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Removal of Reactive Blue Dye from Aqueous Solution Using Neem Leaves Powder as an Adsorbent

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Abstract:
Neem leaves is an agricultural product, perform as an effective adsorbent for colour removal from aqueous solution. A bench scale study was conducted for the removal of Reactive Blue dye. Experimental study was carried out to assess the potential effect of different flow rate and adsorbent depth. The maximum removal efficiency of 81.55% was observed for Reactive Blue colour at 10 cm adsorbent depth and 9ml/min flow rate. The adsorption isotherm of colour on the test of Neem leaves was carried out.

Keywords: *Neem Leaves, Colour, Adsorption, Textile Effluents, Treatment*

1. Introduction

1.1. General

The textile industry use large quantities of water and generate large volumes of wastewater from dyeing and finishing processes. Wastewater from dyeing and printing units is often rich in colour, residues containing of chemicals and reactive dyes [i].Wastewater from textile industry contains dyes in suspended and dissolved form [ii]. The characteristics of textile industrial wastewater are high biological oxygen need, high chemical oxygen need, high pH, high temperature and presence of phenol due to different dyes [iii]. They cause severe health problem and toxic to fish and other aquatic organisms by reducing photosynthetic activity due to less penetration of light [iv].

Cotton provides friendly textile, but reactive dyes are used more than 50% of its production volume. Unfortunately, dyes are not favourable from a view of ecological point, because the wastewater generated are heavily coloured [i].The removal of dyes plays an important factor of wastewater treatment before discharge. Among the different treatment methods, the adsorption provides a great potential for treating industrial effluents containing undesirable compounds. Advantage of adsorption process is cost effective and simple design [ii].

1.2. *Literature Review*

Removal of crystal violet colour Rutaceaevilacarbon (RAC) and Vilvam Carbon (VC) as a low cost adsorbent study was conducted by Priya et al. Removal of colour from textile industry wastewater with different pH, time and dosage of adsorbents [ii]. Experimental study on removal of methyl red colour from a stock solution was conducted by Ghanshyam et al., using Neem leaves powder [v]. Maximum removal efficiency recorded was 80%. Indira Khatodconducted study on removal of methylene blue colour from Neem leaves and Orange peel powder as an adsorbent. Batch adsorption experiments were conducted. Removal efficiency of 90-95% was obtained for 0.3 gm adsorbent dose at 2.5×10^{-5} mg/L dye concentration [vi].

Removal of colour from textile industrial wastewater using cost effective adsorbents experiment was conducted by Sivakumar et al. In the study locally available low cost adsorbents such as Neem leaves, Coconut coir pith, Peanut hulls and Orange peels powders were

used to treat textile industry wastewater for colour removal. The maximum removal of colour in textile industry wastewater is about 74.2, 79.3, 80.7 and 85.6% for Neem leaves, Orange peels, Coconut coir pith and Peanut hulls powders respectively[vii].

2. Materials and Methodology

2.1. Preparation of Solution

Synthetic samples were prepared in laboratory by weighing the known quantity of the dye powder and were dissolved in water as per experimental requirement.

2.2. Preparation of Neem Leaves Adsorbent

Neem leaves were collected from trees and washed using distilled water to remove dust and soluble impurities. Leaves were dried under sunlight until completely dry and they are crushed and screened in 150 micron mesh is retained and 600 micron mesh is passed. Screened Neem leaves powder was washed for several times and kept in oven dry for 5-8 hours at 60˚C. The dried powder was then mixed with 1N HNO_3 and kept in oven for 4-6 hrs at 60˚C. After powder was cooled, it was washed repeatedly to remove free acid and moisture content. Washed powder was dried in oven for 4-6 hrs at 50˚C and prepared adsorbent is stored for further use.

2.3. Experimental Procedure

To study the optimum colour removal bench scale adsorption experiments were conducted at varying flow rate and adsorbent depth. Column of 2.7cm dia and 24cm height was used for the experimental work. Pipe was connected to hole at bottom of column for effluent collection. The prepared colour sample was fed into column through burette by maintaining constant flow rate. Thus the treated solution comes out through nozzle which was connected to the bottom of column. Then the treated sample was analysed for colour. Figure 1 shows the line diagram of column study. Adsorption isotherm mathematical equations are used to describe the removal of colour using adsorbent.

