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Full length Research paper

The Removal Of Dyes From Textile Wastewater: A Study Of The Physical Characteristics And Adsorption Mechanisms Of Date Pits

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The feasibility of using date pits for removal of the problematic direct dyes was investigated. Direct Red75 was considered. Adsorption isotherms of date pits with direct red75 were constructed at different pH values, initial dye concentrations, solution temperature and salt addition. The experimental results were fitted to the Langmuir and Freundlich models. The measured adsorption kinetics was well described by a pseudo-second order kinetic model. Furthermore, the Langmuir isotherm model fitted the experimental equilibrium data.

Key Words: Langmuir and Freundlich models, Date pits, adsorption, direct red75 dye, kinetic models.

INTRODUCTION

Water contamination resulted from dyeing and finishing in textile industry is a major concern. Discharging large amount of dyes in water resources accompanied with organics, bleaches, and salts can affect the physical and chemical properties of fresh water. In addition to their unwanted colors, some of these dyes may degrade to produce carcinogens and toxic products. Consequently, their treatments do not depend on biological degradation alone (Attalla, 1996). One of the powerful treatment processes for the removal of dyes from water with a low cost is adsorption. Several adsorbents are eligible for such a purpose (Aldhahei, 2004; Rahman, 2007; Hamadaa, 2002). The main object of the present study was to explore the feasibility of using date pits as an absorbent for the removal of direct dye, a widely used dye in the cotton textile processing industry. The effect of operating parameters such as temperature, salts addition, solution pH, and dye initial concentration on the adsorptive capacity of the absorbent was examined. Kinetic studies were conducted to determine the absorption mechanism.

EXPERIMENTAL

The date pits were thoroughly washed with distilled water to remove all dirt and then ovendried overnight at 80°C.

The dried pits were then crushed and milled.
Adsorption isotherms were performed in a set of 7 Erlenmeyer flasks (250 mL) where solutions of direct red75 (50 mL) with initial concentration of 10 mg/L and different pH values (2 to 11.5) adjusted by adding either few drops of dilute sodium hydroxide. Equal mass of 0.25 g of date pits was added to direct red75 solutions and kept in an isothermal shaker (30°C) for 24 hours to reach equilibrium of solid solution mixture.

The flasks were then removed from the shaker and the final concentration of direct red75 dye in the solution was measured using UV-VIS spectrophotometer.

The amount of direct red75 uptake by the surface of date pits, q_e (mmol/g), was obtained as follows:

$$q_e = \frac{C_0 - C_e}{m_s} \qquad (1)$$

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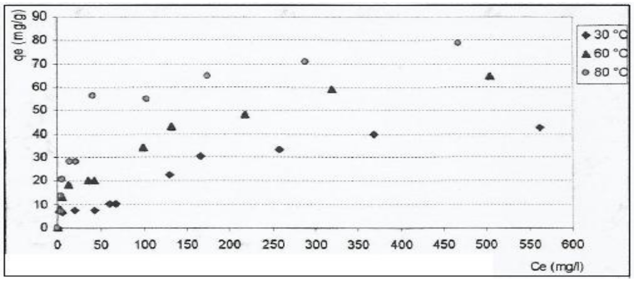

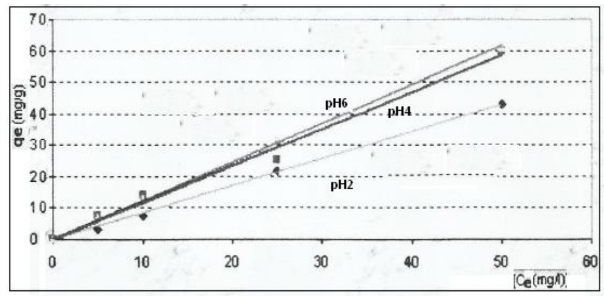

Fig.1: Equilibrium data of direct red75 onto date pitsat different solution temperatures Fig.2: Effect of pH on direct red75 adsorption.

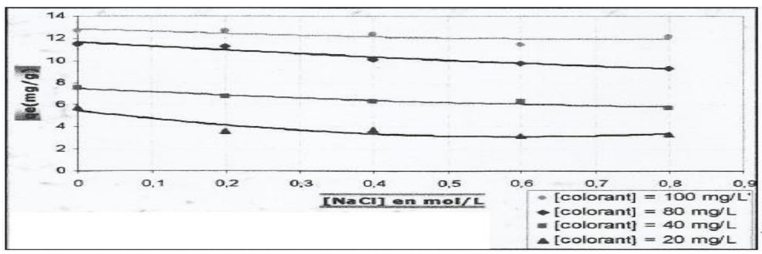

Fig.3: Effect of NaCl concentration on direct red75 adsorption by date pits.

Table1: Parameters of Langmuir and Freundlich models

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	Langmuir					Freundlich					
	$1/q_0$	q_0	K_l	R_l	R_l^2	$1/n$	n	$\ln K_f$	K_f	R_f	R_f^2
30°C	0,0153	65,359	0,00375	0,88	***0,7744***	0,4959	2,0165	0,595	1,812	0,85	***0,7225***
60°C	0,0143	69,93	0,01518	0,96	***0,9216***	0,39	2,5641	1,759	5,804	0,95	***0,9025***
80°C	0,0122	81,967	0,02955	0,99	***0,9801***	0,4252	2,3518	1,983	7,267	0,86	***0,7396***

Where C_0 and C_e (mmol/L) are the initial and final concentrations of direct red75, respectively, and m_s is the concentration of date pits in solution (g/L).

