WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 7.523
Volume 6, Issue 9, 837-844. Research Article ISSN 2277– 7105

REMOVAL OF DYE CRYSTAL VIOLET FROM WASTE WATER BY LOW COST NATURAL ADSORBENT (CCNS)

Shobha Borhade*

Department of Drug Chemistry, S.M.B.S.T. College, Sangamner.

Article Received on
27 June 2017,
Revised on 17 July 2017,
Accepted on 07 August 2017
DOI: 10.20959/wjpr20179-9265

***Corresponding Author**
Shobha Borhade
Department of Drug Chemistry, S.M.B.S.T. College, Sangamner.

ABSTRACT

Adsorption study was conducted with dye crystal violet on natural low cost adsorbent charcoal of cashew nut shell. Adsorption of crystal violet dye was studied with the initial dye concentration at pH 6.0 at 298K, 303K, 308 K & 313 K. The adsorption study were carried out isothermally at four different temperatures. Freudlich isotherm and Langmuir isotherm were used to describe the equilibrium data and the result were discussed in details. The thermodynamic parameters such as standard free energy change, entropy change and enthalpy change were studied for charcoal of cashew nut shell. This values showed that the adsorption of crystal violet on charcoal of cashew nut shell was a spontaneous and endothermic process.

KEYWORDS: Charcoal of cashew nut shell (CCNS), Crystal violet, Adsorption, Langmuir isotherm, Freundlich isotherm, Thermodynamics data.

INTRODUCTION

Colour is an important feature of beauty. Colourants add colour to life and make life as fine-looking as rainbow. Hence, the demand for colouring matter has experienced phenomenal growth in the past some decades. Color matter is dye. Dye is natural, organic compounds or synthetic material. It attach to the fabrics or surface to show bright and lasting colour. They are used in various industries like leather, textile, paper, rubber, cosmetics, plastic, pharmaceuticals and food industries. Most of them are complex organic molecules and are resistant to many things such as the action of detergents.[1-2]

There are more than 100,000 commercial dyes are known with an annual production intonnes per year.[3] It is estimated that 2% of the dyes are discharged in effluent from manufacturing

operation, while 10% was discharged from textile and associated industries.[4] Discharge of these dyes into the water streams will affects the people who may use these effluents for living purposes such as washing, bathing and drinking.[5] Some dyes can cause allergy, dermatitis, skin irritation, cancer and mutations in human.[6] Dyes also associated with environmental concern with their absorption and reflection of sunlight entering the water, which will inhibit the growth of bacteria, limiting it to levels insufficient to biologically degrade impurities in the water.[7] Even a small amount of dye in water can be toxic and highly visible.[8] Many dyes cause health problems like allergic dermatitis, skin irritation and mutations in human. Dyes affect aquatic flora by hindering their photosynthesis[9-10] due to reflection of sun light. Dye containing waste water offers considerable resistance to biodegradation due to their heat and light stability.[11] Synthetic dyes are relatively inexpensive, and as such, are widely used in the textile industry.[12-13] Some are known to be toxic and potential carcinogens, containing chlorine bound organics, chromium, acetic acid, surfactants, and metals such as copper, arsenic, mercury, cobalt, lead, and cadmium.[14] Crystal violet (CV) dye (**Figure 1**), also known as methyl violet 10B, hexamethyl pararosaniline chloride is a triarylmethane or basic violet 3, is an example of a basic synthetic dye, belonging to the group of triarylmethanes.[15-16] Histological stain and in Gram's method of classifying bacteria. Crystal violet has antibacterial, antifungal and anthelmintic properties and was important as a topical antiseptic. The medical use of the dye has been largely superseded by more modern drug although it is still listed by the WHO. The chemical formula of crystal violet is $C_{25}H_{30}ClN_3$ Its molar mass is 407.99 g mol^{-1}.

