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RESEARCH ARTICLE

ADSORPTION OF REACTIVE MAGENTA AND METHYL RED FROM AQUEOUS SOLUTION USING ACTIVATED CARBONS

***Rajamani Mayathevar and Xavier Arulanandham**

Department of Chemistry, the Madura College, Madurai – 625 011, India

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ABSTRACT

Stress Three adsorbents, namely, Bagasse carbon(BC), silk cotton shell carbon(SCSC) and sorghum vulgare carbon (SVC) were prepared for the adsorption of reactive magenta(RM) and methyl red(MR). Adsorption was studying by optimize the process parameters such as the effect of the experimental parameter like, initial concentration of dyes, contact time, dose of adsorbent, pH and extent of removal of dye from water. The kinetic data were fitted to thepseudo-first-order, pseudo-second-order and intraparticle diffusion models. Langmuir, Freundlich, Temkin adsorption isotherms and various kinetic equation and models like Natarajan and Khalaf, Lagergren, Bhattacharya, pseudo-first order, pseudo-second order, Elovich and intra particle diffusion model for the adsorption data by employing linear regression analysis with the help of computer. The results are confirmed by before and after adsorption process with the help of the following instrumental techniques viz., FT-IR Spectrophotometer.

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INTRODUCTION

Industries such as paper, textile, plastic, leather, cosmetic, and foodemploy dyes to colour their products. The residual dye bearing effluents of those processes are discharged into the water bodies (Sivarajasekar *et al.,* 2016). This massive influx of untreated organic chemicals into the waterways not only affects the environmental health of the region. It also represents an increasing environmental danger due to their refractory carcinogenic nature. From an environmental point of view, the removal of synthetic dyes is of great concern (Elmoubarki *et al.,* 2015). Dye molecules consists of two key components: the chromophores, which are largely responsible for producing the colour and the auxo-chromes, which are not only supplement the chromophore but also render the molecule soluble in water and enhance its affinity (to attach) toward the fibers. Dyes may be classified in several ways, according to chemical constitution, application class and end use. Dyes are here classified according to how they are used in the dyeing process. Main dyes are grouped as acid dyes, basic dyes, direct dyes, mordant dyes, vat dyes, reactive dyes, disperse dyes, azo dyes, and Sulphur dyes (Kayode *et al.,* 2015). The scientists, academicians and governmental agencies are very serious on the pollution of water resources globally.

The surface and ground waters at many places of the world are contaminated and not fit for drinking purpose. By 2050, the global population is expected toreach up to 9.3 billion (United Nations, 2011) and the world maybe under great fresh water scarcity (Imran Ali *et al.,* 2012). Therefore, a keen attention and serious effort of researchers are required to eradicate this problem or to find the natural convenient way for the pre-treatment of the noxious dyes effluents (Robati *et al.* 2016). In the present study the various activated carbons were prepared from low cost agricultural waste materials for the adsorption of *reactive magenta and methyl red* dye stuffs.

MATERIALS AND METHODS

Activated carbon preparation

Bagasse, silk cotton shell and sorghum vulgare materials obtained from agriculture waste, which was washed using tap water and finally with double distilled water to remove the suspended impurities like dust and soil and then dried in an air oven. About 500g of bagasse, silk cotton shell and sorghum vulgare carbon are mixed with 100 ml of concentrated sulphuric acid separately and kept at room temperature for 24 hours. Then, it was dried in a hot air oven at 80° C. The dried material was washed with distilled water to remove excess of acid. Charcoal was dried at 110° C for 12 hours to remove moisture and kept in an air tightened bottle.

***Corresponding author:* Rajamani Mayathevar,**
Department of Chemistry, The Madura College, Madurai – 625 011, India.
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Adsorbate used

Reactive magenta and methyl red dye was used as adsorbate to determine the adsorption performance of the prepared activated carbons. The molecular weight of reactive magenta is 1418.94 g/mol. And the absorption maximum of this dye is 530 nm. The C.I. name of methyl red dye is Acid red 2. The molecular formula is C15h15n3o2. The molecular weight is 269.304 g/mol. The wavelength is 410 nm. The IUPAC Name is {[4-(Diethylamino) phenyl]diazyl}benzoic acid. It is an Azo dye and is a dark red crystalline powder. Methyl red is a pH indicator; it is red in pH under 4.4, yellow in pH over 6.2 and in orange within a pKa of 5.1. Methyl red has a special use in Histopathology for showing acidic nature of tissue and presence of organisms with natured cell wall. An accurately weighed quantity of dye was dissolved in double distilled water to prepare the stock solutions.

Adsorption experiments

Batch mode adsorption studies were carried out by adding certain amount of dose of adsorption and 50 ml of dye solution of certain concentrations, contact time at 200 ppm. The samples withdrawn from the shaker at predetermined time intervals and solution were separated from the adsorbent. To determine the residual dye concentration, the absorbance of the supernatant solution was measured before and after treatment with double beam spectrophotometer. The initial dye concentrations in the test solution and the contact time were changed to investigate their effect on the adsorption kinetics. The amount of adsorption in batch experiment the amount adsorbed and adsorption efficiency (% removal) was calculated as follows:

$$\text{Amount adsorbed } (q) = (C_o - C_e)/m \quad (1)$$

$$\text{Efficiency (\%) removal} = (C_o - C_e)/C_o \times 100 \quad (2)$$

Where

Co is the initial concentration (mg/L)
C_e is the equilibrium concentration (mg/L)
m is the mass of the adsorbent (g)
q is the amount adsorbed (mg/g)

