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Equilibrium Sorption Studies of Malachite Green from Aqueous Solution using *Alangium salvifolium* Tree Bark

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ABSTRACT

Treatment of dyes from wastewater is obligatory in order to avoid water pollution. Batch adsoprtion studies were carried out to evaluate the potentiality of ba-gases. Various parameters such as initial dye concentration, pH as well as temperature of the system were studied. The adsorption was found to fallow first order kinetics and intraparticle difussion is the date controlling step. The adsorption data indicates that the process is sponatenous and exothermic in nature. Langmuir adsorption isotherms was found to be well suited for the system, which shows monolayer adsorption.

Key words: Adsorption, Alangium Salvifolium Tree Bark, Malachite Green, Adsorption isotherm.

INTRODUCTION

Wastewater from dyeing and finishing operation in the textile industry is high in colour and organic content. The discharge of inadequately treated wastewater into the aquatic environment imposes several adverse impacts on public health, flora and fauna and aquatic life. Colour removal from textile effluents has been the target of great attention. Such coloured waste water is unfit for recyling without proper treatment. Various treatment methods for removal of colour and dye and coagulation, ozone membrane separation, anaerobic decolorization and adsorption process.

Adsorption process offers most economical and effective treatment method for removal of dyes. Sorption has evolved into one of the most effective physical processes for decolorization of textile wastewater. Thought activated carbon is an ideal adsorbent for organic matter, it is uneconomical for wastewater treatment, due to its hight production and regeneration costs. So natural materials that are cost effective and easily available in large quantities or certain waste products from industrial operation may have potential as inexpensive sorbents. Due to their low cost, they can be disposed off without expensive regeneration.

The adsorptivity of naturally ocurring plant waste as chemically activated carbon was studied for removal of dye from its aqucous solution on a laboratory scale. The adsorption efficiency depends on the particle size. There are many methods to activate the charcoal to increase its surface area. The comparative studied to explore tht potential of Polyvinyl alcohol coated activated wood charcoal to treat dyes have been conducted. This work is primarily an evaluation of the adsorption characteristics to adsorbent on dyes.

MATERIAL AND METHODS

The dye used in present study was malachite green supplied by qualigens fine chemical. Accurately weighted quantity of the dye was dissolved in double distilled water to prepare stock solution. Experimental solutions of the desired concentrations were obtained by successive dilution Batch adsorption study were carried out by shaking 1.0g of adorbent wood charcoal with 50 ml of aqucous solution of malachite green of desired concentration in 250ml Borosil conical flask at different temperatures, pH and at a constant speed of 200 rpm in shaking termostat. The amount of adsorption was determined at different time intervals till the equilibrium. The suspension solution was centrifuged and supernatant liquid analysed using the spectrophotometer, sytronic (model 104) to find our residual dye concentration and the pH of system adjusted using HCl and NaOH. The experiments was carried out at different initial concentrations of the dye ranging from 80 mgl^{-1} to 140mgl^{-1}.

Preparation of Adsorbents (Granular Activated Carbon)

Carban prepared from Alangium salvifalium tree bark was selected as an adsorbent in the present study. The carbon was sieved through a fine mesh and washed with distilled water, several times until the leachate was free from any suspended impurities. Similarly GAC is modified by heating it with HNO_3 for 30 minutes. The washed sample was then dried in an oven at 100-110°C and stored in a desiccator until use.

RESULTS AND DISCUSSION

Equilibrium adsorption isotherms for Ce.Vs.qe. plotted for activated carbon. The adsorption capacity in mg/L was calculated from the equation

$$qe=(Co-Ce)V/M$$

Similarly, 0.5g.m. of modified GAC was taken in 1000 ml round bottom flask and synthetis solution (200 ml) Containing various concentration of Malachite Green was added and stirred using remistirrer at 1000 r.p.m. at (25 + 1)°C.

The amount of Malachite Green on the GAC was determined from

$$qe=(Co-Ce)V/M$$

Where,

q_e = mg of Malachite Green adsorbed per gm of GAC

C_o = Initial concentration of Malachite Green in solution in mg/litre

C_e = Final concentration of Malachite Green in solution in mg/litre.

