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LOW COST ADSORBENT FOR THE REMOVAL OF BASIC BLUE 17 FROM AQUEOUS SOLUTION

Dr. P. PARIMALA DEVI

PG & Research Department of chemistry, Gobi Arts & Science college (Autonomous), Gobichettipalayam, Erode Dt, Tamilnadu, India.

E-mail: parimalachem@gascgobi.ac.in

Abstract: **Adsorption Characteristics of basic dye (Basic Blue 17) using fruit waste obtained from juice processing industry was studied. The adsorption equilibrium capacity of basic dye onto the fruit waste increased with increasing initial pH and with increasing temperature of the solution. Adsorption equilibrium of basic dye onto the adsorbent could be represented by Langmuir isotherm equation. The kinetic data were fitted to the pseudo second order and Elovich models. Thermodynamic parameters such as change in the free energy, the enthalpy and the entropy were also evaluated. Desorption studies of dye in organic acid suggest that the adsorption of basic dye onto fruit waste involves chemisorption mechanism. The adsorbent material could be employed as low cost adsorbent as alternative material to commercial activated carbon for the removal of Basic blue 17.**

Keywords: **Adsorption, Fruit waste, Basic blue 17, Adsorption Isotherm, Equilibrium Kinetics and Thermodynamic parameters, Intra particle study, Desorption.**

I. INTRODUCTION

Discharge of dyeing industrial effluents on the land and water bodies poses a serious threat to the environment due to its high toxicity and non-biodegradable nature. Recently many technologies like electrochemical coagulation, reverse osmosis, nano fitlration, adsorption using activated materials etc.. ,are used for the removal of dye from waste water adsorption has been proposed as a feasible and economical process for the treatment of dyeing industry effluent. In recent past, many researchers have proved that adsorbent prepared from useless plant materials and agricultural wastes can remove substantial amount of dyes from the effluents.

Some of the materials which are used for the preparation of adsorbent in the recent past are orange peel[1],lemon peel[2],saw dust [3,] pinus pinaster bark [4],tamarind kernel powder[5],oil palm waste[6],Turkish Zeolite[7]etc., are of negligible cost as compared to commercial activated carbon.

The present study is undertaken to evaluate the efficiency of an adsorbent prepared from fruit waste for the removal of Basi Blue 17 dye. In this work, the applicability of kinetic and intraparticle diffusion models for the adsorption of Basic Blue 17 onto fruit waste has also been studied.

II. MATERIALS AND METHODS

Materials

Waste fruit residues (FR) obtained from the fruit juice processing industry after the removal of impurities (washed with dil.HCl, distilled water and dried) was used as adsorbent.

All the chemicals used are reagent grade. A cationic dye (Basic Blue 17(or) Toludine Blue O having molecular weight 408 with C.I. No.52040 (E,Merck) was chosen as the adsorbate.

The pH measutements were made on Deluxe pH meter (Model 101E), conductivity measurements were made using Conductivity Meter(Model M-180) and Colorimetric estimations were carried out using UV-VIS Spectrophotometer 119(Systronics).

Character studies

Physico chemical characteristics of the prepared adsorbent were studied as per the standard testing methods[8,9] .Infrared Spectroscopy provides information on the chemical structure of the adsorbent. The surface morphology of adsorbents were visualized via Scanning Electron Microscopy.

Adsorption Studies

The adsorption experiments were carried out in a batch process at 302K,307K,312K,317K and 322K.Known weight of adsorbent was added to 50ml of dye solution with initial concentration ranging from 10 to 40 mg/L. The contents were shaken thoroughly using a mechanical shaker rotating at 120rpm.

Desorption Studies

After adsorption experiments the dye loaded adsorbent was washed gently with double distilled water to remove any un-adsorbed dye if present. Desorption studies were conducted using several such adsorbent samples.500mg of the dye loaded adsorbent was agitated above the equilibration time with 50ml of double distilled water of various pH.

III. RESULTS AND DISCUSSION

Investigation of sorption Parameter

Effect of agitation time and initial concentration of dye solution

The effect of agitation time on the amount of dye adsorbed was observed at the optimum initial concentration of dye. The extent of removal of Basic Blue 17 by the adsorbent (FR) is found to increase and reach a maximum value with increase in contact time. The relative increase in the extent of removal of dye after 165min of contact time is not significant and hence it is the optimum contact time. The results are given in Figure-1.Similar results have been reported in literature for the removal of dyes[10] and metals[11].

