ADSORPTION BEHAVIOR OF ANIONIC AND CATIONIC DYES ONTO SUGARCANE BAGASSE ACTIVATED CARBON

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Abstract*—The present study deals with the feasibility of removal of an anionic dye acid orange (AO7) and a cationic dye Rhodamine B (RhB) from aqueous solutions using activated carbon derived from sugarcane bagasse. Batch adsorption studies were conducted to evaluate various experimental parameters such as contact time, initial concentration of the adsorbate, adsorbent dosage, pH and temperature for maximum sorption. Favorable adsorption of RhB occurs at around pH 4.0 and for AO7 maximum sorption was found to be at pH 2.0. The adsorption process is in conformity with Freundlich isotherm for both RhB and AO7. Different thermodynamic parameters such as Gibb's free energy, enthalpy and entropy of the on-going adsorption process have also been evaluated. The thermodynamic parameters of RhB adsorption indicated that the system was exothermic in nature and at the same time the adsorption process of AO7 was endothermic. Kinetic results suggest that the adsorption of RhB and AO7 onto Bagasse Activated Carbon (BAC) followed pseudo - second - order kinetic model.*

***Keywords* —** **Adsorption, Isotherm, Sugarcane Bagasse, Rhodamine B, Acid Orange 7**

I. Introduction

Currently, textile industry produces a huge quantity of dyed wastewater. The color and the non-biodegradable nature of the spent dye baths constitute serious environmental problems [1]. Dyes and pigments represent one of the problematic groups; they are discharged into wastewaters from various industrial branches, mainly from the dye manufacturing, food coloring, cosmetic, paper, textile and carpet industries [2]. The complex aromatic structures of dyes make them more stable and more difficult to biodegrade [3].

The convectional biological treatment process is not very effective in treating a dyes wastewater, due to low biodegradation of dyes. It is usually treated by either physical or chemical Dye removal from aqueous solution using low cost adsorbent processes. However, these processes were very expensive and could not be effectively used to treat the wide range of dyes [4]. The removal of such colored agents from aquous effluents is thus environmentally significant [5-10], and as certain industries like textile, pulp and paper produce bulk quantity of colored waste water, the production of an effective and cheap activated carbon from agricultural wastes is thus of economic and academic interest.

Adsorption technique is an important method in case of heterogeneous systems. To fully understand the processes, two basic ingredients are required, namely, equilibrium and kinetics. Recently, the growth of adsorption kinetics is of interest for many investigations [11-14].

The focus of the present study was to investigate the effect of the sorbent amount, contact time, dye concentration, and temperature on the adsorption of RhB and AO7 on BAC. Different isotherm models were used to derive the adsorption parameters for RhB and AO7 on BAC. The adsorption rate constants were obtained at different temperatures to estimate the thermodynamic parameters for the dye adsorption.

II. MATERIALS AND METHODS

II.1 Adsorbate and adsorbent

Sugarcane bagasse, as an adsorbent, was collected from local sugar mill, Karur. The collected material was thoroughly washed with distilled water and dried in oven at 105° C and then powdered by using pulveriser. Then the powder was modified as activated carbon and used for adsorption studies. Phosphoric acid (H_3PO_4) (Merck) 85% (wt) solution was used as the chemical activating agent. Rhodamine-B and Acid Orange 7 were procured from Merck with analytical grade. The chemical structures of the dyes were shown in **Fig 1.** All other chemicals were of analytical grade and obtained from Chemical Drug House (CDH) Ltd., India. The double distilled water (DD) was used to prepare all the aqueous solutions.

