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Research Article

ADSORPTIVE REMOVAL OF DYE FROM AQUEOUS SOLUTION USING ACTIVATED CARBON FROM THE GLORIOSASUPERBA STEM

C. Pragathiswaran[1*], N. Anantha Krishnan[2], B. Mahin Abbubakkar[1], P. Govindhan[1] and KA.Syed Abuthahir[3]

[1]Department of Chemistry, Periyar E.V.R College (Autonomous),
Trichy-23 Tamilnadu, India.
[2]Department of chemistry,Saranathan College of Engineering Panjappur,
Trichy, Tamilnadu, India.
[3]Department of Chemistry, Dr.ZakirHussain College,
Ilyangudi, -630 702, Tamil Nadu, India.

ABSTRACT
The preparation of activated carbon using batch adsorption methods. The requirement for the treatment of dye contaminated waste water passed out from the trade. During this study, acid gloriosasuperba stem (AGSC), carbon was studied for its potential use as associate degree adsorbent for removal of a cationic dye methylene blue. The assorted factors poignant surface assimilation, like initial dye concentration, contact time, adsorbent dose and result of temperature, were evaluated.

Keywords: Acid GloriosaSuperba stems Carbon (AGSC), Methylene blue, Adsorption isotherm.

1. INTRODUCTION

Dyestuff in wastewater from various industries, such as textiles, printing, pulp mills, leather, food, dyestuffs, and plastics, is stable and resistant to biodegradation because of its complex aromatic molecular structure.[1,2] Undoubtedly, the removal of dyestuff from waste effluents is of environmental importance. So far, various technologies including biological treatment[3] coagulation/ flocculation[4], ozone treatment[5], chemical oxidation[6], membrane filtration[7], ion exchange, photocatalysis and adsorption have been developed for the treatment of dye-containing effluents. Among them, adsorption is a reliable alternative due to its simplicity and high efficiency as well as the availability of a wide range of adsorbents (e.g., activated carbon, clay, biomass, polymer, zeolite, nanomaterials, etc.). In particular, activated carbon offers an attractive option for the efficient removal of various pollutants from waters because of its high surface area and porous structure. Unfortunately, the utilization of activated carbon on a large scale is limited by process engineering difficulties, such as its dispersion problem and regeneration cost.

The key use of AGSC is in resolution purification and for the removal of color, odors and alternative unpleasant impurities from liquids, water supplies and vegetable and animal oils.In recent years it's been more and more used for the bar of environmental pollution and environmental condition laws have augmented the sales of affordable activated minerals for management the of air and pollution.[8,9] Varied techniques like precipitation, natural process, chemical reaction and surface assimilation are used for the removal of venomous waste product from, wastewater. Methylene Blue (MB) is chosen as a model compound for evaluating the potential of AGSC to get rid of dye from solution.

2. MATERIALS AND METHODS

2.1 Adsorption studies

Methylene blue (MB) was used for the adsorbate within the adsorption experiments. Adsorption from the liquid section was administrated to verify the character the consistency and therefore the capacities of the samples. A solution with quantity 50-250 mg/L was ready by intermixture an approximate amount of MB with distilled water. Adsorption experiments were conducted by putting 0.025 g of the AGSC samples and 50 mL of the aqueous solution in a exceedingly 250 ml of glass-stoppered flask. The flask was then place in an exceedingly constant-temperature shaker bath with a shaker speed of 150 rpm. The isothermal adsorption experiments were carried out at 30±2°C.

2.2 Preparation of adsorbent materials

The poisonous plant Stem collected from agricultural space close Trichy district was with sulphuric acid and washed with water and activated around 1000°C in a muffle furnace for 4 hrs then it had been taken out, ground well to fine powder and kept in a vacuum desiccators.

2.3 Batch equilibrium method

The adsorption experiments were distributed during a batch method at 30, 40, 50 and 60˚C. A known weight of AGSC was added to 50 mLof the dye solutions with associate initial concentration of 50-250 mg/L that is ready from a 1000 mg/L of stock solution. The contents were agitated completely employing a mechanical shaker with a speed of 150 rpm. The solution was then filtered at present time intervals and also the residual dye concentration was measured.

