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The Effectiveness of natural, Low Cost Adsorbent for Removal of Methylene Blue

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Abstract: The low cost absorbent neem leaf powder has been investigated for the effectiveness in decolorization of wastewater containing a dye name methylene blue. Effect of various parameters such as agitation time, pH, temperature and adsorbent dosage has been carried out in this study. Isotherm studies were conducted on a laboratory scale and the data evaluated for compliance with Langmuir and Freundlich isotherm models. Both models were well fit to equilibrium data. Batch pH study indicated that adsorbent was effective in the removal of acid dye and the disperse dye at lower pH values. For the basic dye maximum removals was exhibited at higher pH values.
Key words: Adsorption isotherm, methylene blue(MB), neemleaf powder, Dye removal.

Introduction

A dye is generally a substance that bears an affinity to the substrate to which it is being applied. It is often applied in aqueous solution. It requires a mordant to improve its binding with the fabrics .It appears to be colored because they absorb some wavelengths of light in particular than other.

High production and use of dyes generates colored wastewater and pollute the environment. Textile, paper and food industries, tanneries, electroplating factories discharge colored wastewater (Mckay, et al. 1998),[1]. Color or dye being one of the recalcitrant, persist for long distances in flowing water, retards photosynthesis, inhibit growth of aquatic biota by blocking out sunlight and utilizing dissolved oxygen[2,3] Some dyes may cause allergic dermatitis, skin irritation, cancer and mutation in man.[4]

The are various ways to remove dye from industrial effluents include coagulation, electrochemical process, membrane separation process, chemical oxidation, reverse osmosis , aerobic , anaerobic microbial degradation and adsorption. Among these options, Adsorption is most preferred and is widely used due to low cost and high performance and activated carbon is most effective adsorbent widely employed to treat wastewater containing different classes of dyes, recognizing the economical drawback of commercial activated carbon. [5,6,7]

Besides the activated carbon, the use of other low-cost adsorbents has also been the focus of the recent research. These include silica gel, clays, sawdust, peat, and fly ash[8,9,10].. Economic advantages, performance efficiencies and environment are the main concerns when selecting a adsorbent, thus researchers generally go for using low-cost adsorbents.[11,14]

The present study undertaken to evaluate the efficiency of neem leaf powder as an adsorbent for

the removal of MB dye from aqueous solutions[12,13]. The kinetic, equilibrium and thermodynamic data on batch adsorption studies were carried out to understand the process of adsorption. The effect of adsorption parameters such as initial dye concentration, temperature, pH, adsorbent dose, contact time, agitation time has been studied.

Experimental

The dye , Methylene blue , was obtained from Tomas Barker Chemicals Ltd. India. The stock solutions of the dye were prepared in distilled water .The absorbent ,neemleaf, were collected from one of the forest of Andera Pradesh state in India and washed thoroughly with distilled water to remove dust and other impurities. Washed neem was dried for 5 days in sunlight. Dried neem was grounded in a domestic mixer- grinder. After grinding, the powders were again washed and dried.

Dye adsorption experiments were carried out in batch mode by taking 50 mL solution of dye (10 mg/L) and treated with a dose of 0.1 g of adsorbent. The variable studies were pH, temperature, adsorbent dose,contact time and equilibrium capacity. The solution were stirred by magnetic stirrer. The values of percentage removal and amount of dye adsorbed were calculated using following relationships ,Percentage removal = [(Ci – Cf) / Ci] × 100 ,Amount adsorbed = (Ci – Cf)/ m ,Where, Ci = Initial dye concentration (mg l-1), Cf = Final dye concentration (mg l-1), m= Mass of adsorbent (g l-1).

Results and Discussion

Selected the different process parameters like adsorbent dosage, temperature, contact timeand pH for conducting the batch adsorption study to reduce color in the textile industry wastewater.

Effect of pH

The effect of different pH on dye solution of 100 ppm were investigated by varying the pH 4, 6,8,10. At pH 4 the removal was found to be minimum and it increased as initial pH of dye solutions were increased. It was maximum at pH = 10 as we see in the graph of qe V.s time. Sometimes adsorption is found to decrease with increase in pH of solution. The adsorption of these positively charged dye groups on the adsorbent surface is mainly influenced by the surface charges on the adsorbent which in turn is influenced by the pH of the solution. The results showed that availability of negatively charged groups at the adsorbent surface are necessary for the adsorption of basic dyes to proceed which we see at pH 4 is almost unlikely as there would accumulation of net positive charge in the adsorption .With increase in negative charges on the surface, adsorption of methylene blue dye which is a cationic dye would obviously increase. Thus as the pH increased, more negatively charged surface was available thus increasing the dye removal.The results are given in figure 1.

