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Research Article

THE EFFECTIVE REMOVAL OF RHODAMINE B DYE BY ACTIVATED CARBON (MIMUSOPS ELENGI) BY ADSORPTION STUDIES

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ABSTRACT

Mimusops elengi (ME) was used as a low-cost adsorbent for the removal of Rhodamine B (RhB) from aqueous effluent via batch studies. The adsorption of dye on mimusops elengi leaves was found to be dependent on dye concentration, pH and concentration of adsorbent. The equilibrium was obtained after reaching the pH range 6. The spectrophotometric method was adopted to analyse the concentration of dye before and after adsorption. The adsorption isotherms (Langmuir and Freudlich) were studied.

Keywords

Adsorbent, adsorbate, adsorption isotherms

1. INTRODUCTION

Dyes are widely used in industries such dyeing, leather, textiles, paper, plastics and food industries for colour their products. The dyes are invariably left as a major waste in the industries. The industrial waste water is discharged in the aquatic system which causes serious problems to the aquatic life and pollute the environment [1]. Due to their chemical structures, dyes reduce sunlight transmission into water which are affecting the aquatic plants, disturb the aquatic system and in addition to that it affects the health of human beings. The removal of dyes from the aquatic system and decolorizing the dyes will be a difficult task once it is discharged into the aquatic system. Different methods were adopted to reduce the problems caused by the discharge of dyes in the environment. Reverse osmosis, chemical oxidation, ion exchange, coagulation and flocculation techniques, microbial decolouration techniques, biosorption, biological treatments, photo degradation and adsorption have been used[2],among this adsorption is an most effective methods to adopt. In this adsorption method, various low-cost adsorbent are used as an activated carbon to remove the dyes from the waste water. Some low-cost adsorbent are from industrial or agricultural wastes (i.e., wheat straw, corncob and barley husk , maize cob, wood and rice hull, banana stalk , groundnut hull , oil palm ash , cocoa pod husks , spent tea leaves , ginger waste , mango peels, rice husk, degreased coffee bean , coconut shell)[3- 12]are also used for removal of dye and organic dye effluents. Basically, Rhodamine B is a one of the water soluble xanthenes class dye, a basic red cationic dye which is commonly used in the food and textile industries. The present work aims to investigate the effective removal of dye by using mimusops elengi as an adsorbent and to study the batch adsorption studies (varying the concentration of dye, contact time, adsorbate dosage and pH) and isotherms.

2. MATERIALS AND METHODS

2.1 PREPARATION OF ADSORBENT

The leaves of Mimusops elengi were collected around Trichy district. The leaves were collected and dried in the shadow of sunlight. Then, the leaves were washed thoroughly with double distilled water. The washed leaves were dried again completely in a hot air oven at 80 - 100˚C for a day. The dried leaves were meshed and the powder were stored for further studies.

2.2 PREPARATION OF STOCK SOLUTION

A stock solution of 1000mg/L was prepared by dissolving 1g of dye in one litre of double distilled water by constant stirring in the magnetic stirrer with 160 – 200 rpm at room temperature for complete mixing. The required solutions were prepared by diluting the stock solution with distilled water to give appropriate concentraton. AR grade Rhodamine B (m.wt : 479.02; chemical formulaC28H31ClN2O3 ; λ max : 540nm) dye was used.

2.3 BATCH ADSORPTION EXPERIMENT

Adsorption experiments were carried out to scrutinize the effect of pH, adsorbent dosage, contact time and initial dye concentration on the adsorption of dyes on mimusops elengi leaves by varying the parameter under study and keeping other parameter constant. The experiments were carried out in 250ml Erlenmeyer flasks with 50ml of RhB solution in shaker at 120 rpm. Then, the absorbance of the solution was determined using spectrophotometer. The effect of adsorption dosage, adsorption capacity of adsorbent and percentage removal of dye were calculated using the equations.

$$\% \text{ dye removal} = (C_o – C_e / C_e) \times 100$$

$$\text{Adsorption capacity (mg / g)} = (C_o – C_e / M) \times V$$

Where, C_o and C_e are the initial and final concentration of dye (mg / L), M is the mass of the adsorbent (g), V is the volume of the dye solution.

