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Research Article

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CTMAB/CPAM/bentonite composite preparation and adsorption properties

Shao Hong*, Li Yunjiao, Liu Xianglong and Zhang Zhifang

Institute of Environment and Safety Engineering, Shenyang University of Chemical Technology, Liaoning Shenyang, China

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ABSTRACT

The preparation of composite bentonite that natural sodium bentonite as raw material and CTMAB/CPAM as modifier.The best preparation conditions: CTMAB dosage 5mmol, CPAM dosage 0.03g, original soil dosage 4g, stirring speed 300r / min, the modified time is longer than 2h. It is showed that CTMAB and CPAM had entered the interlayer by SEM and XRD characterization of the composite modified bentonite. Decolorization rate above 95% when dealing with acid red, direct fast black and basic fuchsin three kinds of dyes by composite bentonite. Kinetic results show that quasi-two kinetic model can describe composite bentonite material ofye wastewater adsorption process.

Keywords: CTMAB, CPAM, Bentonite, Complex, Dye wastewater

INTRODUCTION

With the rapid development of printing and dyeing industry, printing and dyeing wastewater have caused the serious problems of environmental pollution.[1] The printing and dyeing wastewater is difficulty to treat, because of its characteristics, such as large water volume, high concentration organic pollutant, deep chromaticity, and difficulty to be degraded.[2-3] In China, bentonite is abundant and cheap. Modified bentonite can dramatically increase the adsorption effect.[4] Modified agents such as pyridine, chitosan, 8-Hydroxyquinoline and ammonium molybdate are widely investigated in recent years.[5-8] Modified bentonite is widely used to treat wastewater. Up to now, the study on preparation and application of bentonite composite material is less at home and abroad. The preparation of composite bentonite that natural sodium bentonite as raw material and CTMAB/CPAM as modifier and the optimal conditions and properties for modified bentonite to treat dye wastewater were investigated.

EXPERIMENTAL SECTION

2.1. Materials and chemicals

Raw material: The sodium bentonite in experiments was prepared from HeiShan, Liaoning Province, China. The basic properties were shown in Table1.

Table 1 Properties of the natural bentonite

Index	pH	colloid valence (mL/15g)	cation exchange capacity (mmol/100g)	Expansion multiple (mL/g)	absorbing blue (g/g)
Value	8-9	100	62	15	23-25

CTMAB were purchased from Jintan Xinan Chenmical Institute (China).CPAM were purchased from Henan Boyuan Company (China).

2.2. Preparation of CTMAB / CPAM / bentonite composite

To prepare CTMAB / CPAM / bentonite composite, a certain amount of CTMAB and CPAM was placed into 100 mL distilled water in a 250 mL reaction flask. The mixture was heated at 40◦C and stirred for dissolving. After dissolution, a certain amount of Na- bentonite was added into the mixture. The solution was stired, filtered and washed. After that, the product was dried at 105◦C. CTMAB / CPAM / bentonite composite was sieved and 200 mesh size of particles was used for adsorption experiments.

2.3 Adsorption experiments of Dye wastewater

A certain amount of CTMAB / CPAM / bentonite composite was placed into 100 mL simulated dye wastewater in a 250 mL reaction flask.After stirred and settled, measure the absorbance of the upper clear liquid and calculate the decolorization rate(η).

$$\eta = \frac{Ao - Ae}{Ao} \times 100\% \tag{1}$$

η- the decolorization rate，Ao- the absorbance of simulated dye wastewater，Ae- the absorbance of the upper clear liquid.

RESULTS AND DISCUSSION

3.1. Optimal conditions of CTMAB / CPAM / bentonite composite preparation

3.1.1 Influence of CTMAB dosage on decolorization rate

Under the conditions of CPAM dosage 0.03g, Na- bentonite dosage 6g, stirring speed 250r / min and the contact time 3h, the influence of different CTMAB dosage on adsorption effect was shown in Fig.1.

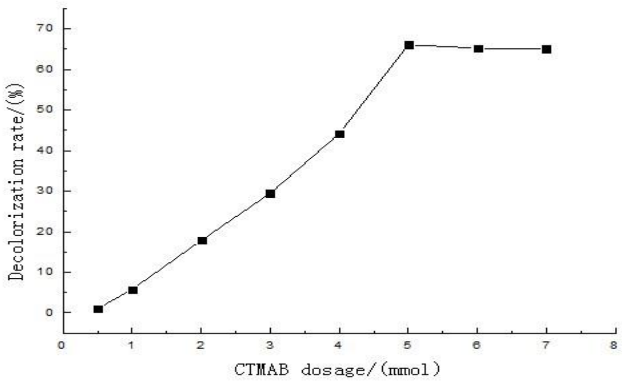

Fig.1 Influence of CTMAB dosage on decolorization rate

The decolorization rate increased with an increase in the CTMAB dosage up to 5mmol. When the CTMAB dosage was more than 5mmol, the decolorization rate was tending towards stability.When the CTMAB dosage was 5mmol, the amount of modifier achieved maximum cation exchange capacity of Na- bentonite and the best effect of treatment reached 66.08%.[9]

