Advanced treatment of traditional Chinese medicine wastewater by coagulating sedimentation after oxidation with Sodium Hypochlorite

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Abstract. The study conducted a pilot-scale research on the effects of Coagulating Sedimentation after Oxidation with Sodium Hypochlorite applied to advanced treatment of Traditional Chinese Medicine Wastewater. Under optimum conditions (i.e. a NaCLO dosage (400 mg•L^{-1}), a Polyaluminium Chloride dosage (40 mg•L^{-1}) and a Cationic Polyacrylamide dosage (2 mg•L^{-1}), the CODcr and the color in the effluent were always under 45mg•L^{-1}and 25 times respectively. The results confirmed that it was efficient for the advanced treatment of Traditional Chinese Medicine Wastewater by implementing coagulating sedimentation after oxidation with Sodium Hypochlorite.

Introduction

In Traditional Chinese Medicine Wastewater (TCMW), lignin, cellulose, hemicellulose, etc. are hard to biodegrade, which was similar to the pulping &papermaking wastewater [1, 2]. The removal of these pollutants has not been fully considered in the existing wastewater treatment system of the sampled factory. In the advanced treatment of the pulping &papermaking wastewater, these pollutants were degraded by using NaCLO, and the tiny suspending solids in wastewater were removed by adding Polyaluminium Chloride (PAC) and Cationic Polyacrylamide (CPAM). These methods were successfully applied to some pulping &papermaking factories and very good results have been achieved [1, 2]. After surveying the existing wastewater treatment system of the sampled factory, several experienced engineers hold that coagulating sedimentation after oxidation with Sodium Hypochlorite (CSOSH) was a suitable technology that can be used to the advanced treatment of TCMW.

The objectives of this paper included: (1) to determine the optimal dosage of medicaments; (2) to test the effect of CSOSH when it was used in the optimal dosage to advanced treatment of TCMW. And by continuously monitoring the CODcr and the color in influent and effluent, the performance of CSOSH was tested.

Materials and methods

Experimental methods

The whole experiment was divided into two steps. The first step was a beaker-test, aiming at determining the optimal dosage of medicaments including NaCLO、PAC and CPAM. The second step was a pilot-scale experiment, aiming at testing the treatment effect of CSOSH when it was used in the optimal dosage to advanced treatment of TCMW and evaluating its economy in the advanced treatment of TCMW.

Experimental influent

The experimental influent quality was listed in table 1.

Table 1 The experimental influent quality

indicators	pH	CODcr(mg•L^{-1})	SS(mg•L^{-1})	Color(times)	BOD_5(mg•L^{-1})
range	7-9	260-300	87-103	125-140	31-37

Experimental setup

The pilot-scale experiment setup (Fig.1) was built on the research spot.

Fig.1 The pilot-scale experiment setup

The setup was made from organic glass, and other related data were: the influent capacity in designing was about 1.6m^3•d^{-1}. The effective volume, the air mixing intensity and the hydraulic retention time (HRT) in NaCLO oxidation pool were 31.5L, 1.2Nm^3•m^{2}h^{-1} and 30 minutes respectively. The effective volume, the stirring rate and the hydraulic retention time in PAC coagulation pool were 2.1L, 140r•min^{-1} and 2 minutes respectively. The effective volume, the stirring rate and the hydraulic retention time in CPAM flocculation pool were 7.6L, 80r•min^{-1} and 7 minutes respectively.

Experimental Medicaments

The main experiment medicaments were sodium hypochlorite, PAC and CPAM. The mass concentration of Sodium hypochlorite was 10% with industrial grade; Both PAC and CPAM were provided by the sampled factory with industrial grade. In order to facilitate dosing, PAC and CPAM were diluted into liquor with mass concentrations of 10% and 0.5% respectively.

Results and discussions

The effect of the NaCLO dosage on the advanced treatment

The results were depicted in Fig.2 (a) and Fig.2 (b). It showed that when NaCLO dosage ranged from 200 mg•L^{-1} to 400 mg•L^{-1}, the COD in supernatant decreased with the increasing of the dosage of NaCLO; the decline slowed down when NaCLO dosage was greater than 400 mg•L^{-1}. This may be explained that tinier solid were produced with the increasing of the NaCLO dosage. Moreover these tiny solid were subject to oxidized by potassium dichromate, which in turn caused more consumption of potassium dichromate. It was also found in previous studies that the COD decline was not obvious at the moment when the NaCLO dosage was greater than some value [3-5].

