DYE REMOVAL FROM TEXTILE WASTEWATER USING BIOADSORBENT

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ABSTRACT

Textile industries throughout the world produce huge quantities of dyes and pigments annually. Effluents from textile industries are dye wastewater, and disposal of these wastes to freshwater bodies causes damage to the environment. Among the treatment technologies, adsorption is an attractive and viable option, provided that the sorbent is inexpensive and readily available for use. In this study, a typical basic dye, methylene blue, in wastewater was treated using Melia azedarach sawdust. The effects of contact time, adsorbent amount and particle size were investigated on the removal efficiency of adsorbent for methylene blue. Complete removal of the dye were attained at higher adsorbent dose of 3 g/L with 50 mg/L initial dye concentration. The maximum adsorption was at 240 minutes, whereas more than 90% removal with 105 µm particle size of 1 g/L adsorbent for same initial dye concentration. The experimental data best fits with Langmuir adsorption isotherm (R^2= 0.991).

Keywords: *Methylene blue, Melia azedarach (MA), adsorption, Isotherm*

1. INTRODUCTION

The effluents from textile industries are dye wastewater and their disposal into freshwater ecosystem causes damage to the environment. Even in very low concentrations, these can be toxic to the aquatic life. Existing physico-chemical methods for dye removal have low efficiency, high operational costs and result in large amount of sludge generation (Charumathi & Das, 2012). Adsorption has been demonstrated as an efficient and economical method for dye removal from wastewater. Some of the reported adsorbents are activated carbon (Auta & Hameed, 2011), bagasse (Tsai, et al., 2001; Valix, Cheung & McKay; 2004, Ahmedna, Marshall, & Rao, 2000), cotton seed shells (Thinakaran, Panneerselvam, Baskaralingam, Elango & Sivanesan, 2008), activated carbon coir pith (Kavitha & Namasivayam, 2007; Namasivayam & Kavitha, 2002; Namasivayam, et al., 2001; Siddique et al. 2009), silk cotton hull (Kadirvelu, et al., 2003) and C. tropicalis (Charumathi & Das, 2012).

The adsorption through activated carbon is a very useful technique; however, the major constraints to this are high production cost and energy consumption. Therefore, the forest and agricultural waste materials can be an alternative choice for dye removal from wastewater because of their good performance and cost effectiveness. In this regard, sawdust from *Melia azedarach (MA)* was investigated for dye removal in a batch experiment. The maximum dye removal was tested as a function of contact time, adsorbent dosage and particle size.

2. MATERIALS AND METHODS

The sawdust of MA was obtained from local wood workers in Abbottabad, Pakistan. It was washed, dried and sieved to variable sizes (400, 250,180 and 105 µm) before being used. Methylene blue dye (C.I. 52015) (Merck, Germany) was used as reagent. The 1000 mg/L stock solution of dye was prepared by dissolving 1 gram of dye in 1000 ml deionized water.

The adsorption experiments were carried out in batch mode. Adsorption studies were conducted by placing 0.050 grams of adsorbent in 50 ml of dye solution in 100 ml conical flasks, using 50 mg/L initial dye concentration. The solutions were agitated at 220 rpm for four hours at 30°C. The solution agitated at 20, 40, 60, 140, 180, 240, 480 minutes to check the effective contact time for maximum dye removal. The effect of adsorbent amount and particle size was also measured. The adsorbent was separated from solution by centrifugation at 4000 rpm for 10 minutes. The concentration of the dye was determined by UV-visible spectrophotometer at maximum wavelength of 688 nm. The methylene blue removal in the adsorbent phase was calculated by the following formula:

$$\text{Percentage removal (\%)} = (C_o - C_e)/C_o \times 100$$

and

$$q_e = (C_o - C_e)V/m$$

Where,

q_e is the amount of dye adsorbed (mg/g) at equilibrium.

C_o and C_e are the initial and final concentrations of the dye, respectively.

'V' is the volume of the solution and 'm' is the mass of adsorbent in grams.