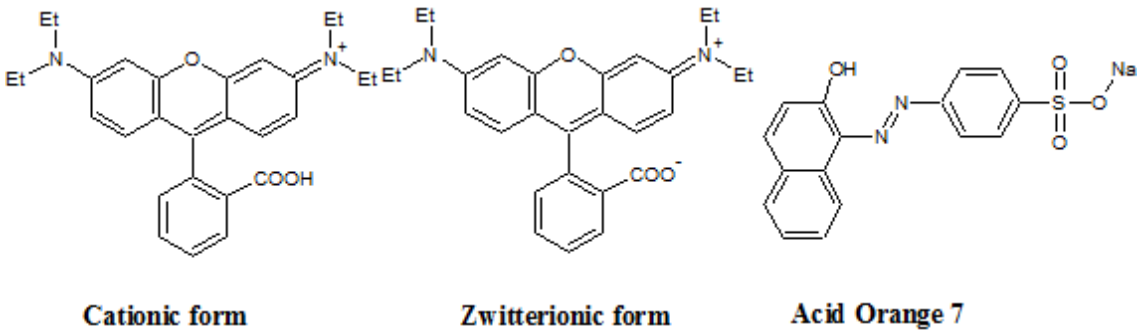

Fig.1- Molecular forms of RhB (cationic and zwitterionic form) and AO7

II.2 Preparation of Activated carbon

Sugarcane bagasse was chosen as precursor for the production of activated carbon by one-step chemical activation. The crushed Sugarcane bagasse was soaked in a ratio of 1 :1.5 wt of bagasse /wt of H_3PO_4 solution to cover it completely, slightly agitated to ensure penetration of the acid throughout, then the mixture was heated to 80°C for 1 h and left overnight at room temperature to help appropriate wetting and impregnation of the precursor. The impregnated mass was dried in an air oven at 80°C overnight, then, carbonized in a closed stainless steel reactor placed in a programmable muffle Furnace. The carbonization process was carried out at 500°C for 30 min in limited air. The product – (BAC) refers to H_3PO_4 treatment – was thoroughly washed with warm distilled water (70°C) until pH of the solution came close to the initial pH of the rinsing water. Finally, the activated carbon was dried at 105°C for 24 h and sieved to different particle size by using ASTM mesh and accepted particle size of 40 µ was kept for use [15].

II.3 Preparation of dye solutions

The stock solution of each dye was prepared by dissolving 1 g of analytical grade dyes in 1000 mL of distilled water and diluted to get desired concentration of the dyes. All experiments were carried out at room temperature (29±1°C) using a constant agitation speed of 100 rpm. The pH of each solution was adjusted to the required value with diluted or concentrated and Hydrochloric acid (HCl), sodium hydroxide (NaOH) solutions before contacting the adsorbent. Experimental solutions of the desired concentrations were prepared by successive dilutions. All the experiments were carried out in a batch system in order to evaluate the effects of different operational variables.

II.4. Batch experiments

The batch experiments were performed in a 250 mL conical flask in which 0.1 g of the activated carbon was added to 50 mL of dye solutions. Then, the mixture was kept at room temperature (30°C) for the desired time under shaking at 300 rpm. After the desired time, the material was filtered through filter paper. The dyes concentrations were determined using absorbance values measured before and after the adsorption by UV-spectrophotometer (Pharo 300 Merck) at the wavelength corresponding to the maximum absorbance of 490 and 554 nm for AO7 and RhB, respectively. The maximum wavelength (λ_{max}) for both adsorbents was recorded by UV–vis

spectrophotometer. In all cases, a proper dilution was necessary to obtain a well measurable absorption. The pH of the solutions during the studies was determined by a pH meter.

To optimize the conditions for dye removal, and also to evaluate the adsorption capacity of BAC, the adsorption reactions were conducted at a wide pH range (pH 2–10), contact time (15–90 min), initial concentration (10–50 mg L^{-1}), and adsorbent dose (0.020–0.140 g). The working solution pH was adjusted by adding 0.1M of HCl / NaOH. For isotherm studies, the experiments were carried out at three different temperatures with four different concentrations of dyes viz., 10, 20, 30 and 40 mg L^{-1}. Thermodynamic parameters such as standard free energy change (ΔG^0_{ads}), standard enthalpy change (ΔH^0_{ads}) and standard entropy change (ΔS^0_{ads}) were determined using equilibrium data. Kinetic data were obtained by conducting experiments at 303K with three different concentrations of both the dyes. While doing the experiment, the samples were withdrawn at pre-determined time interval and analyzed for the dye concentration. The percent dye removal by BAC was computed using the following equation.

