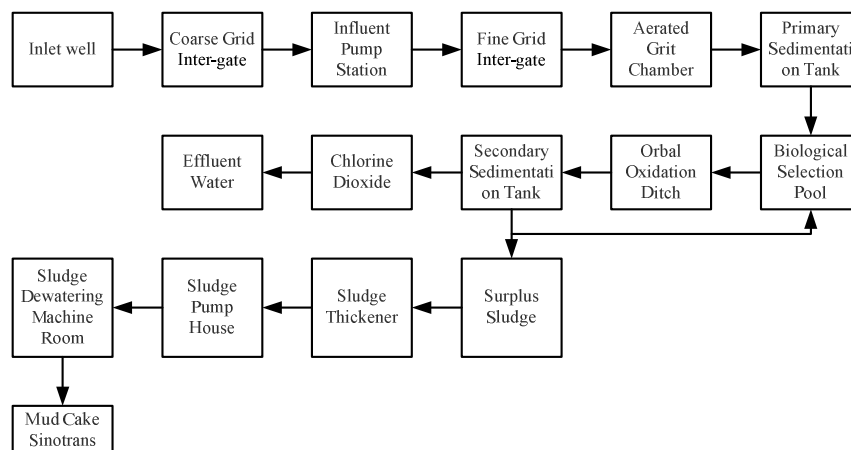


Figure 1. Laixi Sewage Treatment Plant Process Flow Diagram

2. Process Principle

Orbal oxidation ditch is composed of three relatively independent oval channel, sewage first enters the outermost channel, through the submerged water mouth turn into the middle of the channel and the inner channel, and finally from the center channel outflow into two sedimentation tank. Outside the channel accounted for about 48% of the total oxidation ditch volume, the middle channel accounted for about 34% and the inner channel about 18%. At runtime, should maintain outer, middle and inner channel dissolved oxygen accord gradient distribution of respectively 0, 1 and 2 mg/L. Outside channel in a low-oxygen state, the majority organic matter oxidation and nitrification occurs in outside channel. And the outer channel pulse aeration large area hypoxic environment, you can achieve a higher degree of simultaneous nitrification and denitrification, which has high removal efficiency. The inner channel maintains high dissolved oxygen, mainly removal phosphorus.

3. The Main Processing Unit and Characteristics

3.1. Biological Selection Pool

Set biological select pool before biological treatment, and rapid mixing influent and return sludge (return rate of 100%). After uniformly biological inoculate for high substrate raw sewage, according to the microorganism choice theory, a state of hunger main microbial floc at high substrate circumstances, due to the high value-added rate quickly achieve higher metabolic activity, become the preponderant microorganisms. Moreover, in the condition of oxygen - anaerobic quickly convert the solubility of easily degradable organic matter into stored in cells of the organic matter, and then convert it to extracellular material which is responsible for the formation of adhesiveness activated sludge flocs. So rapidly form activated sludge floc with good sedimentation performance in select pool. On the other hand, because of the filamentous bacteria which easy cause sludge bulking value-added rate is low at high substrate concentration, then metabolism is restrained and become disadvantage microbial, have played an important role in controlling sludge bulking. And because the select pool has the peculiar oxygen - anaerobic and high substrate concentration environment, so it will help to improve the effect of nitrogen and phosphorus on craft.

Orbal oxidation ditch

Oxidation ditch not only have completely mixed reactor, but also has a plug-flow reactor. Aeration device spaced set in the ditch so that the concentration of dissolved oxygen ditch showing high and low alternating distribution in the oxidation. Wastewater circulation times in the closed aerobic and anaerobic ditches, very conducive to biological activated sludge floc formation and biological denitrification. In the anoxic ditch, biological occur denitrification, in denitrification process can provide oxygen, which can effectively reduce the actual amount of oxygen and reduce operating costs. Further oxidation ditch process used surface aeration system operation is simple, flexible control, easy maintenance and stable operation. After the aerator has a spoiler, which can effectively prevent sludge sedimentation, and aeration tank flow into the wave ahead. The process has very strong dilution effect to high concentration effluent, the anti-impact ability pollutants of high concentrations, solve the influent pollutant load fluctuations on the impact of water treatment processes. Because sludge has long age in oxidation ditch, has become easy to keep stable, not need build sludge nitrification system.