Therefore, the removal of such coloured compounds from waste effluents becomes environmentally important. Several techniques have been used for the removal of dyes from industrial effluents, including biological (microbial decolorization, biodegradation and bioremediation), chemical (coagulation and flocculation) and physical (electrolysis, reverse osmosis, membrane-filtration, and adsorption).[17-20]

Due to its high cost attention is being paid to low cost adsorbents. Many Investigators have studied the feasibility of using low cost adsorbents such as bagasse fly ash.[21-22] coir pith[23], peat[24], orange and banana peel[25], saw dust, rice husk[26], bark[27-28], Deoiled soya and bottom ash[29], cotton waste[30], slag[31], sugar can stalk[32], dried mango seeds[33], ashoka leaf powder[34], activated carbon from low cost wood[35] and sewage sludge[36], Sewage char and tyres, bamboo dust, coconut shell and husk, groundnut shell and straw, oil palm shell and

fibre, wheat bran.[37-39] Activated carbon is the most successful adsorbent predominantly used in adsorption studies.[40-42] It has some drawbacks that can limit its application, such as flammability, ease of desorption of highly volatile adsorbates, ineffectiveness for removal of oil, grease, and organic contaminants.[43-44]

MATERIALS AND METHODS

Materials

Charcoal of cashew nut shell was prepared as a sample of natural low cost adsorbent. It was powdered by pounding in a porcelain morter and dried at 108^0C. Crystal violet dye was obtained from textile industry Mumbai. The structural form of crystal violet is given in **Fig 1**. Crystal violet has the maximum absorption wavelength at 590 nm. The maximum absorption wavelength of crystal violet was determine the absorption of characteristic wavelength using UV spectrophotometer.

Absorption Study (Batch Process)

The dried charcoal of cashew nut shell 1.0 gm was taken in stoppered bottle. The crystal violet with initial concentration of 10 mg/dm^3, 20 mg/dm^3, 30 mg/dm^3, 40 mg/dm^3, 50 mg/dm^3. The mixture were well stirred on a shaker at 100 rpm at the temperature 298 K, 303 K, 308 K and 313 K for 20, 40, 60, 80, 100 & 120 minutes until the equilibrium condition were reached. The content was filtered. The adsorbate and adsorbent were separated by filtration. The filtrate in the aqueous solution after adsorption was measured by using pH values of the crystal violet dye solution were determined by using pH 6 using pH meter. The percentage of adsorption was determined from initial and equilibrium concentration respectively.

RESULTS AND DISCUSSION

Effect of initial dye crystal violet concentration

The relative crystal violet removal by the process of adsorbent as a function of crystal violet concentration was studied ranging from 10 mg/dm^3 to 50 mg/dm^3. At pH 6 at 313 K **Fig 1** shows the effect of initial crystal violet dye concentration on adsorption increasing initial concentration of crystal violet increases the equilibrium capacity. The crystal violet concentration of 10 mg/dm^3, 20mg/dm^3, 30 mg/dm^3, 40 mg/dm^3, & 50 mg/dm^3 increases the removal of 74.32%, 78.15%, 80.21%, 82.38% & 85.27% respectively. The equilibrium shift during the adsorption process increases the proportion of adsorption and which may result from the increased number of ions competing for the available binding sited on the surface of

crystal violet. Adsorption of crystal violet was a little increase for the concentration higher than 50 mg/dm^3. It indicate that the saturation of adsorption site was achieved. It observed that the rate of adsorption decreases with time and gradually reaches equilibrium **Fig 2** indicate that the adsorption measurement were taken over a period of 20 to 120 minutes in all cases the contact time of 120 minute was sufficient to ensure for affecting the equilibrium.

Effect of Temperature

Temperature is very important factor for adsorption. Higher temperature increases the rate of the adsorbate and decrease in the viscosity of the solution. Change in the temperature changes the equilibrium capacity of the adsorbent for the particular adsorbate. A series of experiments were conducted at 298 K, 303 K, 308 K and 313 K to study the effect of temperature on the adsorbate time rate. For 20, 40, 60, 80, 100 & 120 minutes. **Fig 3.**

Effect of pH

The effect of pH of solution is very important in adsorption process of dye. The ph of solution affect on the surface of adsorbent, solubility. The effect of pH on the removal of dye crystal violet using charcoal of cashew nut shell as an adsorbent. It was studied with the initial pH range from 2 to 9 it relates the initial pH of the dye solution.