$$\text{Removal efficiency} = \frac{C_0 - C_e}{C_0} \times 100 \quad (1)$$

Where, C_0 and C_e are the initial and final concentration of dye, respectively). The sorption capacity of the activated carbon was calculated according to the following mass balance Eq. (2):

$$\text{Sorption Capacity (SC)}, \quad q_t = \frac{(C_0 - C_e)}{M} \times V \ \text{(mg/g)} \quad (2)$$

Where, q is the adsorption capacity of the composite (mg/g), V is the volume of the sample (mL), C_0 is the initial concentration of dye solution (mg/L), C_e is the final concentration of dye solution (mg/L) and M is the mass (g) of the activated carbon.

III. RESULTS AND DISCUSSION

III.1. Characterization of activated carbon

FTIR analyses on BAC before and after dye adsorption were conducted to further understand the adsorption chemistry. As shown in Fig. 2, for untreated BAC sample (2a), the intense band at around 3400- 3450 cm^{-1} assigned to OH group stretching vibration and the absorption band at 2920 cm^{-1} could be attributed to C-H aliphatic axial deformation in CH_2 and CH_3 groups from cellulose, lignin and hemicelluloses [11]. The band at 2852 cm^{-1} is assignable C-H vibration of vibration of OCH_3 groups, which is commonly present in lignin. After dye adsorption, the band intensity at 3430 cm^{-1} significantly reduced, probably indicating some interactions between OH groups in BAC and those of the dye functional groups. The small peaks located at (400 to 700) cm^{-1} could be the C-H out-of-plane bending in benzene derivatives that is quite common for activated carbon. As can be seen in Fig. 2b, 2c the shift and sharp reduction (3397 and 3381 cm^{-1}) suggests the major role of –OH group for RhB and AO7 adsorption onto BAC. [16]

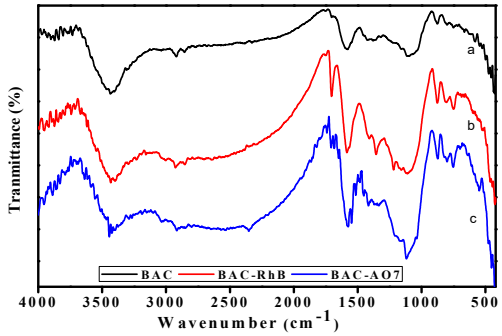

Fig.2- FTIR spectra of (a) BAC (b) RhB adsorbed BAC and (C) AO7 adsorbed BAC

The morphology of activated carbon was studied by SEM. Fig. 3 shows different views of activated carbon. Pores of different size and different shape could be observed in these figures.

