# Analysis on the Operation Effect of the Upgrading and Reconstruction Project of Xincheng Wastewater Treatment Plant

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## ABSTRACT

*The main body of the upgrading and renovation project of Xincheng Wastewater Treatment Plant adopts the $A^2/O$ process, and the advanced treatment adopts the combination of high-efficiency sedimentation tank and denitrification deep-bed filter to efficiently remove total nitrogen and total phosphorus, and the effluent quality is improved from the first-level A standard To the surface level IV water quality standard. This paper analyzes the water quality before the upgrading project and the effluent quality after the upgrading project. The results show that the effluent quality can stably reach the surface level IV standard, which can provide a reference for similar sewage treatment plant upgrading projects.*

**Keywords :** Sewage treatment plant, upgrading and transformation, operation effect

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## INTRODUCTION

The Xincheng Wastewater Treatment Plant in Tongshan District, Xuzhou City is located in the west of Erbao Village, Tongshan District. The current treatment capacity is 20,000 tons per day. The tail water meets the first-level A standard in the Pollutant Discharge Standard for Urban Wastewater Treatment Plants [1](GB18918-2002). The tail water of the Xincheng Sewage Treatment Plant is discharged into the Kui River. The Kui River is a drainage channel shared by Jiangsu and Anhui. It flows into Anhui at the Huangqiao and finally flows into the Huai River. According to the requirements of the "Surface Water (Environment) Functional Zoning of Jiangsu Province", the water quality indicators of the Kui River in Xuzhou must reach surface water Class IV by 2020 According to the standard, the Huangqiao section is assessed according to Class IV water. At present, the effluent index of the Xincheng Wastewater Treatment Plant is Class A Standard, which is basically Class V or inferior to Class V. To achieve the water quality standard of the Kui River IV surface water, it is necessary to raise the effluent water quality standard. Therefore, it is necessary to upgrade the standard of the Xincheng Wastewater Treatment Plant to meet the requirements of the new discharge standards. In addition, the "Emission Standards of Pollutants for Urban Sewage Treatment Plants" (Draft for Solicitation of Comments) and "Emission Limits of Major Water Pollutants for Urban Sewage Treatment Plants and Key Industrial Industries in Taihu Region"[2]

(DB32/1072-2018), "Special Emission Limits for Suzhou" The promulgation of new standards such as "Value Standards" in other regions has put forward higher requirements on the discharge standards of pollutants from sewage treatment plants. The gradual improvement of pollutant discharge standards for sewage treatment plants is already a trend, so it is necessary to carry out further upgrading and transformation of sewage treatment plants.

## MATERIALS AND METHODS

### 1 Analysis of the process and effluent status of the Xincheng Sewage Treatment Plant before the upgrading and renovation project

### 1.1 Rocess before transformation

On December 1, 2010, the Tongshan Xincheng Sewage Treatment Plant carried out upgrading and transformation. The effluent water quality was upgraded from Grade B standard to Grade A standard. The whole plant area can be divided into pretreatment zone, sewage biochemical treatment zone, and sewage treatment zone according to functional zones. Mud treatment area. The main process adopts the $A^2/O$ process[3]. After the sewage enters the plant area, it first passes through the coarse grid and screen to filter out large particles of impurities and suspended pollutants in the water, and then pressurizes the water inlet pump room, and then passes through the fine grid to swirl and settle the sand. The pond filters small particles of pollutants in the water body. Then the preliminary treated sewage enters the biochemical treatment stage, first enters the anaerobic tank of the $A^2/O$ tank, then enters the anoxic tank, then enters the aerobic tank, and the biochemically treated sewage enters the secondary settling tank.

### 1.2 Analysis of effluent water quality before reconstruction

According to the nature of pollutants processed by urban sewage treatment plants, the pollutants are mainly divided into basic control items and selective control items. The basic control items mainly refer to the conventional pollutants that can be removed by the sewage treatment plant through conventional treatment processes[4]. Including five items: COD, SS, TN, TP, and ammonia nitrogen. At present, the Xincheng Sewage Treatment Plant is also mainly for the removal and treatment of these five categories of pollutants. Through the analysis of the water quality of the sewage treatment plant's inflow and outflow for the whole year of 2018, the monthly average value is taken for analysis, and the relevant values of the plant are included in Table 1-1 below.

