

Mechanistic studies on the adsorption of reactive red 2 from aqueous solution by low cost activated carbon and biological applications

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ABSTRACT

The proficiency of activated carbon prepared Azadirachta indica stem carbon (AZSC) for the adsorption of reactive red 2 from fluid arrangement has been concentrated as a component of agitation time, adsorbent dose, starting color fixation, temperature and pH of adsorbate arrangement. The ideal conditions for the adsorption have been shown up and tests were led to discover the Langmuir constants, Freundlich boundaries and kinetic boundaries and the adsorption of reactive red 2 from aqueous solution by low cost activated carbon and biological applications.

Key words: Activated carbon (AZSC), reactive red 2, Adsorption isotherm, Equilibrium, Kinetic boundaries.

INTRODUCTION

In the current investigation, the activated carbon prepared from *Azadirachta indica stem* carbon (AZSC), as the adsorbent and did batch mode analyses to consider the impact of contact time on the evacuation of reactive red 2 color (R2) with the variety of the portion of the adsorbent, Variation of the underlying centralization of the arrangement, variety of pH, variety of size of the adsorbent and variety of temperature. Different models, for example, Lagergren[1], Bhathacharya-Venkobachar[2], Langmuir[3] and Freundlich [4] were tried and the outcomes are deciphered. The recent decades there has been developing enthusiasm for the utilization of electrochemical strategy, for electrocoagulation, electroflotation and electrooxidation[27] for the successful treatment of natural contaminations. Electrocoagulation is a complicated procedure with a large

number of instrument working synergistically to expel the toxins in wastewaters [28] and the adsorption of reactive red 2 from aqueous solution by low cost activated carbon and biological applications [30,31]

MATERIALS AND METHODS

EXPERIMENTAL TECHNIQUES

Arrangement of activated carbon from the plant *Azadirachta indica* includes the accompanying stages like Procurement of crude material for carbonization, impingement with doping operators like H_2SO_4 , $ZnCl_2$ or H_3PO_4 , carbonization and initiation.[29] For the choice of a suitable crude material for planning of permeable carbon, a few components are contemplated. Modernly, cheap material with high carbon and low inorganic (for example low debris) content is favored as crude material for the creation of enacted carbon. The plant *Azadirachta indica* obtained privately, cut into little pieces after the evacuation of their bark and dried. Pyrolysis is the cycle wherein AZSC warmed, disintegrated and inevitably changed over into wanted creation without air in the fixed bed reactor. During carbonisation, the vast majority of the non-carbon components, hydrogen and oxygen are first eliminated in vaporous structure by pyrolytic deterioration of the beginning materials. In this way carbonization includes warm deterioration of carbonaceous material, killing non-carbon species delivering a fixed carbon mass and simple pore structure[5].

Initiation is conveyed to amplify the measurements of the pores which are made during the carbonization cycle and to make some new porosity along these lines bringing about the arrangement of pore structure with enormous surface zone. Compound enactment is done with AZSC as the beginning material. The actuation operators utilized are sulphuric acid and calcium chloride[6]. All actuating operators are drying out specialists which impact the pyrolytic deterioration, hinder tar development and abatement the arrangement of acetic acid, methanol and so forth, and upgrade the yield of carbon. A pseudo-activated carbon has been set up by responding AZSC concentrated sulphuric acid or phosphoric and warming. The initiated AZSC acquired from various cycle were ground utilizing a mortar and pestle sieved into a few size part utilizing American Standard Testing Mesh. The sieved particles were then dried in a hot air oven overnight at 110 °C.

These particles subsequent to eliminating from the oven were cooled in desiccators. At The actuated AZSC tests were inspected utilizing Perkin-Elmer FT-IR spectrophotometer. The surface morphologies of enacted AZSC were seen with Scanning Electron Microscope at CECRI, Karaikudi.

RESULTS AND DISCUSSION

The prepared AZSC of particle size 75-125 μ , bulk density 0.3576g/cc, moisture content 1.85%, loss on ignition 85%, acid insoluble matter 2.78%, water soluble matter 0.62%, pH 6.4, pH_{zpc} 6.45 and surface area 346.8m²/g.

Similarly the FTIR spectra of raw activated carbon AZSC shown in Fig. I. The band at 3412.7 cm⁻¹ is due to stretching of O-H group. The band at 2361.4 cm⁻¹ shows the presence of C=C stretching. The N-H bending vibrations occur in the region of 1590.9 cm⁻¹ and C-O-C stretching vibrations occur in the region of 1156.3 cm⁻¹.

