ADSORPTION OF RHODAMINE – B DYE FROM AQUEOUS SOLUTION BY ALOE VERA AS BIO – ADSORBENT

Guide name : Dr. S. Sujatha, M.E., Ph.D., KRCT, Trichy[1].

Akshaya M[2], Bhuvaneshwari A[3], Dhanalakshmi R[4], Dhivya S.[5]

[1-5]Department of Civil Engineering, K Ramakrishnan college, Trichy, Tamil Nadu

---

Abstract: Adsorbent obtained from Aloe vera gel in powdered form is employed for the removal of Rhodamine B dye from aqueous solution. Batch adsorption studies were carried out by observing the effects of pH, adsorbent dosage, concentration of dye, contact time and temperature. The equilibrium data fitted well to Langmuir isotherm model. The result indicates that the adsorbent obtained from Aloe vera is good for the removal of Rhodamine-B dye.

Index terms – Rhodamine-B dye, isotherm models, Adsorbent dosage, Thermodynamic parameters.

1. INTRODUCTION

Paper industries use large amount of water in their production and discharge large volume of waste water. It contains various types of dyes, heavy metals and organic wastes. These dyes are more harmful when discharged into water bodies. It is mainly used in industries like textile, paper printing and tanning industries. Most of the dyes are toxic and non-biodegradable, hence the removal is a mandatory thing.

Several methods have been designed to remove these dyes from waste water and such methods can be divided into different methods such as physical, biological and chemical. Among these, the adsorption technique using adsorbents derived from natural, agricultural and industrial wastes are effective in removing various dyes from waste water.

Many bio adsorbents were prepared from waste materials such as date stone, jujube seed, garlic peel, olive waste cake, apple wastes, oil palm fruit waste, periwinkle shell, coconut husk and bunch waste, castoir beam cake, maize stem tissue. In this study, we employed, the adsorbent obtained from the Aloe vera for the removal of dye.

EXPERIMENTAL

Preparation of adsorbate

Rhodamine b stock solution was prepared by dissolving appropriate quantity of dye in double distilled water and lower concentrations were obtained by dilution of the stock solution.

Fig.1 Stock solution

Preparation of adsorbent material

Aloe vera were collected and washed with DD water. It is dried in sun shade and charred mass was kept in muffle furnace at 400^{o} C and ground well to fine powder and store in vacuum desiccators and stirrer at 500 rpm.

Fig.2 Stirrer.

The characteristics of the adsorbent is present in the table-1.

pH	6.5
Moisture content %	98
Total solids content %	0.66
Soluble solids %	0.56
Polysaccharides %	53
Sugar %	17
Minerals %	16
Proteins %	7
Lipids %	5
Phenolic compounds %	2

Batch equilibrium studies

Batch experiment was carried out with different concentrations of dye solutions from 10 mg/l to 100 mg/l was taken in 250 ml clean flasks. A certain amount of adsorbent dose was mixed with stock solution and kept in an orbitary shaker with a speed of 125 rpm.

Experimental parameters such as adsorbent dose 50mg, contact time 90 minutes, pH-2, to 9, initial concentrations 10 mg/l to 50 mg/l and kept at room temperature were investigated by changing one parameter at a time,while other parameters were kept content. After filtration, the dye solution was analysed by UV- visible spectrometer. The percentage of Rhodamine-B dye removal was calculated by using the following equation.

Fig.3 UV visible Spectrometer

$$\% \text{ removal} = \frac{C_0 - C_e}{C_0} \times 100$$

Where C_i = initial concentrations (mg/l)

C_e = equilibrium concentrations (mg/l)

The adsorption capacity Q_e (mg/l) is obtained from the abov equations.

Where, Q_e = adsorbent capacity (mg/l)

C_i = initial nickel concentrations (mg/l)

V = volume of the solutions (L)

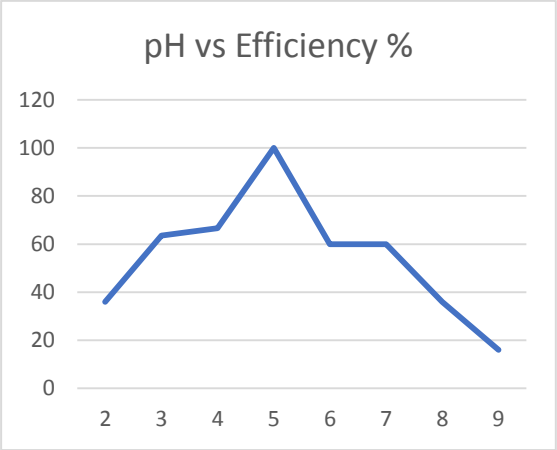
M = mass of the adsorbent (g).

