Preparation of Fly ash Based Adsorbents for Removal Active Red X-3B from Dying Wastewater

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Abstract. Fly ash with a large number of active sites can occur with the adsorbent chemical and physical adsorption, and therefore have a strong adsorption capacity. The original fly ash and raw fly ash compared to the physical and chemical properties to a significant change. On the fly ash in industrial water treatment application were outlined. The purpose is to focus on the modification methods of fly ash and comparison of raw fly ash and fly ash in the effect of dyeing wastewater. Single factor test method; select the appropriate modifier to study the dosage, pH, stirring time on the modification of adsorption properties of fly ash before and after. The results showed that the modified fly ash was better than the adsorption. Greatly improves on active red X-3B dye wastewater removal capacity, pH=5, 6, dosage is 5g / L, the mixing time is 30min, COD removal rate reached 73.07%. This modified material can be used as adsorbent for pre-treating dying wastewater.

Keywords: fly ash; activate and modify; X-3B dying wastewater; COD; color.

1 Introduction

Fly ash is a maximum number of solid waste materials. It will generate dust and pollute the atmosphere if placed in the open field without any disposal. If discharged into rivers and lakes, the rivers will be blockaded, the water bodies will be polluted and the aquatic organism will be poisoned. The toxic chemicals is still possible to infiltrate into the soil and enter the environmental system even if use landfill, eventually causing harm to the whole ecological environment and human health. Fly ash is a loose porous solid composite because of the large specific surface area, generally reach 2500～5000cm^2/g[1-2].Therefore fly ash have a strong adsorption capacity because it have many active sites and can occur with the chemical adsorption and physical adsorption. There are certain flocculation and filtration[3-5].

Dyeing wastewater refers to the mixed wastewater[6],which discharged from the

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various processes in the dyeing process. The features of the dyeing wastewater is the complex components 、high organic content、deep color、high demand of chemical(COD)、relatively low demand of biochemical oxygen(BOD_5)、poor biodegradability and large emission[7-9]. According to 《Discharge standards of water pollutants for dyeing and finishing of textile industry》, in addition to the indicators of class Ⅲ sewage changed little, the government raised the emission standards and other indicators of class I and class Ⅱ effluent, including BOD、COD、color、suspended solids、ammonia、aniline、chlorine oxide and so on. But the quality of dyeing wastewater is COD: 800 ～ 2000mg / L, color: 200 to 800 times in average. Therefore the urgent problem of printing and dyeing industry is dyeing wastewater discharge .In this study, we study from specific Reactive Brilliant Red X-3B dying wastewater. We research on the resources and environmental properties of fly ash from the microscopic mechanism of morphology activity, etc. It provides a new way for the treatment and utilization of dyeing wastewater.

2 Experimental Materials and Methods

2.1 Experimental materials and main instruments

Fly ash used in this experiment is provided by a thermal power plant in Inner Mongolia. The processed is reactive brilliant red X-3B which belongs to the water-soluble dyes. The traits is maroon powder and the molecular weight is 614.49[10]. Experimental configured dyeing wastewater is 50mg / L of reactive brilliant red X-3Bsimulated wastewater as a liquid and set aside.

The main instruments used in the tests are: spherical condenser, electric warming plate or electric furnace, buret, six joint blender, analytical balance, oven, spectrophotometer and other major equipment.

2.2 Experimental methods

The experiment studied the factors to the wastewater treatment ,include the dosage、pH and stirring time. In the first place, drying the fly ash material ,and then screened with a 200 mesh screen standby，Configuring 50mg / L of reactive brilliant red X-3B dye wastewater stand by. The method of modifying fly ash is that take six 200mL beakers were compiled on the number; weigh 3g raw fly ash by electronic scales and place them in six beakers; in six beakers were respectively added 24mL concentration of 20% hydrochloric acid solution (the following are replaced with hydrochloric acid)、24mL concentration of 20% sulfuric acid solution (the following are replaced with sulfuric acid)、mixed with 16mL of hydrochloric acid and 8mL sulfuric acid、mixed with 12mL of hydrochloric acid and 12mL sulfuric acid、mixed with 6mL hydrochloric acid and 18mL sulfuric acid、mixed with 4mL hydrochloric acid and 20mL sulfuric acid, stand 18h after stir slightly; Dry the modified fly ash standby after filtrating. The best acid-modified type selection experiment is that take six 500mL beaker, compiled on the number; the above modified six kinds of fly ash each placed 2g into a beaker, add 200mL dye wastewater; stirring 30min and then standing 10min, filtering, measuring the absorbance.

3 Results and Discussion

3.1 The selection of acid species

Modifying the status quo ante of fly ash by different types and different proportions of

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hydrochloric acid and sulfuric acid, and then dispose the dyeing wastewater under the same conditions, the dosage of modified ash was 2.0g, the volume of wastewater was 200ml, the time of stirring was 30min, and the value of pH was 3.5. The measured results are shown in Table 1. The microstructure of this fly ash before and after modified was shown in Fig.1.

