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Original Research Paper

Comparison of Decolorization by Kaolin Zettlitz with Common Adsorbents in Textile Wastewater

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ABSTRACT

Removal of reactive dye (RED HE7BI) from textile wastewater effluents using Kaolin Zettlitz is described. Its ability for decolorization has been compared with waste newspaper, carbon active and sawdust. Parameters affecting dye uptake including contact time, reagent dosage and pH are examined. The sorption of dyes increased with increase in pH and reached maximum at 28.12% for 100mg/L initial concentration at pH 7.0. Adsorbents dosage optimized is 20g for every 50mL of dye solution. As a result Kaolin Zettllitz is a suitable system for treatment of coloured effluent and decolorization of textile wastewater.

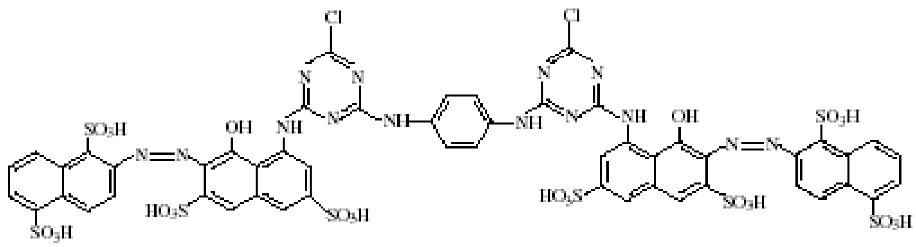
INTRODUCTION

Wastewater from textile dyeing and finishing factories is a significant source of environmental pollution (Solozhenko 1995). Reactive dyes are extensively used in textile industry fundamentally due to the ability of their reactive groups to bind to textile fibres through covalent bonds (Weber 1993). These characteristics facilitate the interaction with the fibre and reduce energy consumption (Camp 1990). The major environmental problem associated with the use of reactive dyes is their loss in the dyeing process since the fixation efficiency ranges from 60 to 90% (Camp 1990).

A wide range of wastewater treatment techniques have been suggested. Biosorption, aerobic and anaerobic treatment (Kennedy 1992, Park 1996, Shaw 2002 and Vilar 2007) are probably the most inexpensive approaches. However, the dyes inhibit bacterial activity and thus a pre-treatment step is often necessary to increase the biodegradability (Georgiou 2002). Physicochemical processes have also been proposed including coagulation with alum, ferric chloride, magnesium chloride, lime and polymers (Kennedy 1992). Adsorption on activated carbon, polymers, mineral sorbents and biosorbents (Robinson 2002, Pala 2002) have also been suggested. Chemical oxidation (Kang 1997), photolysis (Perez 2002, Chu 2002), suspended or supported photocatalysis degradation (Zielinska 2003, Neppolian 2002, Hachem 2001) and electrophoto-catalysis (Zanoni 2003) have been utilized. Among these, the adsorption process gives reliable results as it can be used to remove different types of colouring materials.

Although activated carbon is a preferred adsorbent for colour removal, its widespread use is restricted due to its high cost. Alternative adsorbents, including peat (Poots 1976), plum kernels (Juang 2000), wood (Poots 1976), coal (Zhang 2001), resin (Namasivayam 2001), coir pith (Yoshida 1993) and chitosan fibres (Al-Qodah 2000) have been used with various industrial wastewaters (Viraraghavan 1999, Kumar 2007). Some of these alternative adsorbents, though easily available and cost effective, do not effect complete dye colour removal compared with activated carbon (Al-Qodah 2000). A promising approach for effective colour removal from composite wastewater of cotton

Table1. Chemical structures and absorbance maxima of the examined reactive dye.

Dye	Structure	λ_{max}
RED HE7BI		543

textile mill involved catalytic thermal treatment accompanied with coagulation has been suggested (Kumar 2008).

In the present study, Kaolin Zettlitz was used for removal of reactive dyes in textile wastewater. Advantages offered by using Kaolin Zettlitz are low cost, good efficiency and simple preparation.

MATERIALS AND METHODS

Materials: Pure references reactive dye samples (RED HE7BI) were obtained from local textile factories. Aqueous solutions of the dyes were freshly prepared. The structures of the dye and their maximum wavelengths of absorbance (λ_{max}) are shown in Table 1.