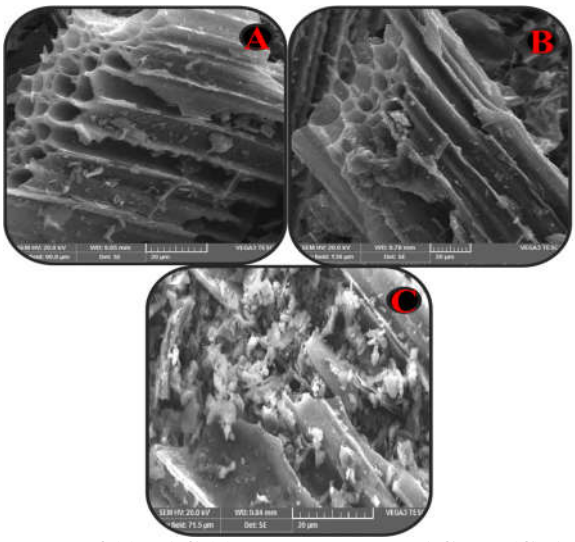

Fig.3- SEM micrographs of (a) BAC (b) RhB adsorbed BAC and (C) AO7 adsorbed BAC

III.2. Effect of pH

The influence of solution pH on the removal of RhB and AO7 onto the BAC was studied and is illustrated in Fig. 4A. The pH measurements were carried out using the expandable ion analyzer EA 940 with pH electrode. The uptake of RhB at pH 10.0-12.0 was the minimum and a maximum uptake was obtained at pH 4.0. However, when the pH of the solution was increased (more than pH 4), the uptake of RhB was decreased. It appears that a change in pH of the solution results in the formation of different ionic species, and different carbon surface charge. At pH values lower than 4, the dye can enter into the pore structure. At a pH value higher than 4, the zwitterions form of RhB in water may increase the aggregation of RhB to form a bigger molecular form (dimmer) and become unable to enter into the pore structure of the carbon surface [17-19]. Due to the amphoteric character of a dye, its adsorption properties may be influenced by the pH value of the solution.

The experiments were carried out for AO7 also at different initial solution pH values varying from 2 to 10. The dye removal percentage of AO7 decreased significantly with an increase in the solution pH and the maximum adsorption level was determined at pH 2. It is well known that at lower pH, more protons will be available to protonate the adsorbent surface, thereby increasing the electrostatic attractions between negatively charged dye anions and positively charged adsorption sites and causing an increase in the dye adsorption. A negatively charged site on the adsorbent does not favour the adsorption of anionic dyes due to the electrostatic repulsion [20-22]. Hence, all the succeeding investigations were performed at pH 2.

III.3 Effect of dosage

Fig. 4B explains the effect of dosage on the removal percentage of RhB and AO7. It was apparent from the graph that the removal of both dyes increased with an increase in dosage. This can be attributed to increase in the number of sorption sites available for the adsorption of both dyes. Also, when the dosage was increased from 0.020 to 0.140 g/L, the removal of RhB increased from 55.05 % to 93.68 % and for AO7 increased from 50.82 % to 91.8 %, respectively. Similar trends were observed for the removal of RhB and AO7 using different adsorbents [23-24].

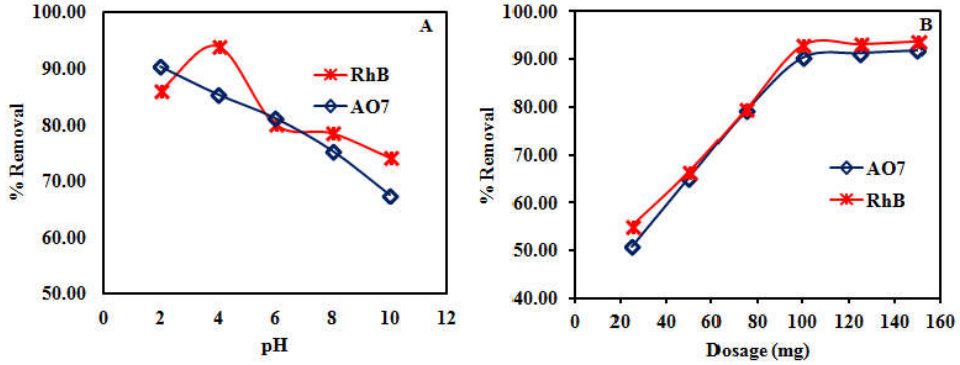

Fig.4- (A) Effect of pH (B) Effect of Dosage

III.4. Effect of contact time and concentration

Fig. 4C and D shows the effect of contact time with 0.1 g of BAC and different initial concentrations on the removal of RhB and AO7. It is evident from the graphs that the removal of RhB and AO7 were rapid increased with increase in contact time. The adsorption process with BAC was almost finished within 60 min and small amount of RhB and AO7 uptake were observed at longer time. It also indicates that the time required to reach equilibrium depends on initial dye concentration. These results revealed that the percentage removal of two dyes mainly depends on the number of active adsorption sites available on the sorbent surface for the sorption. Hence, based on these results, the optimum contact time for the removal of two dyes using BAC was fixed as 60 min for the further adsorption studies and the initial dye concentration was fixed as 10 mg/L.