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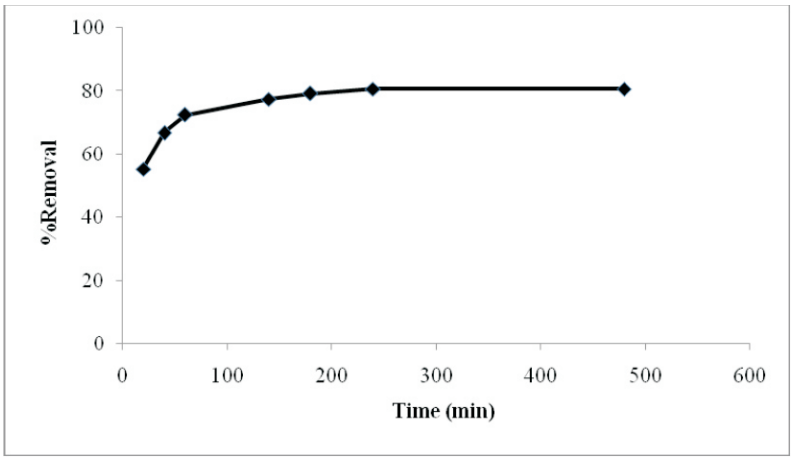

Figure-1: Effect of Contact Time on Methylene Blue Removal (T: 30°C, C_o: 50 mg/L, dosage: 1g/L)

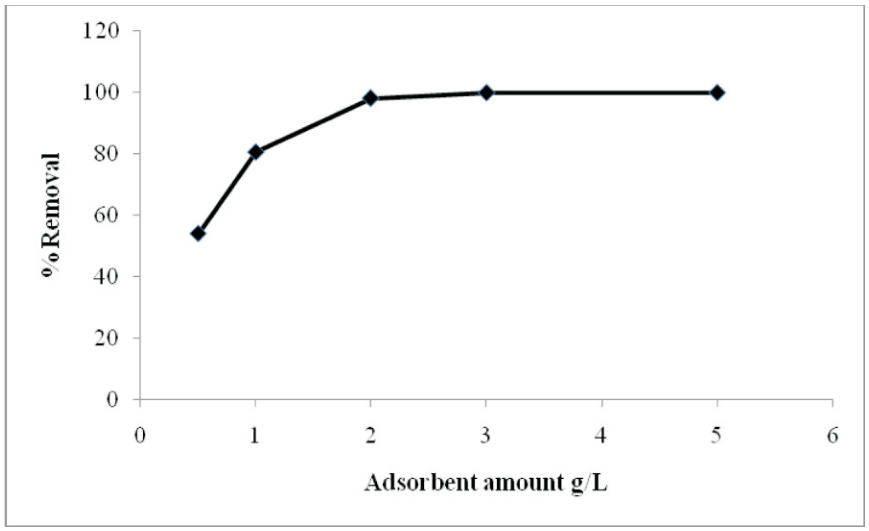

Figure-2: Effect of Adsorbent Dose on Methylene Blue Removal (T: 30°C, C_o: 50 mg/L, time: 240 min)

3. RESULTS

3.1 Effect of Contact Time

The contact time for maximum dye removal was investigated using *Melia azedarach* sawdust (Figure-1). The contact time ranges from 20-480 minutes with interval of 20 minutes. The results indicate that adsorption of methylene blue increases rapidly with time during first 80 minutes, and saturation point reached in 200-240 minutes.

3.2 Effect of Adsorbent Dose

The *Melin azadarach (MA)* adsorbent dose effects were investigated for methylene blue removal. The data collected reflects that the dye removal also increases with increasing bioadsorbent. The adsorbent dose varied from 0.5 to 5 g/L. Hundred percent removal of the methylene blue dye is attained on increasing the adsorbent dosage to 3 g/L. Complete removal of the dye is observed at adsorbent dosage higher than 1 g/L because of more surface area and binding sites availability for dye molecule. However, per gram uptake may reduce.

3.3 Effect of Particle Size

The smaller particle size favors more removal as indicated in Figure-3. The particle size that were investigated vary in the range of 105-400 µm size. The smaller particles of *Melin azadarach (MA)* show more