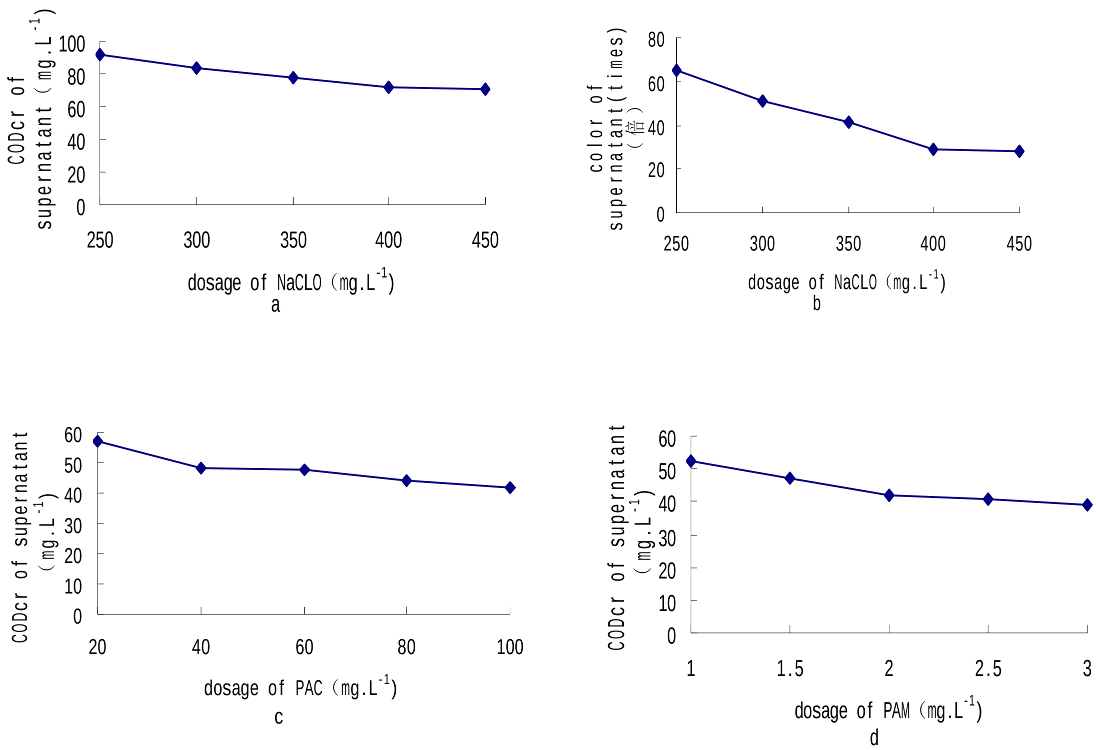

Fig.2 The COD and color in supernatant at different factors value

Based on treatment effect and economic cost, the optimal dosage of NaCLO was set at 400 mg•L^{-1} in the following beaker-test.

The effect of the PAC dosage on the advanced treatment

The results were depicted in Fig.2 (c). It showed that the CODcr in supernatant was decreased with the increasing of the PAC dosage, and the decline slowed down when PAC dosage was greater than 40 mg•L^{-1}. When the PAC dosage was 40 mg•L^{-1}, the COD and the color in supernatant were 49.3 mg•L^{-1} and 26 times respectively. This may be explained that the tiny solid which once lost stabilization now stabilized again and suspended in wastewater. Moreover these tiny solid were subject to oxidized by potassium dichromate, which in turn caused more consumption of potassium dichromate. It has already been reported in previous researches that the COD decline was not obvious when the PAC dosage was greater than some value [6-7].

Based on treatment effect and economic cost, the optimal PAC dosage was set at 40 mg•L^{-1} in the following beaker-test.

The effect of the CPAM dosage on the advanced treatment

The results were depicted in Fig.2 (d). It showed that the COD in supernatant decreased with the increasing of the dosage of CPAM, and the decline slowed down when the dosage of CPAM was above 2.0 mg•L^{-1}. When the CPAM dosage was 2.0mg•L^{-1}, the COD and the color in supernatant were respectively 43.8 mg•L^{-1} and 23 times.

Based on the above test and certain safety margins, the optimal dosage of CPAM was set at 2.0 mg•L^{-1} in the following pilot-scale experiment.

Treatment effect of CSOSH in the optimal dosage

From the research above, it can be concluded that the optimal dosages were: the NaCLO dosage was 400 mg•L^{-1}, the PAC dosage was 40 mg•L^{-1}, and the CPAM dosage was 2.0 mg•L^{-1}. After adjusting the operation to the optimal dosages, the CODcr and the color both in influent and effluent were monitored continuously. The results were depicted in Fig.3.

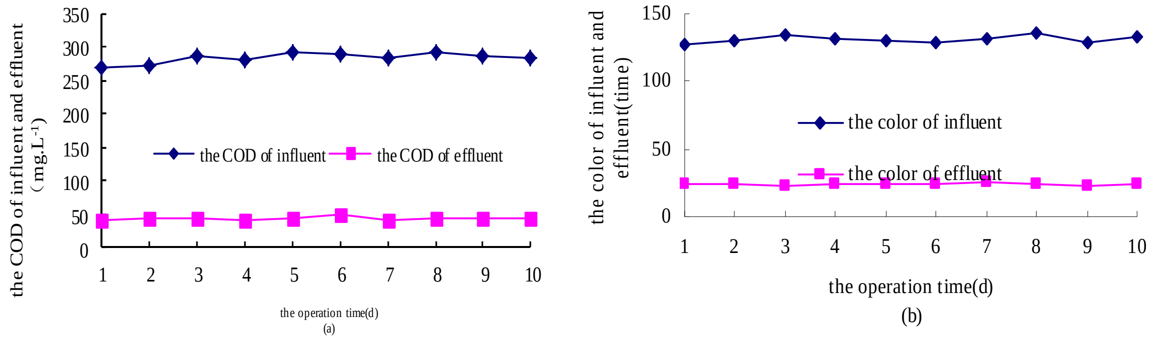

Figure.3 Treatment effect in the optimal conditions

Fig.3 indicated that the system operated stably: the removal efficiency of CODcr ranged from 85.9% to 86.7%; the color removal efficiency ranged from 82.4% to 83.1%; the CODcr in effluent was always under 45 mg•L^{-1}; and the color in effluent were always under 25 times. This has been found in other studies and engineering practice that for physical-chemical technology of wastewater treatment and oxidation technology of wastewater treatment, when the influent quality varied little, the effluent quality keep stable and was influenced little by the operation time [8].

Conclusions

The main findings from this study were：

- This study confirmed that it was very efficient for the advanced treatment of TCMW by implementing coagulating-sedimentation after oxidation with Sodium Hypochlorite.
- The optimal dosages were: the NaCLO dosage was 400 mg•L^{-1}, the PAC dosage was 40 mg•L^{-1}, the CPAM dosage was 2.0 mg•L^{-1}.

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