V = Volume of Malachite Green solution used in litre

W = Weight of GAC in gm

It is seen that at C_e increases q_e also increases but at the saturation level q_e tends to be constant with increasing value of Ce which indicates formation of mono-layer of adsorbate on the surface of adsorbent. This value Q° indicate maximum amount of Malachite Green per gram og GAC that can be adsorbed on GAC under the given set of experimental conditions to form a monolayer of the adsorbate. All isotherms are seen to be of the favourable type and were then subjected for adherance to both Langmuir and Freundlich adsorption isotherm. Using values of q_e and C_e Langmuir equation could be expressed as follows.

$$q = Q^{\circ} b C_e / 1 + b C_e \quad ...(1)$$

The linearised form of Langmuir isotherm is

$$1/q_e = 1/Q^{\circ} b C_e + 1/Q^{\circ} \quad ...(2)$$

Where,

Qo = amount adsorbed per unit weight of the adsorbent forming a monolayer on the adsorbent furface and b = Langmuir constant

A plot of $1/q_e$ versus $1/C_e$ was found to be fairly linear. Similarly, the Freundlich equation used was

...(4)

Where. k and b are constants determine experimentally, using equation 4

...(5)

Plot of log q_e versus log Ce was fairly linear showing validity of Freundlich equation over a range of concentration. These saturation monolayer qe values were used for determine of surface area of the adsorbent. For this purpose a plot 1/qe versus $1/C_e$ helped in determination of $1/Q^o$ and hence Q^o. The surface area of the carbon through such Malachite Green adsorption can then be represented as

...(6)

Where,

S = Surface area adsorbent cm^2/g

Na = Avogadro number

A = Cross - sectional area of adsorbate cm^2

Table 1, show that it is possible to determine the surface area of the adsorbent using the technique of adsorbing Malachite Green on the GAC at the saturation level when a monolayer of the would cover the entire surface of the adsorbent.

The Langmuir equation of a plot of $1/q_e$ versus $1/C_e$ for Malachite Green adsorption could further throw more light on the surface area occupied by the Malachite Green on the GAC. Determination of vlaue of S needed the determination of A the surface area occupied by a single Malachite Green due to adsorption of the Malachite Green by GAC. The value of A were calculated using the expression given by Brunauer and Emmett [4]

Where,

M = Molecular weight of Malachite Green

Na = The Avogadro number and

d = the density of Malchite Green

Using M, Na = 6.023×10^{23} and d = 8.83 [5] the values of A and S were calculated and are reported in the table 1.

$$A = 1.0866\,[M \times 2\,Na.d]^{2/3}$$

Table 1: Values of Q°, A, S and S for a system GAC - Malachite Green

S. No	Grades of GAC	Q^0	A $10.^{16}$ cm^2	S 10^{-3} cm^{-2}/gm	S' 10^{-3} cm^{-2}/gm	qe max mg/gm
1.	GAC	0.5784	7.5316	3.5786	4.5048	0.4364
2.	MGAC	0.6693	8.4375	4.2943	5.3165	0.7306

A glance of the table 1 clearly indicates that the surface area as occupied by the Malachite Green on the surface follows the same trend as for qe max values on modified GAC Malachite Green occupied more surface area than GAC.

$$(\text{qe max} \times 6.023 \times 10^{23}) / 1000{\times}M$$

Multiplication of this with the surface area of a single Malachite Green, A, i.e. 8.4275×10^{-16} would given their actual area occupied by the adsorbed on the surface. The surface occupied by Malachite Green Gollows a trend modified GAC > GAC.

In table 1, Q° values were obtained by the reciprocal of the intercept, from a plot of 1/qe versus 1/Ce at 1/Ce = 0/ Since the values is in mg per gram of carbon it was converted to atoms per gram of cabron of the above mentioned relation which afforded surface areas to be calculated as shown under S. In the same table values of S' the area occupied by Malachite Green forming a monolayer on the surface obtained from qe max values is calculated using qe max.

CONCLUSIONS

The adsorbent isotherms of the Malachite Green on GAC and modified GAC obtained from A.S.T. Bark shows that modified GAC adsorb Malachite Green to a greater extent as compared to the GAC. The high value of a surface area for clearly indicates that the modified GAC surface is largely occupied by Malachite Green as compared to GAC. The rather extremely low value of the surface area calculated compared to the surface area of the supplied carbon indicates that there are very few favourable sites available for direct Malachite Green adsorption on the surface.

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