The Engineering Application on the Treatment of Printing Wastewater with High Strength of Ammonia Nitrogen by MABFT

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Abstract. The MABFT high-density biological enrichment special denitrification process (modified aeration biological fluidized tank) is applied to the high ammonia nitrogen wastewater treatment project formed by digital printing. The results showed that when the influent NH$_3$-N ≤ 300 mg/L, the effluent NH$_3$-N ≤ 10 mg/L treated by MABFT technology, the average removal rate of ammonia nitrogen was as high as 98.9%, and all indexes in effluent would meet the requirements of the People's Republic of China’s Discharge standards of water pollutants for dyeing and finishing of textile industry for new plants. Providing reference for the treatment of similar high ammonia wastewater.

Introduction

A digital printing enterprise in Zhejiang Province, China has built two sets of air flotation treatment facilities for production wastewater and sludge dewatering system, which mainly remove suspended solids and part of COD. With the increasingly stringent environmental protection standards, in order to better implement the task of emission reduction, it is decided to build a set of high ammonia denitrification treatment system. The system is suitable for the water quality characteristic of wastewater from digital printing production, and can better meet various emission standards such as ammonia nitrogen.

Design of Inlet and Outlet Water Quality and Treatment Capacity

The company is mainly engaged in the production of high-grade silk printing. The main sources of pollution in the discharged wastewater are: pulp, dyes, additives, surfactants, etc. The color of wastewater shows green on the whole. The water quality index of raw water to be treated is as follows: the value of chemical oxygen demand is less than or equal to 500 mg/L, the mass concentration of ammonia-nitrogen is less than or equal to 300 mg/L, the chromaticity color is less than or equal to 100 times. After the treatment, the target water quality meets the indirect discharge standard of water pollutants for newly-built enterprises in Discharge standards of water pollutants for dyeing and finishing of textile industry of the People's Republic of China, ie chemical oxygen demand (COD) ≤ 200 mg/L, ammonia-nitrogen (NH$_3$-N) ≤ 20 mg/L, chromaticity color ≤ 80 times, pH range of 6 to 9. The designed processing capacity can reach 480 m$^3$/d.

Denitrification Process

Wastewater Treatment Process

The wastewater treatment process is shown in Figure 1.
Technological Process

The wastewater from the workshop production is collected through the pipe network and then entered the built underground pre-aeration regulating pool. The function of the regulating tank is to adjust the water quantity and homogenize the water quality. The wastewater from the regulating tank is pumped into the existing primary air flotation system by a lifting pump. After mixing and flocculation reaction, the organic pollutants form coarse alum with the suspended solids and the colloids. The sludge is then separated by air flotation and treated in the dehydration system. The effluent of the primary air flotation system enters the integrated multistage MABFT treatment system via the intermediate pool and the lifting pump. In this system, the wastewater is adjusted by adding alkali to the corresponding pH and entered sequentially the aerobic nitrification reaction zone with different concentration gradients (high-speed nitrification reaction zone and low-speed nitrification reaction zone). Using the immobilization of high-density aerated biofluidized ecological membrane fillers, under the conditions of aeration oxygenation, gas flow shearing and turbulence, the organic matter in the wastewater is fully contacted with the microorganism adsorbed by the carrier filler, so that it can be biodegraded. Therefore, the process has good biological denitrification performance and organic matter removal effect.

The effluent after biochemical treatment flows into the secondary sedimentation tank under the action of gravity, and the sludge is completely returned to the front end to ensure the concentration of microorganisms and reduce the generation of excess sludge. The effluent of the secondary clarifier is further removed by the secondary air flotation system to achieve the discharge standard.

New Main Structures and Equipment Parameters

(1) Intermediate pool. An intermediate pool was constructed with an effective volume of 50 m$^3$ and a size of 4.0m×5.0m×3.0m. A set of pre-aeration system was built in the pool. Its main function is to regulate water quality.

(2) Multistage MABFT system. There is a system of modified aeration biological fluidized tank (MABFT), which is divided into five grids and connected gradiently. Its effective volume is 162 m$^3$ and its size is 3.0 m×18.0 m×3.5 m. The system has built-in high density ecological film with biological carrier filler. The filler is NC-5ppi type and the size is 50mm×50mm×50mm. Moreover, the system contains five sets of aeration devices and two fans. One of the two fans is a standby. The fan is controlled by frequency conversion. Its power is 18 kw, the air volume is 13.79 m$^3$/min, and the blast pressure is 5000 mmH$^2$O.