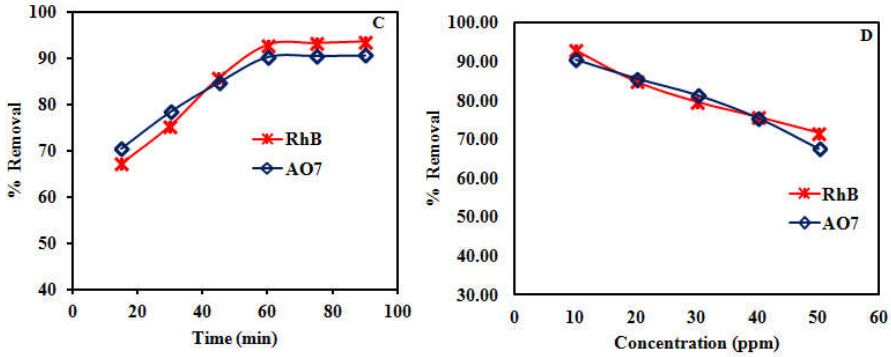

Fig 4 - (C) Effect of Contact time (D) Effect of Concentration

III.5. Effect of Co-anions

The effect of the presence of common anions like chloride, carbonate, and bicarbonate on the removal of two dyes RhB and AO7 were studied by adding a fixed 200 mg/L initial concentration of each selected ion and a 50 mg/L initial dye concentration at room temperature and keeping all other parameters constant. Fig. 4E shows that the dye removal percentage was slightly altered by the presence of co-anions competition with the surface binding sites and hence a slight reduction in dye removal was observed.

III.6. Adsorption isotherm

Adsorption isotherm plays major role in the design of adsorption system and also it provides the maximum sorption capacity for BAC for the removal of RhB and AO7 from aqueous solution. Many isotherm models have been used to describe the adsorption process. However, among the numerous isotherm models Langmuir and Freundlich models have been widely employed to describe the adsorption equilibrium process.

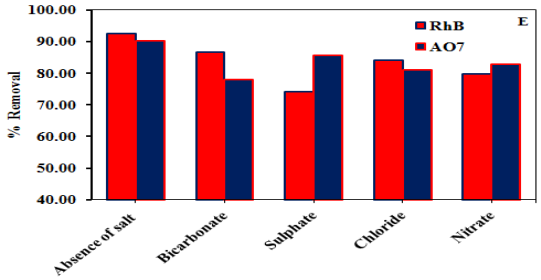

Fig.4- (E) Effect of co-anions on the RhB and AO7 removal using BAC

III.6.1. Langmuir isotherm

The most popular linear form of the Langmuir isotherm [25] is represented by Eq. (3):

$$\frac{C_e}{q_e} = \frac{1}{Q^0 b} + \frac{C_e}{Q^0} \qquad (3)$$

Where, C_e is the equilibrium concentration of dye solution (mg/L), q_e is the amount of dye adsorbed per unit weight of the sorbent (mg/g), Q^0 is the amount of adsorbate at complete monolayer coverage (mg/g) and gives the maximum sorption capacity of sorbent and b (L/mg) is Langmuir isotherm constant that relates to the energy of adsorption.

To identify the feasibility of the adsorption process, the essential characteristics of the Langmuir isotherm can be expressed in terms of the dimensionless constant separation factor or equilibrium parameter, R_L.

$$R_L = \frac{1}{1+bC_o} \qquad (4)$$

Where, b (L mg^{-1}) is Langmuir isotherm constant and C_0 (mg L^{-1}) is initial concentration of dye.

The calculated values for Langmuir isotherm parameters are given in Table 1. The R_L values of Langmuir lies between 0 and 1 indicating that the adsorption process is favourable. The value of Q^0 is decreased with the increase in temperature indicate the exothermic nature of the adsorption process. The obtained value of Langmuir isotherm constant (b) for RhB adsorption was higher than for AO7 adsorption in all three temperatures, which illustrate that the BAC had more affinity towards AO7 rather than RhB since the b is directly proportional to the binding energy.