RESULT AND DISCUSSIONS

Effect of pH

Effect of pH on the adsorption capacity of dosage was studied in the pH range from 2 to 9. The percentage of dye adsorption was determined by varying the pH of the solution, fixing the other parameters constant and the results are given in fig.1. The pH of the solution was adjusted by adding 1N of NaOH solution. When the pH increased and reached a maximum at pH 5 and the pH was decreased. At low pH the dye molecules readily enter into the pore structure of the adsorbent surface but at high pH, the Zwitter-iconic form of Rhodamine B in water aggregated to form a dimer which could not easily enter into the pores due to the bulkier structure of the dimer. Hence the pH the medium was maintained at 7 for further studies.

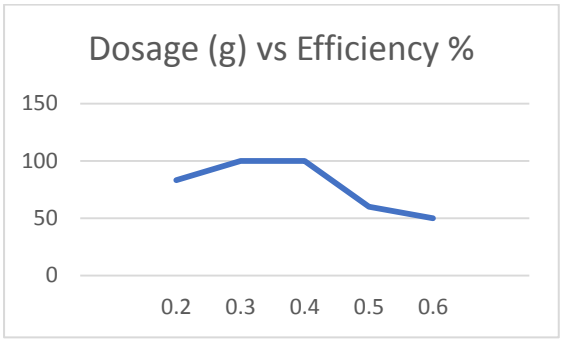
Fig. 4 At different pH



Effect of adsorption dosage

Effect of adsorbent dose on the removal of Rhodamine B dye from aqueous solution was investigated by varying adsorbent dose from 2 mg to 80 mg for 10 mg/l of dye concentration, keeping the other parameters constant and the results are presented in the fifg.2. When the adsorbent dosage of 50 mg, further addition of the adsorbent dosage has no significant effect. The maximum dye uptake occurred at 100 mg dosage, hence it was chosen as the optimized dosage.

Fig.5 At different dosage.



Effect of contact time:

The effect of contact time on the removal of dye process is shown in fig.3. It is observed that initially the percentage removal of the dye increases rapidly and then increases in a slow and gradual manner till it reaches the equilibrium.

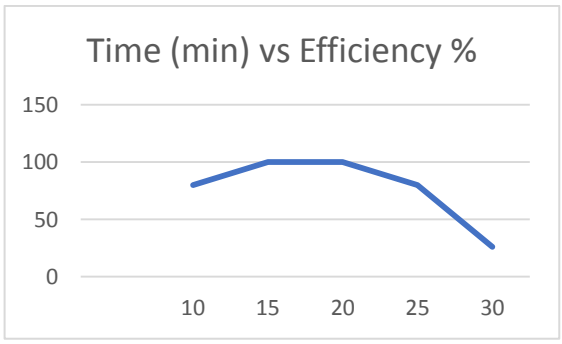
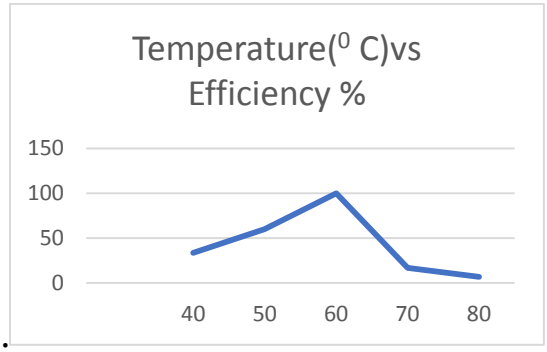


Fig.6 By varying contact time.

Effect of temperature:

The effect of temperature is observed that initially, the percentage of dye is gradually decreased in a slow manner. The optimum efficiency is obtained at 60^0 C.

Fig.7 By varying temperature.



Conclusions

The equilibrium and thermodynamics studies related to the uptake of Rhodamine B dye by Aloe vera adsorbent from aqueous solution was studied. The adsorption was found to highly dependent on various parameters like adsorbent dosage, contact time, pH, initial concentration and temperature. The adsorption data were fitted the best Langmuir adsorption model. The result of this study indicates that this adsorbent can be successfully utilized for the removal on Rhodamine B from aqueous solution.