TABLE1 EFFECT OF DIFFERENT ACID MODIFY ON COLOR REMOVAL

number	1	2	3	4	5	6
acid species	HCl	H_2SO_4	V_{HCl}: V_{H2SO4}			
			2:1	1:1	1:3	1:5
absorbanceA	0.308	0.773	0.799	0.789	0.770	0.819
removal rate(%)	77.10	42.53	40.59	41.34	42.75	39.11

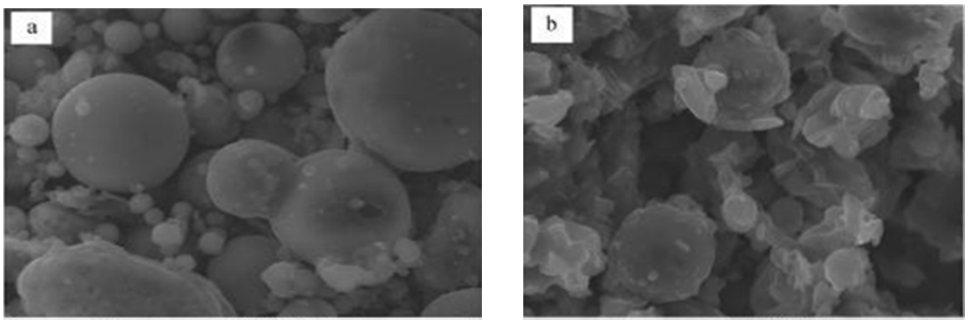

Fig.1 SEM of fly ash before and after modified
(a:before modified, x500; b:after modified, x500)

As can be seen from Table 1, the treatment efficiency of the modified fly ash to dyeing wastewater was much higher than before the modification because the composition of fly ash containing Al_2O_3、CaO、Fe_2O_3、FeO and other metal oxides. The results of acid leaching make these metal oxides react with acid and produce the absorbent and strong flocculate of inorganic salt, such as iron and aluminum sulfates, chlorides and other salts and so on. But different adsorbents have different adsorption decolonization on different dyeing wastewater. From the experimental results, fly ash modified with hydrochloric acid have better effect of removal to the reactive brilliant red X-3B dye wastewater than other acid modified, under the best conditions of other factors yet to determine, the removal has reached 77.10 percent. Therefore, use concentration of 20% HCl to modify the fly ash in the following experiments.

3.2 Ash dosage effect on the treatment effect

Taking 200 mL reactive brilliant red X-3B wastewater and the concentration is 50mg/ L. In this study, adding raw fly ash and modified fly ash to wastewater, the dosing rates were 2.5g / L, 5g / L, 7.5g / L, 10g / L, 12.5g / L. Stirring for 30min at 300rad / min speed, filtering them after resting 10min,the measured results shown in Figure 1. From Fig.2, the adsorption rate of modified fly ash absorb the reactive brilliant red X-3B dye is rises with the dosage increase before the dosage is 1g.But the adsorption rate began to decline after the dosage of adsorbent more than 1g.This may be due to an excessive amount of fly ash such that the alkaline solution increases with the amount of fly ash added, the increase of pH influences the adsorption. The most appropriate dosage of hydrochloric acid modified fly ash is 2.5g / L. It can be clearly seen from the graph that the adsorption properties of the fly ash greatly improve after modification. So the following experiments mainly

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implemented from the factors of modified fly ash.

3.3 Effect of pH on modified fly ash to the reactive brilliant red X-3B wastewater

Fixing other conditions, the dosage of modified fly ash adopts the best dosage obtained in the above experiment, measuring the optimum pH by changing the pH of the solution. Taking 200 mL active red X-3B wastewater and the concentration is 50mg/ L. The dosage of modified fly ash is 1g. Adjusting the pH of solution to 2 to 3、5 to 6、7、8 to 9、11 to 12 respectively by adding HCl solution and NaOH solution. Stirring 30min at 300r / min, then filtering after 10 min standing, the measured absorbance results are known in Fig.3. From Fig.3, the adsorption capacity increased with the value of pH rise when the pH is about 5.0 and the adsorption capacity decreased with the value of pH rise when the pH is greater than 5-6. This phenomenon is consistent with the previous results. Therefore, selecting the value of pH 5 ~ 6 as the optimum pH in the following tests.