The adsorption of reactive red 2 on AZSC shown in Fig. II which shows the change of O-H stretching at 3431.5 cm⁻¹, C=C stretching at 2360.2 cm⁻¹, the bending N-H vibration at 1619.1 cm⁻¹ and C-O-C stretching vibrations at 1167.7 due to adsorption of dye on the adsorbent by physical forces.[7,8].

Fig. I FT-IR SPECTRUM OF RAW AZSC

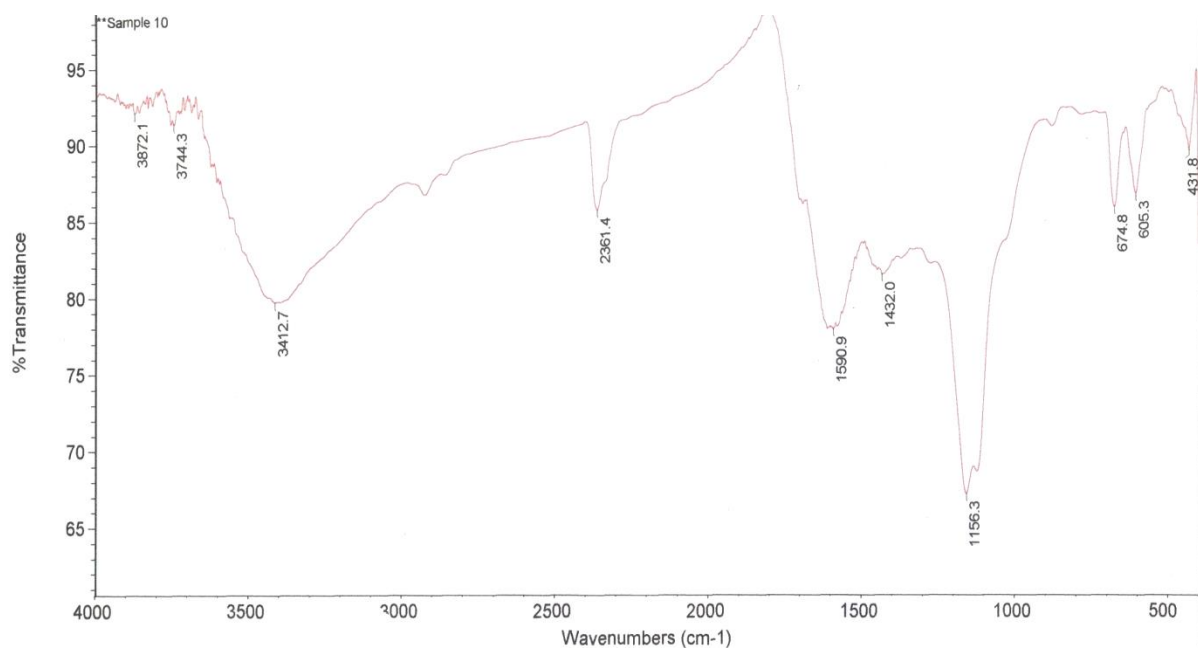
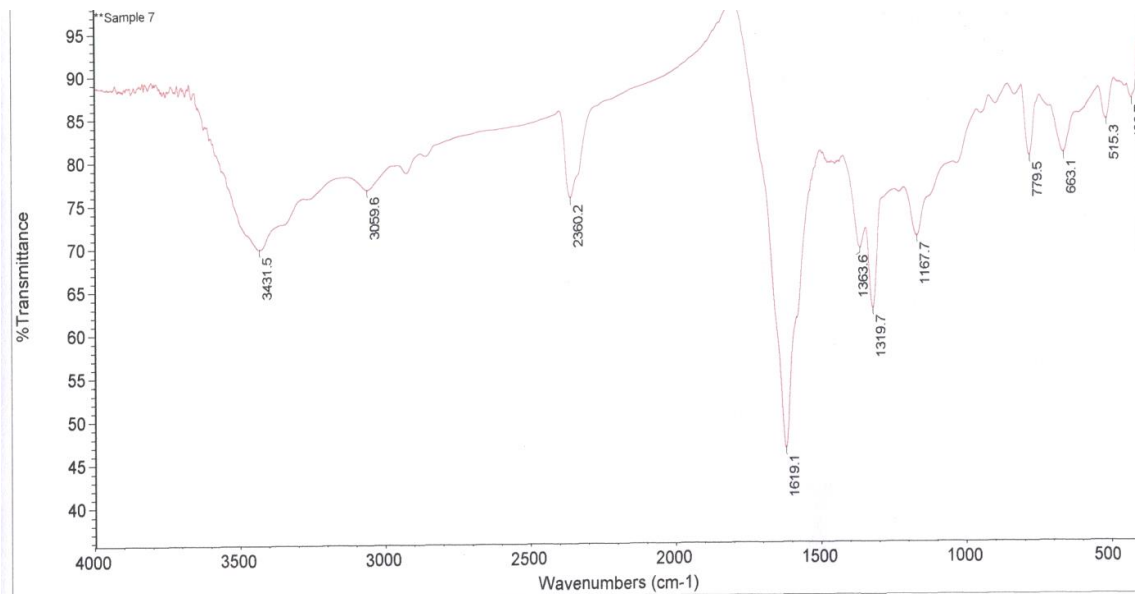


