Treatment of Secondary Sedimentation Tank Wastewater by Fenton Oxidation-Neutralization-Coagulation Sedimentation

Shan Chen, Bin Liu, Cheng-yuan Hu
Yancheng Environmental Monitoring Center of Jiangsu province, Jiangsu, 224000, China

Abstract
In this paper, the COD_{Cr} index is used as the detection item, and the wastewater from the secondary clarifier of a sewage treatment plant is treated by "Fenton oxidation-neutralization-coagulation sedimentation" method. The results showed that the removal rate of COD_{Cr} reached 73.4% by "Fenton oxidation-neutralization-coagulation precipitation" method. It can be seen that this method can make the wastewater discharge up to the standard and provide data support for better treatment of industrial wastewater in engineering.
Keywords Secondary sedimentation tank; CODCr; Fenton oxidation; Up-to-standard emissions
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1. Introduction
The rapid economic development not only promotes social progress, but also brings harm to the environment, which makes pollution become a major problem, among which water pollution is the most important. In order to better control water pollution, China has built sewage treatment plants in cities and towns to treat industrial sewage or domestic sewage, so as to improve water quality [1-4]. The secondary sedimentation tank is a key unit of sewage treatment plant, which will directly affect the effluent quality of biochemical treatment system and the concentration of reflux sludge. Its operation status is related to the effluent index[5-6]. In this study, activated carbon, coagulant polyaluminium chloride (PAC) and polyacrylamide (PAM) were applied to the comprehensive oxidation method of "Fenton oxidation-neutralization-coagulation sedimentation" [7-12]. The secondary sedimentation tank wastewater was treated. By improving the removal rate of CODCr, the wastewater was treated to meet the discharge standards, which provided experimental data support for the water treatment engineering reform.

2 Experiment
2.1 Conventional Water Quality Indicators
The pH value was determined by glass electrode method, the chroma was determined by dilution multiple method, the total phosphorus was determined by ammonium molybdate spectrophotometry, and the COD_{Cr} was determined by potassium dichromate method [13].

2.2 Fenton oxidation of wastewater
2.2.1 Catalyst Addition
The $FeSO_4·7H_2O$ of 0.3‰、0.4‰、0.5‰、0.6‰、and 0.7‰ were added to the beaker with concentrated sulphuric acid to adjust the pH to 3 and 0.24 mL of 30% hydrogen peroxide. After 2 hours of reaction, 0.4 g/L calcium hydroxide was added to the beaker. After static precipitation, supernatant was taken to detect COD_{Cr}. The average value of each water sample was determined twice.

2.2.2 Fenton reaction time
Fixed 1.2mL hydrogen peroxide dosage and 0.5‰ FeSO4·7H2O dosage, the effects of reaction time on fenton oxidation were investigated at 1h, 2h, 3h, 4h, 5h and 6h, respectively. After the experiment, the supernatant was taken to detect CODCr, and the average value of each water sample was determined twice to study the effect of fenton oxidation.

2.2.3 Agitation method
Fixed the dosage of 1.2 mL hydrogen peroxide and 0.5‰ $FeSO_4·7H_2O$, and investigated the effects of mechanical stirring and aeration stirring on fenton oxidation. At the same time, the raw water was transferred to the same condition of fenton oxidation pH about 3 for aeration stripping. The supernatant was taken to detect COD_{Cr} after static precipitation, and the average value was obtained twice for each water sample. The reaction time was 2 hours, and the end was adjusted to pH neutral.

2.2.4 Adsorption-coagulation after fenton oxidation
The addition amount of 1.2mL hydrogen peroxide and 0.5‰ $FeSO_4·7H_2O$ was fixed, fenton reaction was conducted for 2h, and the supernatant was separated into two parts for coagulation and sedimentation and adsorption-coagulation and sedimentation secondary treatment. Among them, the coagulation precipitation was added with 0.2mL 10%PAC solution and 0.2mL 2.5‰PAM solution. The flocs were rapidly stirred until the flocs appeared, stopped and stood. After the precipitation, the supernatant was taken to detect COD_{Cr}. Adsorptions-coagulation precipitation was conducted by adding 0.2‰ activated carbon for adsorption reaction for 1h, adding

0.2mL 10%PAC solution and 0.2mL 2.5‰PAM solution, rapidly stirring until the flocs were stopped. After settling, the supernatant was taken to detect COD_{Cr}, and the average value of each water sample was determined twice.

2.2.5 Fenton oxidation - neutralization - coagulation precipitation under the best conditions

Fixed hydrogen peroxide 1.2 mL dosing quantity and 0.5 ‰ of $FeSO_4 \cdot 7H_2O$ dosing quantity, fenton reaction 4 h, with the method of mechanical agitation, treated water adsorption - coagulation precipitation of secondary processing, quick stir until floc appear to stop stirring, let stand on clear liquid after precipitation test COD_{Cr}, determination of average twice.