3.1.2 Influence of CPAM dosage on decolorization rate

Under the conditions of 3.1.1 ,the conditions of CTMAB dosage changed 5mmol, the influence of different CPAM dosage on adsorption effect was shown in Fig.2

The decolorization rate increased with an increase in the CPAM dosage up to 0.03g. When the CPAM dosage was more than 0.03g, the decolorization rate decreased. Because of the high molecular weight and long carbon chains, the excess CPAM wrapped Na- Bentonite molecules and reduced the adsorption effect. When the CPAM dosage was 0.03g, the best effect of treatment reached 67.86%.

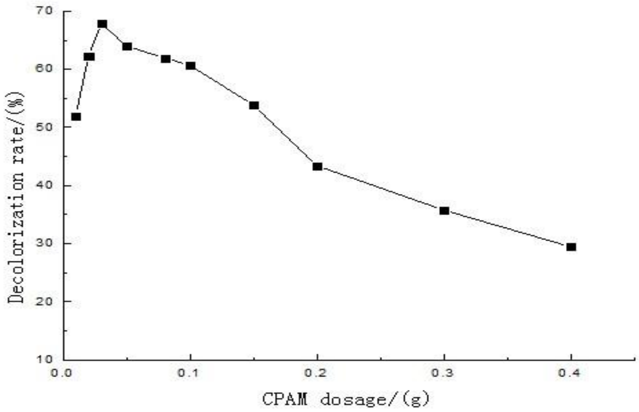

Fig.2 Influence of CPAM dosage on decolorization rate

3.1.3 Influence of Na-bentonite dosage on decolorization rate

Under the conditions of 3.1.2, CPAM dosage changed 0.03g, the influence of different Na-bentonite dosage on adsorption effect was shown in Fig.3

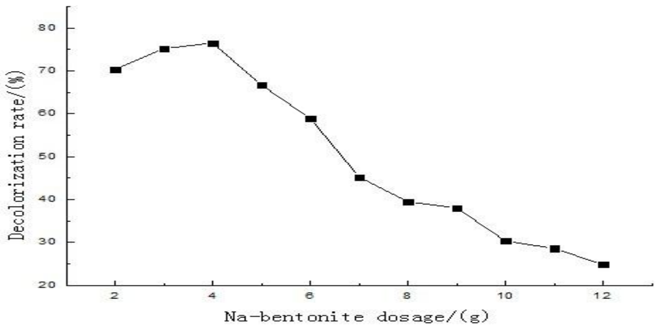

Fig.3 Influence of Na-bentonite dosage on decolorization rate

The decolorization rate increased with an increase in the Na-bentonite up to 4g. When the Na-bentonite dosage was more than 4g, the decolorization rate was decreased. With the increase of the amount of Na-bentonite, compound intercalation agent gradually got into the bentonite interlayer until achieved maximum cation exchange capacity of Na- bentonite.If Na-bentonite dosage was too much, the modified was incomplete. [10]

3.1.4 Influence of contact time on decolorization rate

Under the conditions of 3.1.3, Na- bentonite dosage changed 4g, the influence of different contact time on adsorption effect was shown in Fig.4

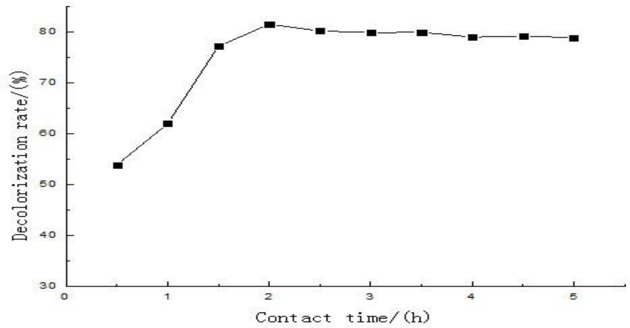

Fig.4 Influence of contact time on decolorization rate

The decolorization rate increased with an increase in the contact time up to 2h. When the contact time was more than 2h, the decolorization rate was tending towards stability .If modification time were short, the modified was incomplete. With increasing time, bentonite was modified completely and achieved dynamic balance, so the decolorization rate remained basically unchanged.

3.1.5 Influence of stirring speed on decolorization rate
Under the conditions of 3.1.4, contact time changed 2h, the influence of different stirring speed on adsorption effect was shown in Fig.5.