RESULTS AND DISCUSSION

Effect of concentration variation

The experimental results of the effect of initial concentration of RM and MR varying (26-40, 36-50 for BC, 52-66 ppm and72-86 for SCSC, 58-72, 96-110 ppm for SVC respectively) and fixed amount of dose and contact time on the extent of the removal of dye in terms of the percentage removal and amount adsorbed (mg/g) using carbon BC, SCSC, SVC. The batch adsorption experiment where performed with the fixed dose 1g/L and constant contact time (45 min). The initial concentration (C_o) of the dye is (26-40, 36-60, 52-66) for RM (BC, SCSC, SVC) and (72-86, 58-71, 96-110) for MR (BC, SCSC, SVC). Equilibrium concentration (C_e) of the dye can be calculated with the help of calibration curve (known concentration of dye without carbon and the absorbance should be noted). As, the concentration of dye increasing, the percentage removal of adsorption decreases. This means that low concentration increases adsorption decreases due to lack of available active site and surface of carbon. However, at high concentration the available sites of adsorption become fewer and hence the percentage removal of dye is depended upon initial concentration.

Effect of contact time

The experimental results for the kinetics and dynamics for adsorption of dyes using carbon by the fixed amount of initial concentration. Particles are at known and constant particle size and the solution in its own pH. These stop watch was started simultaneously during the starting of the experiment. The bottles were withdrawn from the shaker and the different tie (5 to 45 min). The percentage removal increases with the increase of contact time to obtain maximum adsorption at 45 minutes after that to attain stagnated. When time goes on increasing adsorption efficiency decreases due to desorption.

Kinetic Isotherm model

Lagregren equation

$\text{Log } (q_e - q_t = \text{Log } q_e \, (K/2.303)t$

Where
Q_e is the amount adsorbed per unit time of the adsorbent at equilibrium time.
K is the rate constant line with negative slope which equal to (k/2.303) from which K can be calculated and the values are shown.

Bhattacharya and venkobachar equation

The kinetic model known is Bhatttacharya and Veenkobachar equation is

$\text{Log } [1/\text{-}U(t)] = (k/2.303)$

Where
C_i is the initial concentration of adsorbate
C_o is the concentration at various time t
C_o is the concentration of ions at equilibrium
K is the first order adsorption rate constant

A plot of [1-U(t)] Vs time t gives a straight line slope value equal to the first order rate constant of adsorption.

Natarajan and Khalaf equation

Natarajan and khalaf equation is based on the first order kinetic equation which is given below

$K = (2.303/t) \log (C_o/C_t)$

Where
C_o is the initial concentration of the adsorbate
C_t is the concentration at various time t and k is the rate constant of the adsorption.
If the plot of the log (C_o/C_t) Vs time gives a straight line, then the adsorption follows first order kinetics and the constant is compared from the slope of the straight line.

Pseudo first-order kinetic model

This model assume that the rate of change of solute uptake with time is directly proportional to difference in saturation uptake with time. The rate constant of adsorption is expressed as a first-order rate expression as shown below.

Table 1. Effect of initial concentration of RM and MR on BC

BC					
Reactive Magenta			Methyl Red		
Concentration (ppm)	Adsorption efficiency(%)	Amount Adsorbed	Concentration (ppm)	Adsorption efficiency (%)	Amount Adsorbed
26	98.0	1.27	72	96.25	3.46
28	96.4	1.35	74	93.20	3.45
30	95.1	1.42	76	92.76	3.52
32	92.1	1.47	78	92.30	3.60
34	89.0	1.52	80	91.23	3.65
36	81.0	1.47	82	90.24	3.70
38	80.2	1.52	84	89.64	3.76
40	73.5	1.47	86	89.53	3.85

TablE 2. Effect of initial concentration of RM and MR on SCSC

SCSC					
Reactive Magenta			Methyl Red		
Concentration (ppm)	Adsorption efficiency (%)	Amount Adsorbed	Concentration (ppm)	Amount adsorbed	Adsorption efficiency (%)
36	98.0	1.76	58	2.79	96.20
38	93.4	1.77	60	2.86	95.50
40	92.5	1.85	62	2.90	93.70
42	88.8	1.86	64	2.94	92.03
44	86.3	1.90	66	2.97	90.15
46	85.0	1.95	68	3.00	88.23
48	84.3	2.02	70	3.05	87.14
50	82.6	2.065	72	3.10	86.11

Table 3 Effect of initial concentration of RM and MR on SVC

SVC					
Reactive Magenta			Methyl Red		
Concentration (ppm)	Adsorption efficiency (%)	Amount Adsorbed	Concentration (ppm)	Adsorption efficiency (%)	Amount Adsorbed
52	93.2	2.42	96	96.87	4.65
54	91.2	2.46	98	95.91	4.70
56	95.0	2.50	100	95.70	4.78
58	87.0	2.52	102	95.39	4.86
60	85.0	2.55	104	94.71	4.82
62	84.6	2.62	106	93.77	4.97
64	84.3	2.70	108	93.51	5.05
66	84.0	2.77	110	92.09	5.06

Table 4. Langmuir, Freundlich, Temkin isotherms studies of equilibrium Reactive Magenta on BC

Initial Conc.	Equilibrium Conc.	Langmuir		Temkin		Freundlich	
C_i (mg/l)	C_e(mg/l)	$1/C_e$	$1/q_e$	q_e (mg/g)	Ln C_e	Log C_e	Log q_e
26	0.5	2	0.7843	1.275	-0.6931	-0.3010	0.1055
28	1.0	1	0.7467	1.35	0	0	0.1303
30	1.5	0.6	0.7017	1.425	0.4054	0.1760	0.1538
32	2.5	0.4	0.6779	1.475	0.9162	0.3979	0.1687
34	3.5	0.28	0.6557	1.525	0.2527	0.5440	0.1832
36	6.5	0.153	0.6557	1.475	1.8718	0.8129	0.1687
38	7.5	0.133	0.6779	1.525	2.0149	0.8750	0.1832
40	10.6	0.094	0.6802	1.47	2.3608	1.0253	0.1673

