Study on Removal of Trace Phenol in Drinking Water by Fenton Reagent

Junsen Wu[1, a *], Hongtu Wang[1b], Ruibao Jia[2 c], Xiangfeng Jia[1d] and Chenchen Liu[1e]

1 Municipal and environmental engineering institute, Shandong Jianzhu University, China

2 Jinan water supply and drainage monitoring center,China

[a]Junsenwu@163.com,[b]1440443406@qq.com,[c]18764466725@163.com,

[d]jiaxf@sdjzu.edu.cn,[e]chenchening@163.com.

Keywords: drinking water; trace phenol; Fenton reagent

Abstract: The existing conventional water treatment process of the water resources is difficult to meet the drinking water quality requirements. In order to make the treated water to reach the drinking water quality standards, the Fenton Oxidation has been used to remove the trace phenol of the drinking water source in this paper. The result shows that.the best removal effect is needed to find the optimum dosage ratio of catalyst $FeSO_4$ and oxidant H_2O_2.For the water samples (1000mL0.1mg/L phenol) used here,H_2O_2 dosing quantity is 0.02 mL, when $FeSO_4$ dosing quantity is 5 mg, and the highest degradation rate is 93%. If the initial concentration of phenol is different in water samples, the dosage of Fenton reagent is also changed. The amount of Fenton's reagent should be adjusted according to the specific circumstances of the actual work.

Introduction

In recent years, with the development of our country's economy, the speeding up of urbanization, most of the city drinking water sources in China have been varying degrees of pollution. Since 21st century our country environment chemical pollution, frequent accidents, serious damage to the water environment, polluted water sources, especially micro pollutants in water pollution of drinking water sources. Micro pollutants from water due to its low content, difficult to detect, characteristics such as high toxicity, the security problem of micro pollutants are more drinking water[1].

In drinking water, pollution mainly exists in the form of micropollutants, micro pollutants mainly have the widespread and trace high toxic and difficult to detect, conventional water treatment technology is difficult to deal with several characteristics, such as and the micro pollutants concentration is low, not easy to detect the above characteristics, such as the water cannot reach drinking water standard. So how to detect and remove the micro pollutants in the drinking water is now pressing problems[2][3].

Volatile phenolic compounds phenol represents a class of common contaminants of drinking. In this experiment, phenol, for example, by a low concentration of phenol solution, adding the right amount of ferrous sulfate and hydrogen peroxide, the experiment from $FeSO_4$ dosage, dosage of H_2O_2 and the reaction time to study three aspects Fenton Low concentration of phenol removal capacity. So as to study how to improve the removal of contaminated drinking water problem of phenol.

Experimental materials and methods

Reagents and instruments. Phenol, H_2O_2(30%), $FeSO_4 \cdot 7H_2O$, $K_3[Fe(CN)_6]$, 4-Aminoantipyrine, NH_4Cl, $NH_3 \cdot H_20$ and $CHCl_3$ are analytically pure; UV-3 series ultraviolet visible light spectrophotometer (Shanghai United States of Instrument Co., Ltd.), 500ml Separatory funnel.

Experimental method. The $FeSO_4$ and H_2O_2 were added to the phenol containing liquid to be treated (1000ml of phenol containing wastewater), Fenton reagent in 1000 ml of water containing phenol oxidizing reaction and use 4-Aminoantipyrine extraction spectrophotometry measuring absorbance[5]， according to the standard equation to obtain the concentration and degradation rate.

Results and discussion

Standard curve. According to 4-Aminoantipyrine extraction spectrophotometry, we can draw the standard curve of phenol chloroform concentration and absorbance relationship.As shown in Figure1. Regression equation:y=5.8116x+0.0461,Correlation coefficient:R^2=0.9900