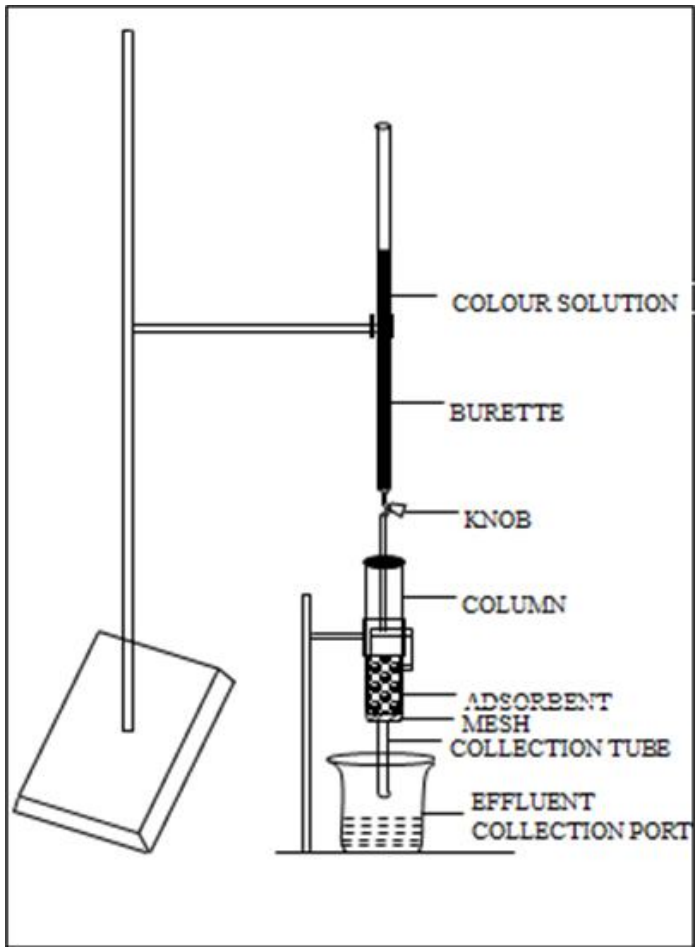

Figure 1: Line Diagram of Column Study

3. Results and Discussion

The different variables like adsorbent depth, flow rate has been selected for conducting bench scale adsorption study to decrease colour in wastewater.

Figure 2 shows the removal efficiency of Reactive Blue colour with different flow rate and adsorbent depth. For flow rate of 9ml/min and adsorbent depth 10cm the higher removal efficiency of 81.55% has been observed. The removal efficiency of 77.5 and 75.12% was observed for the same flow rate and 7.5 and 5 cm adsorbent depth respectively. For flow rate of 16 ml/min and 5 cm adsorbent depth the minimum removal efficiency of 70.09% was recorded. Similarly the removal efficiency of 73.42 and 77.79% was observed at the same flow rate and 7.5 and 5 cm depth was respectively.

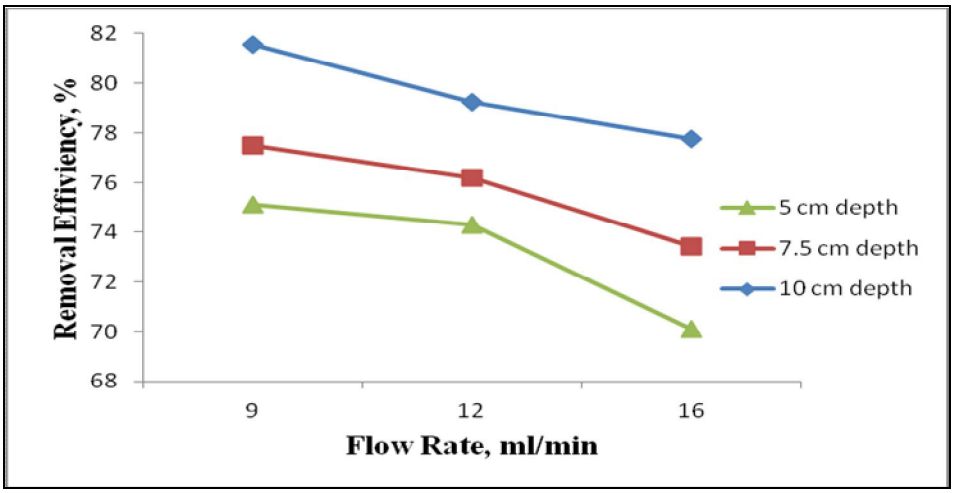

Figure 2: Effect of Flow Rate and Adsorbent Depth on Colour Removal

3.1. Adsorption Isotherm

Adsorption isotherm has mathematical relationships such as the Freundlich isotherm and Langmuir isotherm.