Table 5. Langmuir, Freundlich, Temkin Isotherms studies of equilibrium Reactive magenta on SCSC

Initial Conc.)	Equilibrium Conc.	Langmuir		Temkin		Freundlich	
C_i (mg/l)	C_e(mg/l)	$1/C_e$	$1/q_e$	q_e (mg/g)	Ln C_e	Log C_e	Log q_e
36	0.7	1.4285	0.5665	1.765	-0.3566	-0.1549	0.2467
38	2.5	0.4	0.5633	1.775	0.9162	0.3979	0.2491
40	3.0	0.333	0.5405	1.85	1.0986	0.4771	0.2671
42	4.7	0.2127	0.5361	1.865	1.5475	0.6720	0.2706
44	6.0	0.1666	0.5263	1.9	1.7917	0.7781	0.2787
46	6.9	0.1449	0.5128	1.95	1.9315	0.8388	0.2900
48	7.5	0.1333	0.4938	2.025	2.0149	0.8750	0.3064

Table 6. Langmuir, Freundlich, Temkin isotherms studies of equilibrium Reactive Magenta on SVC

Initial Conc.)	Equilibrium Conc.	Langmuir		Temkin		Freundlich	
C_i(mg/L)	C_e(mg/L)	$1/C_e$	$1/q_e$	q_e (mg/g)	Ln C_e	Log C_e	Log q_e
52	3.5	0.2851	0.4123	2.425	1.227	0.5440	0.3847
54	4.7	0.2127	0.4056	2.465	1.5475	0.6720	0.3918
56	5.9	0.1694	0.3992	2.505	1.7749	0.7708	0.3988
58	7.5	0.1333	0.3960	2.525	2.0149	0.8750	0.4022
60	9.0	1.111	0.3921	2.550	2.1972	0.9542	0.4065
62	9.5	0.1052	0.3809	2.625	2.2512	0.9777	0.4191
64	10.0	0.1	0.3703	2.700	2.3025	1.000	0.4313
66	10.5	0.0952	0.3603	2.775	2.3513	1.0211	0.4432

Table 7. Langmuir, Freundlich, Temkin isotherm studies of equilibrium Methyl Red on BC

Initial(Conc)	Eqi Conc.	Langmuir		Temkin		Freundlich	
C_i (mg/L)	C_e(mgL)	$1/C_e$	$1/q_e$	q_e (mg/g)	Ln C_e	Log C_e	Log q_e
72	2.7	0.370	0.2886	3.465	0.9932	0.4313	0.5397
74	5.0	0.200	0.2898	3.450	1.0694	0.6989	0.5378
76	5.5	0.1818	0.2836	3.525	1.7047	0.7403	0.5471
78	6.0	0.1666	0.2777	3.600	1.7917	0.7781	0.5563
80	7.0	0.142	0.2799	3.650	1.9459	0.8450	0.5622
82	8.0	0.128	0.2702	3.700	2.0794	0.9030	0.5682
84	8.7	0.1149	0.2656	3.765	2.1633	0.9395	0.5757

Table 8. Langmuir, Freundlich, Temkin isotherm studies of equilibrium Methyl Red on SCSC

Initial Conc.)	Equilibrium Conc.	Langmuir		Temkin		Freundlich	
C_i (mg/L)	C_e(mg/L)	$1/C_e$	$1/q_e$	q_e (mg/g)	Ln C_e	Log C_e	Log q_e
58	2.2	0.4545	0.3584	2.790	0.7884	0.3424	0.4456
60	2.7	0.3703	0.3490	2.865	0.9932	0.4313	0.4571
62	3.9	0.2564	0.3442	2.905	1.3609	0.5910	0.4631
64	5.1	0.1960	0.3395	2.945	1.6292	0.7075	0.4690
66	6.5	0.1538	0.3361	2.975	1.8718	0.8129	0.4734
68	8.0	0.125	0.333	3.000	2.0794	0.9030	0.4771
70	9.0	0.111	0.3278	3.050	2.1972	0.9542	0.4842
72	10.0	0.100	0.3225	3.100	2.3025	1.000	0.4913

Table 9. Langmuir, Freundlich, Temkin isotherm studies of equilibrium Methyl red on SVC

Initial Conc.)	Equilibrium Conc.	Langmuir		Temkin		Freundlich	
C_i (mg/I)	C_e(mg/I)	$1/C_e$	$1/q_e$	q_e (mg/g)	Ln C_e	Log C_e	Log q_e
96	3.0	0.333	0.2150	4.65	1.0986	0.4771	0.6674
98	4.0	0.25	0.2127	4.7	1.3862	0.6020	0.6720
100	4.3	0.2325	0.2089	4.785	1.4586	0.6334	0.6798
102	4.7	0.2121	0.2055	4.865	1.5475	0.6720	0.6870
104	5.5	0.1818	0.2030	4.925	1.7047	0.7403	0.6924
106	6.6	0.1515	0.2012	4.97	1.8870	0.8195	0.6963

Table 10. Effect of contact time for RM and MR on BC

BC							
Reactive Magenta				Methyl red			
Time	Conc. (ppm)	Amount adsorbed	% Efficiency	Time	Conc. (ppm)	Amount adsorbed	% Efficiency
15	32	1.15	71.8	15	80	3.36	84.0
20	32	1.225	76.5	20	80	3.425	85.62
25	32	1.275	79.6	25	80	3.45	86.25
30	32	1.345	84.0	30	80	3.465	86.62
35	32	1.365	85.3	35	80	3.48	87.0
40	32	1.425	89.0	40	80	3.53	88.25
45	32	1.485	92.8	45	80	3.66	91.5