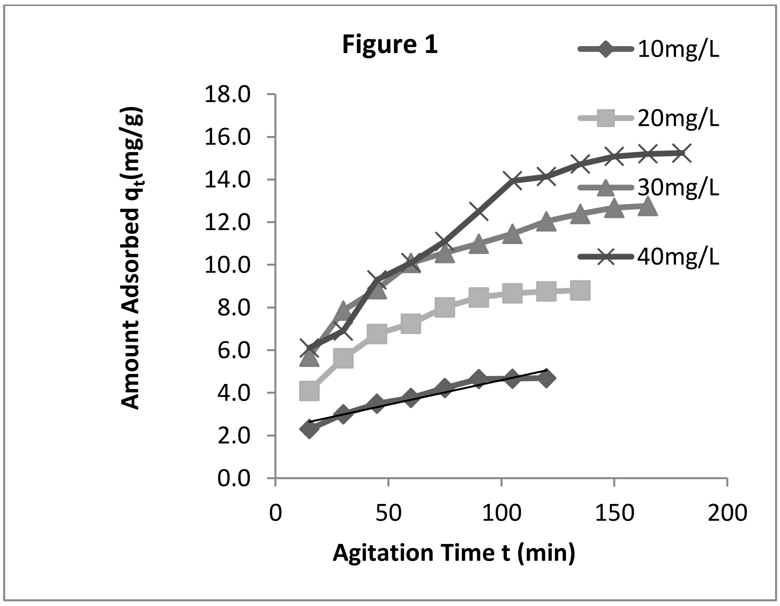

Fig.1. Effect of agitation time and initial concentration on the removal of Basic Blue 17 with FR adsorbent

Effect of Initial pH

The effect of initial pH of the dye solution on the amount of Basic Blue 17 adsorbed was studied by varying the initial pH, under constant conditions of other parameters[12] the results are shown in Figure-2.

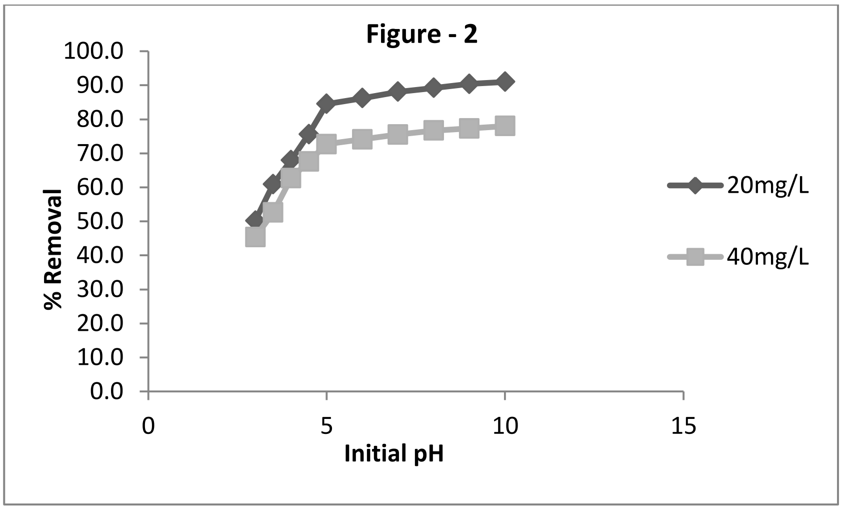

Fig.2 Effect of pH on the removal of Basic Blue 17

Effect of Adsorbent Dose

The effect of adsorbent dose was also investigated for the removal of dyes from aqueous solution. The experiments were carried out with adsorbent dose varied from 25mg to 450mg by keeping all other parameters are constant. The results are shown in Table-1 .Similar results have been reported by the other investigators[12].

TABLE 1: Effect of Adsorbent Dose

Adsorbent (FR) Dose (mg)	%Removal	
	20mg/L	40mg/L
25	35.92	21.63
50	43.39	35.68
75	71.21	42.35
100	88.63	53.86
125	92.23	58.62
150	94.32	67.32
175	96.68	71.23
200	98.25	76.39
225	99.01	79.32
250	100.00	86.67
275	-	95.63
300	-	100.00

Kinetic Model of Adsorption

The Kinetics and dynamics of adsorption of Basic Blue 17 on treated fruit waste have been studied by applying pseudo first order, Pseudo second order and Elovich models[13].The adsorption follows pseudo second order kinetic model (Figure-3).