**Table1-1** Monthly average data statistics of pollutants in Xincheng sewage treatment plant(unit:mg/L)

| | COD | | SS | | TN | | TP | | Ammonia | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 166 | 23 | 125 | 6 | 38 | 14 | 2.9 | 0.43 | 33 | 0.75 |
| 2 | 183 | 24 | 109 | 4 | 40 | 15 | 2.9 | 0.45 | 36 | 1.02 |
| 3 | 191 | 24 | 147 | 5 | 43 | 15 | 2.9 | 0.43 | 38 | 1.13 |
| 4 | 211 | 23 | 183 | 6 | 43 | 17 | 3.2 | 0.42 | 38 | 1.32 |
| 5 | 202 | 20 | 169 | 6 | 46 | 13 | 3.4 | 0.37 | 41 | 1.21 |
| 6 | 193 | 25 | 186 | 6 | 41 | 13 | 3.6 | 0.38 | 36 | 1.31 |
| 7 | 185 | 17 | 175 | 6 | 45 | 13 | 3.2 | 0.36 | 40 | 1.73 |
| 8 | 152 | 15 | 171 | 6 | 36 | 13 | 3.1 | 0.36 | 32 | 1.02 |
| 9 | 133 | 19 | 174 | 6 | 41 | 13 | 3.0 | 0.39 | 36 | 1.08 |
| 10 | 132 | 19 | 173 | 5 | 39 | 13 | 3.0 | 0.38 | 34 | 0.98 |
| 11 | 134 | 18 | 168 | 5 | 39 | 13 | 3.1 | 0.37 | 35 | 1.03 |
| 12 | 158 | 16 | 161 | 6 | 49 | 17 | 2.9 | 0.38 | 44 | 1.39 |
| Annual average | 170 | 20 | 162 | 6 | 42 | 14 | 3.1 | 0.39 | 37 | 1.17 |

According to the monthly average pollutant data statistics of Xincheng Wastewater Treatment Plant (Table 1-1), the monthly average pollutant removal rate is calculated as shown in Table 1-2.

**Table1-2** Statistics of monthly average removal rate of pollutants in Xincheng sewage treatment plant（unit：%）

| | COD removal rate | SS removal rate | TN removal rate | TPremoval rate | Ammonia nitrogen removal rate |
|---|---|---|---|---|---|
| 1 | 86.14 | 95.20 | 63.16 | 85.17 | 97.73 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | 86.89 | 96.33 | 62.50 | 84.48 | 97.17 |
| 3 | 87.43 | 96.60 | 65.12 | 85.17 | 97.03 |
| 4 | 89.10 | 96.72 | 60.47 | 86.88 | 96.53 |
| 5 | 90.10 | 96.45 | 71.74 | 89.12 | 97.05 |
| 6 | 87.05 | 96.77 | 68.29 | 89.44 | 96.36 |
| 7 | 90.81 | 96.57 | 71.11 | 88.75 | 95.68 |
| 8 | 90.13 | 96.49 | 63.89 | 88.39 | 96.81 |
| 9 | 85.71 | 96.55 | 68.29 | 87.00 | 97.00 |
| 10 | 85.61 | 97.11 | 66.67 | 87.33 | 97.12 |
| 11 | 86.57 | 97.02 | 66.67 | 88.06 | 97.06 |
| 12 | 89.87 | 96.27 | 65.31 | 86.90 | 96.84 |
| Annual average | 88.24 | 96.30 | 66.67 | 87.42 | 96.84 |

Since the official operation of Xincheng Wastewater Treatment Plant in October 2005, the overall situation has been relatively stable. From Table 1-2, we can see that in 2018, the average annual removal rate of COD was 88.24%, the average annual removal rate of SS was 96.30%, and the average annual removal rate of TN was 66.67%. The average annual removal rate of TP is 87.42%, and the average annual removal rate of ammonia nitrogen is 96.84%. The overall effluent quality meets the sewage discharge level A standard, but there is a certain gap between TN and the surface quasi-IV standard.

**2 Upgrading and reforming process and analysis of effluent effect**

**2.1 Process selection analysis**

Combining the actual land conditions of the Xincheng Wastewater Treatment Plant in Tongshan District, and fully considering the surrounding environment, funding, actual operation problems, and the requirements of the designed effluent water quality, the plan for the upgrading and upgrading of the Xincheng Wastewater Treatment Plant is determined as follows:

Transform the original A²/O tank body into an aerobic area of the A²/O tank; 2. Increase the anaerobic and anoxic areas of the A2/O tank; 3. Increase the secondary biochemical treatment and build a denitrification deep-bed filter , Strengthen the TN removal process; 4. Increase the secondary biochemical treatment, build a high-efficiency sedimentation tank, and strengthen the TP removal process; 5. Newly add a contact disinfection tank.

**2.2 Analysis of effluent effect**

The post-treatment capacity of the Tongshan Xincheng Sewage Treatment Plant is 20,000 tons/day. The basic control items mainly include COD, SS, TN, TP, and ammonia nitrogen. Through the

statistical analysis of the inflow and outflow water quality of the sewage treatment plant for the whole year of 2020, and the monthly average value for analysis, the relevant values of the plant are included in Table 2-1 below.