The initial pH of the dye solution was adjusted to values in the pH range of 2-9 by the addition of 0.1N HC1 or 0.1N NaOH prior to experiment. Certain volume of sample (50 mL) was equilibrated with varying sorbent dosage (5 to 20 gr), pH values (2-9), and contact time (10 to 120 min). Experiments were carried out in cylindrical column to study the effect of parameters (sorbent dosage, pH values and contact time). The cylindrical column had a diameter 16 mm and height of 100 cm.

Equipment: Instruments were UV-Vis spectrophotometer (Perkin elmer Lambada 2) (400-800 nm), and spectrophotometer (Jenway 6305). Batch tests were set for all experiments and performed in the laboratory at room temperature. The steps of the experiments are described in the paper. The pH measurements were performed with a pH meter (Jenway 3510).

Procedure: First, λ_{max} was determined with UV-visible spectrophotometer of textile wastewater. Experiments for adsorption by Kaolin Zettllitz were conducted at 25°C temperature by different amounts of adsorbents (5 to 20 g), different pH of dye solutions (2 to 9) and different times (10 to 120 minute). In all test steps 50 mL dye solutions were used. After passing dye solutions from adsorbent column, remaining dye was determined by spectrophotometer in wastewater samples.

Table 2: Max wavelength for dye sample.

pH	RED HE7BI	
	λ_{max}	A
7	543	0.513595

Where λ_{max} is max. wavelength and A is absorbance.

RESULTS AND DISCUSSION

Fig. 1 shows the percent of decolorization by various adsorbents. It is apparent that kaolin zettlitz was better

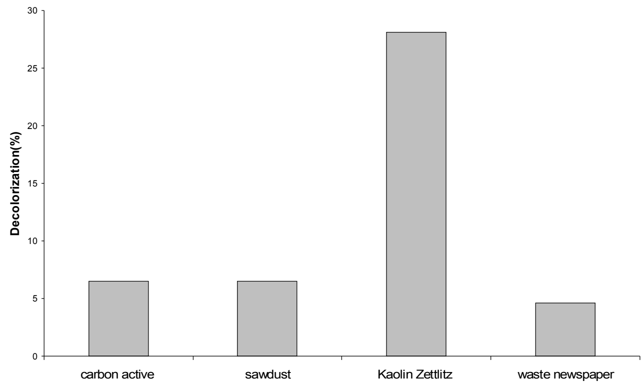


Fig.1: Effect of various adsorbents on decolorization. (5 gr sorbent, 50mL of sample, pH 7, temperature: 25±1˚C).

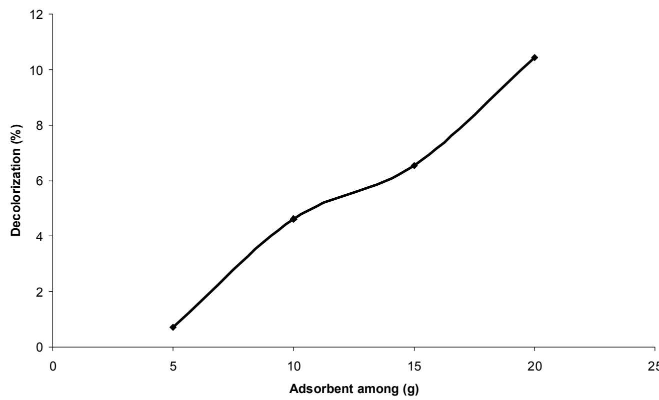


Fig.2. Effect of sorbent dosage on decolorization using kaolin zettlitz (5-20 gr sorbent, 50mL of sample, pH 7, temperature: 25±1 ˚C).