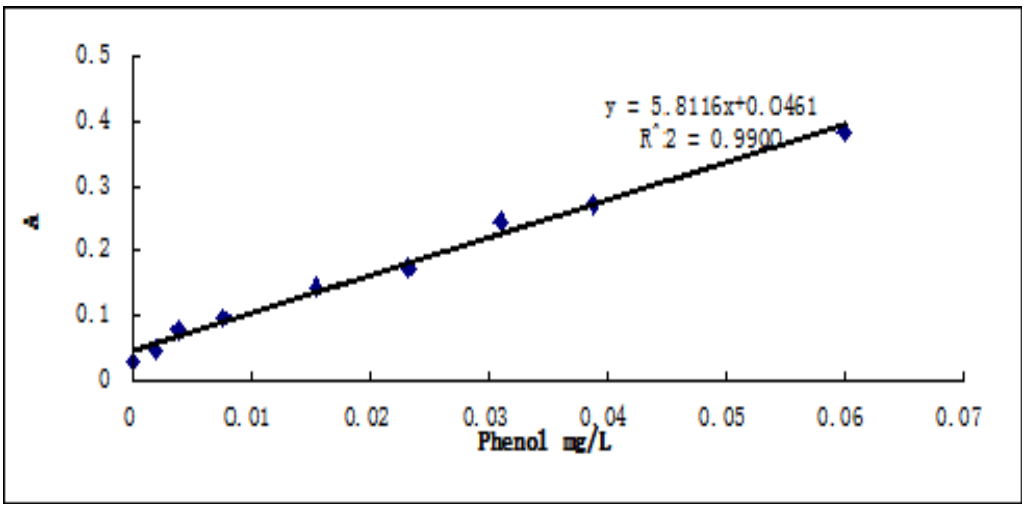

Figure 1. The influence of Phenol concentration on Absorbance

Treatment effect of different amounts of $FeSO_4$ on low concentration phenol. Adding 0.1mL of 30% hydrogen peroxide to 1000mL 0.1mg/L containing phenol,the amount of ferrous sulfate was 2mg, 3mg, 4mg, 5mg, 6mg, 7Mg, 8mg, 9mg, 10mg.At room temperature, the effects of different amounts of ferrous sulfate on the treatment of phenol are shown in Figure 2.

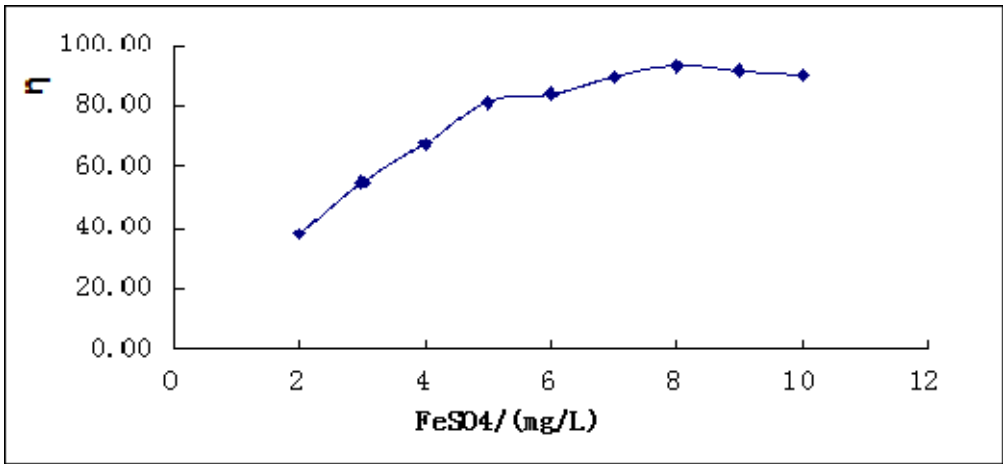

Figure 2. Effect of different concentrations of ferrous sulfate on the degradation of phenol solution

From Figure 2, the degradation rate of phenol was higher than 93% when the quality of ferrous sulfate was 8mg. Thus the best dosage of ferrous sulfate was 8mg.

Reaction mechanism of Fenton reagent[4]

$$Fe^{2+}+H_2O_2 \rightarrow Fe^{3+}+OH^-+\cdot OH$$

The reaction rate of Fenton was mainly determined by the concentration of H_2O_2 and Fe^{2+}.When the concentration of Fe^{2+} is too low, it is not conducive to the production of the initial ·OH, which makes the reaction rate decrease. When the catalyst Fe^{2+} concentration is too high, the initial reaction with the H_2O_2 rapid reaction to produce a large number of ·OH, part of the ·OH and organic compounds in the future will have a side reaction, which leads to a decrease in H_2O_2 utilization, degradation rate. Therefore, the choice of the appropriate amount of $FeSO_4$ has a crucial effect on the reaction rate.

Treatment effect of different amounts of H_20_2 on different concentration phenol. Adding 5mg of ferrous sulfate to 1000mL 0.1mg/L containing phenol and 1000mL 0.1mg/L containing phenol,the amount of hydrogen peroxide was 0.02mL, 0.03mL, 0,05mL, 0.1mL, 0.15mL, 0.2mL,, 60min, and, respectively. The effect of different amount of hydrogen peroxide on the treatment of phenol with different concentrations was shown in Figure 3.

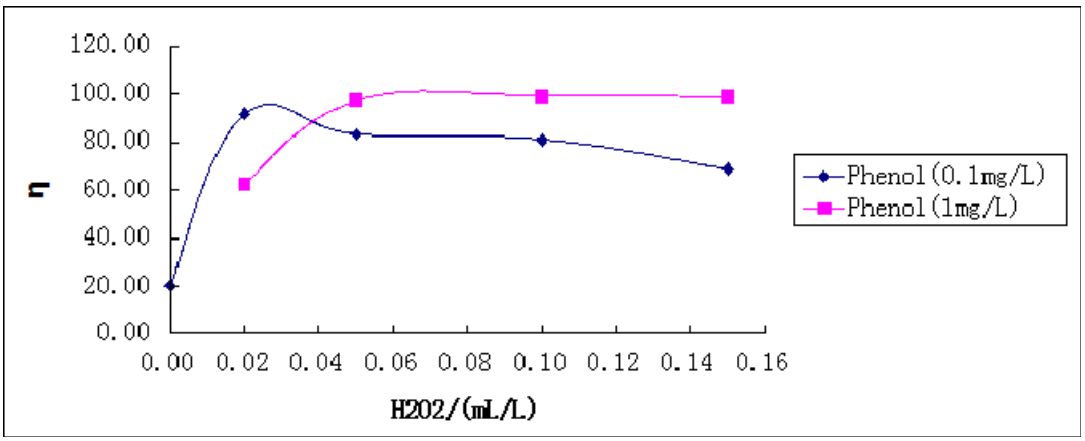

Figure 3.Effect of different concentrations of hydrogen peroxide on the degradation of phenol solution