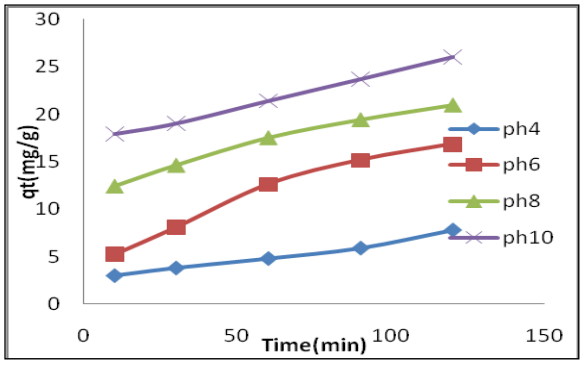

Figure 1Effect of time on adsorption capacity in different pH

$$q_t = \frac{(C_0 - C_t)V}{w}$$

Effect of Contact Time

The effect of contact time with 0.1 gmadsorbent dose in 50 ml (10 m/g) dye solutionwith pH= 7 were investigation, the colour removal increaseswith increase in time. It is clear that the extent of adsorption is rapid in the initial stages andbecomes slow in later stages tillsaturation is allowed. The colour removalreached 80

percent within first 90 minutes.However contact time required to reach equilibriumis 120 minutes. At equilibrium the colourremoval was 90%. It is basically due to saturation of the active site which do not allow further adsorption to take place .The results are given in figure 2.

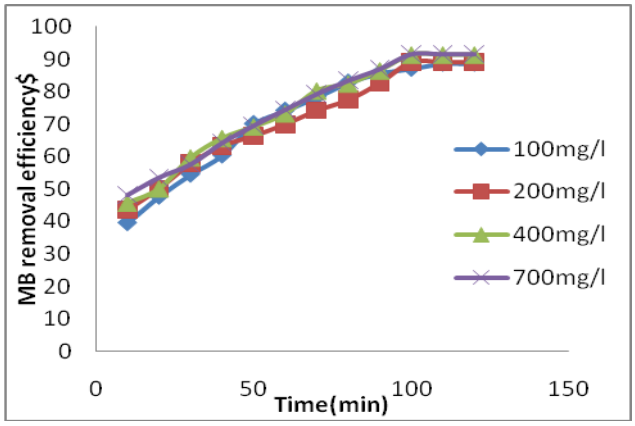

Figure 2 Effect of contact time on % MB removal efficiency at Temp=30◦c and pH= 7

Effect of Temperature

The effect of temperature on removalof dye solution was studied with initial concentration of methylene blue =100mg/1L and neem leaf powder concentration 1g/1L atpH=solutionpH the temperatures were varied in therange of 30, 40and 50°C. The results indicated that the adsorption capacity increases with increase in temperature. This can be ascribed by the fact that with increase in temperature there is increase in the mobility of the large dye ions. The molecules may also acquire sufficient energy to undergo an interaction with active sites at the surface. Further increasing the temperature may produce as welling effect within the internal structure of the neem leaf powder enabling large methylene blue dyes to penetrate further into it. The result implies that chemical adsorption mechanism may play an important role in this system. The results are given in

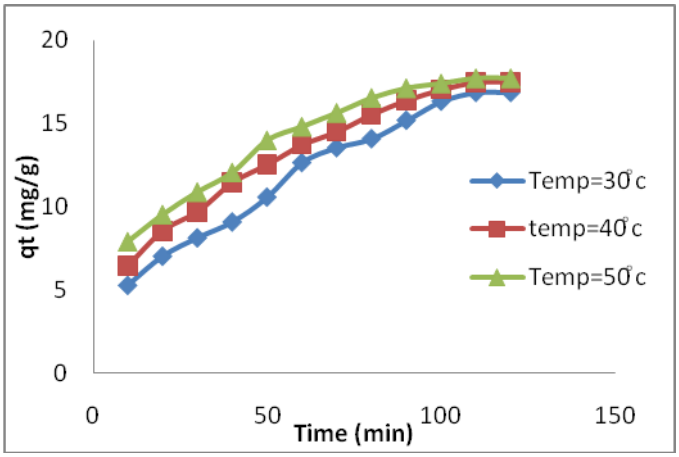

figure 3.

