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Study on the Effect of the Fe^{2+}/NaClO Oxidation of CN^-

H.W. Zhou

School of Resources and Environmental Engineering, Wuhan University of Technology, Wuhan 430070, China

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Abstract: The effects of various parameters on the removal rate of CN^- were discussed in the paper. The results showed that under the conditions of 30 °C, pH = 3.0, Fe^{2+} dosage was 80 mg/L, the NaClO concentration of 0.10 mol/L, reaction time in 60 min, Fe^{2+} has a satisfactory catalytic activation, and the removal rate of CN^- was about 37.89%.

Key words: Fe^{2+}/NaClO, oxidation, CN^-.

1. Introduction

NaCN is an extremely poisonous salt. Large doses of NaCN of wastewater can lead to difficulty breathing, increased blood pressure and heart rate, and kidney failure.

Fe^{2+}/NaClO mechanism in wastewater treatment is as follow [1-3]:

The mechanism of this method is similar to the principle and Fenton law, mainly because of HClO is broken down into free radicals HO• under Fe^{2+} as catalyst. Compared with some other oxidants, HO• has a stronger oxidation capacity.

$$Fe^{2+} + HClO \rightarrow HO\bullet + Fe^{2+} + Cl^-$$

HClO in aqueous solution with superoxide radical ($O_2^-\bullet$) react to produce hydroxyl radicals (HO•).

$$O_2^-\bullet + HClO \rightarrow O_2 + HO\bullet + Cl^-$$

When the liquid in the presence of organic material, HO• radical can extract hydrogen from organic compounds, according to the following mechanism of the formation of organic free radical R•.

$$RH + HO\bullet \rightarrow R\bullet + H_2O$$

$$R\bullet + HClO \rightarrow HO\bullet + RCl$$

HO• produced simultaneously with the organic free radical induced chain reaction, eventually leading to the liquid phase oxidation of organic substrates [4, 5]. Studies on oxidation of CN^- will play an important role in environmental protection. Therefore, in the present investigation, the effects of various parameters on the removal rate of CN^- have been investigated.

2 Materials and Methods

2.1 Materials

The analytical grade reagents were purchased from Tianjin Chemical Co., Ltd.

2.2 The Source of Wastewater

Wastewater used in this experiment was laboratory simulation cyanogen containing wastewater, and the CN^- concentration was 0.091 mol/L.

2.3 Analytical Method

The CN^- concentration was measured according to $AgNO_3^-$ spectrophotometry.

2.4 Test Methods

100 mL laboratory simulation cyanogen-containing wastewater was added in a 250 mL conical flask, the initial pH value of solution was adjusted with 0.10 mol/L NaOH or HCl solutions. The effects of Fe^{2+} dosage, NaClO concentration, reaction time, and initial solution pH were investigated to optimize the oxidation conditions. The reagents were placed on a

Corresponding author: H.W. Zhou, Ph.D., main research field: marine environmental engineering. E-mail: zhwzhxy@163.com.

shaking table in a temperature-controlled cabinet at 30 °C, 130 rpm for duration of the test. After shaking the flasks for predetermined time intervals, the experimental mixtures were separated by filtration with stainless steel strainer, and then centrifuged at 3500 rpm for 15 min. The supernatants were analyzed using $AgNO_3^-$ spectrophotometry.

3. Results and Discussion

3.1 Influence of Fe^{2+} Dosage

Influence of Fe^{2+} dosage on the removal of CN^- was investigated. The solution pH is 2.5, the concentration of NaClO is 0.10 mol/L, the temperature is 30 °C, reaction time is 120 min, and stirring speed is about 130 r/min, the Fe^{2+} concentration from 50 to 250 mg/L, the effect of Fe^{2+} dosage on the removal of CN^- is shown in Fig. 1.

It can be seen in Fig. 1 that the CN^- removal rate increases with the Fe^{2+} dosage increases, when the amount of Fe^{2+} more than 80 mg/L, the removal rate of CN^- increases slowly. When Fe^{2+} dosage increases form 80 mg/L to 200 mg/L, the removal rate of CN^- increases form 34.83% to 39.43%, increased only by 4.56%. Therefore, the most appropriate dosage of Fe^{2+} is 80 mg/L.

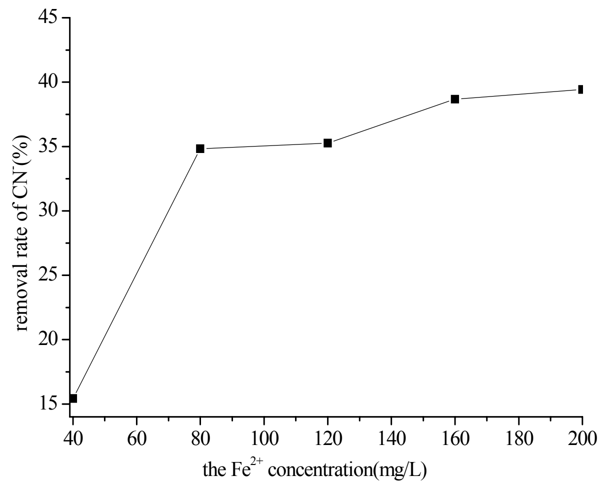

Fig. 1 Effect of Fe^{2+} dosage on the removal of CN^-.