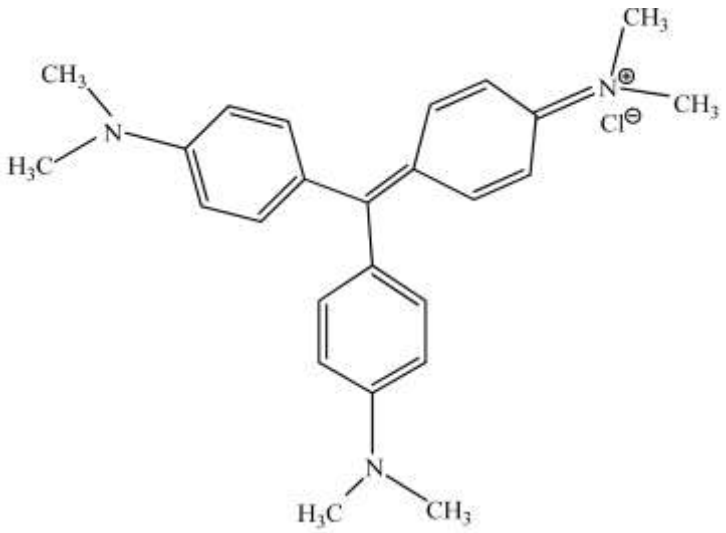

Fig 1: Structure of Crystal violet.

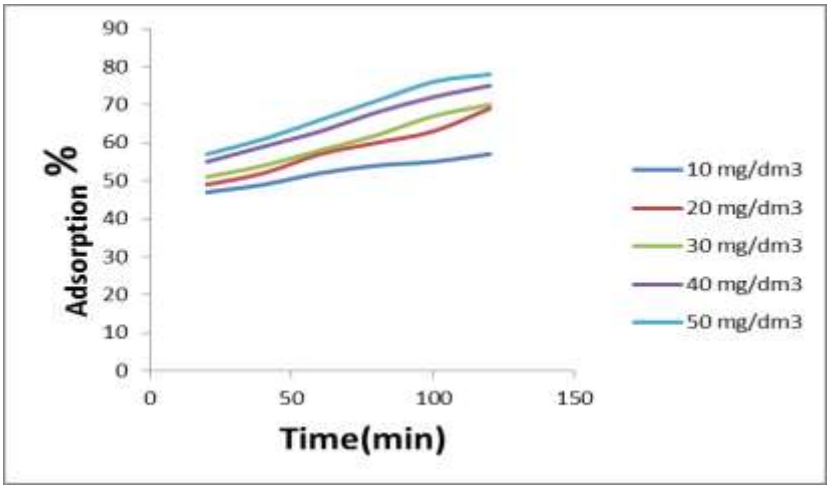

Fig 2: Effect of contact time and initial dye concentration on dye adsorption. Charcoal of cashew nut shell dose 1g/dm^3 (pH=6 at 313 K).

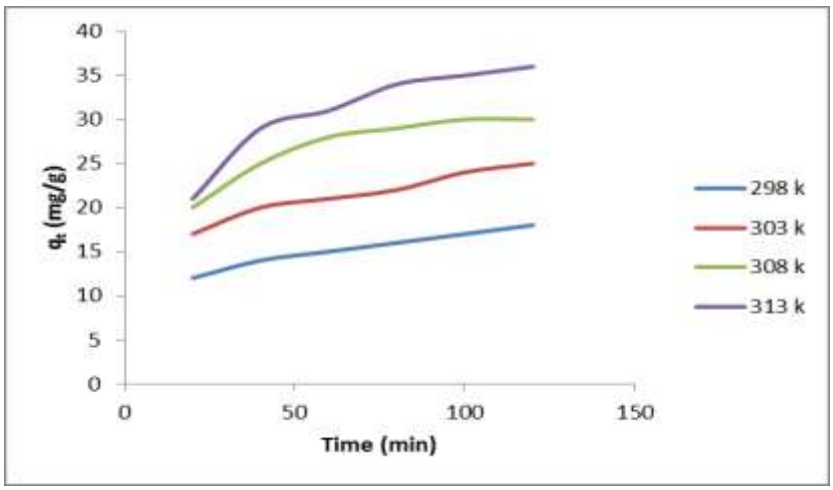

Fig 3: Effect of temperature on adsorption of crystal violet on to charcoal of cashew nut shell.