Figure 3 Effect Contact time VS Adsorption capacity in different emperature

Effect of Adsorbent dose:

Effect of adsorbent dose was studied with adsorbent dose varying in the range of 40 mg/100ml, 60mg/100ml,80mg/100ml, 100mg/100ml and 150 mg/100ml. We take 100mg/100ml as the optimum dose of adsorbent as with concentration 150mg/100ml we find nearly same adsorption so using this dose will only be cost inefficient and loss of neem powder. The results are given in figure 4.

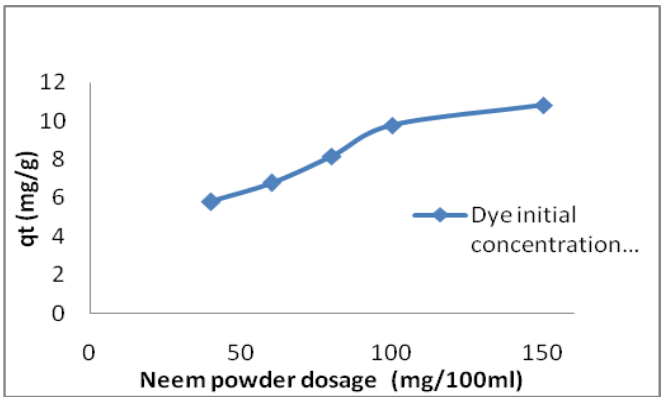

Figure 4 Effect of adsorbent dose

Adsorptionisotherms

Freundlich adsorption Isotherm:

The Freundlich equation was employed for the adsorption of MB onto the adsorbent. The isotherm linear model was represented by

log qe = log Kf + 1/n log Ce

The plots of log qe against log Ce showed good linearity (R2 = 0.885 to 0.977) indicating the adsorption of MB obeys the Freundlich adsorption isotherm. The optimum temperature was found 30c (R2=0.977).The results are given in figure 5.

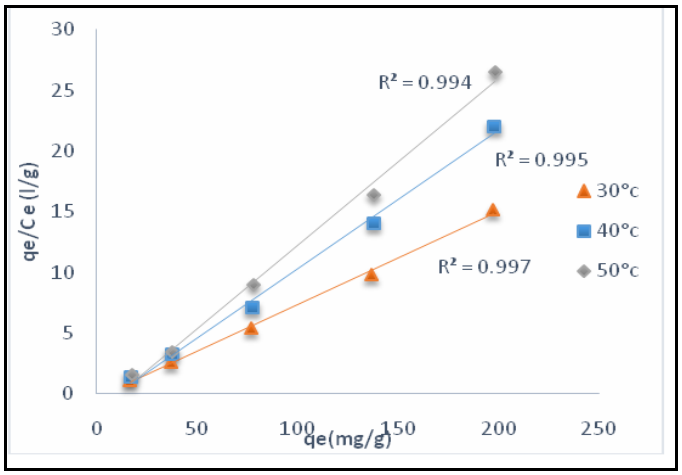

Figure 5 Frundlich isotherm model at different temperature

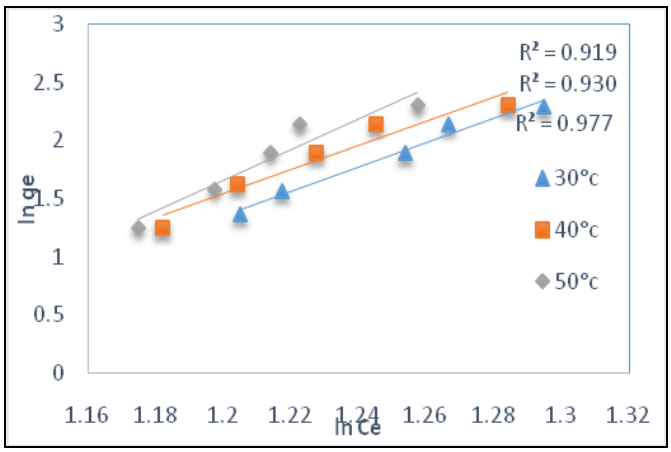

Figure 6 Langmuirisotherm model at different temperature

Langmuir Adsorption Isotherm:

This describes quantitatively the formation of a monolayer adsorbate on the outer surface of the adsorbent, and after that no further adsorption takes place. Thereby, the Langmuir represents the equilibrium distribution of metal ions between the solid and liquid phases . The Langmuir isotherm is valid for monolayer adsorption onto a surface containing a finite number of identical sites. The model assumes uniform energies of adsorption onto the surface and no transmigration of adsorbate in the plane of the surface.[14]

The Langmuir isotherm linear model was represented by the following equation.

