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KINETIC AND EQUILIBRIUM STUDY OF ALSTONIA SCHOLARIS LEAF POWDER AS AN ADSORBENT FOR REMOVAL OF RHODAMINE-B

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ABSTRACT The adsorption competence of Alstonia Scholaris leaf powder was examined for the Rhodamine-B. The optimum condition for adsorption was found by analyzing the effect various parameters. The adsorption data was analyzed by applying kinetic model and isotherm model. The existing studied follows the pseudo second order kinetic model.

KEYWORDS : Basic violet 10, Brilliant Pink, Saptaparni, devil plant, bio adsorbent

INTRODUCTION

Chemicals were extensively used in various industries for different purposes, out of these chemicals; organic synthetic dyes were used for coloring in pulp, paper, and leather etc. industries. The water requirement of these industries is high creating effluent with this hazardous material which causes serous environment problems. Some commonly used methods to remove hazardous material are adsorption, coagulation, precipitation, flocculation, ultra filtration, reverse osmosis etc,. [1-4]. the utilization of activated carbon as an adsorbent for adsorptive removal of dyes is most common method [5]. Due to the high cost of commercial grade activated charcoals, various bio waste materials such as peal waste [6] were used to prepared charcoal. In the recent years the use of bio adsorbent derived from plant materials such as pomegranate peel [7], mustered cake [8], mango leaf powder [9], citrus leaves [10], Gmelina aborea leaf powder [11] etc.

Rhodamine- B is a basic dye from xanthene class and used in various industries. It causes serious health hazard and lead to neurotoxicity and carcinogenic effect [12]. So current work is taken to study the adsorption capacity of alkali treated leaf powder for the adsoptive removal of Rhodamine-B.

Experimental:

The entire chemical used was supplied by Loba Chem Pvt. LTD (India). The standard curve was prepared at 555 nm using Elico double beam spectrophotometer (SL 210). The pH was adjusted using 0.1 M HCl and 0.1 M NaOH. A stock solution of 2000 mg/L was prepared in distilled water and used to make desired concentration of dye solution. The leaves of Alstonia Scholaris were collected, dried, grinded washed with distilled water followed by washing with 0.1 M NaOH. The excess alkali was removed by washing with distilled water, dried in hot air oven. Batch adsorption studied was performed by taking 100 mL dye solution of desired concentration and pH, 0.1 g leaf powder was added and stirred. At set time interval 5 mL solution was removed, centrifuged and the absorption of supernatant liquid is measured. The following equation was used to determine the solid phase concentration.

$$q_t=(C_0-C_t)V/W$$

Where qt is adsorption amount at time t, Co and Ct are dye concentration initial and at time t in mg L-1 respectively, V is volume of solution in L and W is weight of adsorbent in g [13]

Effect Of pH

The effect of pH was studied by stirring 50mL dye solution of concentration 50mg/L with 0.1 g leaf powder for 30 min. The optimum pH was 6

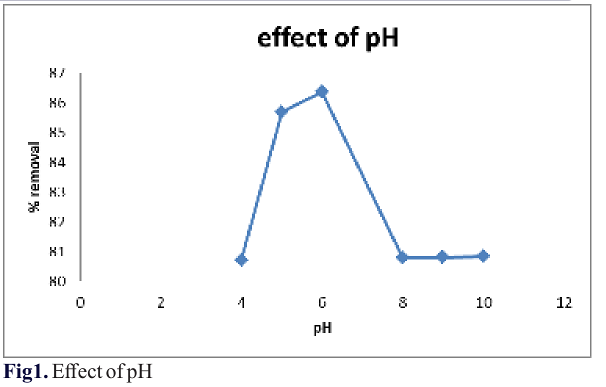

Fig1. Effect of pH

Effect Of Adsorbent Dose

The effect of adsorbent dose was evaluated by stirring 50 mL 75 mg/L Rhodamine B at optimum pH with adsorbent amount (0.05 to 0.3 g) for 30 min. The result was represented in Fig.2. % removal increases with increase in adsorbent dose.

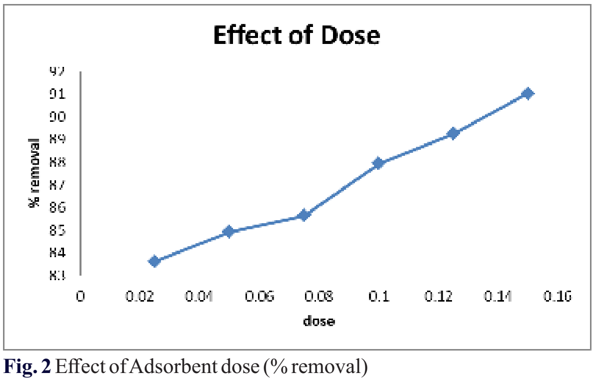

Fig. 2 Effect of Adsorbent dose (% removal)

Effect Of Dye Concentration

The effect of Rhodamine B concentration was investigated by stirring 50 mL dye solution with 0.1 g adsorbent at optimum pH.