3.2 Influence of NaClO Concentration

The solution pH is 2.5, the dosage of the Fe^{2+} is 80 mg/L, temperature is 30 °C, reaction time is 120 min and stirring speed is about 130 r/min, the NaClO concentration from 0.05 to 0.40 mol/L, the effect of NaClO concentration on the removal of CN^- is shown in Fig. 2.

Fig. 2 shows that the percent removal efficiency of CN^- increases from 34.83% to 40.70% when the NaClO concentration increases from 0.10 to 0.40 mg/L. So, the NaClO concentration of 0.10 mol/L was chosen for the following experiments.

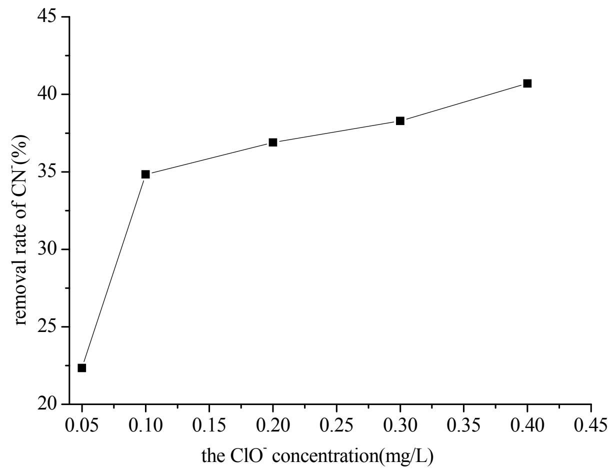

Fig. 2 Effect of NaClO concentration on the removal of CN^-.

3.3 Influence of Reaction Time

The solution pH is 2.5, the dosage of the Fe^{2+} is 80 mg/L, temperature is 30 °C, stirring speed is about 130 r/min, the NaClO concentration is 0.10 mol/L, the reaction time is from 30 to 180 min, the effect of reaction time on the removal of CN^- is shown in Fig. 3.

Fig. 3 shows that when the reaction time increases, the removal rate of CN^- increases. When the reaction time more than 60 min, the increase of removal rate of CN^- is not marketable and gently in later period. When the reaction time was 60 min, the removal rate of CN^- was 32.27%, when increasing the reaction time to 180 min, the removal rate increased only 3.93%. Therefore, the optimum reaction time was 60 min.

3.4 Influence of Solution pH

The experiments were only conducted from pH 1.0

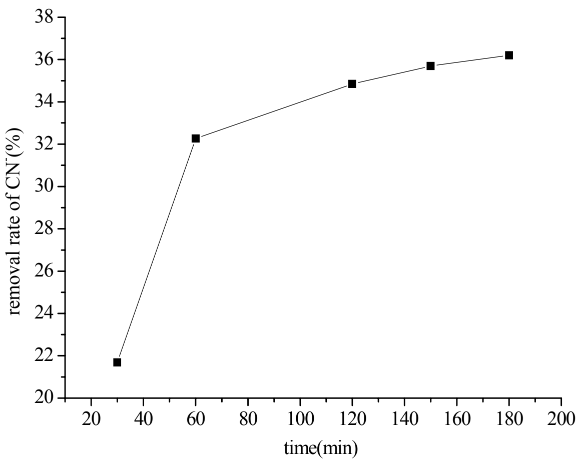

Fig. 3 Effect of reaction time on the removal of CN^-.

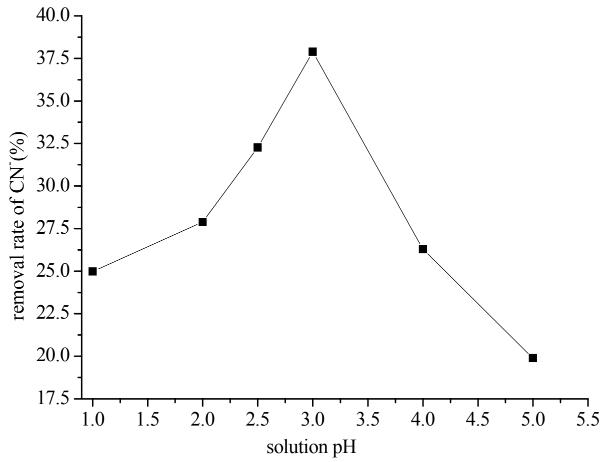

Fig. 4 Effect of solution pH on the removal of CN^-.

to 4.0, the dosage of the Fe^{2+} is 80 mg/L, temperature is 30 °C, stirring speed is about 130 r/min, the NaClO concentration is 0.10 mol/L, the reaction time is from 30 to 180 min. The effect of solution pH on the removal of CN^- is shown in Fig. 4.

Fig. 4 shows that CN^- removal rate with the pH value of solution first increases and then decreases. When the solution pH value of 3.0, the removal rate of CN^- can be reached the maximum and the maximum removal rate was 37.89%.

4. Conclusions

The effects of various parameters on the removal rate of CN^- were discussed in the paper. The main conclusions are as follows: When the temperature was 30 °C, pH = 3.0, reaction time in 60 min, the Fe^{2+} and NaClO concentration of 80 mg/L, 0.10 mol/L, respectively, the removal rate of CN^- can be reached the maximum and the maximum removal rate was 37.89%.

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