III.6.2. Freundlich isotherm

The linear form Freundlich isotherm [26] is represented by Eq. (5):

$$\log\ q_e\ =\ \log k_F + \frac{1}{n}\log C_e \qquad (5)$$

Where, k_F is the measure of adsorption capacity and 1/n is the adsorption intensity. The obtained values for Freundlich isotherm parameters are given in Table 1. The magnitude of the exponent 1/n lies between 0 and 1 indicates the favourable conditions for the adsorption. The exothermic nature of the adsorption process is further confirmed by the k_F value which is decreased with an increase in temperature.

III.7. Chi-square (χ^2) analysis

χ^2 analysis [27] was carried out to identify the suitable isotherm model for describing the removal of RhB and AO7 from aqueous solution using BAC. The χ^2 values provide the significant information about the suitability of the isotherm model.

The mathematical expression for the χ^2 analysis is represented by Eq. (6)

$$\chi^2 = \sum \frac{(q_e - q_{e,m})^2}{q_{e,m}} \qquad (6)$$

Table 1- Freundlich and Langmuir constants of BAC

Isotherm	Parameters	RhB			AO7		
		303 K	313 K	323 K	303 K	313 K	323 K
Freundlich	1/n	0.560	0.726	0.789	0.655	0.747	0.842
	k_F (mg/g) (L/mg)$^{1/n}$	4.922	2.76	1.99	3.96	2.50	1.69
	r^2	0.999	0.999	0.999	0.995	0.998	0.998
	χ^2	0.033	0.036	0.046	0.094	0.086	0.068
Langmuir	Q^o (mg/g)	11.99	11.51	11.36	26.95	32.21	46.47
	b (L/g)	0.355	0.236	0.184	0.161	0.075	0.034
	r^2	0.992	0.997	0.992	0.999	0.997	0.993
	R_L	0.26	0.347	0.404	0.437	0.626	0.786
	χ^2	8.33	8.46	8.62	22.96	21.23	20.12

Where, K^0 is the sorption distribution coefficient, ΔG^0 is the standard free energy change of sorption (kJ mol^{-1}), T is the temperature in K, R is the universal gas constant (8.314 J mol^{-1}K^{-1}), ΔH^0 is the standard enthalpy change (kJ mol^{-1}) and ΔS^0 is standard entropy change (kJ mol^{-1} K^{-1}). The values of ΔH^0 and ΔS^0 can be obtained from the slope and intercept of a plot of $\ln K^0$ against 1/T. The obtained values for ΔG^0, ΔH^0 and ΔS^0 are listed in Table 2.

The negative values of ΔG^0 indicate the removal of RhB and AO7 by BAC is a spontaneous process. The negative and positive value of ΔH^0 confirmed the exothermic and endothermic nature of the RhB and AO7 sorption process, respectively. It has also been stated that the value of ΔH^0 provides useful information about the type of adsorption process. The typical range of ΔH^0 value for physisorption is between 2.1 and 20.9 kJ/mol and for chemisorption involving complexation is between 20.9 and 418.4 kJ/mol [28-30]. The ΔH^0 values were obtained by this study, which falls within the range of physical adsorption. i.e. electrostatic interaction between BAC and both dyes. In addition, the negative and positive values of ΔS^0 indicates a decrease and increase in randomness at solid/solution interface and no significant changes occurs in the internal structure [30] during the RhB and AO7 sorption onto BAC.

III.8. Sorption dynamics

III.8.1. Reaction-based models

The most commonly used pseudo-first-order and pseudo-second-order models were employed to explain the solid/liquid adsorption based.

pseudo-first-order equation of Lagergren [31] is generally expressed as:

$$\log(q_e - q_t) = \log q_e - k_{ad}\frac{t}{2.303} \quad (9)$$

Where, q_e and q_t are the adsorption capacity (mg g^{-1}) of the sorbent at equilibrium and at time t (min), respectively, k_{ad} is the equilibrium rate constant of the pseudo-first-order sorption (min^{-1}).