Pseudo second order equation:

$$t/q_t = 1/k_2q_e^2 + t/q_e$$

k_2 –rate constant of second order adsorption (g/mg/min)

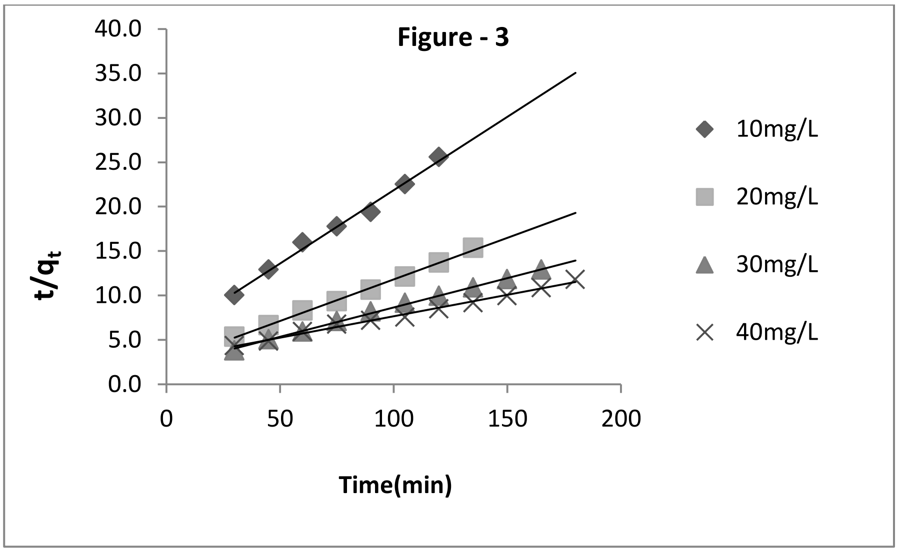

Fig.3. Pseudo Second order reaction

Adsorption Isotherms

The adsorption data were analysed with the help of the following linearised forms of Freundlich and Langmuir isotherms[14].

Freundlich isotherm: $\log q_e = \log K + 1/n \log c_e$

Langmuir isotherm: $c_e/q_e = 1/Q_o b + c_e/Q_o$

Where

K=adsorption capacity

(1/n)=order/intensity of adsorption

q_e =amount of MG adsorption per unit mass of adsorbent (mglg)

c_e =equilibrium concentration of dye (ppm)

Q_o=monolayer (maximum) adsorption capacity (mglg)

b=Langmuir constant related to energy of adsorption (l/mg)

In the present study, the values of R_L are observed to be fraction (0.2040 to 0.6059), which indicate that the adsorption process is favourable.

Table – 2.Langmuir Isotherm

Dye conc. C_o(mg/L)	C_e (mg/L)	q_e (mg/g)	C_e/q_e (g/L)
20	8.46	11.54	1.3640
40	15.82	24.18	1.5284
60	20.55	39.45	1.9197
80	24.12	55.88	2.3167
100	25.20	74.80	2.9682
120	24.12	95.88	3.7867

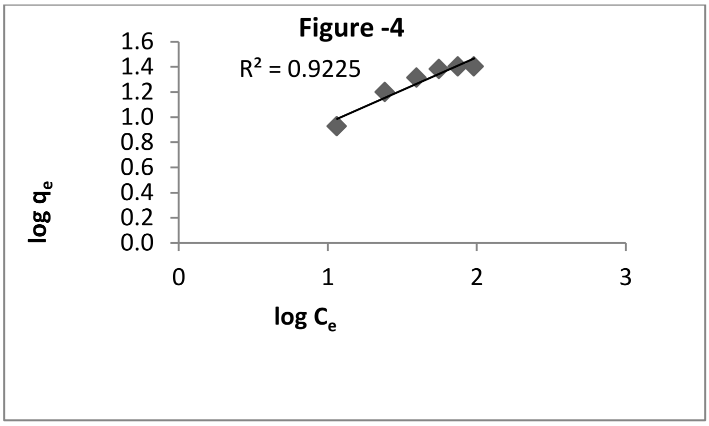

Fig.4 Freundlich Isotherm

Effect of Temperature

Increase of temperature hardly increased q_e value. The thermodynamic parameters were determined using the following equations.

$$\Delta G^{\circ} = \Delta H^{\circ} - T\Delta S^{\circ}$$

$$\Delta G^{\circ} = -RT \ln K_c$$

The negative value of Gibbs free energy change (ΔG°) indicates the spontaneous nature of adsorption[15].The results are shown in Figure 5.