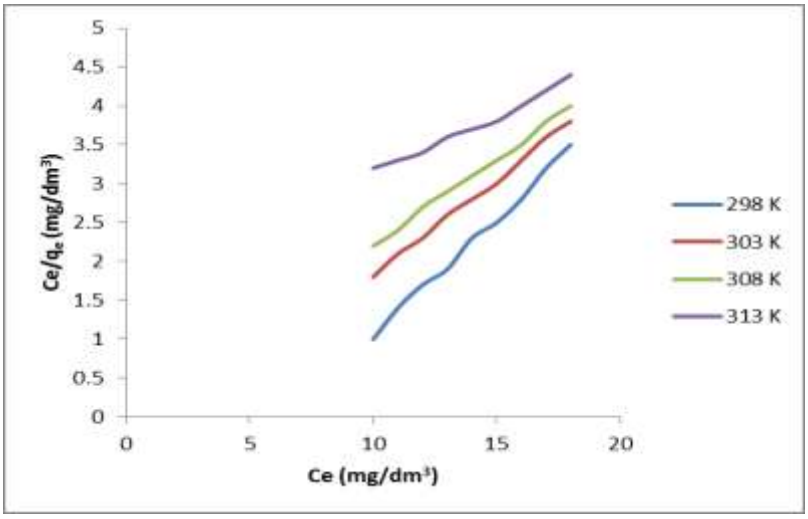

Fig 4: Langmuir Adsorption isotherm.

CONCLUSION

* CCNS was used as a adsorbent for removal of crystal violet dye. It is good adsorbent, Adsorption process is rapid at the starting and a becomes slow at the standard stage. It dependent on initial concentration of adsorbate and also time for adsorption.
* CCNS does increased percentage of adsorption also increased.
* This adsorption is good agreement with Freundlich adsorption isotherm and also for Langmuir adsorption isotherm.
* Adsorption process is good at pH 6. The uptake capacity of crystal violet is better for CCNS.
* Temperature effect shows that with increasing temperature capacity of adsorption increases.
* CCNS could be exploited for commercial applicable.
* The cost of adsorbent is very low & is easily available.
* The adsorbent CCNS can be deposed safely.

ACKNOWLEDGMENT

The author are grateful to the Principal of S.M.B.S.T. College, Sangamner, Ahmednagar.

REFERENCES

1. Chincholi M., Sagwekar, P., Nagaria, C., Kulkarni, S., and Dhokpande, S., Int. J. Sci. Eng. Technol Res., 2014; 3: 835-840.
2. Yagub M. T., Sen T. K., Afroze S., Ang H. M., 2014, Adv. Colloid Interfac, 2014; 209: 172-184.
3. Sen T. K., Afroze S., Ang, H., Water Air Soil Pollut, 2011; 218: 499-515.
4. Allen S. J., Mckay G., Porter, J. F., J. Colloid Interf. Sci., 2014; 280: 322-333.
5. Sharma M. K., Sobti R. C., Mutat. Res. Genet. Toxicol. Environ. Mutagen, 2000; 465: 27-38.
6. Bhatnagar A., Jain, A. K., J. Colloid Interf. Sci., 2005; 281: 49-55.
7. Mckay G., Al Duri, B., Chem. Eng. Process, 1987; 22: 145-156.
8. Chiou M. S., Ho P.Y., Li H.Y., J. Dyes Pig, 2004; 60: 69-84.
9. Annadurai G., Juang R.S., Lee D.J., J. Hazardous Materials, 2002; 92: 3, 263.
10. Malik P. K., Dyes and Pigments, 2003; 56: 239.
11. Morais L.C., Frietas O.M., Goncalves E.P., Vasconcelos L.T., Water Research, 1999; 33: 979.

