Analysis of Wastewater Treatment Engineering in Reconstituted Tobacco Company

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Abstract. The wastewater of a reconstituted tobacco company in Guangdong Province has the characteristics of high concentration and complex composition. By comparison, the pretreatment (Grid / Air Flotation) and Up-flow Anaerobic Sludge Bed / anoxic / aerobic process combined with advanced treatment process (Air Flotation / Ozonation-Biological aerated filter) were applied. After stable operation of the system was achieved, the effluent quality could meet the first level standard of the maximum allowable discharge concentration of the second class pollutants in the second period of the Discharge limits of water pollutants (DB44 / 26-2001) in Guangdong Province. This paper introduces the process flow of the project and the design parameters of the main structure, and provides a reliable reference for the similar engineering design.

Keywords: Reconstituted tobacco wastewater, Up-flow Anaerobic Sludge Bed, Ozonation-Biological aerated filter

1. Introduction
Reconstituted tobacco, also known as tobacco flake, is a kind of regenerated product made from tobacco materials such as tobacco powder, tobacco stem and tobacco flake by paper-making method [1, 2]. It is a comprehensive product of tobacco industry and agriculture production and used as cigarette filler. Due to the adoption of the traditional papermaking technology, about 30 ~ 60t waste water is produced per 1t of reconstituted tobacco products [3, 4]. The wastewater from tobacco production by papermaking is a kind of high concentration organic wastewater which is difficult to treat because of its large discharge, complex composition, high chroma, high chemical oxygen demand, many fiber suspensions and large concentration fluctuation [5, 6, 7].

In foreign countries, the wastewater from reconstituted tobacco discharged into the municipal sewage pipe network for centralized treatment by large-scale sewage treatment plants. However, in China, enterprises had to deal with the wastewater from reconstituted tobacco by their own according to their own actual situation because of the imperfect sewage pipe network around [8, 9].

In this paper, a wastewater treatment project of reconstituted tobacco leaves in Guangdong Province is taken as an example, and its treatment process is analyzed and introduced in detail. The production wastewater of a reconstituted tobacco company in Guangdong mainly comes from extraction pulping, pulp washing, white water overflow and other washing wastewater. In the production process, after recovery, purification and concentration, the dipping liquid and extraction liquid are used to make coating liquid, which is added to the finished product. The recovery rate of the dipping liquid and extraction liquid is more
than 90%, and some high concentration dipping liquid and extraction liquid are still discharged. The wastewater has the characteristics of high COD and high chroma because it contains tobacco, fine fiber, hemicellulose and lignin [10]. According to the characteristics of waste water, the pretreatment (Grid / Air Flotation) and Up-flow Anaerobic Sludge Bed / anoxic / aerobic process combined with advanced treatment process (Air Flotation / Ozonation-Biological aerated filter) were applied to the project. The total amount of wastewater treatment designed for the project is 4000t/d.

2. Design Water Quality and Process Flow

2.1. Design inlet and outlet water quality

The designed influent quality is determined according to the actual monitoring of the water quality of the same kind of project and referring to the influent quality provided by the owner. The effluent quality is determined according to the requirements of the environmental impact assessment, combined with the industry standards and the environmental standards for ensuring the discharge of water, and implements the first-level standard of the maximum allowable discharge concentration of the second type of pollutants in the second period of the Discharge limits of water pollutants (DB44 / 26-2001) in Guangdong Province.

The inlet and outlet water quality is as follows.

Table 1. design inlet and outlet water quality (list only main indexes)

| Number | Pollutant | Inlet water quality | Outlet water quality |
|--------|-----------|---------------------|----------------------|
| 1      | pH        | 6-10                | 6-9                  |
| 2      | COD$\text{Cr}$ | 12000 mg/L        | ≤90 mg/L             |
| 3      | BOD$_5$   | 5700 mg/L           | ≤20 mg/L             |
| 4      | SS        | 7000 mg/L           | ≤60 mg/L             |
| 5      | Chroma    | 2500                | ≤40                  |

2.2. Process flow and characteristic analysis

The wastewater treatment combined process of the physicochemical pretreatment unit with flocculants, the biological treatment unit of “up-flow anaerobic sludge blanket (UASB)+anoxic/ aerobic tank (A/O)” and the advanced treatment unit of “air floatation+ozone-biological aerated filter (O$_3$-BAF)” is essentially a water treatment technology which is mainly based on biochemical treatment and supplemented by improved physicochemical technology. The process system can be divided into four parts: pretreatment system, biochemical treatment system, advanced treatment system and sludge treatment system.