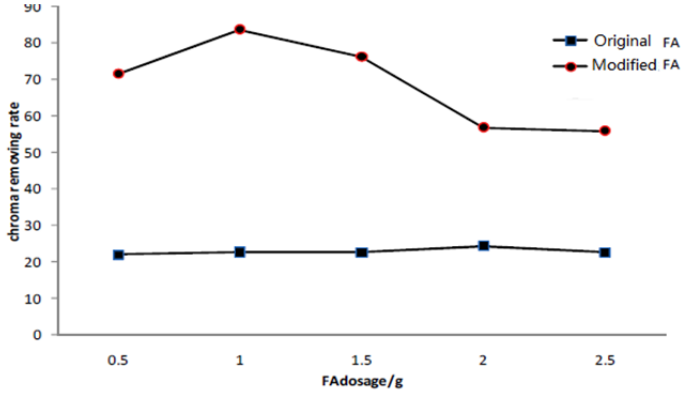

Fig.2 Effect of fly ash dosage on color removal

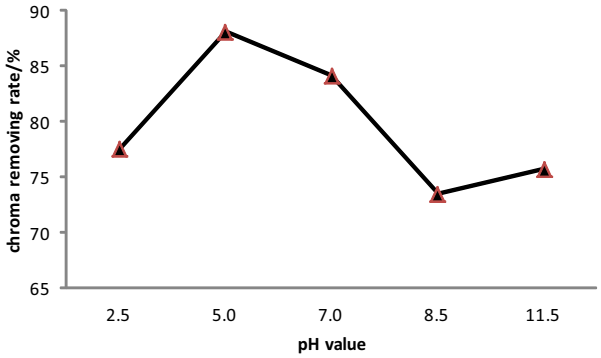

Fig.3 Effect of wastewater pH on color removal

3.4 Effect of stirring time on the modified fly ash to the active red X-3B wastewater

Fixing other conditions, the best dosage of fly ash was 1g and the value of pH was

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adjusted to 5 to 6.Messuring the effect of processing efficiency of fly ash by changing the mixing time. Taking 200 mL active red X-3B wastewater and the concentration is 50mg/ L. The dosage of modified fly ash is 1g. Adjust the solution pH from 5 to 6 by adding HCl.

Stirring them 10min、15min、30min、45min、60min respectively at 300 r / min and standing 10min before filtrating. The measured absorbance results are shown in Fig.4. As seen in Fig.4, removal is not high and there is an upward trend because fly ash has not reacted completely. The removal is reached the maximum at 30min and the reaction is substantially complete. Stirring them continuously，leaving part of the unstable floc is broken and leaving the solution is cloudy because the time is too long. The removal rate decreased obviously[11-12]. The removal rate changed little because they were more stable after 45min. Thus, it can be seen that the optimum mixing time is preferably in 30min.

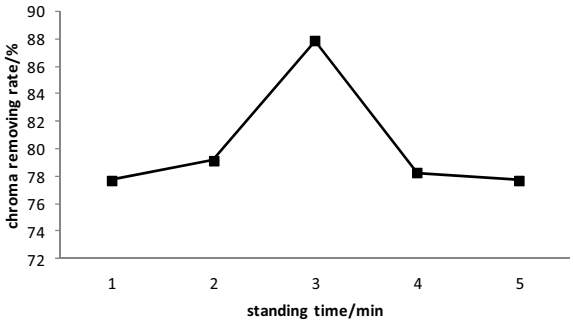

Fig.4 Effect of stirring time on color removal

3.5 Effect of wastewater treatment under optimum conditions

Using a single variable method in the previous experiments and eventually get a set of experiments that either the dosage or the pH or the mixing time were the best. Measuring this set of treated wastewater chromaticity、 pH and COD and the results are shown in Table 2. It's obviously that the modified fly ash has good effect on treating the active red X-3B wastewater and the rate of removal can reach 87.88% under optimum conditions. It has significantly higher of removal than the unmodified and the better effect of treatment to dye wastewater in terms of color and the effluent COD. The keramchalite and the Purple aluminum vanadium iron generated by the acid-modified fly ash can release aluminum and iron ions in the role of the acid[13-14]. It can effectively reduce the potential of the particles suspended in the water and make the modified fly ash participate adsorption[15-16]. Therefore, the modified fly ash can not only effectively remove wastewater's chromaticity, but also reduce the wastewater's COD.

TABLE2 RESULTS OF WASTEWATER UNDER THE OPTIMAL CONDITIONS

Parameter COD(mg/L)	SS(mg/L)	Chromaticity(times)	
Raw water	250.8	90	2^{11}
Treating water	30.4	30	2^{4}
Removal rate(%)	87.88	60	98.4

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4 Conclusions

The removal rate of raw fly ash handle the dyeing wastewater was 49.07%、the removal rate of COD was 27.59%、 the color was 29 times and the pH was 3～4. The best dosage of modified fly ash was 1g、the optimum pH was weak acid, PH was 5～6 and the best mixing time was 30min.

The removal rate of COD could reach 87.88% when the modified fly ash handled with this active red X-3B wastewater under the modified adsorption conditions. The removal rate of SS reached 60 percent and the removal of color could up to 98.4%. It could greatly improve the treatment effect of fly ash handle the wastewater after modification. The effect of modified fly ash handle the active red X-3B wastewater is obvious and the pollutant index was greatly reduced after handling. It provides convenient for subsequent processing and can greatly reduce the cost of processing.

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