12. Kant R., Natural Science, 2011; 4: 22-26.
13. Dahri M.K., Kooh M.R., Lim L.B., Environmental Chemistry, 2013; 1: 8.
14. Bertolini T.C, Izidoro J.C., Magdalena C.P., Fungaro D.A., Orbital-The Electronic Journal of Chemistry, 2013; 5: 179-191.
15. Adak A., Bandyopadhyay, M., Pal A. Separation and Purification Technology, 2005; 44: 139-144.
16. Mittal A., Mittal J., Malviya A., Kaur D., Gupta V., Journal of Colloid and Interface Science, 2010; 343: 463-473.
17. Hema M., Arivoli S., Int. J. Phys. Sci, 2007; 2: 10.
18. Pavan F. A., Dias S.L., Lima E.C., Benvenutti E.V., Dyes Pigments, 2008; 76: 64.
19. Wong Y.,Yu J., Water Res., 1999; 33: 16, 3512.
20. McKay G., J. Chem. Technol. Biotechnol, 1982; 32: 759.
21. Mall I.D., Srivastava V.C., Aggarwal N.K., Dyes Pigments, 2006; 69: 210.
22. Swamy M.M., Mall I.D., Prasad B., Mishra I.M., Ind. J. Environ Health, 1998; 40: 1,67.
23. Namasivayam C., Kavitha D., Dyes Pigments, 2002; 54: 47.
24. McKay G., Allens S.J., Meconney I.F., Qttrburn M.S., J. Colloid Interface Sci., 1981; 80: 2, 323.
25. Annadurai G., Juang R.S., Lee D.J., J. Hazardous Materials, 2002; 92: 3,263.
26. Malik P.K., Dyes and Pigments, 2003; 56: 239.
27. Morais L.C., Frietas O.M., Goncalves E.P., Vasconcelos L.T., Water Research, 1999; 33: 979.
28. Dave P.N., Kaur S., Khosla E., Ind Journal of Chemical Technology (ISSN-0971-457x), 2011; 18(1): 53.
29. Mittal A., Gupta V. K., Toxicological and Environmental Chemistry, 2010; 92: 1813.
30. Mckay G., Proter J.F., Prasad G.R., Water Air Soil Pollution, 1999; 1(4): 423.
31. Ramakrishna K.R., Virarghvan T., Waste Management, 1997; 17: 483-488.
32. El Sayed G.O., Mohammed T.Y., El Sayed O.E., Advances in Applied Science Research, 2011; 2(4): 283.
33. Itodo A.U., Itodo H.U., Atiku F.U., Koko R.A., Kwaido A.A., Asian Journal of Plant Science and Research, 2011; 1(1): 57.
34. Shelke R.S., Bharad J.V., Madje B.R., Ubale M.B., Der Chemica Sinica, 2011; 2(4): 6.
35. Sivakumar P., Palanisamy N., Advances in Applied Science Research, 2010; 1(1): 58.
36. Dave P.N, Kaur S., Khosla E., Ind Journal of Chemical Technology (ISSN-0971-457x), 2011; 18(5): 220.

37. Mohammed M., Shitu A., Ibrahim A., Research Journal of Chemical Sciences, 2014; 4: 91-102.
38. Yang Y., Centrone A., Chen L., Simeon F., Alan Hatton T., Rutledge G.C. Carbon, 2011; 49: 3395-3403.
39. Rafatullah M., Sulaiman O., Hashim R., Ahmad A., Journal of Hazardous Materials, 2010; 177: 70-80.
40. McKay G., J. Chem. Technol. Biotechnol, 1982; 32: 759.
41. Luna F.T., Araújo C.C., Veloso C.B., Silva I.J., Azevedo D.C., Cavalcante C.L., Adsorption, 2011; 17: 937-947.
42. Ania C., Cabal B., Parra J., Arenillas A., Arias B., Pis J. Adsorption, 2008; 14: 343-355.
43. Kaya E.O., Ozcan A.S., Gok O., Ozcan A., Adsorption, 2013; 19: 879-888.
44. Chang C.F., Chang C.Y., Chen K.H., Tsai W.T., Shie J.L., Chen Y.H., Journal of Colloid and Interface Science, 2004; 277: 29-34.