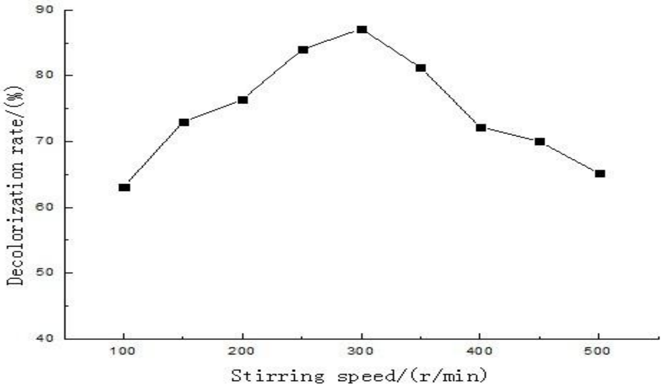

Fig.5 Influence of stirring speed on decolorization rate

The decolorization rate increased with an increase in the stirring speed up to 300r/min. When the stirring speed was more than 300r/min, the decolorization rate was decreased. The enough stirring rate was needed to make the complex bentonite intercalation agent to fully function in solution. Under stirring speed 300r / min, bentonite was modified completely and results of decolorization were good. Increase of stirring rate could make the modifier desorption and reduced the treatment effect.

3.2 Optimal conditions of the treatment of dye wasterwater
3.2.1 Influence of composite bentonite dosage on decolorization rate
Under the conditions of stirring speed 200r / min, stirring time 1h and dye wastewater concentration 1000mg/L, the influence of different composite bentonite dosage on decolorization rate of acid red, direct fast black and basic fuchsin was shown in Fig.6.

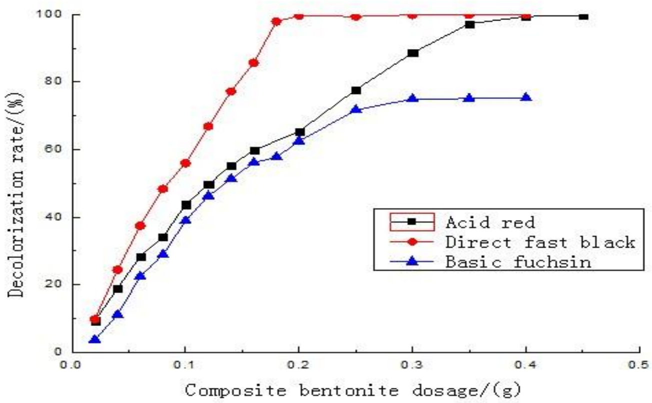

Fig.6 Influence of composite bentonite dosage on decolorization rate

According figure showed the optimum composite bentonite dosage of treatment of acid scarlet was 0.35g, the optimum composite bentonite dosage of treatment of direct fast black was 0.18g, the optimum composite bentonite dosage of treatment of basic fuchsin was 0.3g.

3.2.2 Influence of stirring speed on decolorization rate
Under the conditions of 3.2.1,composite bentonite dosage changed 0.35g,0.18g,0.3g, the influence of different stirring speed on decolorization rate of acid red, direct fast black and basic fuchsin was shown in Fig.7.

When the stirring speed is 200~250r/min, 3 kinds of dye wastewater decolorization rate were higher. This was because with the increase of stirring speed, the adsorption of dye particles was sufficient and appropriate stirring speed provided the adsorption process of composite bentonite necessary of mass transfer conditions. Unde the optimal rate of stirring, modified bentonite and dye molecules contacted fully and formed floc sedimentation. After precipitation, the dye molecules were removed. [11-12]

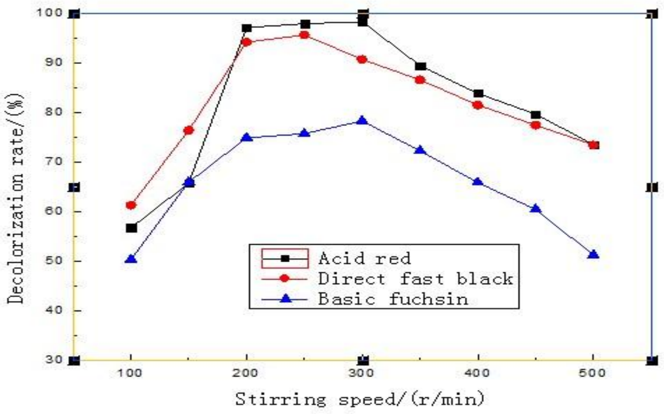

Fig.7 Influence of stirring speed on decolorization rate

3.2.3 Influence of stirring time on decolorization rate

Under the conditions of 3.2.2, stirring speed changed 250r/min, the influence of different stirring time on decolorization rate of acid red, direct fast black and basic fuchsin was shown in Fig.8.