Table 11. Effect of contact time for RM and MR on SCSC

SCSC							
Reactive Magenta				Methyl red			
Time	Conc. (ppm)	Amount adsorbed	% Efficiency	Time	Conc. (ppm)	Amount adsorbed	% Efficiency
15	44	1.635	74.3	15	66	2.70	81.81
20	44	1.66	75.4	20	66	2.75	83.33
25	44	1.715	77.9	25	66	2.77	83.93
30	44	1.745	79.3	30	66	2.78	84.42
35	44	1.765	80.2	35	66	2.8	84.48
40	44	1.945	88.4	40	66	2.9	87.87
45	44	1.905	86.5	45	66	3.0	90.90

Table 12. Effect of contact time for RM and MR on SVC

SVC							
Reactive Magenta				Methyl red			
Time	Conc. (ppm)	Amount adsorbed	% Efficiency	Time	Conc. (ppm)	Amount adsorbed	% Efficiency
15	58	2.355	81.2	15	104	4.6	98.07
20	58	2.37	81.7	20	104	4.625	88.94
25	58	2.4	82.7	25	104	4.65	89.42
30	58	2.425	83.6	30	104	4.67	89.07
35	58	2.45	84.4	35	104	4.7	90.38
40	58	2.475	85.3	40	104	4.75	91.34
45	58	2.52	86.8	45	104	4.92	94.61

Table 13. LAGREGREN plot for RM and MR on BC

RM				MR			
q_e	q_t	q_e/q_t	Log q_e/q_t	q_e	q_t	q_e/q_t	Log q_e/q_t
1.2275	1.225	1.0408	0.01736	3.465	3.35	1.0343	0.01464
1.35	1.15	1.1739	0.06963	3.455	3.36	0.09	-1.0457
1.425	1.225	1.1632	0.0656	3.525	3.425	1.02919	0.01249
1.475	1.275	1.1568	0.0632	3.60	3.45	1.04347	0.01847
1.525	1.345	1.1338	0.0545	3.65	3.465	1.05339	0.02258
1.475	1.365	1.0805	0.03362	3.7	3.48	1.06321	0.0616
1.525	1.425	1.0701	0.02942	3.765	3.53	1.06657	0.02798
1.47	1.485	0.9898	-0.0044	3.85	3.66	1.0519	0.02444

Table 14. LAGREGREN plot for RM and MR on SCSC

RM				MR			
q_e	q_e	q_e/q_t	Log q_e/q_t	q_e	q_t	q_e/q_t	Log q_e/q_t
1.765	1.53	1.1153	0.04739	2.79	2.685	0.9738	-0.0115
1.775	1.635	1.0856	0.03566	2.865	2.7	1.0611	0.0257
1.85	1.66	1.1145	0.04708	2.905	2.75	1.05636	0.02381
1.865	1.715	1.0822	0.03430	2.945	2.77	1.0631	0.0265
1.9	1.745	1.0888	0.03694	2.975	2.78	1.0701	0.02942
1.95	1.765	1.1048	0.0432	3.0	2.8	1.0714	0.02995
2.025	1.945	2.0413	0.01757	3.05	2.9	1.0517	0.02189
2.065	1.905	1.0839	0.03498	3.10	3	1.0333	0.01422

Table 15. LAGREGREN plot for RM and MR on SVC

RM				MR			
q_e	q_t	q_e/q_t	Log q_e/q_t	q_e	q_t	q_e/q_t	Logq_e/q_t
2.425	2.31	1.049	0.02077	4.65	4.56	1.01973	0.00847
2.465	2.355	0.966	-0.1475	4.7	4.6	1.02173	0.009336
2.505	2.37	1.0569	0.0240	4.785	4.625	1.03459	0.01476
2.525	2.4	1.0520	0.0220	4.865	4.65	1.0462	0.01961
2.55	2.425	1.0515	0.02180	4.925	4.67	1.0546	0.02284
2.625	2.45	1.0714	0.02995	4.97	4.7	1.05744	0.02425
2.7	2.475	1.0909	0.03778	5.05	4.75	1.06315	0.0265
2.775	2.52	1.1011	0.04182	5.065	4.92	1.0294	0.0125

Effect of initial concentration of

Fig. 1. BC

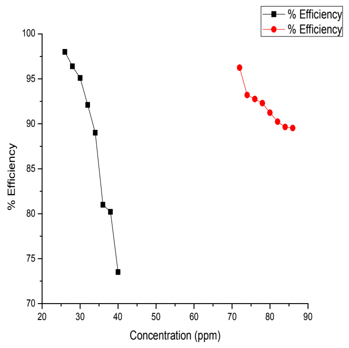


Fig.2 SCSC

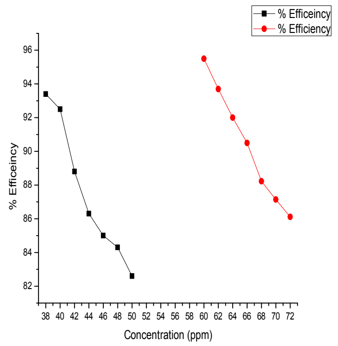
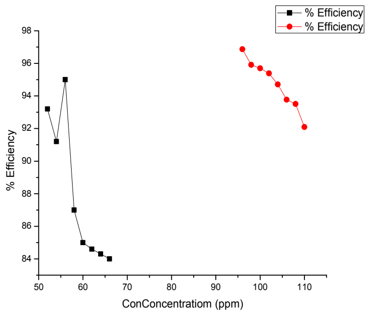