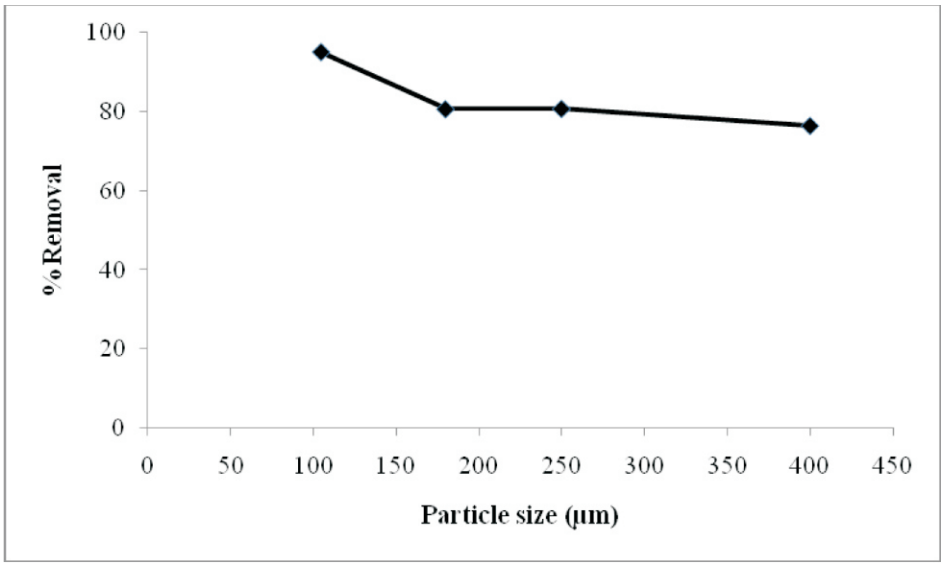

Figure-3: Effect of Contact Time on Methylene Blue Removal (T:30°C, C_o:50 mg/L, dosage: 1g/L, Time: 240 min)

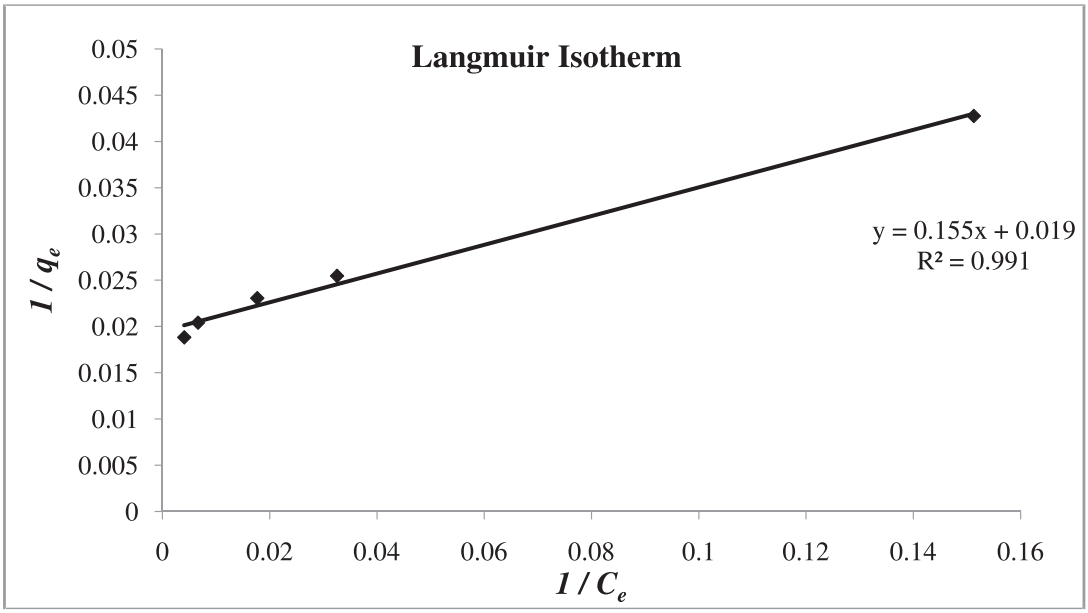

Figure-4: Correlation between Adsorption capacity of MA and residual concentration of the adsorbate (Methylene blue)

uptake because of more exposed surface area; as in the case of 105 µm size, more than 90 % removal attained.

3.4 Isotherm Studies

Adsorption isotherm studies were conducted in order to correlate adsorption capacity of the adsorbent and residual concentration of the adsorbate present in the aqueous solution (Rehman, et al., 2012). Various isotherm models have been applied for several dye concentrations and same adsorbent dose. The higher determination coefficient (R^2 = 0.991) suggests that Langmuir isotherm model best fits with the adsorption data (Figure-4). In the Langmuir isotherm model, it is assumed that adsorption occurs at specific homogeneous sites on the surface of an adsorbent and there are no significant interactions among adsorbed species. A single layer of adsorbent molecules saturates the adsorbent surface.

4. CONCLUSIONS

The aim of this study was to investigate the potential of *Melin azadarach* sawdust as an adsorbent for removal of methylene blue dye from water. The adsorption process is studied as a function of the contact time, adsorbent amount, and variable particle sizes. The results show that the MA sawdust was effective in removing methylene blue from wastewater. More than 90 percent removal of the methylene blue is achieved at 105 micrometer adsorbent particles size and only 1 g/L dosage. The Langmuir adsorption isotherm best fits (R^2=0.991) and the adsorption data suggests the specific homogeneous adsorption on adsorbent surface.

These results showed that *Melin azadarach* can be used effectively as an adsorbent material for the removal of methylene blue from wastewaters.

ACKNOWLEDGEMENT

We are indebted to the Higher Education Commission (HEC), Pakistan, for financial and logistical support for this study project.

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