Fig. II FT-IR SPECTRUM OF AZSC AFTER REACTIVE RED 2 ADSORPTION

The SEM images of raw activated carbons of AZSC and the same after dye adsorption are shown in Fig. III and IV. The bright spots show the presence of tiny holes on the crystalline structure of raw activated carbons. After treatment with dye, the bright spots have become dark which reveal that the adsorption of dye on the surface of the carbon by means of physisorption[7-9] SEM images of AZSC shows that the adsorbent has a rough surface with almost non-compact structure. It is obvious that the sorbent has considerable number of pore spaces, where appropriate conditions exist for reactive red 2 dyes to be trapped and adsorbed into the pores. The SEM images also illustrate that the dye can be homogeneously adsorbed on the surface of adsorbent. The surfaces of AZSC are found to be not so random but rough in such a way to adhere the solute species on to the surface of the adsorbent which is revealed from the SEM images. Hence, the adsorptive characteristics of AZSC are expected to be highly effective.

Fig. III SEM IMAGE OF RAW AZSC

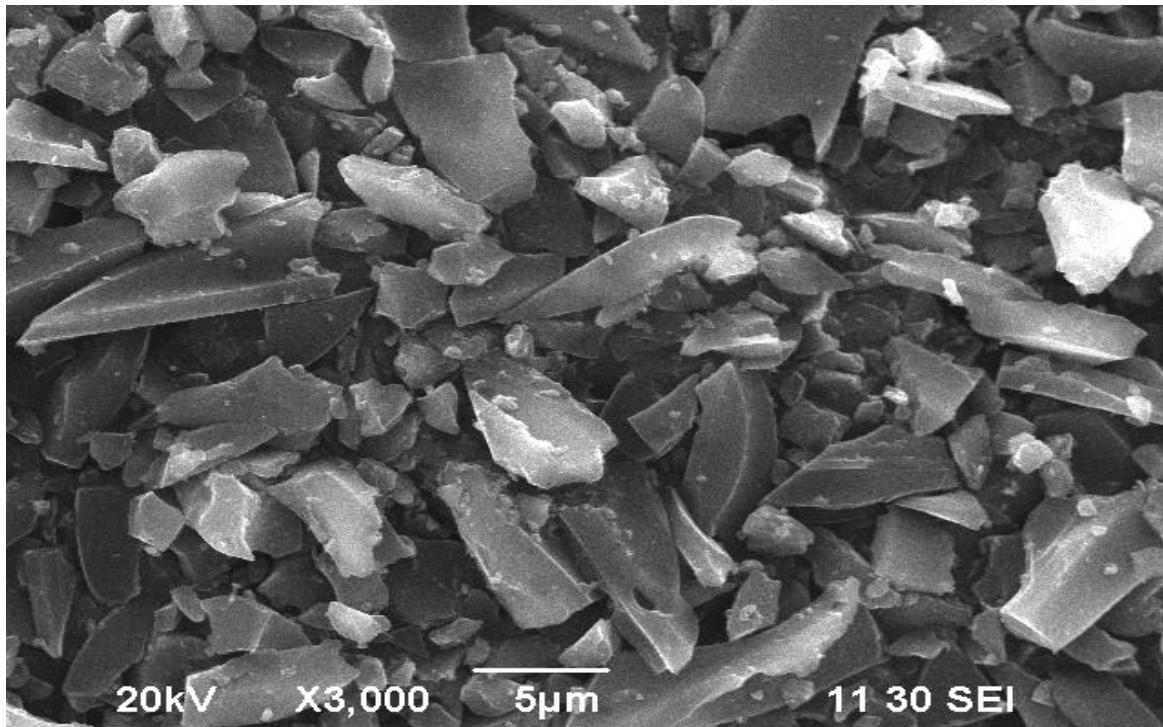
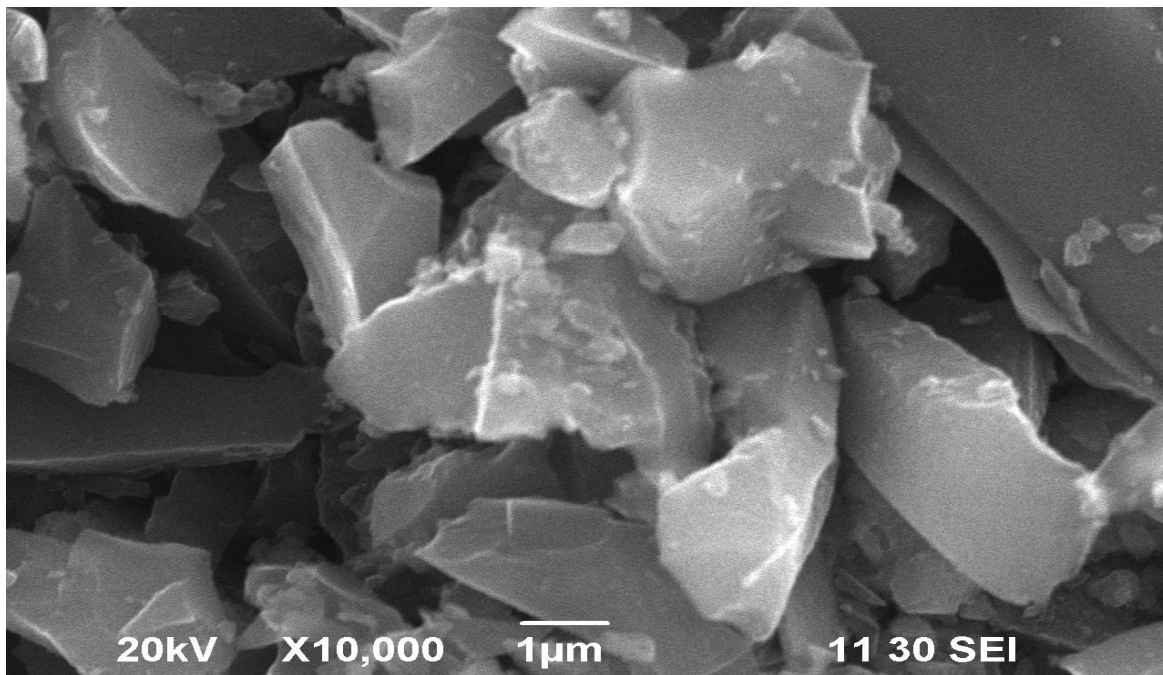