Fig. 3SVS



Langmuir isotherm studies of equilibrium

Fig.4Langmuir plot for BC

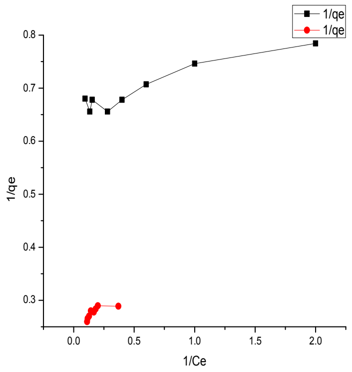


Fig.5 Langmuir plot for SCS

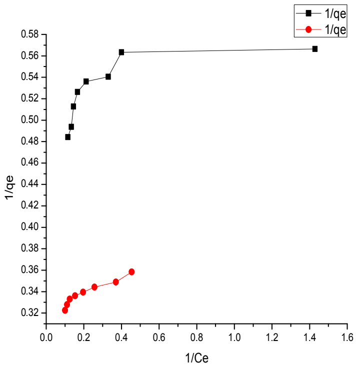
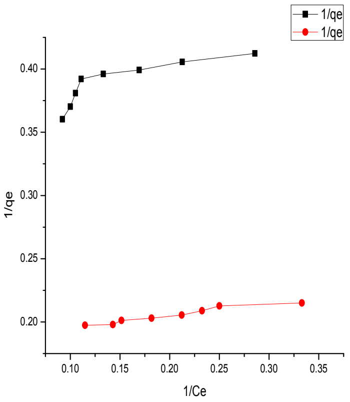


Fig.6 Langmuir plot for SVC



Freundlich isotherm studies of equilibrium

Fig.7 Freundlich plot for BC

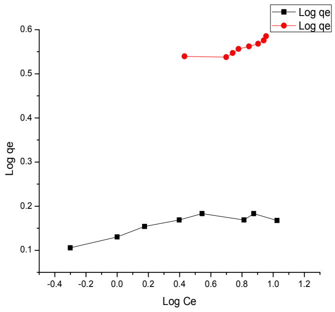


Fig.8 Freundlich plot for SCS

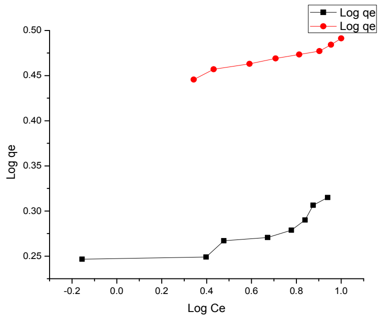
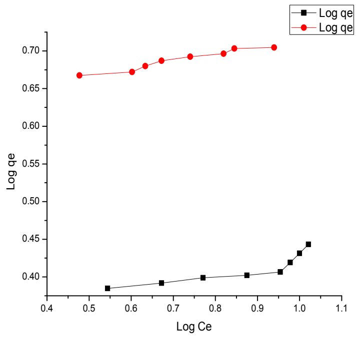


Fig.9 Freundlich plot for SVC



Temkin isotherm studies of equilibrium

Fig.10Temkin plot for BC

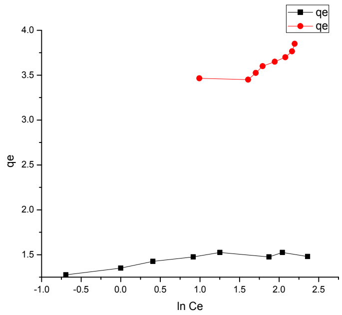


Fig.11 Temkin plot for SCS

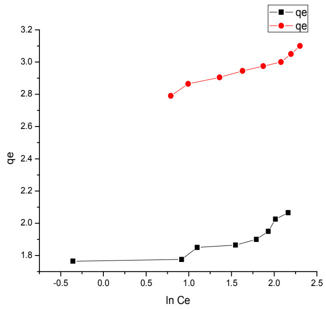
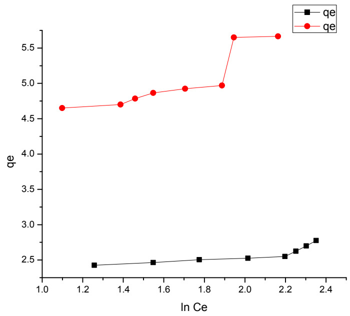


Fig.12 Temkin plot for SVC



Effect of contact time for

Fig.13 BC

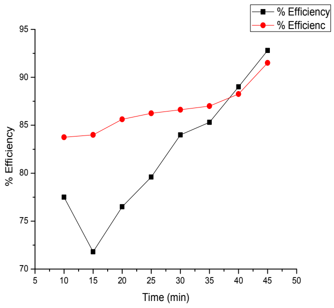


Fig.14 SCSC

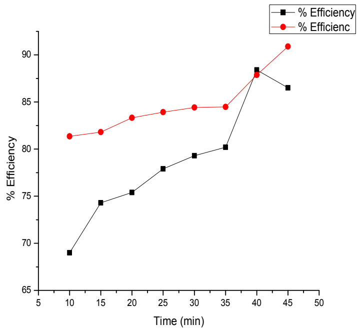
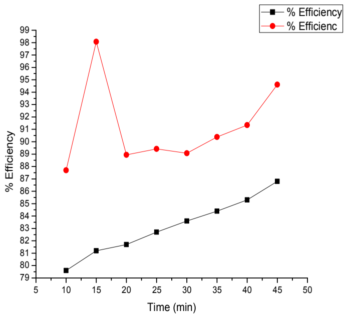