Pseudo-second-order model was also generally applied to fit the experimental data. The linear form of pseudo-second-order model [32] can be expressed as:

$$\frac{t}{q_t} = \frac{1}{h} + \frac{t}{q_e} \quad (10)$$

Where, $q_t = (q_e^2 kt)/(1 + q_e kt)$, the amount of dye adsorbed on the surface of the BAC at any time, t (mg g^{-1}), k is the pseudo-second-order rate constant (g mg^{-1} min^{-1}) and the initial sorption rate, $h = k\ q_e^2$ (mg g^{-1} min^{-1}).

Table 2 – Thermodynamic parameters of BAC

Thermodynamic parameters		RhB	AO7
ΔG^o (kJ mol^{-1})	303 K	-5.23	-6.073
	313 K	-7.49	-7.807
	323 K	-8.95	-9.737
ΔH^o (kJ mol^{-1})		-18.71	19.95
ΔS^o (kJ $mol^{-1}K^{-1}$)		-0.19	0.18

The values obtained for the pseudo-first-order and pseudo-second-order kinetic models are given in Table 3. It can be seen from the table that the correlation co-efficient (r) value obtained by pseudo-second-order model is higher than the pseudo-first-order model in all the studied conditions. In addition, the $q_{e,cal}$ values obtained by pseudo-second-order model are closer to that of the $q_{e,exp}$ values indicated that the pseudo-second-order model was better at describing the sorption system.

III.8.2. Diffusion-based models

In a solid–liquid sorption process the transfer of solute is characterized by pore diffusion or particle diffusion control.

The pore diffusion model used here was proposed by Weber and Morris [33]. The linear form of the equation is represented by:

$$q_t = k_i t^{0.5} \quad (11)$$

Where, k_i is the intraparticle rate constant (mg g^{-1} $min^{-0.5}$). The slope of the plot of q_t against $t^{0.5}$ will give the value of intraparticle rate constant.

A particle diffusion controlled sorption process [25] is represented by the equation:

$$\ln(1 - \frac{C_t}{C_e}) = -k_p t \quad (12)$$

Where, C_t and C_e are the dye concentration at time t and equilibrium, respectively, and k_p is the particle rate constant (min^{-1}). The value of particle rate constant is obtained by the slope of the plot of ln(1−Ct/Ce) against t.

The straight line plots of $\ln(1-C_t/C_e)$ vs. t and q_t vs. $t^{0.5}$ indicate the applicability of both particle and intraparticle diffusion models. The k_p, k_i and r values of particle and intraparticle diffusion models are

Table 3- Kinetic parameters of BAC at different temperatures with different initial concentrations

Dye	Kinetic models	Parameters	303 K				313 K				323 K			
			10 mg/L	20 mg/L	30 mg/L	40 mg/L	10 mg/L	20 mg/L	30 mg/L	40 mg/L	10 mg/L	20 mg/L	30 mg/L	40 mg/L
RhB	Pseudo-first-order	k_{ad} (min^{-1})	0.015	0.014	0.017	0.021	0.013	0.035	0.013	0.011	0.016	0.029	0.014	0.021
		r	0.997	0.996	0.998	0.993	0.996	0.953	0.989	0.999	0.996	0.981	0.996	0.999
	Pseudo-second-order	q_e (mg/g)	3.803	8.021	8.545	10.228	3.806	6.554	8.061	9.179	3.711	5.903	7.621	9.008
		$k\times10^{-2}$ (g/mg min)	0.028	0.021	0.023	0.021	0.021	0.016	0.018	0.020	0.019	0.021	0.016	0.016
		h (mg/g min)	0.400	1.375	1.679	2.198	0.305	0.708	1.158	1.686	0.268	0.742	0.924	1.288
		r	0.998	0.999	0.999	0.999	0.996	0.998	0.998	0.999	0.997	0.999	0.998	0.999
AO7	Pseudo-first-order	k_{ad} (min^{-1})	0.010	0.027	0.036	0.028	0.012	0.016	0.026	0.024	0.011	0.061	0.027	0.046
		r	0.997	0.983	0.945	0.945	0.995	0.990	0.978	0.994	0.993	0.873	0.970	0.910
	Pseudo-second-order	q_e (mg/g)	3.800	6.946	8.981	10.363	3.704	6.005	8.627	9.967	3.407	5.992	8.139	9.183
		$k\times10^{-2}$ (g/mg min)	0.024	0.016	0.021	0.023	0.020	0.025	0.026	0.032	0.027	0.024	0.030	0.031
		h (mg/g min)	0.341	0.754	1.683	2.460	0.275	0.904	1.956	3.177	0.313	0.873	2.009	2.574
		r	0.996	0.998	0.999	0.999	0.995	0.998	0.999	0.999	0.996	0.999	0.999	0.999