Fig. IV SEM IMAGE OF AZSC AFTER REACTIVE RED 2 ADSORPTION



Effect of Dosage of AZSC

The Table-1 presents the result of the effect of the dose of the adsorbent on the removal of reactive red 2, namely, 2.0, 4.0, 6.0, 8.0 and 10.0 g/L respectively. Figure-1 represents the plot of reactive red 2 adsorbed in percentage for various doses of the adsorbent. Results showed that removal of reactive red 2 increases with the increase in the dosage of adsorbent.[10-12]

Effect of Contact Time

The Table-2 represents the result of the effect of contact time on removal of reactive red 2. The respective figure for the effect of contact time on percentage of reactive red 2 removal is shown in figure-2. The maximum amount of reactive red 2 adsorbed corresponding to the equilibration time is found to be 70.8 % for a weight of 2 g/L of the adsorbent[13,14]

Effect of Initial Dye Concentration[3,15]

The result of the effect of concentration of solution on removal of reactive red 2, viz., 50, 100, 150, 200 and 250 mg/L respectively presented in Table-3. Results showed that as the concentration of the solution increases, percentage removal of reactive red 2 decreases (Fig.3).

Effect of Size of the Adsorbent [4,16]

The experimental results of adsorptions of red 2 ion on to the activated carbon with various sizes (75-125, 125-200, 200-250, 250-300 μ) of the adsorbent are shown in Table-4 and the corresponding values for the effect of size of the adsorbent on removal of reactive red 2 are plotted in figure-4.

Effect of pH

The effect of pH for the adsorption of reactive red 2 dye onto AZSC has been studied and the values are presented in Table-5. The optimum pH is found to be around 5.0-6.0 shown in figure-5. This indicates that adsorption is favorable at less acidic medium[17-20].

Effect of Temperature

The effect of temperature on the adsorption of reactive red 2 has been studied and the values are presented in Table-6. The increase in temperature increases the adsorption of reactive red 2 dye on AZSC. This shows that adsorption is favorable at higher temperatures [21-24, 28] (Fig.6) and found to be an endothermic process.