**Table 2-1** Statistical Table of Monthly Average Pollutants of Xincheng Sewage Treatment Plant(unit:mg/L)

| | COD | | SS | | TN | | TP | | Ammonia | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average | Monthly average water intake | Monthly average |
| 1 | 106.29 | 17.26 | 62.74 | 3.35 | 29.64 | 8.94 | 2.01 | 0.08 | 22.20 | 0.62 |
| 2 | 82.86 | 20.14 | 62.21 | 3.34 | 26.94 | 9.53 | 1.98 | 0.16 | 18.73 | 1.31 |
| 3 | 70.35 | 15.32 | 53.03 | 3.11 | 23.02 | 9.18 | 1.69 | 0.13 | 17.64 | 0.50 |
| 4 | 89.37 | 14.80 | 51.17 | 3.00 | 25.70 | 9.60 | 1.77 | 0.08 | 19.18 | 0.72 |
| 5 | 176.58 | 17.48 | 66.13 | 4.35 | 32.83 | 7.58 | 2.00 | 0.10 | 27.71 | 0.75 |
| 6 | 169.47 | 24.50 | 58.33 | 3.93 | 33.28 | 7.48 | 2.18 | 0.10 | 27.66 | 0.53 |
| 7 | 176.84 | 23.26 | 57.55 | 4.02 | 28.54 | 8.58 | 1.80 | 0.15 | 22.01 | 0.75 |
| 8 | 218.87 | 15.84 | 61.61 | 4.10 | 27.53 | 8.56 | 1.81 | 0.08 | 21.28 | 0.61 |
| 9 | 177.87 | 17.27 | 67.93 | 3.17 | 34.73 | 9.76 | 2.40 | 0.16 | 29.44 | 0.75 |
| 10 | 177.58 | 15.87 | 75.00 | 3.06 | 34.54 | 10.00 | 2.50 | 0.08 | 30.10 | 0.44 |
| 11 | 124.45 | 18.21 | 69.69 | 3.48 | 32.13 | 9.35 | 2.96 | 0.16 | 26.28 | 0.33 |
| 12 | 145.87 | 19.81 | 78.29 | 3.52 | 31.89 | 9.43 | 3.46 | 0.24 | 27.73 | 0.31 |
| Annual average | 143.03 | 18.31 | 63.64 | 3.54 | 30.06 | 9.00 | 2.21 | 0.13 | 24.16 | 0.63 |

According to the monthly average inflow and outflow concentration of various pollutants in the monthly average pollutant data statistics table (Table 2-1) of the Xincheng Wastewater Treatment Plant in 2020, the calculated monthly average removal rate of pollutants is shown in Table 2-2.

**Table2-2** Statistics of monthly average removal rate of pollutants from Xincheng Sewage Treatment Plant（unit：%）

|  | COD removal rate | SS removal rate | TN removal rate | TPremoval rate | Ammonia nitrogen removal rate |
|---|---|---|---|---|---|
| 1 | 0.84 | 0.95 | 0.70 | 0.96 | 0.97 |
| 2 | 0.76 | 0.95 | 0.65 | 0.92 | 0.93 |
| 3 | 0.78 | 0.94 | 0.60 | 0.93 | 0.97 |
| 4 | 0.83 | 0.94 | 0.63 | 0.96 | 0.96 |
| 5 | 0.90 | 0.93 | 0.77 | 0.95 | 0.97 |
| 6 | 0.86 | 0.93 | 0.78 | 0.95 | 0.98 |
| 7 | 0.87 | 0.93 | 0.70 | 0.92 | 0.97 |
| 8 | 0.93 | 0.93 | 0.69 | 0.95 | 0.97 |
| 9 | 0.90 | 0.95 | 0.72 | 0.94 | 0.97 |
| 10 | 0.91 | 0.96 | 0.71 | 0.97 | 0.99 |
| 11 | 0.85 | 0.95 | 0.71 | 0.95 | 0.99 |
| 12 | 0.86 | 0.96 | 0.70 | 0.93 | 0.99 |
| Annual average | 0.87 | 0.94 | 0.70 | 0.94 | 0.97 |

The upgrading and renovation project of the Xincheng Wastewater Treatment Plant has been implemented since the beginning of 2018 and will be completed at the end of October 2019, with conditions for commissioning. It was officially put into operation in January 2020. Since the official operation, the overall situation has been stable. Table 5-2 shows that the average annual removal rate of COD in 2018 is 87%, the average annual removal rate of SS is 94%, the annual average removal rate of TN is 67%, and the annual average removal rate of TN is 67%. The average removal rate is 94%, and the average annual removal rate of ammonia nitrogen is 97%. The overall effluent water quality meets the surface level IV standard.

## CONCLUSION

Through analysis of the incoming and outgoing water quality data of the Xincheng Sewage Treatment Plant after the upgrading and upgrading project, the data shows that after the upgrading and upgrading project, the pollutants monitored by each key can be discharged stably up to the standard, indicating the effectiveness of the upgrading and upgrading project.

For the advanced treatment process-high-efficiency sedimentation tank[5] and denitrification deep-bed filter[6] , the removal effect of the main target was tracked. The dosage of high-efficiency sedimentation tank in PAC[7] and PAM [8]is controlled at 25mg/L and 0.2mg/L, respectively. When the dosage of carbon source in the hypoxic zone of A2/O tank is controlled at 106kg per day[9], the overall operation of the sewage treatment plant is the most economical and has the most effective water output. Optimal. According to the analysis of the operation effect, the effluent COD, SS, ammonia nitrogen, total nitrogen, and total phosphorus concentration all reach the surface level IV standard[10], especially for ammonia nitrogen and total phosphorus.

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