3. RESULT AND DISCUSSION

3.1 EFFECT OF pH

The effect of pH was examined by varying the range of pH from 2 to 10 in 50ml of 100mg/L initial concentration with the Adsorbent dose of 0.4g / 100ml for 75 minutes at 120 rpm. By varying the pH, the percentage removal of dye increase with increase in pH. The percentage removal of dye increased upto the pH 6, after that there was no observable changes in the percentage removal of dye i.e., almost it was constant. It showed that at low pH, the positive charge on the solution interface would increase and the adsorbent surface would appear positive which hindered the adsorption. Whereas, the pH increased to higher concentration, the positive charge on the solution medium started to decrease which lead to increase the adsorption. The maximum efficiency of removal dye was attained at the range of pH 6 (Figure 1). The optimize range was maintained for further experiments.

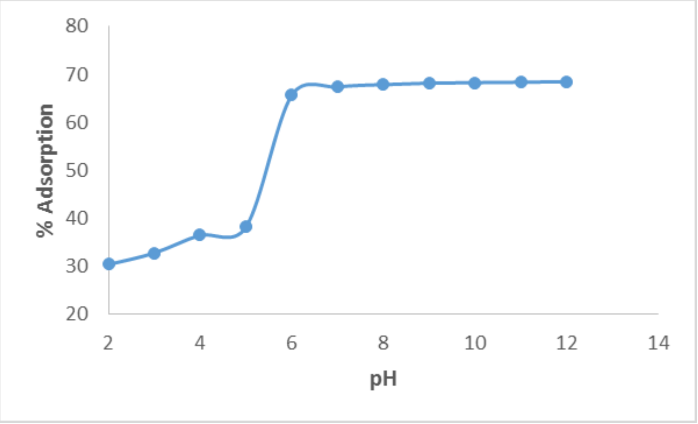

Figure -1. Effect of pH

3.2 EFFECT OF CONTACT TIME

The effect of contact time was analyzed by changing the agitation time. As a result of varying the agitation time, the percentage removal of dye decreases rapidly with an increase in contact time initially and thereafter beyond contact time, the adsorbing efficiency was not much noticeable change in the percentage of removal after 75 minutes. Therefore the optimum contact time is considered to be 75 minutes. The removal of dye is observed at the beginning after that it is gradually decreased (Figure 2).

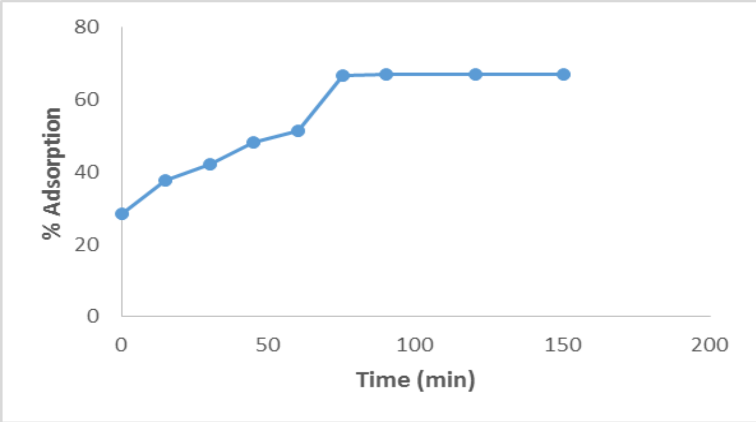

Figure -2. Effect of contact time

3.3 EFFECT OF ADSORBATE DOSAGE

The effect of adsorbate dosage was studied in the range of 0.1 to 0.8g in the initial dye concentration at their optimum pH and equilibrium time of dye. As a result of varying the adsorbate dosage, the percentage of dye removal increased with increasing dosage i.e., the amount of sorption sites at the surface of adsorbent would increase by the increase of dose of adsorbent. After reaching constant at 0.4g, the removal percentage almost remains constant. This could be noted down as a reason that the increasing adsorbent dosage would provide more surface area, thereby leading to more binding sites for the adsorption of dye molecules to adhere to it. But, after its maximum adsorption capacity the sites become saturated. Hence, 0.4g was taken as optimum adsorbent dosage for RhB (Figure 3).