3 Results and discussion

3.1 Testing results of raw water sample

According to the method specified in section 1.1 of the original water samples for testing, the original water quality presents a beige, its pH, CODCr, total phosphorus and chromaticity are shown in Table 1.

Table 1 the second pond water quality inspection situation

Water source	pH	COD_{Cr} mg/L	Total phosphorus mg/L	Chroma Diluted multiples
Secondary sedimentation tank effluent	7.77	183	0.4	50

3.2 Fenton oxidation experiment

3.2.1 Oxidation treatment effect after adding catalyst

As described in 2.2.1, fenton oxidation treatment effect is shown in Fig. 1.
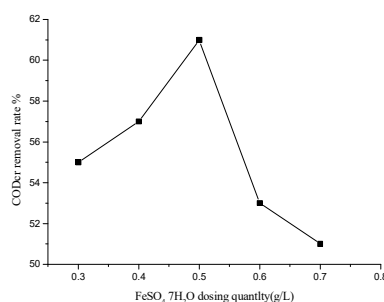

Fig.1 Influence of $FeSO_4 \cdot 7H_2O$ dosage on COD_{Cr} removal rate

It can be seen from Fig. 1 that the removal rate of COD_{Cr} increased first and then decreased with the addition amount of FeSO4·7H2O. When FeSO4·7H2O dosage was 0.3‰, 0.4‰, 0.5‰, 0.6‰ and 0.7‰ respectively, the removal rates of COD_{Cr} measured were 54.7%, 57.6%, 60.9%, 55.2% and 51.4%, respectively.

When $FeSO_4 \cdot 7H_2O$ was added at a small dosage, Fe^{2+} would be oxidized by H_2O_2 to Fe^{3+} and generate a large amount of hydroxyl radicals, which would easily react with refractory organic pollutants in wastewater and decompose them to play the role of flocculation and sedimentation. Therefore, the removal rate of COD_{Cr} in wastewater was constantly improved. When the dosage of $FeSO_4 \cdot 7H_2O$ was gradually increased to more than 0.5‰, the high concentration of Fe^{2+} in the wastewater would consume part of H_2O_2, resulting in ineffective decomposition of H_2O_2, and the release of H_2O_2, which affected the oxidation effect and reduced the removal rate of COD_{Cr} in the wastewater. At the same time, excessive Fe^{3+} generated by Fe^{2+} oxidation will make the wastewater return to color and cause secondary pollution. Therefore, if the fixed addition amount of hydrogen peroxide was 1.2mL, the best oxidation treatment effect was obtained by adding 0.5‰ $FeSO_4 \bullet 7H_2O$.

3.2.2 Influence of reaction time on oxidation treatment

As described in 2.2.2, the effect of reaction time on fenton oxidation treatment effect is shown in fig.2. It can be seen from Fig. 2 that the removal rate of COD_{Cr} in waste water first increased and then decreased with the increase of reaction time. When the reaction time was 1h, 2h, 3h, 4h, 5h and 6h, respectively, the removal rates of COD_{Cr} were 55.1%, 59.5%, 64.8%, 68.5%, 67.2% and 65.8%, respectively.

The length of reaction time in a certain situation directly affects the degree of reaction and whether the reaction can be carried out completely. On the contrary, if the reaction time is too long, the reactor volume will be affected instead of further effects. When the reaction time was less than 4h, the removal rate curve of COD_{Cr} increased rapidly, indicating that fenton's oxidation rate was very fast at this time. Organic matter in wastewater was continuously oxidized with the increase of time, and the concentration of reactant was sufficient to maintain the requirement of reaction rate. However, when the reaction time was longer than 4h, the reaction gradually became complete, and the removal rate of organic compounds no longer increased with the extension of time. This indicates that when fenton oxidation time was 4h, the removal rate of COD_{Cr} in waste water was the highest, and the oxidation treatment had the best effect.
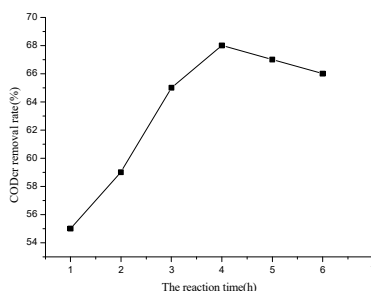
Fig. 2 Effect of reaction time on COD_{Cr} removal rate

3.2.3 Influence of stirring mode on oxidation effect

As described in section 2.2.3, the influence of stirring mode on fenton oxidation treatment effect is shown in fig.2.Influence of stirring method on COD_{Cr} removal rate.

As can be seen from Fig.2, COD_{Cr} of secondary sedimentation tank wastewater decreased under the same condition of aeration and blowing, and the removal rate of COD^{Cr} was 9.3%, while the removal rate of COD_{Cr} was more than 55% in both aeration stirring and mechanical stirring fenton oxidation treatment, and the removal efficiency of COD_{Cr} by aeration and stirring was 4.4% lower than that of mechanical stirring, so the volatilization of organic matter with low boiling point in wastewater could not play a leading role in aeration and agitation fenton oxidation treatment.