Adsorption Kinetics

The experimental data obtained for the adsorption of reactive red 2 on to the surface of AZSC under the given set of conditions, were analyzed in the light of pseudo first order model suggested by Lagergren [1], with the view to evaluating the mechanistic parameters associated with the process of adsorption. The Lagergren equation suggests linearity for the plot of $\log_{10} (q_e - q)$ against time, t . The figure-7 represents the relation between $\log_{10} (q_e - q)$ and t under a given set of experimental conditions. From the slope of each line, the rate constants were determined. The values of $k_{Lager} \times 10^4, s^{-1}$ obtained when different concentrations of solution are presented in Table-17. The results obtained in the light of Lagergren were further confirmed by Bhattacharya and Venkobachar² equation Table 7-16. The values of $k_{Bhatt} \times 10^4 s^{-1}$ obtained by using different concentrations of the adsorbent at pH 5.5, are presented in the Table-17. It is found that the k_{Bhatt} values are also similar to those of k_{Lager} . These values reveal the decreasing trend with the increase of the dose of the adsorbent [24]. Furthermore, the applicability of the Bhattacharya and Venkobachar equation confirms the formation of a monomolecular layer of reactive red 2 dye on to the surface of adsorbent, as well as the first order kinetic nature of the process. (Fig.8)

Adsorption Isotherms

The experimental data were analyzed by using linear form of the Langmuir [3] and Freundlich [4] isotherms. The values are given in Table-18. The linear plots of $C_e q_e$ versus C_e suggest the applicability of the Langmuir isotherm (Fig.9). The values of Q_m and b were determined from slope and intercepts of the plots and are presented in Table-19. Linear plot of $\log q_e$ versus $\log C_e$ shows that the adsorption of reactive red 2 follows the Freundlich isotherm (Fig.10). The values of K_F and n were found and given in the

Table-19. The R_L values (Table-20) of AZSC suggests the favorability of adsorption process [25,26].

TABLE-1
EFFECT OF THE DOSE OF THE ADSORBENT ON THE REMOVAL OF REACTIVE RED 2

$[R2]_{ini.}, \text{mg/L} = 50$; Solution pH = 5.5 ; Temp., °C = 35.0 ± 1

S.No.	Dose of the adsorbent m, g/ L	Maximum adsorption, %	Minimum time for maximum removal, min
1	2.0	70.8	180
2	4.0	74.2	180
3	6.0	77.9	180
4	8.0	81.4	180
5	10.0	86.5	180

TABLE-2
EFFECT OF THE CONTACT TIME ON REMOVAL OF REACTIVE RED 2
 $W_{\text{adsorbent}, \text{m,g/L}} = 2.0$; Solution pH = 5.5 ; $[R2]_{ini.}, \text{mg/L} = 50$; Temp., °C = 35.0 ± 1

S.No.	Contact time, min	$[R2]_{\text{adsorbed at equilibrium}}, \%$
1	30	52.4
2	60	56.8
3	90	61.0
4	120	64.4
5	150	68.2
6	180	70.8
7	210	70.8

TABLE-3
EFFECT OF THE CONCENTRATION OF THE SOLUTION ON REMOVAL OF REACTIVE RED 2

$W_{\text{adsorbent, m,g/L}} = 2.0$; Solution pH = 5.5 ; Temp., °C = 35.0 ± 1

S.No.	Concentration of R2, mg/L	[R2] _{adsorbed at equilibrium} , %	Minimum time for maximum removal, min
1	50	70.8	180
2	100	39.8	180
3	150	28.2	180
4	200	23.25	180
5	250	20.9	180

TABLE-4
EFFECT OF THE SIZE OF THE ADSORBENT ON REMOVAL OF REACTIVE RED 2

$W_{\text{adsorbent, m, g/L}} = 2.0$; Solution pH = 5.5 ; [R2]_{ini}. mg/L = 50
 Contact time=180 min ; Temp., °C = 35.0 ± 1

S.No.	Size of the adsorbent μ	[R2] _{adsorbed at equilibrium} , %
1	75-125	70.8
2	125-200	64.3
3	200-250	59.2
4	250-300	53.5

TABLE-5
FFECT OF pH THE ON REMOVAL OF REACTIVE RED 2

$W_{\text{adsorbent}}$, m, g/L, = 2.0; Contact time, min=180; $[R2]_{\text{ini}}$. mg/L = 50 ; Temp., °C =35.0 ± 1

S.No.	pH	[R2] _{adsorbed at equilibrium} , %
1	0.5	48.2
2	1.0	51.6
3	1.5	54.0
4	2.0	56.2
5	2.5	58.8
6	3.0	50.8
7	3.5	63.1
8	4.0	60.2
9	4.5	66.5
10	5.0	67.2
11	5.5	70.8
12	6.0	70.5
13	6.5	68.2
14	7.0	66.1
15	7.5	60.4
16	8.0	56.2