3. RESULT AND DISCUSSIONS

3.1 Effect of contact time and initial dye concentration

The impact of contact time on the quantity of dye adsorbed was investigated at 1000 mg/L concentration of the dye. From the Table 1 and Figure1 observed that the percentage removal of dye will increase speedily with a rise to bear time at the start, and thenceforth, on the far side a contact time of regarding 45 min, no noticeable amendment within the share removal is determined the share removals once 45 min were 85%. Therefore, the optimum contact time is taken into account to be forty five min. This is often conjointly the equilibrium time of the batch adsorption experiments, since on the far side a contact time of 45 min, sorption isn't modified. The fast removal of dye is determined at the start of the contact time because of the share of huge range of binding sites accessible for sorption. The experimental results of adsorptions at totally different concentrations (50 to 150mg/L) are determined that percent adsorption decreased with increase in initial dye concentration; however the particular quantity of dye adsorbable per unit mass of AGSC increased ends up in increase in dye concentration. However, at high concentration the accessible sites of adsorption become less and therefore the removal percentage of dye is dependent upon initial concentration[10,11].

Table.1. Percentage removal of MB with contact time

Time (in min)	Removal %
10	64
20	71.5
30	83
40	88
50	90
60	89.5

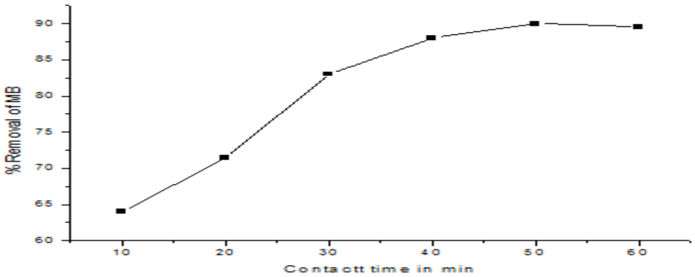


Fig. 1: Effect of contact time on the removal of MB dye [MB]=50mg/L; Temp:30^{0}C; Adsorbent dose=25mg/50ml

3.2 Effect of adsorbent dosage

The sorption of the MB dye on AGSC was studied by variable the adsorbent dose (50–250 mg/50ml) for fifty mg/L of dye concentration. The percentage of adsorption increased with increases in the AGSC concentration that is attributed to increased carbon surface area and therefore the accessibility of additional sorption sites[12,13,14]. Hence, all studies were administrated with 0.025g of adsorbent /50 ml of the variable adsorbate solutions 50, 100, 150, 200 and 250. The Results obtained from this study are shown in Table 2 and Figure 2. The quantity of MB adsorbed per gram reduced with increase within the dose of AGSC. This reveals that the direct and equilibrium capacities of MB are functions of the activated AGSC dose.

Table.2. Percentage removal of MB with adsorbent dosages

Adsorbent dose	% Removal
25	60
50	89
75	91
100	93
150	95
200	96.1
250	97.5

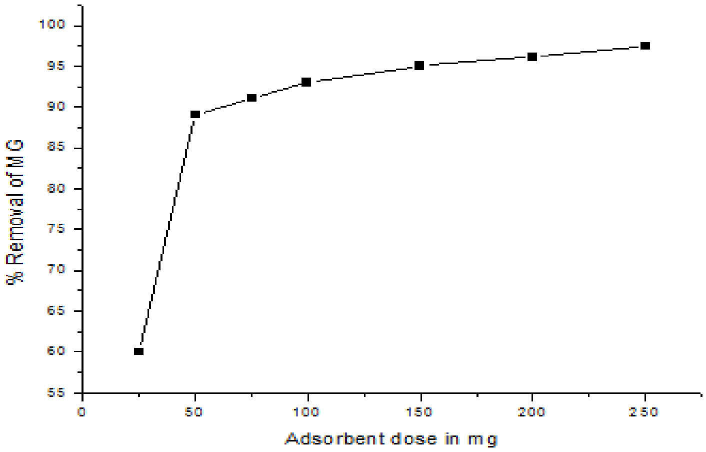


Fig. 2:Effect of adsorbent dose on the removal of MB dye [MB]=50mg/L; Temp:30^{0}C; Contact time=50 min

3.3 Effect of solution pH

The solution pH is one in all the foremost necessary factors that management the adsorption of dye on the material. The sorption capability is attributed to the chemical variety of dye within the resolution at specific pH. Additionally, owing to completely different purposeful teams on the adsorbent surface, that become active sites for the dye binding at a particular pH the result of adsorption will vary considerably. Therefore, a rise in pH could cause a rise or decrease within the adsorption, ensuing completely different optimum pH values obsessed with the kind of adsorbent. To look at the effect of pH on the sharp removal of MB dye, the solution pH were varied from 2.0 to 10.0 by adding acid and base to the stock resolution This will increase is also due to the presence of negative charge on the surface of the adsorbent. AGSC which will be responds for the dye binding. However, because the pH is down, the hydrogen ions with dye for the adsorption sites within the adsorbent AGSC, the overall surface charge on the particles become positive and hinds the binding of charged dye. On other hand, decrease in the adsorption beneath pH>6.3 is also owing to occupation of the adsorption sites by OH^- ions that retard the approach of such dye more toward the adsorbent AGSC surface. From the experimental results, the optimum pH range varies for the adsorption of the MB dye is 2.0 to 6.5 shown in Table 3 and Fig.3.