Adsorption Dynamics

The adsorption dynamics was studied for pseudo first Elovic model order kinetic model, and pseudo second order kinetic model.

The Pseudo First Order Kinetic Model

Lagergren expression for pseudo first order kinetic model is as follows [14]

$$q_t = \frac{1}{\beta}\ln(\alpha\beta) + \frac{1}{\beta}\ln(t)$$

Where qt dye adsorbed at time t, qe dye adsorbed at equilibrium and k1 is the rate constant. The values of k1 and qe are represented in table1. Regression coefficient values confirm the non-applicability the pseudo first order kinetic model.

Elovic model

The Elovic equation represented as follows was used [14]

$$q_t = \frac{1}{\beta}\ln(\alpha\beta) + \frac{1}{\beta}\ln(t)$$

Where β represent the number of available sites for adsorption and α represent the initial adsorption rate, the data represented in table 1

The pseudo second order kinetic model

The pseudo second order is expressed as follows [14]

$$\frac{t}{q_t} = \frac{1}{q_e^2 k_2} + \frac{t}{q_t}$$

Fig.3 represents the plot of t/qt versus t. The values of equilibrium adsorption capacity (qe) and second order rate constant (k2) were represented in table 1. Experimental data follows pseudo second order kinetic model.

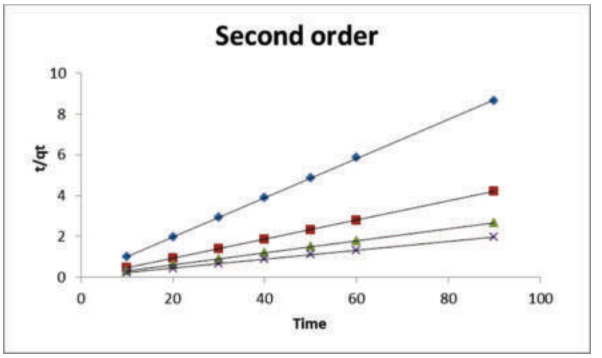

Fig. 3 The pseudo second order kinetic

Adsorption Equilibrium Study

Temkin isotherm, Langmuir isotherm and Freundlich isotherm were used

Langmuir isotherm is represented by following equation [15]

$$\frac{C_e}{q_e} = \frac{C_e}{q_m} + \frac{1}{bq_m}$$

Freundlich isotherm is represented by following equation [15]

$$\log q_e = (1/n) \log C_e + \log k_f$$

Temkin isotherm is represented by [16]

$$q_e = \frac{RT}{b} \; (aC_e)$$

Table 1 Rate Constants For Pseudo First-order, Pseudo Second-order Adsorption And Elovic Model

Dye Conc.	First order			Second order			Elovich model		
($mg\ L^{-1}$)	K_1	q_e	R^2	K_2	q_e	R^2	β	α	R^2
	(min^{-1})	($mg\ g^{-1}$)		(min^{-1})	($mg\ g^{-1}$)		($mg\ g^{-1}$)	($mg\ g^{-1}\ min^{-1}$)	
25	0.0168	0.3948	0.7341	0.1343	10.438	0.9999	6.540	0.655	0.8478
50	0.0481	0.0686	0.7114	1.5511	21.459	1.0000	67.114	0.0207	0.8811
75	0.0251	1.7060	0.9688	0.0366	34.013	0.9999	1.814	2.0305	0.9334
100	0.0110	1.4115	0.8966	0.0310	45.871	0.9998	2.158	3.9770	0.6845

Table 2 Langmuir, Freundlich And Temkin Isotherm Parameter

Langmuir Isotherm			Freundlich Isotherm			Temkin Isotherm		
b (L mg-1)	q_m (mg g-1)	R^2	n	Kf($mg\ g^{-1}$)	R^2	a (L mg-1)	b (J mole-1)	R^2
-12.629	6.3856	0.8658	9.3985	35.204	0.9986	4.685	-47.455	0.9688

CONCLUSION

In the present work it has been found that the percentage adsorption of Rhodamine-B is depend on pH, initial dye concentration and adsorbent amount. Under the optimum condition a maximum adsorption was 45.87 mg per gram of leaf powder. The adsorbent can be used as efficient, practical and affordable for the removal of Rhodamine-B

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