Table 4- Particle and Intraparticle kinetic model parameters of BAC at different temperatures with different initial concentrations

Dye	Kinetic models	Parameters	303 K				313 K				323 K			
			10 mg/L	20 mg/L	30 mg/L	40 mg/L	10 mg/L	20 mg/L	30 mg/L	40 mg/L	10 mg/L	20 mg/L	30 mg/L	40 mg/L
RhB	Particle diffusion	k_p (min^{-1})	0.517	0.698	1.337	1.543	0.566	1.069	1.385	1.592	0.518	1.020	1.404	1.599
		r	0.997	0.997	0.992	0.993	0.992	0.999	0.999	0.994	0.995	0.997	0.999	0.980
		sd	0.036	0.030	0.013	0.009	0.067	0.007	0.005	0.007	0.053	0.011	0.005	0.015
	Intraparticle diffusion	k_i (mg/g $min^{0.5}$)	1.900	5.287	5.870	7.269	1.596	3.432	4.996	6.181	1.370	3.328	4.261	5.293
		r	0.998	0.995	0.999	1.000	0.998	0.997	0.994	1.000	0.999	0.999	0.999	0.995
		sd	0.026	0.056	0.028	0.019	0.032	0.048	0.070	0.011	0.017	0.019	0.034	0.083
AO7	Particle diffusion	k_p (min^{-1})	0.610	1.110	1.292	1.505	0.601	1.023	1.217	1.443	0.389	0.956	1.189	1.470
		r	0.991	0.995	0.999	0.999	0.992	1.000	0.998	0.992	0.993	0.998	0.999	0.999
		sd	0.061	0.023	0.005	0.002	0.059	0.004	0.006	0.007	0.044	0.010	0.003	0.002
	Intraparticle diffusion	k_i (mg/g $min^{0.5}$)	1.764	3.630	6.167	7.772	1.468	3.801	6.285	7.912	1.604	3.660	6.112	7.148
		r	0.996	0.995	0.997	0.992	0.994	0.995	0.999	0.998	0.994	0.999	0.998	0.997
		sd	0.037	0.071	0.042	0.070	0.049	0.047	0.018	0.026	0.040	0.023	0.027	0.036

illustrated in Table 4. The higher r values obtained for both particle and intraparticle diffusion models suggest that BAC composite follow both the models on dye sorption.

IV. Conclusions

The possibility of prepared BAC as an adsorbent for the removal of RhB and AO7 from aqueous solution was investigated by batch method. The pH of the reaction was found to play a major role in the RhB and AO7 dyes removal process and the optimum pH for the removal of RhB was at pH 4 and for AO7 it was at pH 2. The results obtained for RhB and AO7 dyes sorption successfully fit the Freundlich isotherm model than the Langmuir model. The thermodynamic parameters (ΔG°, ΔH°, and ΔS°) of RhB adsorption indicated that the system was exothermic in nature and at the same time the adsorption process of AO7 was endothermic. Subsequently the kinetic data fit to pseudo-second-order model and the sorption process was controlled by the pattern of both particle and intra-particle diffusion. Based on these results, the prepared BAC can be considered as potential adsorbent to remove RhB and AO7 dyes effectively from industrial effluent.

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