Study on Treatment of Secondary Tailwater of Wastewater Treatment Plant by New Reinforced Flocculation Sedimentation

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Abstract. The advanced treatment and reuse of secondary effluent from urban sewage plants is currently one of the reliable ways to solve the shortage of urban water resources. This paper proposes a new type of enhanced flocculation and sedimentation process for the advanced treatment of secondary effluent from a wastewater treatment plant. The new type of enhanced flocculation sedimentation tank is used as a main process for new advanced wastewater treatment. The combination of wing micro vortex flocculation tank, net catching flocculation, inclined plate sedimentation tank and biological filter has good effluent quality. Basically, CODCr were stable at 35 mg/L, turbidity of effluent were stable at 2 NTU, chroma were stable at 30 degrees, TP were stable at 1 mg/L.

1. Introduction
The process of global urbanization, industrialization, and intensification of agriculture, as well as the dramatic increase in population, have fundamentally led to the increasing seriousness of water pollution [1]. Urban sewage has characteristics of large volume, concentration, stable water quality and quantity, etc. It can be used for industrial production after being properly treated, thus greatly reducing the shortage of water resources [2].

At present, the discharge requirements of effluent from urban sewage treatment plants are increasingly stringent, but the secondary effluent of existing urban sewage treatment plants is still difficult to meet the water quality requirements of industrial cooling water, environmental landscape water and urban miscellaneous water use[3] [4]. In general, the application of urban sewage to industrial reuse after secondary treatment has the following problems: (1) the sewage contains a certain amount of dissolved solids. (2) The concentration of pollutants such as organics and nutrients is relatively high. (3) For the reused objects with certain requirements for chroma and turbidity, corresponding processing techniques are required to meet the requirements. (4) Containing toxic and harmful substances such as bacteria and heavy metals may adversely affect reuse and require further purification to achieve reuse requirements.

To sum up, one of the effective ways to solve the water shortage is the deep treatment and reuse of wastewater. The purpose of advanced wastewater treatment is to further remove suspended solids, organic matter, nitrogen and phosphorus in the sewage. In this paper, a new type of enhanced
flocculation and sedimentation process is developed to address the water quality characteristics and problems of the secondary tail water of sewage treatment plants.

2. Materials and methods

2.1. Experimental set-up
The new enhanced flocculation and sedimentation process is a new type of water treatment facility that incorporates wing micro vortex flocculation tank, net catching flocculation and inclined plate sedimentation in traditional coagulation and sedimentation methods. The process is mixed by fin vortex flocculation grid, and the flocculation reaction is strengthened by the small volume flocculation zone. In the sedimentation zone, a vertical oblique composite plate member is additionally provided to enhance the sedimentation effect, and simultaneous sludge settlement can be achieved. Figure 1 shows the test flow chart.

![Figure 1](image)

**Figure 1. Schematic diagram Dynamic experimental**

2.2. Water Quality Indicators
The test was conducted in the chlorination room of a sewage treatment plant in Shenyang City. The secondary effluent from the plant was used as raw water. During the test period, the raw water quality is shown in the following table (Tab.1):

| Project (unit)      | range | Project (unit)      | range | Project (unit)      | range |
|---------------------|-------|---------------------|-------|---------------------|-------|
| CODc (mg/L)         | 30-102| NH3-N (mg/L)        | 0-25  | Cu (mg/L)           | 0.0627|
| BOD5 (mg/L)         | 5-30  | NO3-N (mg/L)        | 0-0.3 | Fe (mg/L)           | 0.1169|
| Turbidity (NTU)     | 4-45  | NO2-N (mg/L)        | 2-16  | Zn (mg/L)           | 0.087 |
| Chroma (mg/L)       | 35-156| TN (mg/L)           | 26-42 | Cd (mg/L)           | 0.0028|
| TP (mg/L)           | 1-6   | Alkalinity (mg/L)   | 150-300| Mn (mg/L)           | 0.1174|
| SS (mg/L)           | 3-25  | Temperature (°C)    | 8-26.7| Pb (mg/L)           | 0.0038|
| PH                  | 6.84-7.40 |

Note: 1) Metal elements were measured only once due to test conditions and other reasons, and no indicators were found.
2.3. Water quality analysis methods and instruments
The test items and test methods for this test are shown in Table 2.

| Test items | Analysis methods | Measure instruments |
|------------|------------------|---------------------|
| CODCr      | Potassium dichromate method | Furnace and burette |
| TP         | Molybdenum antimony spectrophotometric method | High pressure steamer and UV spectrophotometer |
| Turbidity  | Photoelectric method | Optoelectronic turbid meter |
| Chroma     | Chromaimetry      | HACH DR/2500 spectrophotometer |

3. Results and Analysis

3.1. The removal effect of CODCr
The removal effect of CODCr are shown in Table 2. According to the Fig.2. When the influent CODCr varies between 30 and 70 mg/L, the effluent CODCr water quality index fluctuates around 35 mg/L after a new type of enhanced flocculation sedimentation tank, and the average CODCr in the sedimentation tank effluent is 35.4 mg/liter. L, the average removal rate was 35%. It shows that the removal of CODCr is stable within a certain range.

3.2. The removal effect of turbidity
The removal effect of turbidity are shown in Table 3. According to the Fig.3. In the test process, when the turbidity of the raw water changes from 4 to 13.4 NTU, the effluent turbidity of the sedimentation tank can basically be kept below 3 NTU. The sediment effluent turbidity averaged 1.9 NTU and the average removal rate was 69.8%. However, with the fluctuation of raw water quality, the effluent turbidity is sometimes slightly higher than 3NTU. From the operation results, the sedimentation tank has an ideal removal effect on turbidity.

3.3. The removal effect of chroma
The removal effect of chroma are shown in Table 4. According to the Fig.4. When the chroma of the original water changes from 45 to 117 degrees, the chroma of the sedimentation tank can basically be stabilized below 30 degrees. The average chroma of sedimentation tanks was 28.9 NTU, and the average removal rate was 54.5%. The effect of the new enhanced flocculation and settling tank on the removal of chroma is the same as that of turbidity, and there is also a certain degree of fluctuation. Sometimes the effluent chroma exceeds 30 degrees, but the overall effect is significantly higher than the conventional sedimentation tank.
3.4. The removal effect of TP
The removal effect of TP are shown in Table 5. According to the Fig. 5. When the raw water TP is changed from 2.1 to 5.6 mg/L, the effluent TP is basically below 1 mg/L after this process. The average TP of sedimentation tank was 0.8 mg/L, and the average removal rate was 81.8%. This shows that the process has a good removal effect on TP.

4. Conclusion
The new enhanced flocculation sedimentation tank is used to treat the secondary effluent. Due to the addition of the fin members in the grid reaction tank, minute micro-vortices can be generated when the water passes through the fin members. The colloidal particles collided with each other in the water were strengthened, and the flocculation efficiency was improved. Gradually yielding large sinks that are easy to sink provides a favorable basis for subsequent precipitation separation. In the sedimentation tank was installed a small pitch vertical diagonal composite plate member. The water stream entrained with the flocculate particles first flows vertically upwards through the vertical plate, and the flocs and fine particles in the water are trapped by the active sludge deposited downward, resulting in contact flocculation and settling. Therefore, the effluent quality of the sedimentation tank is excellent. Basically, CODCr were stable at 35 mg/L, turbidity of effluent were stable at 2 NTU, chroma were stable at 30 degrees, TP were stable at 1 mg/L.

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