- Freundlich Isotherm
  $qe=(C0-Ce/M)=kCe^{1/n}$
  Where
  Co is initial concentration (mg/L),
  Ce is equilibrium concentration (mg/L),
  m is the amount of activated carbon used(g),
  k are Freundlich's constants(1/n).
  qe is amount of adsorbed per gram adsorbent (mg/g).
- Langmuir Isotherm
  (Ce/qe)=(1/a*b)+(Ce/a)
  Where
  qe= The amount of solute adsorbed per unit weight of adsorbent at equilibrium
  b = The Langmuir constant related to the heat of adsorption
  a = Amount of solute adsorbed per unit weight of adsorbent required for monolayer capacity whenCe/qe is plotted vs. Ce a straight line, The values of (a) and (b) have been determined from the slop(1/a) and intercept (1/(b * a))for this line.

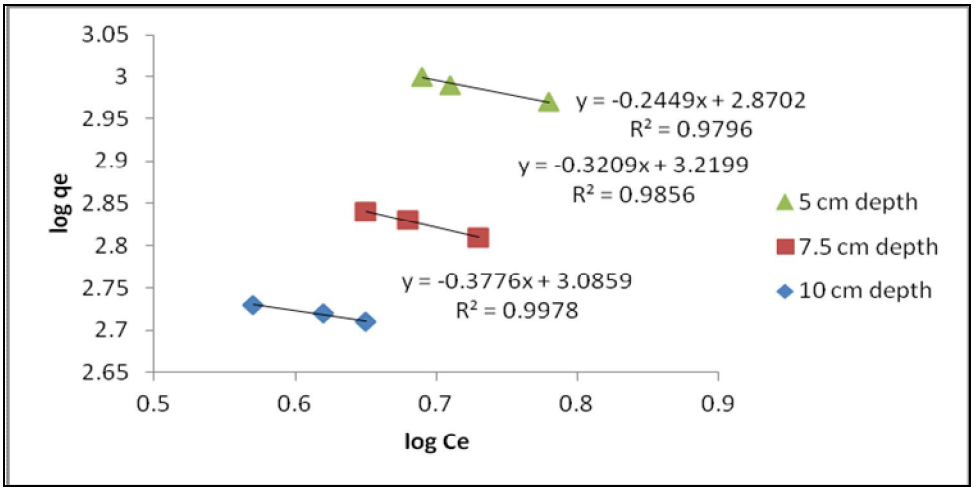

Figure 3: Freundlich Isotherm

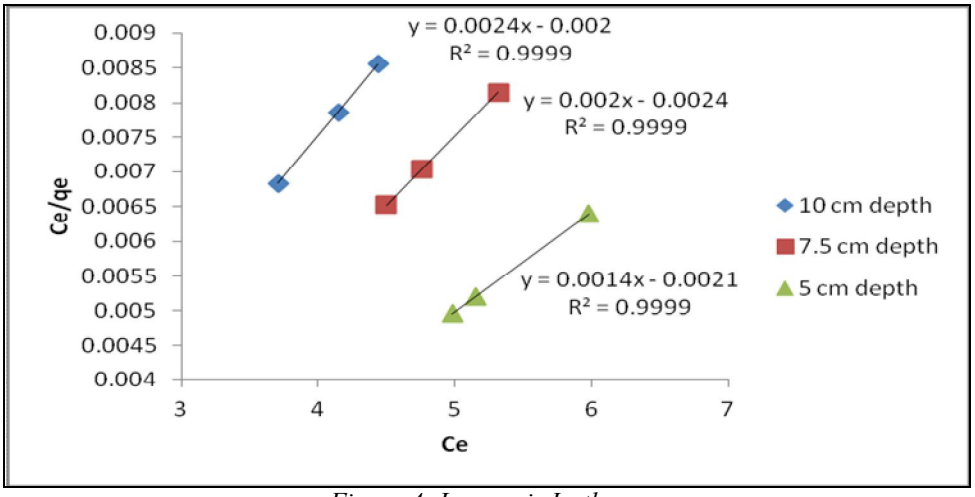

Figure 4: Langmuir Isotherm

Figure 3 and 4 shows the linear plot of log qe Vs log Ce and Ce/qe Vs Ce indicates the applicability of Freundlich and Langmuir adsorption isotherm. Values of R<1 represent favourable adsorption, the R value is found to be 0.997, 0.985 and 0.979 for 10, 7.5 and 5 cm adsorbent depth respectively. The R value for Langmuir isotherm was found to be 0.999, 0.999 and 0.999 for 10, 7.5 and 5 cm adsorbent depth respectively. These values indicated a favourable system.

4. Conclusion

In the present study, it has been observed that naturally available Neem leaves can be used as an effective adsorbent material.The removal efficiencies of 81.55, 79.24 and 77.79% have been recorded at 10cm adsorbent depth for flow rate 9, 12 and 16ml/min respectively. Maximum removal efficiency was observed for 10cm depth of adsorbent and9ml/min flow rate. Freundlich and Langmuir adsorption isotherm values indicated a favourable system.

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