Fig.15 SVS



LAGREGREN plot for RM and MR on BC

Fig. 16 BC

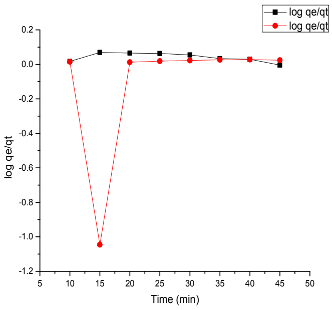


Fig.17 SCSC

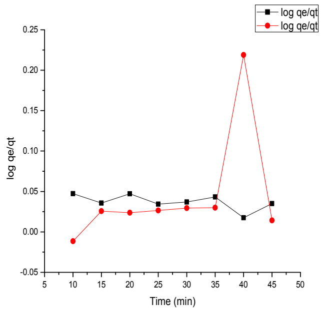
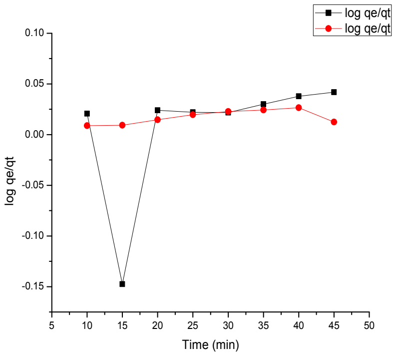


Fig. 18SVC



Battacharya plot for RM and MR on BC

Fig.4.19 BC

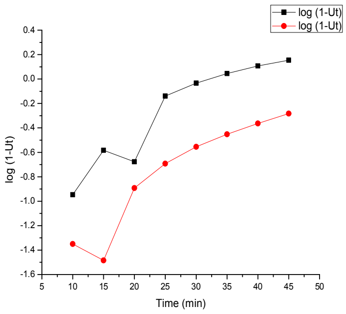


Fig.4.20 SCSC

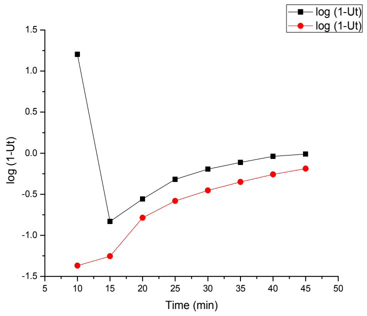
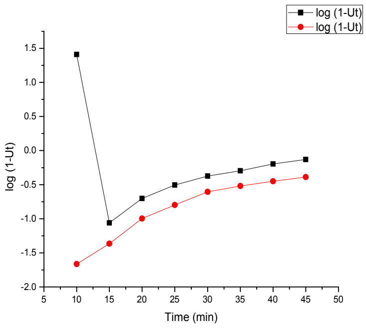


Fig. 4.21 BC



Natarajan and Khalaf plot for RM and MR on

Fig. 22 BC

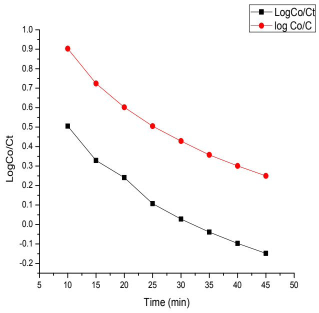


Fig.23 SCSC

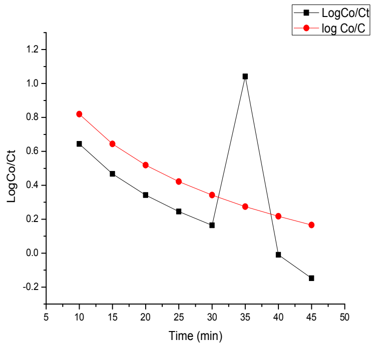
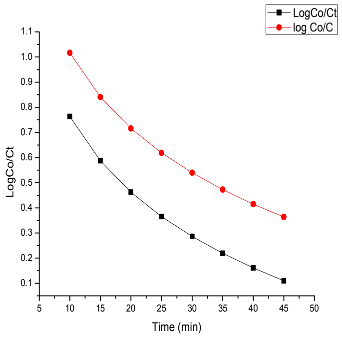


Fig.24 SVC



Pseudo-first order kinetic model for RM and MR on

Fig. 25 BC

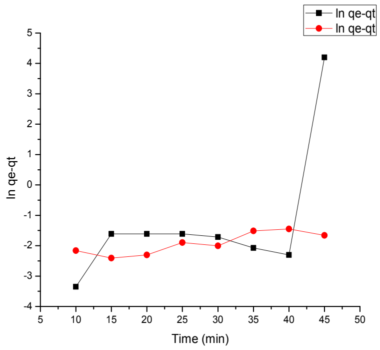


Fig.26 SCSC

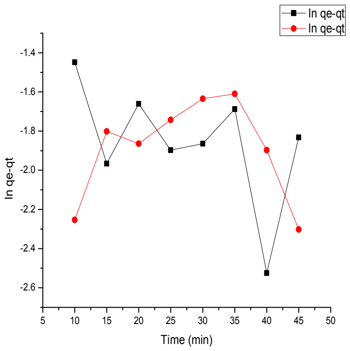
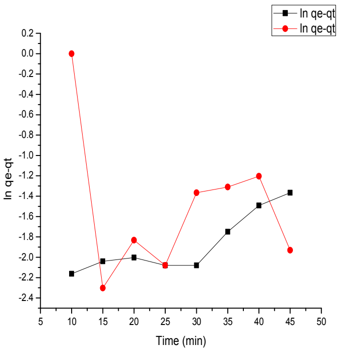