3.2. Sedimentation Tank

Wastewater sedimentation tank adopts the radial flow pool structure. The traditional sedimentation tank often occur short flow and suspended solid transaction flow because of the improper hydraulic design, resulting in effluent SS concentration on the high side or effluent water quality is not stable. In the engineering design, has improved the structure of traditional radial flow sedimentation tank effluent weir and pool-type.

Add bezel at the bottom of the weir to effectively prevent effluent take away suspended sludge, the baffle can be guided away from the effluent suspended solids up weir plate, to ensure that effluent SS reach discharge standards.

4. The Run Data Analysis

The Laixi sewage factory inflow water quality fluctuates bigger since running. Water indicators beyond the design specifications, through improving the process of the regulation, the effluent indicators are all better than B standards. Actual operation parameters and the processing results are respectively shown in Table 2 and Table 3.

Table 2. In January - June 2013 Actual Operation Parameters

Project	2013.1	2013.2	2013.3	2013.4	2013.5	2013.6	
Water Inflow(ten Thousand m ³ /d)	7.36	7.41	7.42	7.48	7.49	7.56	
Inlet Water Temperature(°C)	9.6-14.2	9.4-15.5	10.4-16.2	14.1-19.2	16.4-20.7	18.6-22.3	
Inflow PH	6.12-8.19	7.01-7.9	6.6-7.51	5.8-8.52	6.1-8.2	6.4-8.72	
Sludge Return Ratio (%)	100	100	98	100	98	97	
Oxygen ditch	Water Retention Time(h)	16.4	16.8	16.1	16.3	16.1	15.7
	Sludge Age(d)	10.9	11.4	10.9	10.6	10.3	9.8

	Sludge Loading kgBOD5/kgMLSS.d	0.12	0.127	0.123	0.129	0.135	0.131
	Available Depth(m)	4.22	4.22	4.22	4.22	4.22	4.22
	MLSS(mg/l)	4230	4070	4150	3900	3850	3860
	SVI(mg/l)	98	102.8	105	104.1	108.4	106.9

Note: Data in the table are monthly averages

Table 3. In January - June 2013 Processing Effect Analysis

Project		2013.1	2013.2	2013.3	2013.4	2013.5	2013.6
COD _{Cr}	Inflow (mg/l)	593	562	569	550	505	520
	Effluent (mg/l)	52	55	51	45	47	41
	Removal Rate (%)	91.2%	90.2%	91%	91.8%	90.7%	92.1%
BOD ₅	Inflow (mg/l)	172	161	129	175	189	173
	Effluent (mg/l)	6	8	8	5	6	4
	Removal Rate (%)	96.5%	95%	93.8%	97.1%	96.8%	97.7%
SS	Inflow (mg/l)	182	204	198	167	179	262
	Effluent (mg/l)	13.7	12.8	12.1	11.4	11.6	12.8
	Removal Rate (%)	92.5%	93.7%	93.9%	93.2%	93.5%	95.1%
Ammonia Nitrogen	Inflow (mg/l)	31.5	28.9	32.2	36.7	41.2	35.5
	Effluent (mg/l)	9.2	7.6	6.5	6.9	6.2	5.4
	Removal Rate (%)	70.8%	73.7%	79.8%	81.2%	84.9%	84.8%

Note: Data in the table are monthly averages

5. Experience and Conclusion

1. Orbal oxidation ditch process for urban sewage treatment, especially under the conditions of higher influent concentration, slightly less carbon source can achieve a higher pollutant removal. Since Laixi pass water, the operation has been stable and reliable, BOD₅, COD, SS, ammonia and other water indicators are better than design standards, which fully reflects the excellent performance of oxidation ditch process.

