Research Article

Evaluation of Adsorption Effiency of Ferronia Elefuntum Fruit Shell for Rhodamine-B Retrieval from Aqueous Solution

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ABSTRACT

Rhodamine - B adsorption from an aqueous solution on to Ferronia Elefuntum Fruit Shell has been studied experimentally using the batch adsorption method. The operating variables studied are pH, initial dye concentration contact time. Adsorption isotherm (Langmuir and Freundlich) and kinetics model were studied. The adsorption capacity of FEFS was found to increasing with increase in temperature, Thermodynamics parameters such as ☐G, ☐H and ☐S for adsorption were evaluated. Adsorption of Rhodamine - B on FEFS found to be endothermic process. The aim of present work is to study the effectiveness of the adsorbent to remove dyes from their aqueous solution and the removal of color from textile and various industrial waste water.

Keywords: Adsorption, Ferronia Elefuntum Fruit Shell, Rhodamine-B, Adsorption kinetics.

INTRODUCATION

The retrieval of color from industrial effluent is a major problem as restriction become more stringent. Effluents from textile pulp and paper industries are highly colored due to residual dyes, and thus lower the aesthetic value structure and are toxic and harmful for aquatic and human life. Presently it is estimated that about 10,000 of different commercial dyes and pigments exists and over 7 x10^5 tons are produced annually worldwide. The presence of color in water inhibits the growth of aquatic fauna and flora by reducing light penetration. Various techniques, such as Chemical, Coagulation, Bio-sorption, Oxidation using ozone and adsorption have been generally employed for retrieval of color. Adsorption is one of the most effective physical process and has a great potential for the removal of dyes from wastewater. The aim of this study was to prepare activated carbon from Ferronia Elefuntum Fruit Shell and adsorption isotherm was developed for Rhodamine - B dye, which can be readily used to designing purposes in pollution amendment and control.

MATERIAL AND METHODS

Adsorbent Preparation

The adsorbent Ferronia Elefuntum Fruit Shell was collected from the Pandhari forest situated in between Warud and Pandhurna. The Ferronia Elefuntum Fruit Shell was first dired at a temperature of 160^{0}C for six hours. After grinding it was then soaked overnight in 0.1 N NaOH solution to remove the lignin content, excess alkalinity was then neutralized with 0.1 N HCl solution. It was washed with distilled water several time till the wash water become colorless. Then it was kept in muffle furnace at 130^{0}C for 6 hrs. It was sieved to obtain average particle size of 200 mesh. Finally it was dried again in an over at 50^0 C for 6 hours. The adsorbent was then stored in desiccators for final studies.

Adsorbate Preparation and Batch study

Stock solution (1000 mg/L) of Rhodamine - B was prepared by dissolving 1 gm of dye in 1000 ml of double distilled water. The stock solution were diluted with double distilled water to obtain required standard solution. The dried amount of 0.2 gm. Of Ferronia Elefuntum Fruit Shell Shell was take in 250 ml reagent bottle and standard solution (100ml) containing various concentration of Rhodamine – B dye was added and system is equilibrated by shaking the contents of the flask at room temperature, The adsorbent and adsorbate were separated by filtration and filtrate was determined by spectrophotometer at 543 nm a against a reagent blank. The spectrophotometer

systrornic (model 104) was used to measure the concentration of Rhodamine – B at 543 nm.

Effect of pH on the scavenging the dye was studied using 100ml dye solution having 40 mg/L initial concentration. Effect of initial concentration, agitating time and adsorbent dose was also studied.

RESULT AND DISCUSSION

Effect of Initial dye concentration & Contact time

The initial concentration of Rhodamine - B solution was varied from 20, 30, 40, 60 mg/L and batch experiments were carried out by taking 200 ml of this soln with dried 200 mg of the adsorbent and the system is equilibrated by shaking the contents of the flask at room temperature, equilibrium reached in 2 hours. Final concentration of Rhodamine - B was determined by spectrophotometer at 665 n.m. The percentage removal of Rhodamine - B was observed to be 87%. To establish equilibrium time for maximum uptake and to know the kinetics of adsorption process, the adsorption of Rhodamine - B on adsorbent was studied as a function of contact time. Percentage removal of dye is found to decrease with increase in dye concentration. From contact time data it may be seen that dye removal is very rapid during initial period of contact and the maximum are reached within the first 30 minutes removal.

Effect of pH

The adsorption capacity of Rhodamine - B as a function of pH is plotted in fig. 3. It was observed that percentage removal of Rhodamine - B is maximum of pH = 8 and then decrease with increase of pH.

Effect of sorbent Dosage

Batch sorption studies were performed to determine the effect of sorbent dosage on Rhodamine - B removal. (fig.4) The percent removal increase rapidly and reaches about 95%. For 100% removal of the Rhodamine - B, the dosage required is 300mg/50ml for the initial concentration of 50 mg/L at pH = 8.□

Sorption Kinetics

The rate of adsorption of Rhodamine - B on Ferronia Elefuntum Fruit Shell was studied by using the first order kinetic model, Pseudo second order kinetic and Elovich models are used to test the experimental data.