TABLE-6
EFFECT OF THE TEMPERATURE OF THE SOLUTION ON REMOVAL OF REACTIVE RED 2

$W_{\text{adsorbent}}$, m, g/L, = 2.0 ; Solution pH = 5.5 ; $[R2]_{\text{ini}}$. mg/L = 50 ; Contact time =180 min

S.No.	Temperature, °C	[R2] _{adsorbed at equilibrium} , %
1	35	70.8
2	40	72.5
3	45	74.1
4	50	75.9

TABLE-7**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL – CONCENTRATION VARIATION**

[R2]_{ini.}, C_{0.}, = 50 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75 – 125 μ ; pH = 5.5 ; Temp., = 35 °C
C_e = 14.6 mg/L ; q_e = 17.7 mg/g

S.No.	Contact time t, min	[R2] _{t.} , C _{t.} , mg/L	[R2] _{ad.} , x, mg/L	[R2] _{ad.} , x %	(x/m), q, mg/g	(q _e -q), mg/g	2+log ₁₀ (q _e -q)
1	30	23.8	26.2	52.4	13.1	4.6	2.6627
2	60	21.6	28.4	56.8	14.2	3.5	2.5440
3	90	19.5	30.5	61	15.25	2.45	2.3891
4	120	17.8	32.2	64.4	16.1	1.6	2.2041
5	150	15.9	34.1	68.2	17.05	0.65	1.8129
6	180	14.6	35.4	70.8	17.7	0	-
7	210	14.6	35.4	70.8	17.7	0	-

TABLE-8**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL –CONCENTRATION VARIATION**

[R2]_{ini.}, C_{0.}, = 100 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 °C
C_e = 60.2 mg/L ; q_e = 19.9 mg/g

S.No.	Contact time t, min	[R2] _{t.} , C _{t.} , mg/L	[R2] _{ad.} , x, mg/L	[R2] _{ad.} ,X %	(x/m), q, mg/g	(q _e -q)	2+log ₁₀ (q _e -q)
1	30	70.8	29.2	29.2	14.6	5.3	2.7242
2	60	68.5	31.5	31.5	15.75	4.15	2.6180
3	90	66.9	33.1	33.1	16.55	3.35	2.5250
4	120	64.7	35.3	35.3	17.65	2.25	2.3521
5	150	62.6	37.4	37.4	18.7	1.2	2.0791
6	180	60.2	39.8	39.8	19.9	0	-

TABLE-9**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL – CONCENTRATION VARIATION**

[R2]_{ini.}, C_{0.}, = 150 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 °C
C_e = 107.7 mg/L ; q_e = 21.15 mg/g

S.No.	Contact time t, min	[R2] _{t.} , C _{t.} , mg/L	[R2] _{ad.} , x, mg/L	[R2] _{ad.} ,X %	(x/m), q mg/g	(q _e -q)	2+log ₁₀ (q _e -q)
1	30	117.8	32.2	21.46	16.1	5.05	2.7118
2	60	115.9	34.1	22.7	17.05	4.1	2.6127
3	90	113.5	36.5	24.3	18.25	2.9	2.4623
4	120	111.8	38.2	25.4	19.1	2.05	2.3117
5	150	109.6	40.4	26.9	20.2	0.95	1.9777
6	180	107.7	42.3	28.2	21.15	0	-

TABLE-10**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL – CONCENTRATION VARIATION**

[R2]_{ini.}, C_{0.}, = 200 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 °C
C_e = 153.5 mg/L ; q_e = 23.25 mg/g

S.No.	Contact time t, min	[R2] _{t.} , C _{t.} , mg/L	[R2] _{ad.} , x, mg/L	[R2] _{ad.} ,X %	(x/m), q mg/g	(q _e -q)	2+log ₁₀ (q _e -q)
1	30	163.8	36.2	18.1	18.1	5.15	2.7118
2	60	161.6	38.4	19.2	19.2	4.05	2.6074
3	90	159.5	40.5	20.25	20.25	3.0	2.4771
4	120	157.6	42.4	21.2	21.2	2.05	2.3117
5	150	155.8	44.2	22.1	22.1	1.15	2.0606
6	180	153.5	46.5	23.25	23.25	0	-

TABLE-11
EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL – CONCENTRATION VARIATION

[R2]_{ini.}, C_{0.}, = 250 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 °C
 C_e = 197.7 mg/L ; q_e = 26.15 mg/g

S.No.	Contact time t, min	[R2] _{t.} , C _{t.} , mg/L	[R2] _{ad.} , x, mg/L	[R2] _{ad.} , x %	(x/m), q mg/g	(q _e -q)	2+log ₁₀ (q _e -q)
1	30	207.8	42.2	16.8	21.1	5.05	2.7032
2	60	205.6	44.4	17.76	22.2	3.95	2.5965
3	90	203.5	46.5	18.6	23.25	2.90	2.4623
4	120	201.8	48.2	19.28	24.1	2.05	2.3117
5	150	199.9	50.1	20.04	25.05	1.1	2.0413
6	180	197.7	52.3	20.92	26.15	-	-