Table.3. Percentage removal of MB with different pH

pH	Removal %
2	73
3	76.5
4	79
5	82
6	85
6.5	89
7	84
8	53
9	49
10	45

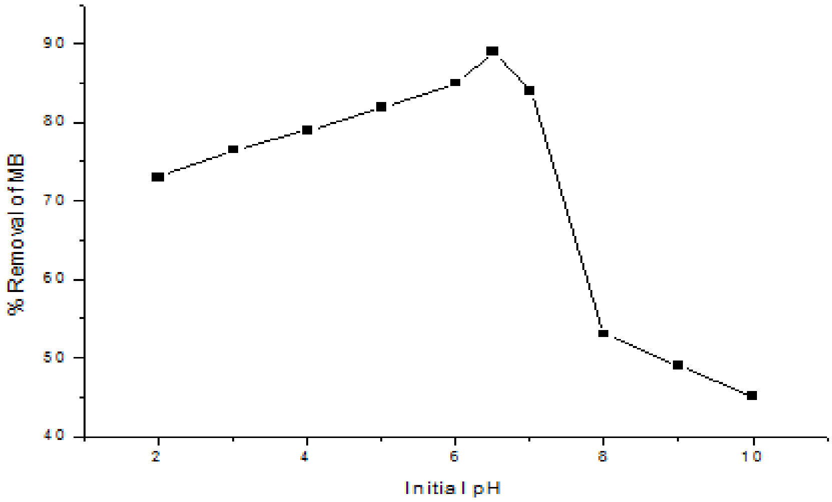


Fig. 3: Effect of initial pH on the removal of MB dye [MG]=50mg/L; Temp:30^{0}C; Contact time=50 min. Adsorbent dose = 25mg/50ml

3.4 Effect of temperature

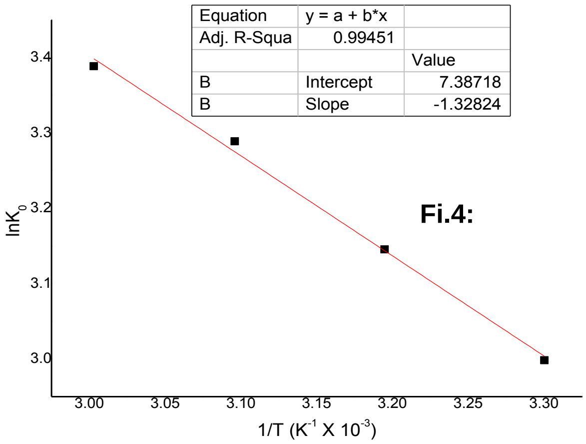
To study the result of temperature on the adsorption of dye adsorption by AGSC, the experiments were performed at temperatures of 30, 40, 50, 60°C. As it was determined that, the equilibrium adsorption capability of MB onto AGSC was found to extend with increasing temperature, particularly in higher equilibrium concentration, or lower adsorbent dose owing to high driving force of adsorption. This reality indicates that the mobility of dye molecules increased with the temperature. The adsorbent shows the exothermic nature of adsorption. The adsorption capability of the AGSC increased with increase of the temperature in the system from 30° to 60°C. Thermodynamic parameters like change in free energy (ΔG°) (kJ/mol), enthalpy (ΔH°) (kJ/mol) and entropy(ΔS°) (J/K/mol) were determined using the subsequent equations.

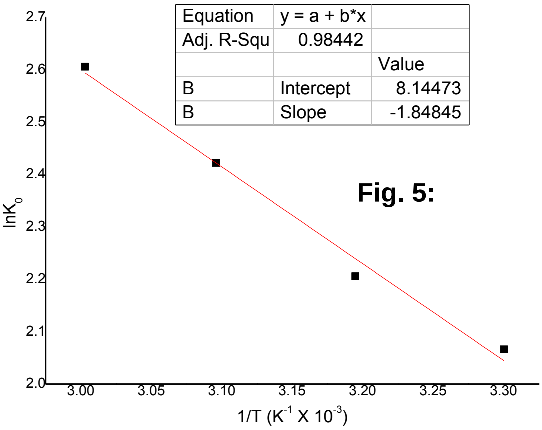
$$K_0 = C_{solid}/C_{liquid} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