First order kinetics

The rate of adsorption of Rhodamine – B on Ferronia Elefuntum Fruit Shell was studied by using the first order rate equation proposed by Lagergren. And shown in figure 5. It is found that as initial dye concentration increases, Lagergren rate constant decrease. This indicate that, adsorption does not follow the 1st order kinetics.

Pseudo Second order models

Figure 6. Shows Pseudo second order model and it is found that, Rate constant K_2 is almost constant at different initial concentration which is shown in Table 1. This indicate that adsorption of Rhodamine - B on Ferronia Elefuntum Fruit Shell obey the 2nd order kinetics. Also the concentration of Rhodamine - B increasing from 20mg/L to 60 mg/L, equilibrium sorption capacity q_e increase.

Elovich Model

Adsorption of Rhodamine - B an Ferronia Elefuntum Fruit Shell are shown in figure 7. A linear relationship is obtained bet^{n} the amount of Rhodamine - B adsorbed, q_t and lnt. From the Table 1, show that value □ and □ varied as a function of Rhodamine - B concentration. As the concentration of Rhodamine - B increases from 20mg/L. to 6mg/L.value of □ increase and □ decreases. This favoured the adsorption phenomenon.

Isotherm Modeling

Langmuir Adsorption Isotherm

The Langmuir sorption isotherm is shown in fig 8 and given in Table 2. Qo values found to be comparable with commercial activated carbon. Value of R_L lies between 0 and 1 indicate the favourable adsorption. It indicates the applicability of Langmuir adsorption isotherm. The calculated value r^2 confirm the applicability of Langmuir adsorption isotherm.

Freundlich Adsorption isotherm

Freundlich plot for the adsorption of Rhodamine - B on Ferromia Elefuntum Fruit Shell is given in figure 9 and the result of Freundlich plot are given in Table 2. It show that the values of adsorption intensity 1/n < 1, reveal the applicability of Freundlich adsorption.

Thermodynamics Parameters

The influence of temperature upon the adsorption rate was investigated at 30^0C, 40^0C and 50^0C. It is observed that mass of the M.B. adsorbed per unit mass of adsorbent increase with increasing temperature. The heat of adsorption was calculated by plotting a graph of $\ln K_L$, versus reciplocal of temperature as show in in fig.10 The negative value of free energy change □G indicates the feasibility and spontaneous nature of adsorption of Rhodamine - B. □H value suggests endothermic nature of Rhodamine - B on Ferronia Elefuntum Fruit Shell. Positive value of □S is due to increase randomness during adsorption of Rhodamine - B.

CONCLUSION

1. Ferronia Elefuntum Fruit Shell was studied as good adsorbent for removal of Rhodamine - B. The removal is found rapid in initial stage followed by slow adsorption up to saturation level. It also depend an initial concentration of adsorbate and agitating time.
2. The present work on adsorption process is in good agreement with Langmuir & Freundlich isotherm indicating monolayer adsorption process.
3. The result of adsorption process reveals that at pH = 8.0, Rhodamine - B uptake capacity is better.
4. The adsorption of Rhodamine - B an Ferronia Elefuntum Fruit Shell followed the Pseudo second order model and Elovich model.
5. Study of temperature effects on Freundlich parameters reveals increasing trend in adsorption capacity with increase in temperature. It followed the endothermic process.
6. It is calculated that the adsorbent prepared from Ferronia Elefuntum Fruit Shell could be exploited for commercial applications. Regeneration studies are not necessary with the view that the cost of the adsorbent is very low and it can be disposed of safely.

Table 1: Kinetic model value for adsorption of Rhodamine - B on Ferronia Elefuntum Fruit Shell

Concentration	1st order			Pseudo second order			Elovich		
	K_L	q_e	r^2	q_e	k_2	r^2	□	□	r^2
20mg/L	0.0607	4.5	0.978	6.381	0.0235	0.990	0.2948	0.1306	0.9897
40mg/L	0.0584	10.2	0.994	9.135	0.0136	0.9921	0.606	0.0732	0.9850
60mg/L	0.03512	16.2	0.998	17.234	0.0256	0.9923	1.546	0.0505	0.9860

Table 2: Isothermal Constants

Concentration	Langmuir Constants				Freundlich Constants		
	b L/mg	Q^0 mg/g	R_L	r^2	1/n	k_f	r^2
30^0C	0.0456	20.89	0.771	0.969	0.479	2.031	0.933
40^0C	0.0321	22.77	0.6346	0.997	0.395	3.825	0.982
50^0C	0.0251	27.25	0.5341	0.991	0.252	4.896	0.979

Table 3: Thermodynamics Parameters

Temperature	□H	□S	□G
30^0C	0.2813	0.0467	-0.5542
40^0C			-72.5488
50^0C			-320.360

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