REFERENCES

1. B.R. Babu, A.K. Parande, S. Raghu and T.P. Kumar, Cotton textile processing: Waste generation and effluent treatment, Journal of Cotton Science., 11,141-153. 2007.
2. S. Mondal, Methods of dye removal from dye house effluents-An overview. Environ. Eng. Sci., 25:383- 396,2008.
3. G. Crini , Non –conventional low-cost adsorbents for dye removal: A review . Bioresour. Technol., 97(9): 1061-1085.2006.
4. I.A.W. Tan, A.L. Ahmad and B.H. Hameed, Preparation of activated carbon from coconut husk: optimization study on removal of 2,4,6- trichlorophenol using response surface methodology, J. Hazard. Mater., 153,709- 717,2008.
5. T. Santhi, S. Manonmani and T. Smitha, Kinetics and isotherm studies on cationic dyes adsorption onto Annona squmosa Seed Activated Carbon. Int. J.Eng.Sci. Technol., 2(3),287-295,2010.
6. B.H.Hameed, D.K. Mahmoud and A.L. Ahmad, Equilibrium modeling and kinetic studies on the adsorption of basic dye by a low-cost adsorbent: coconut (Cocos nucifera) bunch waste, J. Hazard. Mater., 158,65-72,2008.
7. M.J. Ahmed and S.K. Dhedan, Equilibrium isotherms and kinetics modeling of methylene blue adsorption on agricultural wastes-based activated carbons, Fluid phase Equilibria, 317,9-14,2012.
8. M.C. Somasekhara Reddy, L. Sivaramakrishnab and A. Varada Reddy, The use of an agricultural waste material, jujuba seeds, for the removal of anionic dye (Congo red) from aqueous medium, J.Hazard. Mater., 203-204, 118-127,2012.
9. B.H. Hameed and A.A. Ahmad, Batch adsorption of methylene blue from aqueous solution by garlic peel, an agricultural waste biomass. J.Hazard. Mater., 164,870- 875,2009.
10. R. Baccar, P. Blanquez, J. Bouzid, M. Feki, H. Attiya and M. Sarra, Modeling of adsorption isotherms and kinetics of a tannery dye onto an activated carbon prepared from an agricultural by-product, Fuel process. Technol.,106, 408-415,2013.
www.ijsrp.org 11. R.H. Hessa, A. Arami-Niya, W.M.A.W. Daud and J.N.Sahu, preparation and characterization of activated carbon from apple waste by microwave-assisted phosphoric acid activation: application in methylene blue adsorption, Bio Resources, 8(2), 2950-2966,2013.
12. O.S. Bello and M.A. Ahmad, Removal of Remazol Brilliant Violet-5R dye using periwinkle shells, Chem. Ecol., 27(5),481-492,2011.
13. O.S. Bello, Adsorptive removal of malachite green using activated carbon prepared from oil palm fruit fibre by KOH activation and CO_2 gasification, S. Afr. J. Chem., 66,32-41,2013.
14. M.C. Somasekhara Reddy, V. Nirmala and C. Ashwini, Bengal gram seed husk as an adsorbent for the removal of dyes from aqueous solutions-Batch studies, Arab. J. Chem., 2013, DOI: http://dx.doi.org/10.1016/j.arabjc.2013.09.029.
15. Z.M. Magriotis, M.Z. Carvalho, P.F. de Sales, F.C. Alves, R.F. Resende and A.A. Saczk, Castor bean (Ricinus communis L.) presscake from biodiesel production: an efficient low cost adsorbent for removal of

textile dyes, J. Environ. Chem. Eng., 2, 1731-1740,2014.
16. V.M. Vucurovic, R.N. Razmovski, U.D. Miljic and V.S. Puskas, Removal of cationic and anionic azo dyes from aqueous solutions by adsorption on maize stem tissue, J. Taiwan Inst. Chem. Eng., 45,1700-1708,2014.
17. S. Ramuthai ,V. Nandhakumar, M. Thiruchelvi, S. Arivoli, V. Vijayakumaran, Rhodamine B adsorption- kinetic, mechanistic and thermodynamic studies, E-J. Chem.,6(S1):S363-S373,2009.
18. I. Langmuiir, the constitution and fundamental properties of solids and liquids. Journal of American Society.,38,2221-2295,1916.