RESULTS AND DISCUSSION

Equilibrium data of direct red75 onto date pits at different solution temperatures is shown in fig.1. It is clear that date pits have an adsorption capacity ranging from 40 to 50 mg/g when the solution temperature is between 30 and 60 °C. This capacity is increased, to some extent, with increasing temperature. This was clear at lower solution concentrations when an equilibrium condition is not yet reached.

The influence of the initial pH of the solution on the uptake of direct red75 by date pits was studied at three pH levels 2, 4 and 6.When the solution pH is increased, the direct red75 uptake is expected to increase. This phenomenon could not be attributed to adsorption behaviour but to different themes: either direct red75 undergoes dimerization at higher concentration or reacts with sodium hydroxide.

The effect of salinity on the adsorption o direct red75 was tested by the addition o sodium chloride to the solution. The concentration of NaCl used ranged from 0.1 to 0.8 mol/L. Dye solutions of 20, 40, 60, 80 and 100 mg/L were used in this study. The presence of salt had no effect on the adsorption of direct red75 by date pits (fig.3). This leads to deduce that there was no interaction between the salt and the surface of the absorbent nor between the salt and the solute (direct red75).

The equilibrium isotherms at different temperatures wer-

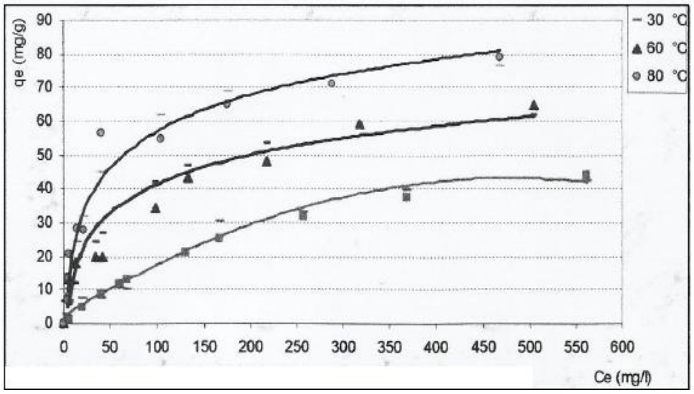

Fig.4: Application of Langmuir model.

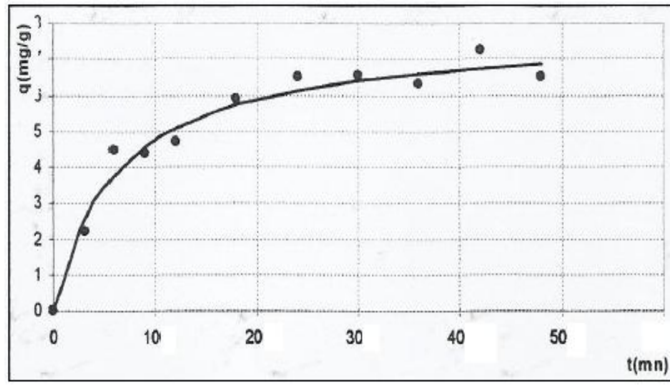

Fig.5: kinetic of direct red75 uptake by date pits.

e fitted using Langmuir and Freundlich models. The parameters for these models with their sum of square errors and regression coefficient were displayed in table1 1. Langmuir model depicted higher regression coefficient (R=0.9) and lower error discrepancy.

Kinetics data of direct red 75 onto date pits are shown in fig.4. The time required to obtain 90% removal was less than 20 min. Fig. 4 displays the effect of changing initial concentration of direct red 75 from 0.4 to 4 mg/g on the rate of adsorption. Increasing the initial concentration increases the competition of direct red 75 molecules at the active site of the adsorbent, and as a result, more direct red75 adsorbed per gram of date pits. Fig.5 shows the saturation values obtained from the pseudo-first-order model, which are in good agreement with the experimental value. The values of q_e were kept constant with the increasing initial concentration. This is because of the surface of date pits that gets saturated at solution concentration of 6 mg/g and no more adsorption can take place at the surface by increasing the concentration of direct red75.

The pseudo-first-order model was also applied to fit the kinetic data. However, none of the experimental data could be described by this model.

CONCLUSION

Date pits were used as an adsorbent for removal of direct red75 dye from water. The adsorption equilibrium revealed that date pits can uptake 42 mmol/L dye /100 g in relatively low concentration in aqueous medium. This naturally occurring material could substitute the use of activated carbon as adsorbent due to its availability and its low cost. For the efficient use of such a material, its particle size, mass concentration, mixing speed, initial concentration, and temperature of direct red75 solution must be efficiently designed to obtain the highest possible removal for direct red75. A pseudo-first-order kinetic model can be efficiently used to predict the kinetic of adsorption of direct red75 by the date pits.

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