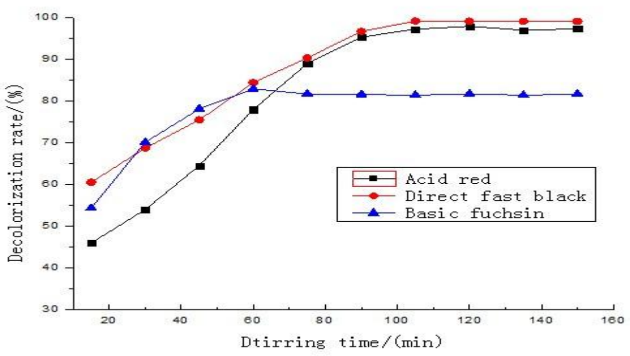

Fig.8 Influence of stirring time on decolorization rate

According figure showed the optimum stirring time of treatment of acid scarlet, direct fast black and basic fuchsin was 1.5h.

3.2.4 Influence of pH on decolorization rate

Under the conditions of 3.2.3, stirring time changed 1.5h, the influence of different pH on decolorization rate of acid red, direct fast black and basic fuchsin was shown in Fig.9.

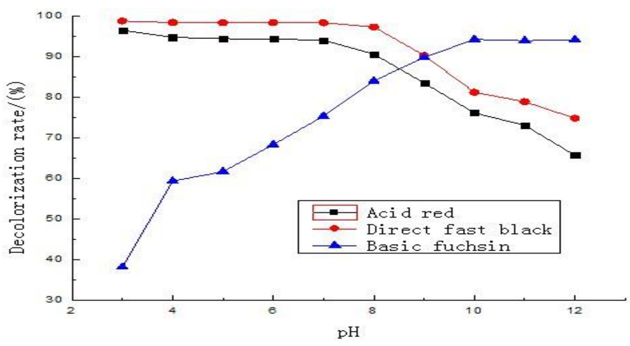

Fig.9 Influence of pH on decolorization rate

Under acidic condition, treatment effect of acid red and direct fast black was better. Under alkaline condition, treatment effect of basic fuchsin was better. Acid red and direct black dye was alkaline. When pH is relatively low, composite bentonite would take lots of positive charge and the electrostatic attraction was formed between acid scarlet and direct black. Therefore, the decolorization rate was higher.

3.2.5 Influence of dye wastewater concentration on decolorization rate

Under the conditions of 3.2.4, pH changed 7,7,9, the influence of different dye wastewater concentration on decolorization rate of acid red, direct fast black and basic fuchsin was shown in Fig.10.

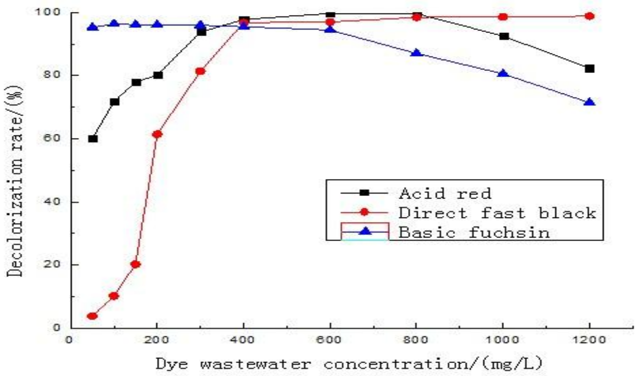

Fig.10 Influence of dye wastewater concentration on decolorization rate

The higher the concentration, the more dye particles in dye wastewater. Bentonite was not sufficient and could not adsorb dye molecules completely. Therefore, the decolorization rate decreased. When the original concentration was low, the molecular weight of the dye was relatively small and bentonite content was relatively abundant, the dye molecules were adsorbed completely. Therefore, the decolorization rate increased gradually. The optimum dye wastewater concentration of treatment of acid scarlet, direct fast black and basic fuchsin was 400~600mg/L.

CONCLUSION

The preparation of composite bentonite that natural sodium bentonite as raw material and CTMAB/CPAM as modifier.The best preparation conditions: CTMAB dosage 5mmol, CPAM dosage 0.03g, original soil dosage 4g, stirring speed 300r / min, the modified time is longer than 2h. The preparation process was simple and did not produce secondary pollution. The optimum composite bentonite dosage of treatment of acid scarlet was 0.35g, the optimum composite bentonite dosage of treatment of direct fast black was 0.18g, the optimum composite bentonite dosage of treatment of basic fuchsin was 0.3g. The optimum stirring speed was 200~250r/min. The optimum stirring was time 1.5h. The optimum pH of treatment of acid scarlet was 7, the optimum pH of treatment of direct fast black was 7 and the optimum pH of treatment of basic fuchsin was 9. The optimum dye wastewater concentration of treatment was 400~600mg/L. Decolorization rates were over 95%. The composite bentonite could be used to treat a variety of dye wastewater and these conclusions could provide some guidance to treatment of wasterwater.

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