Fig. 27 SVC



Intra particle diffusion plot for

Fig. 28 BC

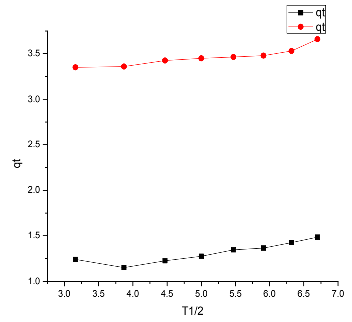


Fig.29 SCSC

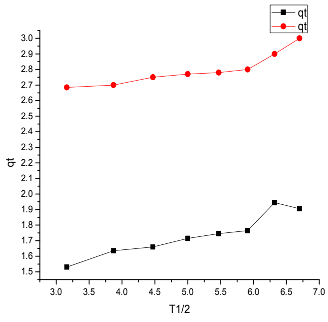
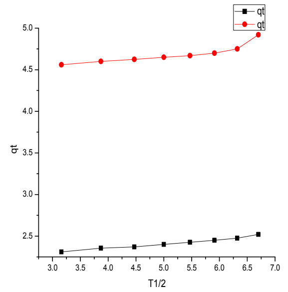


Fig. 30 SVC



Elovich equation for RM and MR on BC

Fig.31 BC

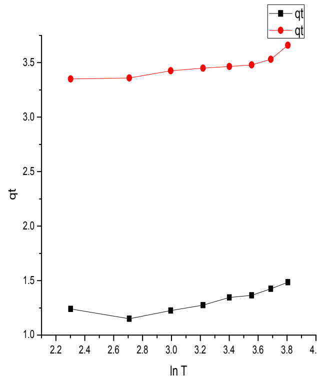


Fig.32 SCSC

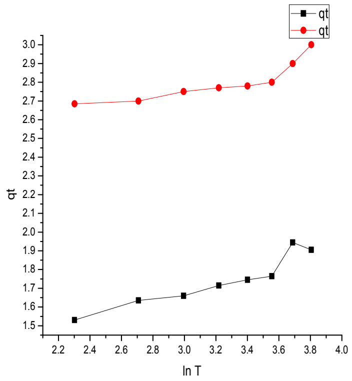
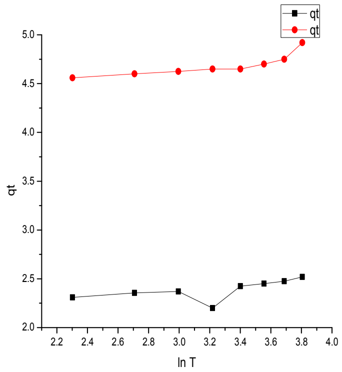


Fig. 33 SVC



Effect of adsorption mass for

Fig. 34 BC

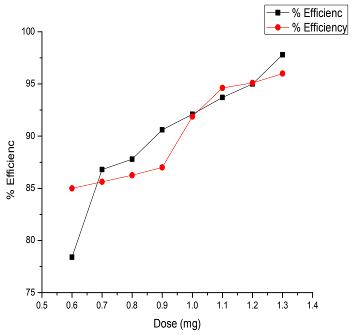


Fig.35 SCSC

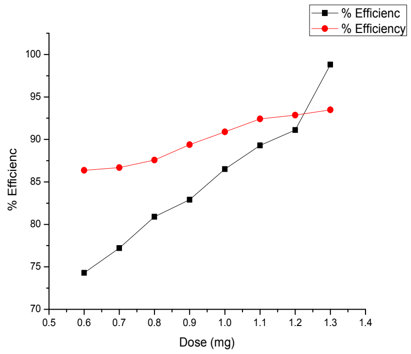
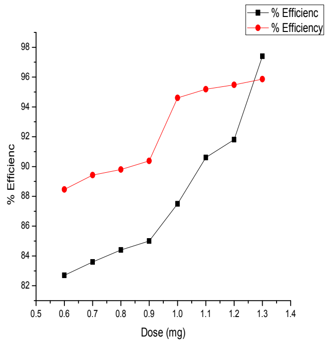


Fig. 36 SVC



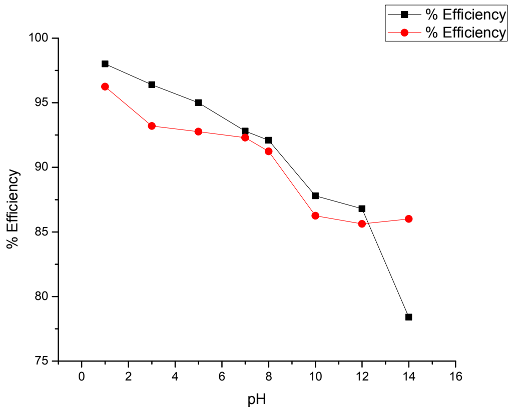


Fig.37 Effect of pH for RM and MR on BC

Where
q_e is the amount of dye adsorbed at equilibrium
q_t is the amount adsorbed at constant time
$K_1$is the pseudo-first order rate constan

Intra-particle diffusion model

The possibility of intra particle diffusion process was explored by applying the intra particle diffusion model.

$$q_t = K_p t^{1/2} + C$$

Where
q_t is the amount of dye adsorbed at time t
C is the intercept and
Kp is the intra particle diffusion rate constant.

Elovich equation

The Elovich equation is generally expressed as

$$Dq/dt = \alpha e^{-\beta t}$$

On integrating this equation for the boundary conditions, it gives

$$q_t = 1/\beta \ln(\alpha\beta) + 1/\beta \ln t$$

Where
α is the initial adsorption rate
β is the desorption constant which is related to the extent of surface coverage and the activation energy for chemisorption.

Effect of adsorbent mass

The percentage removal and amount adsorbed dyes on the surface of carbon were obtained with different carbon dose of range (0.6 g-1.3 g) with fixed amount of initial concentration and contact time 45 mins. The percentage removal of dyes increases with increase of carbon dose because of the availability of active sites on the surface of carbon.

Effect of pH

The percentage removal and pH of dyes of the surface of carbon were obtained with different pH range (1-14)with fixed initial concentration, amount of carbon be 1g and contact time be 45 mins. The percentage removal decreases with the increase of pH.

