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Evaluation of adsorption efficiency of *Alangium salvifolium* tree bark for methylene blue retrieval from aqueous solution

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ABSTRACT

Methylene Blue adsorption from an aqueous solution on to *Alangium salvifolium* Tree Bark (ASTB) 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 ASTB was found to increasing with in temperature. Thermodynamics parameters such as ΔG, ΔH and ΔS for adsorption were evaluated. Adsorption of Methylene Blue on ASTB 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.

Key words: Adsorption *Alangium salvifolium* Tree Bark, Methylene Blue, Adsorption kinetics, Thermodynamics adsorption isotherm.

INTRODUCTION

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. 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 to activated carbon from *Alangium salvifolium* Tree Bark and adsorption isotherm was developed for Methylene Blue dye, which can be readily used to designing purpose in pollution amendment and control.

MATERIAL AND METHODS

Adsorbent preparation

The adsorbent *Alangium salvifolium* Tree Bark (ASTB) was collected from the Pandhari forest situated in between Warud and Padhuran. The *Alangium salvifolium* Tree Bard was first dried at a temperature of 160°C for six hours. After grinding it was then soaked overnight in 0.1N 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°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°C for 6 hours. The adsorbent was then stored in desiccators for final studies.

RESULTS AND DISCUSSION

Effect of Initial dye concentration & contact time

The initial concentration of Methylene Blue solution was varied from 20, 30, 40, 60 mg/L and batch experiments were carried out by taking 220ml 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 time for maximum uptake and to know the kinetics of adsorption process, the adsorption of Methylene Blue on adsorbent was studied as 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 sorbent dosage

Batch sorption studies were performed to determine the effect or sorbent dosage on Methylene Blue removal. The percent removal increase rapidly and reaches about 95%. For 100% removal of the Methylene Blue, the dosage required is 300mg/50ml for the initial concentration of 50 mg/L at pH = 8.θ.

Sorption Kinetics

The rate of adsorption of Methylene Blue on Alangium Salvifolium Tree Bard 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 Methylene Blue on (ASTB) was studied by using the first order rate equation proposed by Lagergren. It is found that as initial dye concentration increase. Lagergren rate constant decrease. This indicate that, adsorption does not follow the 1st order kinetics.

Table 1: Kinetic model value for adsorption of Methylene Blue on ASTB

Concent-	1st order			Pseudo second order			Elovich		
ration	K_L	q_e	r^2	q_e	k_2	r^2	∝	β	r^2
20 mg/L	0.0307	7.60	0.997	9.021	0.0016	0.998	0.4948	0.1506	0.9997
40 mg/L	0.0284	14.40	0.974	16.1820	0.0414	0.9821	1.306	0.8732	0.9860
60 mg/L	0.02612	20.10	0.988	20.390	0.0013	0.9723	2.246	0.1005	0.9760

Table 2: Isothermal Constants

Temperature	Langmuir constants				Freundlich constants		
°C	b L/mg	Q^0 mg/g	RL	r^2	1/n	k_f	r^2
30°C	0.0461	24.89	0.671	0.999	0.479	1.449	0.997
40°C	0.0251	26.77	0.7346	0.987	0.595	3.455	0.982
50°C	0.0240	30.25	0.4340	0.961	0.472	4.273	0.989

Table 3: Thermodynamics parameters

Temperature	ΔH	ΔS	ΔG
30°C			-0.6521
40°C	0.1813	0.06133	-83.3488
50°C			-340.360

Pseudo Second order models

In Pseudo order model, 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 M.B. on *Alangium salvifolium* Tree Bark obey the 2nd order kinetics. Also the concentration of Methylene Blue increasing from 20mg/L to 60mg/L, equilibrium sorption capacity q_e increase.

Elovich Model

Adsorption of Methylene Blue an Alangium Salvifolium Tree Bark are shown in figure 7. A linear relationship is obtained bet^n the amount of M.B. adsorbed, q_t and Int. From the table 1, show that value $\propto$ and β varied as a function of Methylene Blue concentration. As the concentration of Methylene Blue increase from 20mg/L to 60mg/L. Value $\propto$ increase and β decrease. This favoured the adsorption phenomenon.

Isotherm Modeling

Langmuir Adsorption Isotherm

The Langmuir sorption isotherm is given in table 2. Q_0 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 vlaue r^2 confirm the applicability of Langmuir adsorption isotherm.

Freundlich Adsorption isotherm

Freundlich plot for the adsorption of Methylene Blue on *Ferromia elefuntum* Fruit Shell and the result of Freundlich plot are given in Table 2. It show that value 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°C, 40°C and 50°C. 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 $1nK_L$, versus reciplocal of temperature. The negative value of free energy change ΔG indicates the feasibility and spontaneous nature of adsorption of Methylene Blue. ΔH value suggests endothermic nature of Methylene Blue on Alangium Salvifolium Tree Bark. Positive values of ΔS is due to increase randomness during adsorption of Methylene Blue.

CONCLUSIONS

1. Alangium Salvifolium Tree Bark was studied as good adsorbent for removal of methylene Blue. The removal is found rapid on initial stage followed by slow adsorption upto 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 results on adsorption process reveals that at pH = 8.0, Methylene Blue uptake capacity is better.
4. The adsorption of Methylene Blue on ASTB 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 (ASTB) 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.

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