By Figure 3, For 0.1mg/L containing phenol water samples,when the $FeSO_4$ dosage is 5mg, the dosage of H_2O_2 is 0.02mL, the degradation rate is the highest, which can reach more than 93%. When $FeSO_4$ dosage is H202, the 5mg dosage is too high or too low to be beneficial to the degradation of phenol. The increase of H_2O_2 dosage is not to increase the degradation rate, which indicates that when H_2O_2 concentration is too high, too many H_2O_2 will continue to react with OH, increase the chance of occurrence of adverse reactions. Therefore, in the Fenton reaction, the optimal dosage of H_2O_2 is also very important to improve the efficiency of the reaction.When $FeSO_4$ dosage is 8mg, the dosage of H_2O_2 is 0.03mL, the degradation rate can reach 93%, but according to the principle of low carbon, choose $FeSO_4$ 5mg.

For 1mg/L containing phenol water samples, the degradation rate of phenol could reach more than 99% when the dosage of H_2O_2 was 0.1mL, the reaction time was 3 minutes, the reaction time was 60 minutes, and the reaction conditions were constant. When the dosage of H_2O_2 was 0.1mL, the degradation rate of phenol was lower than 80%. Thus, for the different concentrations of water containing phenol, the choice of Fenton reagent dosage is also different.

Effect of reaction time on the degradation rate of phenol in low concentration. Adding 0.02mL of 30% hydrogen peroxide to 1000mL 0.1mg/L containing phenol,the amount of ferrous sulfate was 5mg, 6mg, 8mg. At room temperature, 30min, 60min and 90min of different treatment time are shown in Figure 4.

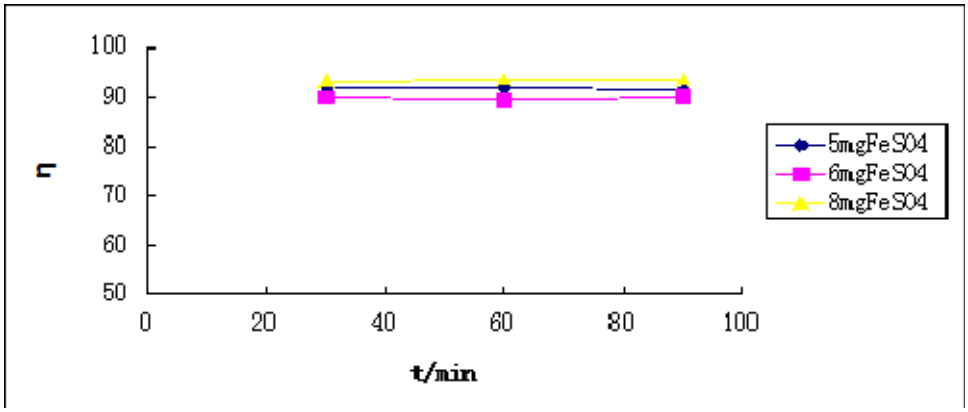

Figure 4.Effect of different time on the degradation of phenol solution

By Figure 4, under the condition of room temperature, when the reaction time from 30min to 90min, the degradation rate was not significantly increased with time, but it is more gentle. So, when the reaction was in 30min, Fenton's reagent had completely changed. So for the removal of phenol in drinking water, the treatment time was 30min.

Conclusions

After the studied of degradation rate of phenol in micro polluted water, We can draw treating degradation of 0.1mg/L pheno,that the optimum reaction conditions were 30min, $FeSO_4$ dosage was 5mg, H_2O_2 dosage was 0.02mL, the degradation rate could reach 93% or more.And for different concentrations of benzene in water samples, the required amount Fenton also changed, the need to adjust the amount of the actual work Fenton added depending on the circumstances.

Acknowledgements

Fund: State water pollution control and treatment technology major projects (2012ZX07404-003)

References

[1]Yue Wang. Study on the technology of water supply emergency treatment of sudden water pollution[D] .In Chinese,2015.

[2]Chun Xie. Study on treatment of phenol and COD in micro polluted water by high potassium iron[D] .In Chinese,2010.

[3]Shouxuan Wu,Mingyu Li.Removal of Trace Phenol in drinking water by high potassium iron oxide[J].Ecological Science,In Chinese,2013,22(2):127-129.

[4]Hong Li.Study on oxidation degradation of polycyclic aromatic hydrocarbons by Fenton advanced oxidation technology[D].In Chinese,2007.

[5]State Environmental Protection Administration. Water and wastewater monitoring analysis method[M],In Chinese,Beijing,China Environmental Science Press,2002,462-463.