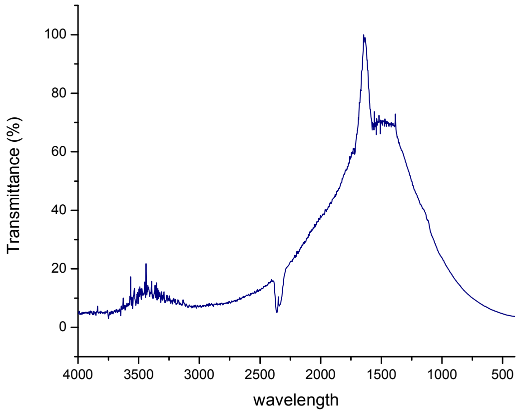
Effect of pH for RM and MR on BC

Spectra details

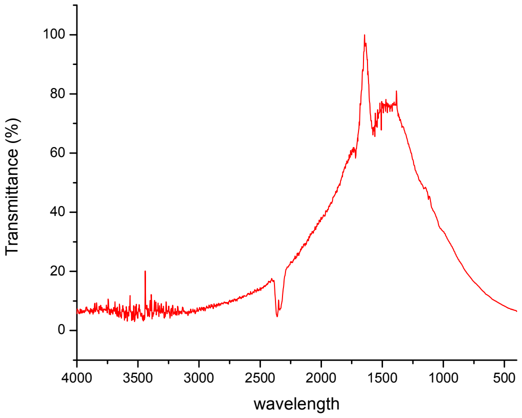
FT-IR: FT-IR Technique is an interesting application for studying the interaction between an adsorbate (dyes) and the active group on the surface of adsorbent. It is taken in the FT-IR.

FT-IR Spectrum for BC(Before adsorption): FT-IR technique is an interesting for studying the interaction between an adsorbate(dyes) and the active group on the surface of adsorbent. It is taken in the FT-IR schimadzu spectrometer instrument. FT-IR spectra of before adsorption of BC as shown in the fig. This shows thatIR is the analytical technique to ensure the adsorption takes place.

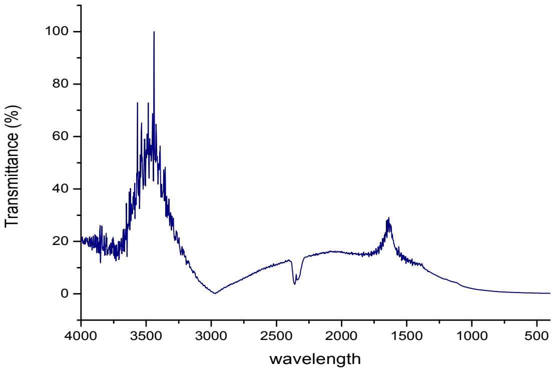
FT-IR Spectrum for BC(Before adsorption):



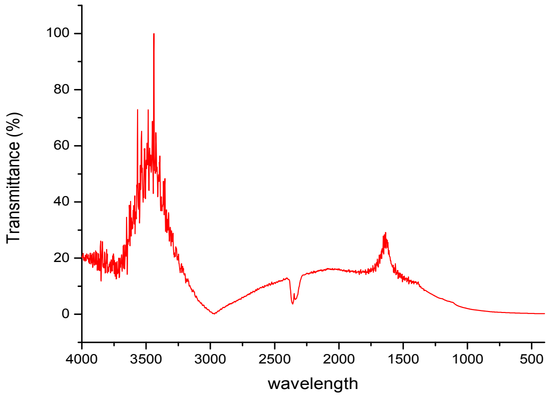
IR Spectrum of BC (After adsorption):



(Before adsorption):



(After adsorption):



IR Spectrum of BC (After adsorption): FT-IR spectra of after adsorption of BC as shown in the fig. The peak value is 2380.87 cm^{-1}, 2339.65 cm^{-1}. This showsnthatIR is the analytical technique to ensure the adsorption takes place.

IR Spectrum of SCSC (Before adsorption): FT-IR spectra of before adsorption of SCSC as shown in the fig.This shows thatIR is the analytical technique to ensure the adsorption takes place

IR Spectrum of SCSC (After adsorption): FT-IR spectra of after adsorption of SCSC as shown in the fig. The peak value is 1955.82 cm^{-1}, 1751.36 cm^{-1}. This shows that IR is the analytical technique to ensure the adsorption takes place

IR Spectrum of SVC (Before adsorption): FT-IR spectra of before adsorption of SCSC as shown in the fig. This shows that IR is the analytical technique to ensure the adsorption takes place

IR Spectrum of SVC (After adsorption): FT-IR spectra of after adsorption of SVC as shown in the fig. The peak value is 2395.59 cm^{-1}, 2360.87 cm^{-1}. This shows that IR is the analytical technique to ensure the adsorption takes place.

Conclusion

- The activated carbon from agricultural by products wastes are used as an adorbent which are found to possess the essentially needed physico-chemical and the textural properties of an adsorbent and hence they can be used as adsorbent.
- The percentage removal of dyesare found to decrease in initial concentration adsorbent. The process parameters were optimized.
- The relative adsorption capacities of the activated carbon has the maximum adsorption capacity, low cfost adsorbents alternative to CAC in water water treatment, especially for the removal of pollutants in general and dyes in particular.
- The adsorption data obeyed Freundlich, Langmuir and Temkin adsorption isotherms indicating thr formation of monolayer of dye molecules on the surface of the adsorbent.
- The adsorption data were modelled with the various kinetic equations and models such as Natarajan, Khalaf, Lagregren, Bhattacharya, Pseudo-First orderm Pseudo-Second order, Elovich and Intra particle diffusion model. These models are found to be applicable.

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