Ce / qe = 1/ (qm b) + Ce /qm

A linear plots of Ce / qe against Ce ,1/q eVs 1/Ce ,qeVs qe/Ce and qe /C eVs qe suggest the applicability of the Langmuir isotherms (R2= 0.853 to 0.997). The optimum temperature was found 30c (R2=0.997).The results are given in figure 6.

By comparing data from below table , Both isotherm models are well-fitted with the equiliubruim data, which there is less error .Another important point which data shows , is that the optimum temperature for isotherm adsorption is in 30°c as we can see from the graph.

Conclusion

In the present study, conducted the experiments to find out the suitability of bio-adsorbents in removing color from textile industry wastewater. The ability of bio-adsorbents for removing color at a pH of 7 in a textile industry wastewater by various adsorbent dosage, various contact time, various temperature and various pH were monitored for this present study.

The following conclusions can be drawn from the experimental results:

1. The maximum percentage reduction of methylene blue dye were obtained at an optimum pH of 10, an optimum contact time of 85 min., an optimum temperature of 30c.
2. The Langmuir and Freundlich isotherm models were found to be best fitting isotherm model.
3. Finally, The low cost adsorbent prepared neem leaf powder was found effective in removing methyleneblue dye from aqueous solution. It can be used as a cheap substitute for commercial adsorbent for the removing of dye from textile wastewater for a better environment.

References

1. Forajpourlar M, S.Ram Mohan rao, Kariman M . Removal of Nitrate from waste water by ion exchange",International Jouranal of Chemical Engg.Reserch,ISSN 0975-6442 Volume 5,No 2,PP.117-. 125,2013

2. Mckay G. The adsorption of dyes tuffs from aqueous solutions using activated carbon: an external mass transfer and homogeneous surface diffusion model. AIChE J. 1985, 31 (2), 335−346.
3. Juang R.S., Swei S.L. Effect of dyes nature on its adsorption form aqueous solutions onto activated carbon. Sep. Sci. Technol. 1996, 31(15),2143−2156.
4. Gailliez-Degrémont E., Bacquet M., Laureyns J., Morcellet M. // J. Appl. Polym. Sci. 1997, 65 ,871−882.
5. Bacquet M., Gailliez-Degrément E., Morcellet M., in : H. Hommel (Ed), Polymers and surfaces. A Versatile Combination, Research Signpost, India, 1998, pp. 77−101.
6. Nassar M.M., El-Geundi M.S. Comparative cost of color removal from textile effluents using natural adsorbents. J. Chem. Tech. Biotechnol. 1991, 50, 257−265.
7. Basava Rao, V. V., and S. Ram Mohan Rao. "Adsorption studies on treatment of textile dyeing industrial effluent by flyash." Chemical Engineering Journal116.1 (2006): 77-84.
8. Satish Patil, Sameer Renukdas, Naseema Patel,Removal of methylene blue, a basic dye from aqueous solutions by adsorption using teak tree (Tectona grandis) bark powder, International Journal of Environmental Sciences, 1(5), (2011)
9. Kannan, Nagarethinam, and Mariappan Meenakshi Sundaram. "Kinetics and mechanism of removal of methylene blue by adsorption on various carbons—a comparative study." Dyes and pigments 51.1 (2001): 25-40.
10. Rafatullah, Mohd, et al. "Adsorption of methylene blue on low-cost adsorbents: a review." Journal of hazardous materials 177.1 (2010): 70-80.
11. Weng, Chih-Huang, Yao-Tung Lin, and Tai-Wei Tzeng. "Removal of methylene blue from aqueous solution by adsorption onto pineapple leaf powder." Journal of hazardous materials 170.1 (2009): 417-424.
12. Uddin, Md Tamez, et al. "Adsorptive removal of methylene blue by tea waste."Journal of Hazardous Materials 164.1 (2009): 53-60.
13. Bhattacharyya, Krishna G., and Arunima Sarma. "Adsorption characteristics of the dye, Brilliant Green, on neem leaf powder." Dyes and Pigments 57.3 (2003): 211-222.
14. Crini, Gregorio. "Non-conventional low-cost adsorbents for dye removal: a review." Bioresource technology 97.9 (2006): 1061-1085.

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