Process flow is as follows.

Figure1. Process flow of wastewater treatment
When selecting the process, the characteristics of difficult treatment and complex and changeable components of the comprehensive reclaimed tobacco wastewater are fully considered. The pretreatment tank is set up in the front section of the regulating tank to reduce the impact of high concentration of suspended solids on the biochemical system. In addition, considering the demand of water for production and reuse, the advanced treatment process of ozone-biological aerated filter (O$_3$-BAF) is used to treat and reuse the wastewater in the process design, and an air flotation process is added in front of O$_3$-BAF to further remove suspended solids and chromaticity.

### 3. Main Structure Parameters and Design Features

#### 3.1. Pretreatment system

The pretreatment system mainly includes a fine grid pool, an adjusting tank, a flocculation reaction tank and an air flotation tank.

3.1.1. Grid tank. Set up a fine grid tank, the size of the tank is 5.0m*1.0m*4.0m. The grid tank is equipped with a rotating grille machine. Function feature: Through physical interception, it is used for intercepting large-particle suspended particles in production wastewater, protecting the follow-up mechanical equipment, and reducing the load of the follow-up system.

3.1.2. Adjusting tank. Set up an adjusting tank, the size of the tank is 22.0m*15.0m*5.0m, the design residence time is 9.0 h. Function features: Collect wastewater, uniform water quality; use as an accident pool in the accident, and pump into the follow-up system when the system is normal.

3.1.3. Flocculation reaction tank and Air flotation tank. Set up a flocculation reaction tank, the size of the tank body is 5.0m*2.5m*4.0m, and the designed residence time is 15 min. Set up an air flotation tank, the size of the tank body is 8.0m*5.0m*3.0m, and the designed surface load is 4.2m$^3$/ (m$^2$.h). Function features: Flocculants is added to flocculate and precipitate, and the treatment effect is strengthened by air floatation.

#### 3.2. Biochemical treatment system

The biochemical treatment system mainly includes UASB, A/O and secondary sedimentation tank.

3.2.1. UASB tank. Set up four UASB tanks, the size of the single tank is 22.0m*11.0m*10.0m, the volume load is 3.5kgCOD/(m$^3$.d), the residence time is 49.0h, and the rising velocity is 0.17m/h. Function features: the high concentration characteristics of reclaimed tobacco production wastewater make most of the organic matter be degraded or removed through the anaerobic reaction of granular sludge, after four stages of hydrolysis, acidizing, acid production and methane production, which creates conditions for the subsequent aerobic treatment. A certain number of high efficiency bioaffinity fillers are installed in the tank, and the filler is in good contact with the wastewater in the reactor to improve the biodecomposition efficiency by using the impact of the pulse water distributor. UASB tank is equipped with three separators, and the biogas produced in the tank is collected and led into the biogas combustion device for combustion disposal.

3.2.2. A/O tank. Set up one anoxic tank, the size of the tank is 20.0m*7.0m*6.0m, the volume load is 2.0kgCOD/ (m$^3$.d), the residence time is 4.6 h; Set up four aerobic tanks, the size of the tank is 20.0m*9.0m*6.0m, the volume load is 0.8kgCOD/(m$^3$.d), the residence time is about 23.8h, the ratio of water to gas is about 1: 40, and the ratio of mixed liquid to reflux is about 250%. Function features: the core part of wastewater treatment. The effluent of UASB can further remove or degrade some polymer organic matter by anoxic reaction under the action of facultative bacteria through the anoxic tank. After that, through the organic combination of different kinds of microbial flora attached to the combined packing in the aerobic tank, the pollutants can be effectively removed and the water quality can be purified. A tubular variable microporous aerator is arranged at the bottom of the aerobic pool. Tubular variable microporous aerator is a new type of aeration equipment with high efficiency and negative pressure design, which has the characteristics of microporous aeration, anti-blockage, large effective service area, small bubble diameter and high oxygen utilization ratio. During the overhaul, the repaired aerator group can be repaired and replaced from the water without the sewage drainage pool, so its operation and management is very convenient.