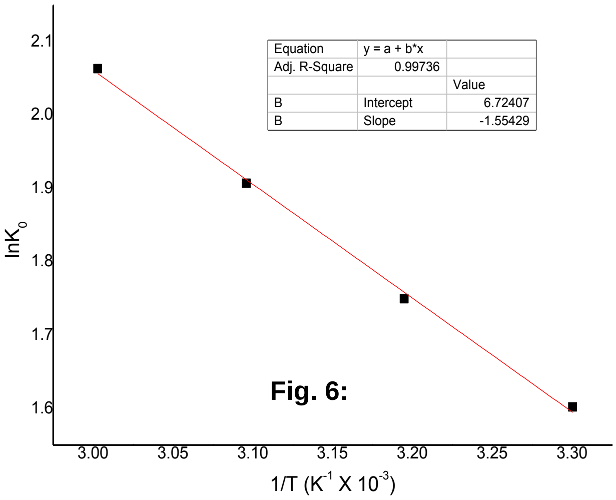
$$\Delta G^\circ = -RT\, \ln K_0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

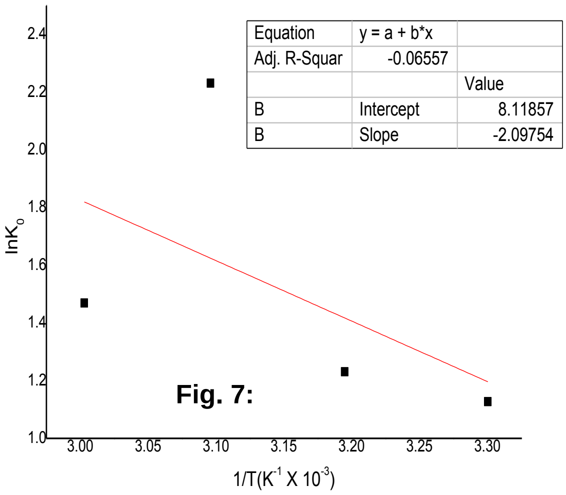
$$\log K_0 = \Delta S^\circ / (2.303R) - \Delta H^\circ / (2.303RT) \ldots\ldots\ldots\ldots \quad (5)$$

Where K_0 is the equilibrium constant, C_{solid} is that the solid phase concentration at equilibrium (mg/L), C_{liquid} is that the liquid phase concentration at equilibrium (mg/L), T is that the temperature in Kelvin, and R is that the universal gas constant(8.314 J/K/mol). A graph has drawn between $\ln K_0$ vs 1/T and shown the following figures from 4 to 8. The ΔH° and ΔS° values obtained from the slope and intercept of Van't Hoff plots area given in the values of ΔH° is that the varty of 11 to 17 kJ/mol, indicate the physisorption. The results show that physisorption is far possible for the adsorption of MB dye. The negative values of ΔH° shows the exothermic nature of adsorption that governs the chance of physical adsorption[15-17]. As a result of within the case of physical adsorption, whereas increasing the temperature of the system, the extent of dye adsorption will increase, there's no chance of chemisorptions. The negative values of ΔG° show that the adsorption is extremely favorable and spontaneous. The positive values of ΔS° show the increased disorder and randomness at the solid solution interface of MB dye with AGSC adsorbent. The increasing of adsorption capability of the activated AGSC at higher temperatures was ascribed to the enlargement of pore size and activation of the adsorbent surface.









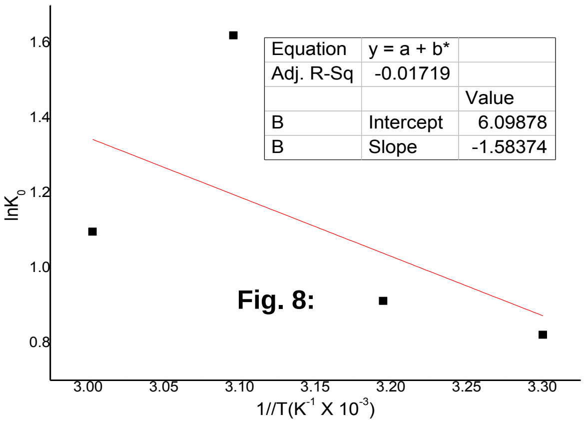


Fig. 4, 5, 6, 7, 8: Effect of temperature for adsorption of MB dye on to AGSC

4. CONCLUSION

Gloriosa Superba stem is often sensible precursors for manufacturing extremely porous Acid Gloriosa Superba stem by easy preceding strategies. An adsorption check has been administrated for industrial pollutants (MB dye) below different experimental conditions in batch mode. The adsorption of MB dye was dependent on adsorbent surface characteristics, adsorbent dose, MB dye concentration, time of contact and temperature. From the ΔG^0, ΔH^0 and ΔS^0 values reveal the process is a spontaneous, exothermic and physical adsorption.

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