In addition, aeration stirring is a stirring method that forcibly dissolves the oxygen in the air into the water body and maintains the dissolved oxygen content in the water. It promotes the oxidation and decomposition of refractory organic matter to a certain extent and reduces the CODCr value of waste water. The mechanical stirring relies on the agitator to stir the waste water, which can better disperse the insoluble particles in the waste water and facilitate the flocculation and precipitation of organic matters. Therefore, the mechanical stirring method was adopted to treat the wastewater, and the removal rate of CODCr in the wastewater was the highest and the oxidation treatment effect was the best.

3.2.4 Influence of adsorption-coagulation on oxidation effect after fenton oxidation

As described in 2.2.4, COD_{Cr} of supernatant was determined under different adsorption-coagulation conditions, and the effect of secondary treatment on fenton oxidation treatment was shown in fig. 3.
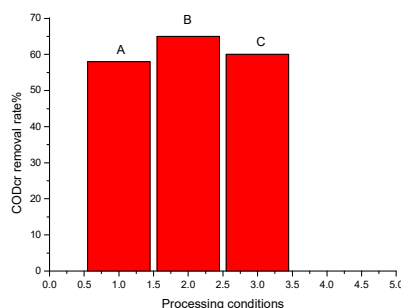
A:Fenton water

B: Fenton water-activated carbon adsorption-cogulation

C: Fenton water- cogulation

Fig. 3 Effects of different treatments on COD_{Cr} removal rate

Fig.3 shows that the removal rate of CODCr after fenton treatment of waste water is 59%, the removal rate increases by 4.1% after the secondary treatment of coagulation precipitation, and the removal rate of CODCr after the secondary treatment of adsorption-coagulation is up to 64.5%.

Fenton's reagent was oxidized, and fenton's reagent was oxidized, so fenton's reagent was oxidized. In the secondary treatment of coagulation and precipitation, the suspended matter in the water was effectively removed under the flocculation and precipitation of PAC and PAM, so the removal rate of COD_{Cr} was also improved. In the secondary treatment of adsorption-coagulation, due to the strong adsorption of activated carbon itself, the refractory organic matter contained in the wastewater was completely precipitated, the water quality was rapidly improved, and the removal rate of COD_{Cr} was further improved. Therefore, fenton effluent-activated carbon adsorption 1h-coagulation method was used for the secondary treatment of wastewater. The removal rate of COD_{Cr} in wastewater was the highest, and fenton oxidation treatment had the best effect.

3.2.5 influence of optimal conditions on oxidation effect

As described in 2.2.5, COD_{Cr} of water samples was determined under the best conditions, and the treatment effect was shown in Table 2.

Table 2 Treatment effects under optimal conditions

conditions	COD_{Cr} mg/L	COD_{Cr} average mg/L	COD_{Cr} Removal rate%
Best condition	50.5	48.5	73.4

Based on the above data, when the wastewater was treated under the optimal condition of fenton oxidation experiment, the total removal rate of COD_{Cr} was up to 73.4%, and the COD_{Cr} value of wastewater was reduced from 183 to 48.5, meeting the pollutant discharge standard and meeting the discharge standard, providing data support for better treatment of industrial wastewater.

4 Conclusion

Comprehensive research project the data above, we can know the sewage factory the second pond effluent water quality can be "fenton oxidation - and - coagulation sedimentation" oxidation method, through the "fenton oxidation - and - coagulation sedimentation treatment, when fixed hydrogen peroxide dosing quantity is 1.2 mL/L, $FeSO_4 \cdot 7H_2O$ dosing quantity is 0.5 ‰, fenton reaction time is 4 h, and adopts the mechanical mixing method, active carbon adsorption of 1 h - coagulation secondary treatment of removing effect is best, when the removal rate of COD_{Cr} reached 73.4%. Among them, the contribution rate of the wastewater itself to COD_{Cr} removal was 9.3%, and the mechanical stirring method was better than the aeration stirring method.

Meanwhile, from the perspective of economic benefits, the treatment costs are shown in Table 3. It can be seen that this method can improve the removal rate of COD_{Cr} and promote the discharge of waste water up to the standard. Fenton oxidation - neutralization - coagulation precipitation method can achieve better treatment effect, meet the economic benefits of sewage treatment plants, and provide data support for better treatment of industrial waste water.

Table 3 fenton oxidation treatment costs

Drug kinds	Unit price yuan /t	The dosage g/L	Processing cost yuan /t
Ferrous sulfate	400	0.5	0.2
30% hydrogen peroxide solution	1200	1.33	1.596
PAC	2000	0.2	0.4
PAM	9000	0.005	0.045
98% of sulfuric acid	500	1	0.5
lime	500	0.5	0.25
Sludge (dry)	3000	0.1	0.3
Total			3.291

Acknowledgement

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