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Kinetic Studies on Biosorption of Methyl Violet Dye Using Blue Green Algae

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Abstract - In the present study, the parameters, temperature, adsorbent dose, contact time, adsorbent size and agitation speed were optimized for Methyl violet removal from aqueous medium by using response surface methodology **(RSM)**. The optimum conditions for maximum removal of Methyl Violet from an aqueous solution of **100 mg/L** were found as follows: room temperature **(33 degrees C),** adsorbent dose (500mg), contact time **(180 min)**, adsorbent size (**250 meshes**) and agitation speed **(200 rpm)**. Adsorption kinetic data were tested using Intra-particle diffusion model and Elovich's equation. Kinetic studies showed that the adsorption follows first order reaction. Studies revealed that the intraparticle diffusion plays an important role in the mechanism of dye adsorption.

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Kinetic Studies on Biosorption of Methyl Violet Dye Using Blue Green Algae

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Abstract - **In the present study, the parameters, temperature, adsorbent dose, contact time, adsorbent size and agitation speed were optimized for Methyl violet removal from aqueous medium by using response surface methodology (RSM). The optimum conditions for maximum removal of Methyl Violet from an aqueous solution of 100 mg/L were found as follows: room temperature (33 degrees C), adsorbent dose (500mg), contact time (180 min), adsorbent size (250 meshes) and agitation speed (200 rpm). Adsorption kinetic data were tested using Intra-particle diffusion model and Elovich's equation. Kinetic studies showed that the adsorption follows first order reaction. Studies revealed that the intraparticle diffusion plays an important role in the mechanism of dye adsorption.**

I. Introduction

In recent years, considerable attention has been focused on the removal of dye from aqueous solution using adsorbents derived from low cost materials. Several adsorbents, such as sawdust, silica and iron oxide[1], wheat shell [2], bagasse fly ash [3], fly ash [4], spent activated clay [5] and modified goethite[6] have been used for the treatment of effluents at the solid – liquid interface. In the present investigation Blue Green Algae (BGA) has been used as adsorbent for the removal of Methyl Violet dye. The aim of the present work is to explore the possibility of utilizing BGA for the adsorption of Methyl Violet dye from industrial dye effluents. The kinetics of dye adsorption on adsorbent was analysed by various kinetic models.

II. Methods and Materials

a) Adsorbent

Algae were collected from the pond water, Coimbatore, Tamilnadu, India. It was washed with distilled water several times. The clean algae were dried at room temperature for 30 days. The dried algae were grinded and sieved was labeled as BGA and used for batch mode adsorption experiments.

b) Chemicals

Methyl Violet dye used in this study were of commercial grade. Stock solution of dye was prepared by dissolving accurately weighed amount of Methyl Violet dye in 1000ml distilled water. All experimental solution was prepared by diluting the stock solution to the required concentration. The pH of each experimental solution was adjusted to the required initial pH value using 1N HCl or 1N NaOH before mixing the adsorbent. The absorbance of the dye solution before and after agitation was noted with colorimeter.

c) Response Surface Methodology

The effect of various parameters on the removal of Methyl Violet dye onto the response surface BGA was studied; batch adsorption experiments were conducted at room temperature. For each experiment, 100ml of initial concentration dye solution at pH 6.0 were taken in 250ml Erlenmeyer flask. 500mg of BGA adsorbent is added and was shaken at a constant agitation speed (200 rpm). The supernatant was analysed and the effect of adsorbent dose on the removal of dye was measured with different amounts, different pH and various concentration by contacting time (10, 20, 30, 40, 50, 60, 90, 120, 150 and 180 minutes) till attained equillibrium. The optimum conditions for maximum removal of Methyl Violet from an aqueous solution of 100 mg/L were determined as follows: room temperature (33 degrees C), adsorbent dose (500mg), contact time (180 min), adsorbent size (250 mesh), pH 6.0 and agitation speed (200 rpm).

III. Results and Discussion

Analysis of adsorption data is important for developing kinetic equation that can be used for design purposes. By the above said batch experiments kinetic models have been used to investigate the mechanism of adsorption and potential rate controlling steps, which is helpful for selecting optimum operating conditions for the full- scale batch process[7].

a) Intra-particle diffusion study

The most commonly used technique for identifying the mechanism involved in the adsorption process is by using intra-particle diffusion model as [8,9]

$$q = K_P \sqrt{t}$$

where K_P is the intra-particle diffusion rate constant. If intra-particle diffusion occurs, then q against $\sqrt{t}$ will be linear and the line will pass through the origin if the intra-particle diffusion was the only rate limiting parameter controlling the process. Otherwise, some other mechanism is also involved. Figure: 1 represents

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Intra-particle plot for Methyl Violet onto BGA for different dye concentrations. The figure shows two linear portions, [10, 11] the first part of curve is attributed to boundary layer diffusion while, the final linear parts indicated effect of intra-particle diffusion.