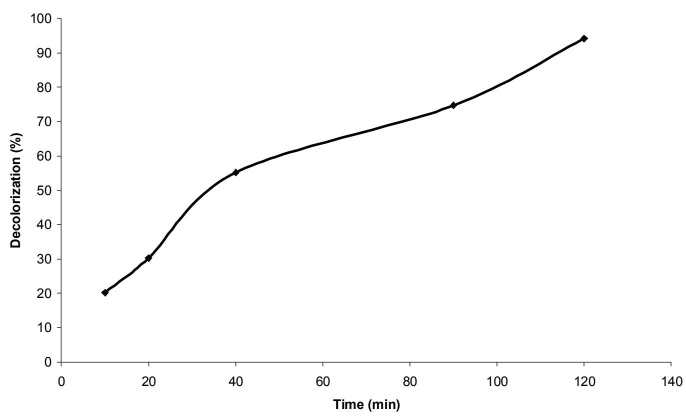


Fig.3. Effect of contact time on decolorization using kaolin zettlitz (5 gr sorbent, 50mL of sample, pH 7, temperature: 25±1 ˚C).

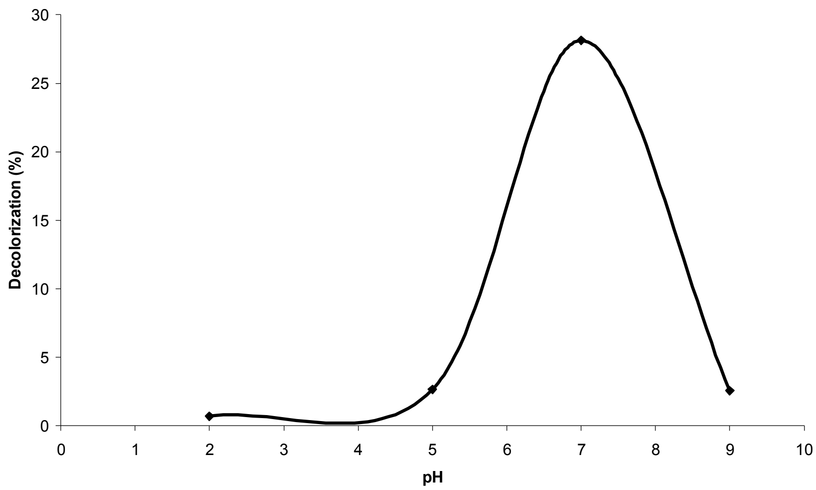


Fig.4. Effect of pH on decolorization using kaolin zettlitz gr sorbent, 50mL of sample, pH 2-9, temperature: 25±1 °C).

than three other adsorbents. So kaolin zettlitz can be accepted as adsorbent for survey. The main parameters influencing decolorization contained amount of adsorbent, contact time and pH value.

Effect of adsorbents dosage on decolorization*:* Adsorption of reactive dye (RED HE7BI) as a function of adsorbent dosage was investigated. Adsorbents dosage varied from 5 to 20g of the dyes solution for 10 min at an initial metal ion concentration (Fig. 2). It is apparent that the metal ion concentration in solution decreases with increasing sorbent amount for a given initial dye concentration. The optimum kaolin zettlitz dosage for maximum dye removal is 20g/50mL for an initial dye concentration of 100 mg/L.

Effect of contact time: Fig. 3 shows the effect of sorption time on sorption efficiency. Adsorption rate is almost fast; about 55.22% of RED HE7BI is removed within 40 min. The adsorption capacity reaches 94.16% of the equilibrium adsorption capacity within 120 min. So the optimum agitating time for adsorption of RED HE7BI can be accepted as 120 min**.**

This revealed that kaolin zettlitz is a good adsorbent for removal of reactive dyes compared with other previously suggested adsorption materials which take a much longer time and it can use instead of carbon active under condition.

Effect of pH: The effect of pH on the removal of reactive dyes by kaolin zettlitz is shown in Fig. 4. It showed that the sorption amount of RED HE7BI increases with the increase of solution pH; the sorption process is pH dependent. The percent decolorization increased with increase in pH and reached maximum of 28.12% at pH 7.0. The percentage removal of dye decreased from 28.12% to 2.65% with an increase of pH from 7.0 to 9.0. These results agree with effective pH rang obtained by other workers for removal of some reactive dyes by natural clay minerals.

CONCLUSION

The kaolin zettlitz is natural clay mineral. This product exhibits very good adsorption for reactive dyes from wastewater. Adsorption of reactive dye (RED HE7BI) by kaolin zettlitz has been shown to depend significantly on the pH, kaolin zettlitz dosage and contact time. The kaolin zettlitz would be useful in treatment of wastewater containing reactive dyes.

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