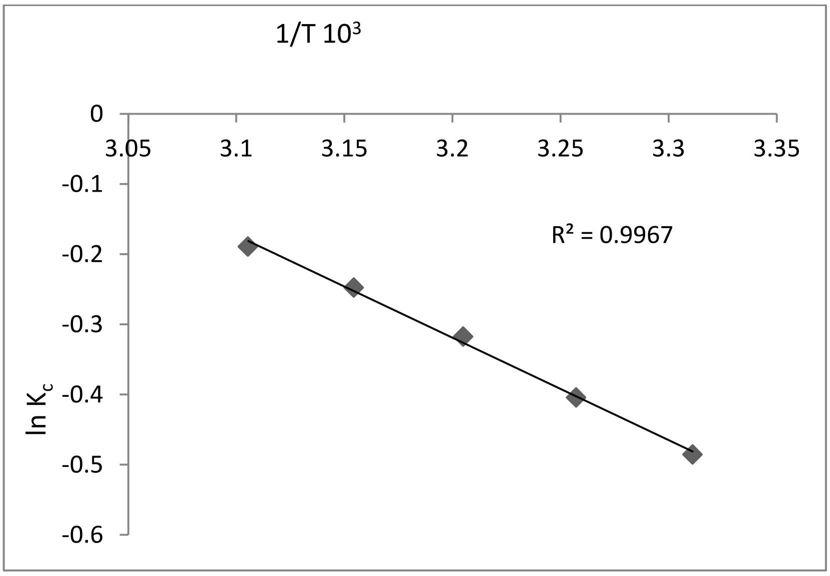

Fig.5 Eyring Plot

Desorption Studies

The poor desorption of the dye Basic Blue 17 with acetic acid indicates that the dye adsorbed onto the adsorbent through by chemisorption mechanism[16].

IV. CONCLUSION

The adsorption of Basic Blue 17 with fruit residue as an adsorbent was studied. The adsorption rate increases with increase in dye solution concentration and increase of adsorbent dose. The adsorption followed pseudo second order kinetics and also supported by Elovich model. The adsorption isotherm data were well described by Langmuir and Freundlich adsorption models. The adsorption process was found to be endothermic in nature. The thermodynamic study reveals,a spontaneous adsorption process. Desorption studies reveals that no satisfactory desorption taking place indicating chemisorptive nature of adsorption.

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REFERENCES

[1] Aswathi R Krishnan and Duithy George,Methylene blue removal using orange peel,Inter J.sci. & Eng. Res.,7(4),250-252 ,2016.

[2] Amit Bhatnagar,EvaKumar,A.K.Minocha,Byong-Hun Jeon,Hocheol Song and Yong-Chan Seo,Removal of Anionic dyes from water using Citrus limonum peel :Equilibrium Studies and Kinetic Modeling,Sep.Sci. and Tech.,44(2), 316-334,2009.

[3] Aharoni C.,Ungarish M.,Kinetics of activated chemisorptions Part 2,Theoretical models, J.Chem.Soc.Farady Trans.,73,456-464,1977.

[4] APHA ,Standard methods for the examination of water and wastewater,20th ed.American Public Health Association,Washington,DC,(1998).

[5] Freundlich H.,Colloid and capillary chemistry,E.P.Dutton and Co.,Newyork,1928.

[6] Dubinin M.M.,The potential theory of adsorption of gases and vapours for adsorbents with energetically non-uniform Surface.Chem.Rev.60,235-266,1960.

[7] Sibel Kilinc Alpat,Ozge Ozbayrak,Senol Alpat,Hijsamettin Akcay,The Adsorption Kinetics and removal of Cationic dyeToludine Blue O from aqueous solution with Turkish Zeolite,J.Hazardous Materials,151(1),213-220,2008.

[8] Hsieh C.T.,Teng H.,Liquid-Phase adsorption of phenol onto activated carbons prepared with different activation levels,J.Colloid.Interf.Sci.,171-175,2000.

[9] Ilhan U.,Kinetics of the adsorption of reactive dyes by Chitosan,Dyes Pigments.,70,76-83,2006.

[10] Deo N and Ali M,Adsorption by a new low cost material :Congo red 1 and 2,Indian J.Environ.Protec.,17(5),328-331,1997.

[11] Kannan N and Rajakumar A,Studies on the removal of Lead (II) ions by adsorption on indigenously prepared activated carbon,J.Environ.Stud.Policy.,4,75-86,2001.

[12] N.Kannan and S.Murugavel,Comparative Study on the removal of Acid violet by Adsorption on various low cost adsorbents,Global Nest Journal,10(3),395-403,2008.

[13] P.Parimala devi and V.Venkateswaran ,Kinetics Thermodynamics and Isotherm modeling of Adsorption of Triphenylmethane dyes(Methyl violet,Malachite green and Magenta II) onto Fruit Waste,J.Applied Tech.in Environ.Sanitation,1(3),273-283,2011.

[14] P.Parimala devi and V.Venkateswaran ,Adsorption of Cationic dyes (Rhodamine B and Methylene Blue) from aqueous solution using treated Fruit Waste, J.Applied Tech.in Environ.Sanitation,1(3),285-293,2011.

[15] R.Priya,R.Nithya,R.Anuradha and T.Kamachi,Removal of colour from Crystal violet dye using Low cost Adsorbents,Inter.J.Chem .Tech.Res.,6(9),4346-4351,2014.

[16] P.Parimala devi and V.Venkateswaran,Removal of basic dyes(Methylene blue And Rhodamine B) from aqueous solution by biosorption onto fruit waste,Indian J. Environ.Sci.,16(1),1-7,2012.