3.2.3. Secondary sedimentation tank. Set up one secondary sedimentation tank, the size of the tank is Ф20.0m*4.5m, the designed surface load is 0.53 m$^3$/ (m$^2$.h). Function features: separation of sludge from
effluent of biochemical system; sludge is partially refluxed to anoxic tank and UASB tank, and excess sludge is discharged to sludge thickening tank.

3.3. Advanced treatment system

The advanced treatment system mainly includes air floatation tank, O3-BAF tank.

3.3.1. Air floatation tank. Set up a flocculation reaction tank, the size of the tank is 5.0m*2.5m*4.0m, and the designed residence time is 15 min. Set up an air floatation tank, the size of the tank is 8.0m*5.0m*3.0m, and the designed surface load is 4.2m³/(m².h). Function features: Flocculants is added to flocculate and precipitate, and the effect of suspended matter treatment is strengthened by air floatation; and the decolorization treatment is carried out by adding flocculants.

3.3.2. Clean water tank. Set up one clear water tank, the size of the tank is 8.0m*5.0m*5.0m, and the designed residence time is 1.1h. Function features: It is used for storing the effluent of the secondary sedimentation tank and the backwashing water of the O3-BAF tank.

3.3.3. O3-BAF tank. Set up four O3-BAF tank, the size of the single tank is 6.0m*5.0m*5.5m, the hydraulic load is 1.39m³/m²·h, the ratio of water to gas is about 1:3 to 1:5, and the backwashing period is 3~5d. Function features: advanced oxidation and biochemical combination of water treatment technology. The waste water is pre-treated with advanced oxidation technology (ozone oxidation) to change the molecular structure of the organic matter which is difficult to degrade, so as to improve the biodegradability of the waste water, and then the biological treatment technology is used to further purify the waste water. This technology combines chemical oxidation and biological oxidation technology organically. The advanced oxidation is used as a pretreatment, and its treatment cost is greatly reduced. The high efficiency of the treatment is ensured through the subsequent biological treatment, and makes full use of their respective advantages to achieve complementary effects.

3.3.4. Reuse tank. Set up one reuse tank, the size of the tank is 12.6m*5.0m*5.0m, the residence time 1.7 hours. Function features: It is used for storing the water from advanced treatment system and reuse it after disinfection by adding agents.

3.4. Sludge treatment system

The residual sludge of the wastewater station is concentrated in the sludge concentration tank, then sent to a plate-and-frame filter press for pressure filtration and dehydration through a chemical-adding conditioning, and the sludge after the pressure filtration is transported for disposal. The residual sludge is treated and disposed in a harmless and stabilized manner.

4. Operation Results

The project is running well, and the effluent quality could meet the first level standard of the maximum allowable discharge concentration of the second class pollutants in the second period of the Discharge standard of water pollutants (DB44 / 26-2001) in Guangdong Province, China. The actual running water quality of inlet and outlet is shown in Table 2.

| Number | Pollutant | Inlet water quality | Outlet water quality |
|--------|-----------|---------------------|---------------------|
| 1      | pH        | 6-10                | 6-9                 |
| 2      | CODCr     | 12000 mg/L          | 60~75 mg/L          |
| 3      | BOD5      | 5700 mg/L           | 10~15 mg/L          |
| 4      | SS        | 7000 mg/L           | 20~40 mg/L          |
| 5      | Chroma    | 2500                | 10~30               |
5. Conclusion
A tobacco leaf reclaimed wastewater treatment project in Guangdong Province, China was designed by combining pretreatment (grille+air floatation), biochemical treatment (UASB+A/O) and advanced treatment (O3-BAF). After stable operation, the effluent quality of the system can reach the first-level standard of the maximum allowable discharge concentration of the second type of pollutants in the second period of Guangdong Province Discharge Limits of Water Pollutants DB44/26-2001, and the sludge is treated and disposed in a harmless and stabilized manner.

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