TABLE-12
EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL –CONCENTRATION VARIATION
 [R2]_{ini.}, C_{0.}, = 50 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 °C ; C_e = 14.6 mg/L

S.No.	Contact time t, min	[R2] _{t.} , C _t mg/L	U _t	1-U _t	2+log(1-U _t)
1	30	23.8	0.7401	0.2599	1.4148
2	60	21.6	0.8022	0.1978	1.2962
3	90	19.5	0.8615	0.1385	1.1414
4	120	17.8	0.9096	0.0904	0.9542
5	150	15.9	0.9632	0.0368	0.5658
6	180	14.6	1	0	-
7	210	14.6	1	0	-

$$U_t = [(C_0 - C_t) / (C_0 - C_e)]$$

TABLE-13**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL –CONCENTRATION VARIATION**

$[R2]_{ini.}, C_{0.}, = 100 \text{ mg/L}$; Adsorbent Dose =2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 ° C; $C_e = 60.2 \text{ mg/L}$

S.No.	Contact time t, min	$[R2]_{t.}, C_t$ mg/L	U_t	$1-U_t$	$2+\log(1-U_t)$
1	30	70.8	0.7336	0.2664	1.4255
2	60	68.5	0.7914	0.2083	1.3186
3	90	66.9	0.8316	0.1684	1.2263
4	120	64.7	0.8869	0.1131	1.0534
5	150	62.6	0.9396	0.0604	0.7810
6	180	60.2	1	0	-

$$U_t = [(C_0-C_t)/(C_0-C_e)]$$

TABLE-14**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL –CONCENTRATION VARIATION**

$[R2]_{ini.}, C_{0.}, = 150 \text{ mg/L}$; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ;Temp., = 35 ° C; $C_e = 107.7 \text{ mg/L}$

S.No.	Contact time t, min	$[R2]_{t.}, C_t$ mg/L	U_t	$1-U_t$	$2+\log(1-U_t)$
1	30	117.8	0.7612	0.2388	1.3780
2	60	115.9	0.8061	0.1939	1.2875
3	90	113.5	0.8628	0.1372	1.1373
4	120	111.8	0.9030	0.0970	0.9867
5	150	109.6	0.9550	0.045	0.6532
6	180	107.7	1	-	-

$$U_t = [(C_0-C_t)/(C_0-C_e)]$$

TABLE-15**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL – CONCENTRATION VARIATION**

[R2]_{ini.}, C_{0.}, = 200 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 ° C ; C_e=153.5 mg/L

S.No.	Contact time t, min	[R2] _{t.} , C _t mg/L	U _t	1-U _t	2+log(1-U _t)
1	30	163.8	0.7784	0.2215	1.3453
2	60	161.6	0.8258	0.1742	1.2410
3	90	159.5	0.8709	0.1290	1.1107
4	120	157.6	0.9118	0.0882	0.9454
5	150	155.8	0.9505	0.0495	0.6946
6	180	153.5	1	0	-

$$U_t = [(C_0 - C_t) / (C_0 - C_e)]$$

TABLE-16**EFFECT OF CONTACT TIME ON REACTIVE RED 2 REMOVAL –CONCENTRATION VARIATION**

[R2]_{ini.}, C_{0.}, = 250 mg/L ; Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 ° C ; C_e=197.7 mg/L

S.No.	Contact time t, min	[R2] _{t.} , C _t mg/L	U _t	1-U _t	2+log(1-U _t)
1	30	207.8	0.8068	0.1932	1.2860
2	60	205.6	0.8489	0.1511	1.1792
3	90	203.5	0.8891	0.1109	1.0449
4	120	201.8	0.9216	0.0784	10.8943
5	150	199.9	0.9579	0.0421	0.6242
6	180	197.7	1	0	-

$$U_t = [(C_0 - C_t) / (C_0 - C_e)]$$

TABLE-17
EFFECT OF THE CONCENTRATION OF THE SOLUTION ON k_{Lager} AND k_{Bhatt}
 $[R2]_{ini.}, \text{mg/L} = 50$; Solution pH = 5.5 ; Temp., ° C = 35.0 ± 1

S.No.	$[R2]_{ini.}, C_0, \text{mg/L}$	$k_{Lager} \times 10^4, \text{s}^{-1}$	$k_{Bhatt} \times 10^4, \text{s}^{-1}$
1	50	2.61	2.61
2	100	1.99	1.99
3	150	2.26	2.22
4	200	2.03	2.03
5	250	2.07	2.07

