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Kinetic studies of acid violet dye removal using Blue Green Algae

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Abstract

The present investigation deals with the utilization of Blue Green Algae (BGA) as adsorbent for the removal of Acid Violet from aqueous solution. A series of experiments were conducted in a batch system to evaluate the effect of system variables. Adsorption kinetic data were tested using Intra-particle diffusion model and Elovich's equation. Studies revealed that the Intraparticle diffusion played an important role in the mechanism of dye adsorption.

Key words: Acid Violet (AV), Blue Green Algae (BGA).

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 Acid Violet dye. The aim of the present work is to explore the possibility of utilizing BGA for the adsorption of Acid Violet dye from industrial dye effluents.

Methods and Materials

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, sieved, labeled as BGA and used for batch mode adsorption experiments.

Chemicals :

Acid Violet dye used in this study was of commercial grade. Stock solution of dye was prepared by dissolving accurately weighed amount of Acid 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.

Batch mode experiments :

The effect of various initial concentration of dye solution(60mg/L,80mg/L, 100mg/L and 120mg/L) for the removal of Acid Violet dye onto BGA was studied by batch mode adsorption experiments which was conducted at room temperature and pH 6.0 with 500mg of BGA adsorbent by constant agitation speed (200 rpm).

Results and Discussion

Analysis of adsorption data is important and calculated for developing equilibrium and 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].

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 Intra-particle plot for Acid 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 indicate effect of intra-particle diffusion. Values of $R^2 = 0.986 – 0.993$ gives an idea about the successfulness of the process. The increase of Kp with the increase of AV dye initial concentration shows the thickness of the boundary layer and the constant diffusion of the dye onto BGA. The diffusion rate parameters were shown in Table 1. The data indicated that intra-particle diffusion controls the adsorption rate[12].

Table 1. The parameters and correlation coefficients for the removal AV dye on BGA

Concentration of dye solution mg/L	Intraparticle diffusion rateconstant		Elovich rateconstant	
	K_p	R^2	Desorption constant [β]	R^2
60	1. 84	0.986	0.1484	0.9841
80	2.07	0.986	0.1315	0.9884
100	4.62	0.982	0.0789	0.9591
120	3. 53	0.993	0.0526	0.9904

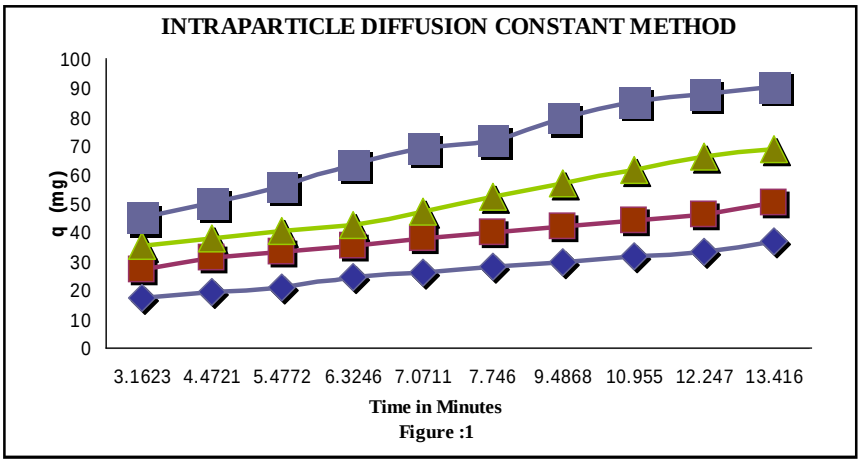

Figure :1

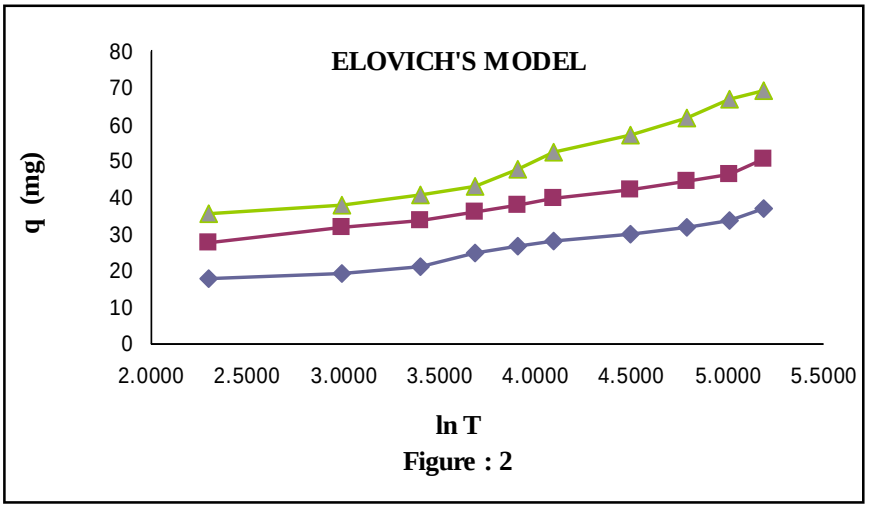

Figure : 2

Elovich's equation :

Elovich's equation[13] is given as:

$$dq_t/dt = \alpha \, ex \, (-\beta \, q_t)$$

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; the integrated form of equation (3) 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). The removal of dye onto BGA (R^2 = 0.9591– 0.9904). This shows that the film diffusion is not the only rate controlling parameter. It may be concluded that the film and pores diffusion were carried out on the surface of BGA adsorbent.

Conclusion

Adsorption of AV onto BGA was best fitted by the first order model confirmed by kinetic models. Mechanism of adsorption was rather complex and is probably a combination of external mass transfer and intra-particle diffusion. The application of adsorption of Acid Violet dye by BGA had proved its efficiency in wastewater treatment applications. Using waste biomass for preparing new biosorbents is particularly advantageous. Blue green algae are recognized as a promising class of low-cost adsorbents for removal of Acid Violet from aqueous waste solution.

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