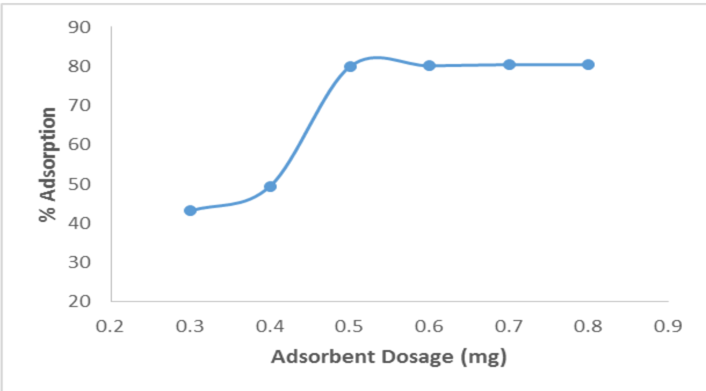

Figure -3. Effect of adsorbate dosage

3.4 EFFECT OF INITIAL CONCENTRATION

The effect of initial concentration showed the immediate relation between the dye concentration and the available binding sites on the adsorbent surface. The removal efficiency decreased with an increase in the initial dye concentration due to the saturation of adsorption sites on the adsorbent surface. There will be unoccupied binding sites on the adsorbent surface at a low dye concentration and when the initial dye concentration increases, there will be insufficient sites for the adsorption of dye molecules, thus decreasing the dye removal efficiency (figure 4).

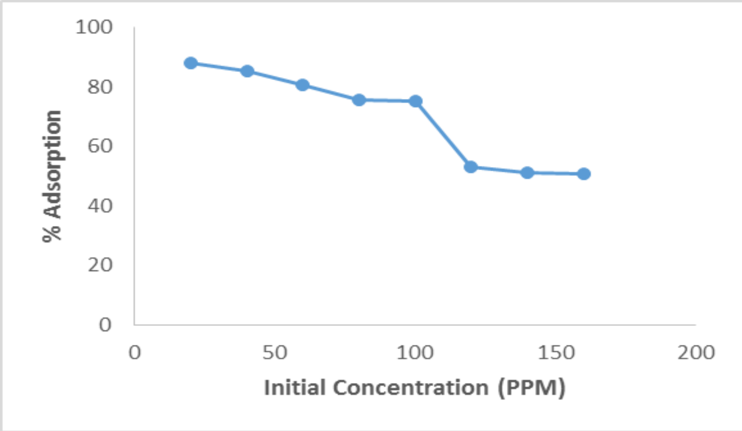

Figure -4. Effect of initial concentration

3.4 ADSORPTION ISOTHERMS

The adsorption data was investigated with the help of the following linear forms of freundlich and Langmuir isotherms:

(Ce/qe) = 1/Qob+Ce/Qo (Langmuir equation)

Log qe = log Kf + (1/n) log Ce (Freundlich isotherms)

Table – 1. Adsorption isotherms

Langmuir isotherm				Freundlich Constant			
Temp (˚C)	Q_0	b	R	Temp (˚C)	K_f	N	R
30	1.7	1.3	0.92	30	0.18	0.9	0.97
45	2.3	1.7	0.97	45	2.35	1.2	0.95
60	2.0	1.2	0.96	60	1.74	1.3	0.98

In the Langmuir parameters, Qo and b have been calculated from the slope and intercepts of the straight lines of the plot Ce / qe vs Ce, whereas in the Freudlich isotherm constants i.e., Kf and n have been calculated from the graph plots between log qe and log Ce. The Langmuir parameters and freundlich constants were used to determine the linear regression R2 values. The R values lies in between 0.92 – 0.97 suggested that the adsorption can be fitted in the above equations (Table – 1).

4. CONCLUSION

The carbon prepared from the leaves of Mimusops elengi can be used as an efficient adsorbent for the removal of dye effulent. As the percentage removal of rhodamine B increases from 45.8 to 84.7 with the carbon in 75 minutes agitation from the initial concentration. The efficiency of dye removal decreases with increasing the initial concentration due to its surface area and the availability of binding sites. More over the adsorption of Rhodamine B using a low-cost adsorbent was obtained from the leaves of mimusops elengi was found to be efficient adsorbent for removal of dye.

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