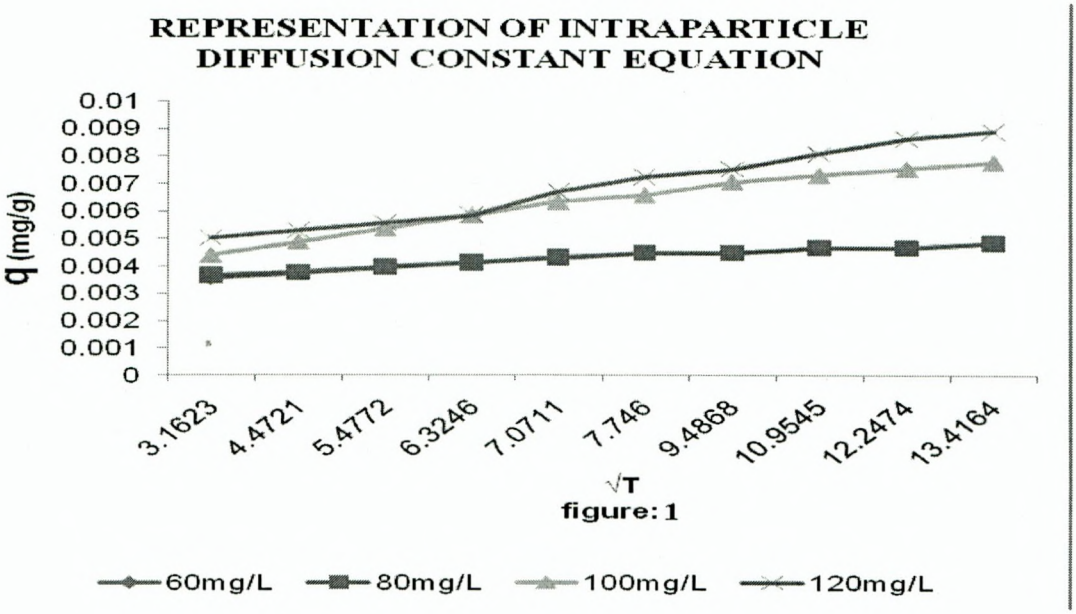

figure: 1

Values of $R^2 = 0.954 - 0.986$ give an idea about the successfulness of the process. The increase of Kp with the increase of MV dye initial concentration shows the thickness of the boundary layer and the constant diffusion of the dye onto BGA. The diffusion rateparameters were shown in Table: 1. The data's indicated that Intra-particle diffusion controls the adsorption rate. Simultaneously, external mass transfer resistance cannot be neglected although this resistance is only significant for the initial period of time [12].

Table 1 : The parameters and correlation coefficients for the removal MV dye on BGA

Concentration of dye solution mg/L	Intraparticle diffusion rate constant		Elovich rateconstant	
	K_p x 10^{-3}	R^2	Desorption constant [β] x 10^3	R^2
60	1.3	0.954	2.174	0.981
80	1.23	0.957	2.304	0.975
100	3.6	0.976	0.762	0.991
120	4.1	0.986	0.673	0.968

b) Elovich's equation

Elovich's equation [13] is given as: $dq_t/dt = \alpha \exp(-\beta q_t)$ Where q_t is the amount of dye adsorbed at time t, α is the initial adsorption rate (mg/g min) and β is the desorption constant (g/mg). After integration and applying boundary conditions, $t = 0$ to t and $q = 0$ to q_e; after integration the above equation becomes: $q_t = \beta \ln(\alpha\beta) + \ln t$

Values of desorption rate constant (β) for the dye adsorption onto BGA were determined from the linear relation of straight line plot of ln t against q_t shown in figure: 2 the data were fitted with a high correlation coefficient (Table: 1) for the removal of dye onto BGA ($R^2 = 0.968 - 0.991$). This shows that the film diffusion is not the only rate controlling parameter. It concluded that the film and pores diffusion were carried out on the surface of BGA adsorbent.

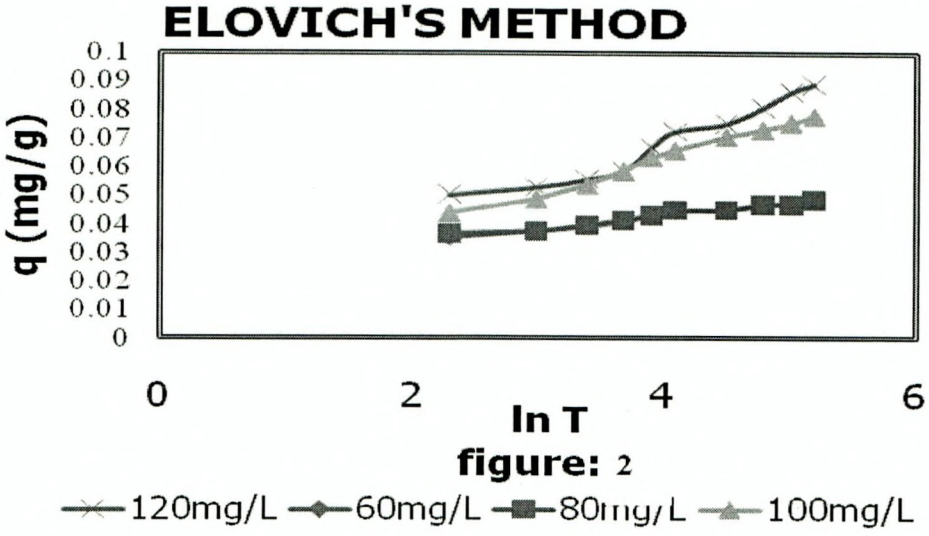

figure: 2

IV. Conclusion

Adsorption of MV onto BGA was best fitted by the first order model confirmed by kinetic models. Mechanism of adsorption is probably a combination of external mass transfer and intra-particle diffusion. A comparison of these values with the one obtained in this study shows that Blue Green Algae used in this research exhibited a higher capacity for MV adsorption from aqueous solutions. Using waste biomass for preparing new biosorbents is particularly advantageous. Blue Green Algae are recognized as a promising class of low-cost adsorbents for the removal of colour from aqueous waste solutions. The application of the adsorption of Methyl Violet dye by using BGA adsorbent will proved its efficiency in wastewater treatment applications.

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