2. Because of its high proportion of industrial wastewater in the water, water quality fluctuations is also great, if one day the water PH, COD_{Cr}, ammonia have a greater change, influent water are volatile in different periods. If organic matter index exceeds the design value, although the sewage treatment plant influent flow under load operation, organic oxidation ditch sludge load has amounted to 0.10-0.12 kgBOD₅ / kgMLSS. D. Which exceed the design 0.074kgBOD₅/kgMLSS.d, volume load reached 0.45-0.6kg BOD₅ / (m³.d), significantly more than the design value 0.35kg BOD₅ / (m³.d), and the system can maintain normal operation, water quality is stability. Oxidation ditch act as a conditioning tank, has strong anti-impact ability of water quality and high efficiency removal of organic.

3. In practice, we found that maintain a high sludge concentration in the oxidation ditch, especially in the winter can ensure good removal (the low temperature is generally higher than 4000 mg / l). But the actual oxygen demand exceed the design value, in the case of no increase the oxygen supply, resulting in a lower DO in oxidation ditch. Within the ditch near the rotating

disk of DO greater than 1 mg / l, the other area DO is remaining less the 1 mg / l, the middle ditch DO less 0.5 mg / l, the outer ditch close to 0mg / l, lower than the design of 2mg / l, 1mg / l, 0mg / l (within the ditch, middle the ditch and outer the ditch). Although this is not originally expected, from the situation of several years running, this hypoxic state running can effectively improve the oxygen transfer efficiency. Not only can ensure organic matter removal efficiency, but also can ensure a high ammonia removal efficiency, more importantly, can really save energy and reduce costs.

4. Sludge index is represent the aggregation of activated sludge sedimentation and concentrated performance indicators, but also is a major indicator of daily monitoring. When SVI is low, settling performance is good, but the adsorption performance is poor. When SVI is high, the settling performance is not good, even with good adsorption properties, can not well controlled dewatering. According to the characteristics of the factory, we generally control SVI in 100, that can ensure a better operating effect.

5. Orbal oxidation ditch use aeration plate forming the unique flow pattern in the ditch, that is particular flow pattern of the plug flow and completely mixed organic unity. Spaced set aeration plate makes the dissolved oxygen have a certain gradient. While in the ditch the high velocity can make dissolved oxygen more uniform distribution, does not form an absolute lack of oxygen, aerobic zone. But formed ranged between hypoxia and anaerobic anoxic / anaerobic zone and ranged between aerobic and anoxic aerobic / anoxic zones, leading to each point of the original water repeated experiences the anoxic / anaerobic area and

aerobic / anoxic zone. This is a completely mixed form because of the point source aeration state increase the high-speed flow, can form macroscopic "simultaneous nitrification and denitrification," play better nitrogen removal.

6. Because the characteristics of oxidation ditch process, denitrification and phosphorus removal requirements for sludge age is precisely contradictory. Denitrification requires sludge age as long as possible, and phosphorus removal requires short sludge age. In order to find the right combination point of nitrogen and phosphorus removal, that requires flexible control sludge age. In the production, according to sludge age reasonable arrangement the remaining sludge emissions. It is best to

consider installing wide-range and have frequency conversion functions excess sludge pump, in order to regulate and protect subsequent operating results.

References

- [6] L. Rodríguez-Fragoso, A. Sandoval-Ocampo, M. Corbalá-Nava, C. Arjona-Canul, D. Gomez-Galicia, G. Tellez, B. Hargis and J. Reyes-Esparza, "Evaluation Regarding the Efficacy and Safety of a Probiotic Mixture in Healthy Volunteers with Evacuation Disorders," *Food and Nutrition Sciences*, Vol. 3 No. 1, 2012, pp. 117-122. doi: 10.4236/fns.2012.31017.
- [7] A. Basu and B. Saha, "Kinetic Studies on Hexavalent Chromium Reduction," *American Journal of Analytical Chemistry*, Vol. 1 No. 1, 2010, pp. 25-30. doi: 10.4236/ajac.2010.11003.