(3) Secondary sedimentation tank. There is a secondary sedimentation tank with a size of 6.0m×3.0m×3.5m, divided into two lattices. The effective volume of the secondary clarifier is 27m$^3$, and it is equipped with a diversion system.

System Commissioning Operation and Benefit Analysis

System Debugging and Operation Results

In the initial stage of commissioning, the domesticated sludge was taken from the dewatered sludge from a nearby municipal sewage treatment plant. Due to the serious imbalance of C/N in the
The influent, the industrial glucose is initially added as a carbon source. The pH is controlled by adding alkali, and the fan and dissolved oxygen (DO) are controlled by frequency converter. The indexes of pH, COD, NH$_3$-N and DO in each reaction area were detected once a day$^{[4,5,6]}$. After the gradual stabilization, the water intake was started, and the MKNC-001 special nitrifying bacteria was added. At the same time, the parameters such as DO and pH are strictly controlled. According to the daily test data and treatment effect, the water intake is gradually increased step by step$^{[7]}$. In September, the influent volume reached the design load. In October, it was operated according to the design load (20m$^3$/h) and delivered to the owner for normal operation. The inspection data recorded by the owner for 3 months are shown in Figure 2.

![Figure 2. Ammonia nitrogen in influent and outlet water during operation chart of wastewater treatment process.](image)

Figure 2 shows that the concentration of ammonia nitrogen in the influent fluctuates greatly from 130 mg/L to 300 mg/L, the ammonia nitrogen of effluent in the high-speed nitrification zone is about 30 mg/L, and the removal of ammonia nitrogen is over 80%, which is in the key unit. The ammonia nitrogen in the effluent of the low-speed nitrification zone is less than 20 mg/L, which meets the design requirements. In addition, the final effluent ammonia nitrogen of the secondary sedimentation tank has been stable below 10 mg/L, and the total removal rate has averaged over 98.5%.

**Economic Benefit Analysis**

The total investment of the system is 1.5 million yuan. The direct operating costs are as follows:

1. **Electricity charge.** The total power of the equipment operation is 25 kilowatt, and the daily electricity consumption is 400.0 yuan at 0.6 yuan/(kw.h).

2. **Pharmaceutical expenses.** The daily consumption of alkali is 0.15 tons, and the unit price is 1200 yuan/ton, while daily consumption of pharmaceuticals is 180 yuan.

3. **Water consumption for pharmaceutical preparation.** About 3 tons of tap water is consumed per day, and the unit price is 2.65 yuan/ton, so it costs 5.3 yuan per day.

4. **Labor cost.** According to the operation situation, one worker usually works day shift. And during night shifts, it is operated by machine self-control or part-time managers. In terms of monthly wage of 3000 yuan, the daily labor cost is 100 yuan.

5. **Depreciation and maintenance expenses.** It is about 40 yuan per day.
According to the treatment capacity of 480 tons of wastewater per day, the direct treatment cost per ton of wastewater is 1.51 yuan.

**Environmental Benefit Analysis**

After the implementation of this project, the effluent quality meets the indirect discharge standard of water pollutants for newly-built enterprises in Discharge standards of water pollutants for dyeing and finishing of textile industry of the People's Republic of China.

According to the monitoring data for three consecutive months, when the maximum concentration of ammonia nitrogen in influent does not exceed 300 mg/L and the average value is 181.5 mg/L, the average value of ammonia nitrogen in effluent is 1.99 mg/L. Therefore, when the daily discharge of water is 480 tons and the annual operation is 300 days, the annual reduction of ammonia nitrogen reaches 25.85 tons, that is, the discharge of ammonia nitrogen decreased significantly.

**Conclusion**

The high concentration of ammonia nitrogen in printing wastewater can be effectively removed by denitrification process with high density biological enrichment. In other words, it is an improved biological aeration fluidization process. Field operation results show that when the influent NH$_3$-N≤300mg/L, the effluent NH$_3$-N≤10mg/L, the average removal rate of ammonia nitrogen is 98.9%. This indicates that when the concentration of ammonia nitrogen in wastewater is less than 300 mg/L, after the treatment of MABFT, the ammonia nitrogen of the effluent can reach the indirect emission standard of water pollutants for newly-built enterprises in Discharge standards of water pollutants for dyeing and finishing of textile industry of the People's Republic of China.

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