TABLE-18
DATA FOR LANGMUIR AND FREUNDLICH PLOTS
 Adsorbent Dose = 2.0 g/L ; Adsorbent Size = 75-125 μ ; pH = 5.5 ; Temp., = 35 °C ;
 Contact time =180 min

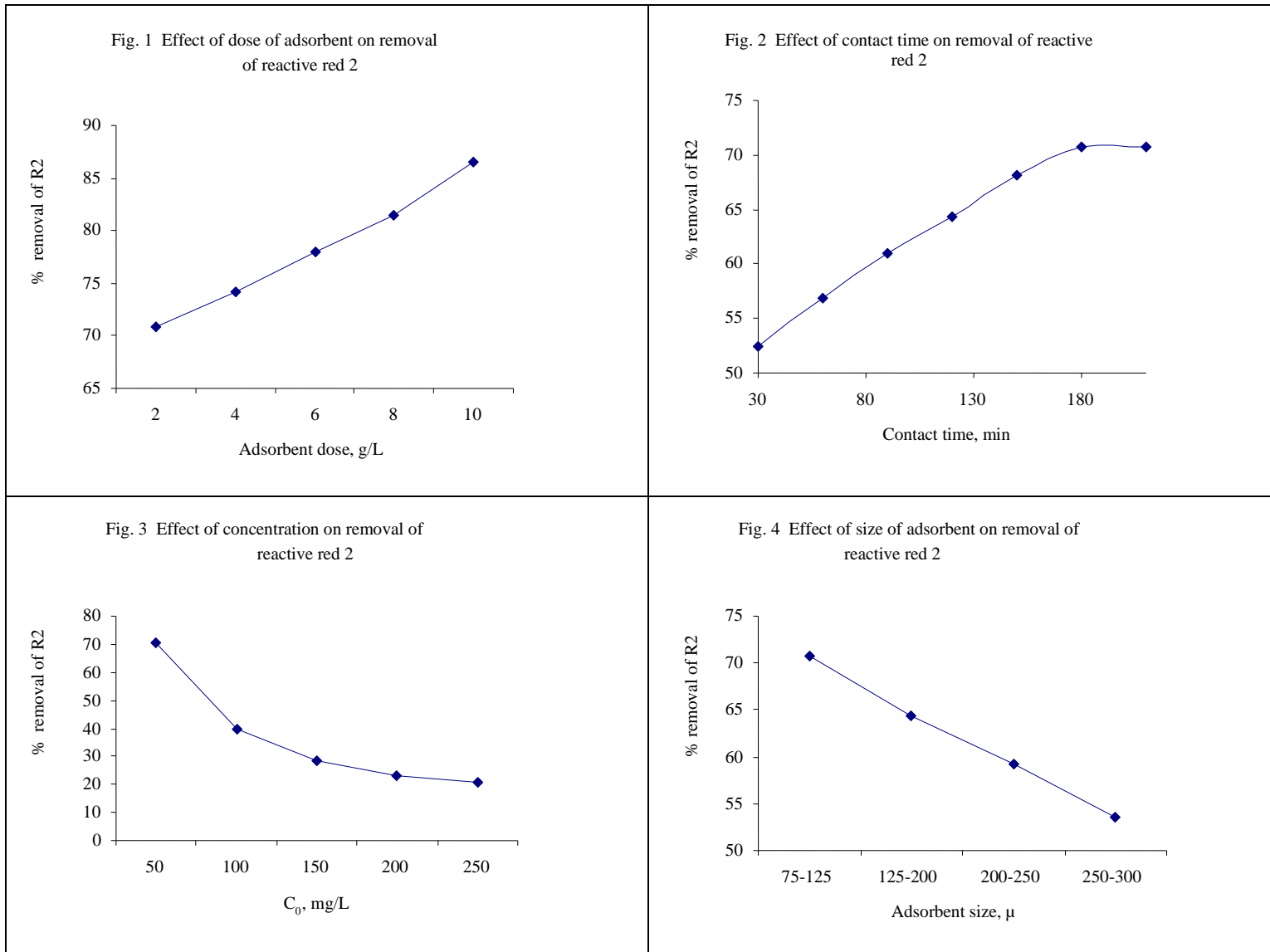
S.No.	$[R2]_{ini.}, C_0, \text{mg/L}$	x, mg / L	$C_e, \text{mg / L}$	log C_e	(x/m), $q_e, \text{mg/g}$	log q_e	C_{eq}/q_e
1	50	35.4	14.6	1.1643	17.7	1.2479	0.8248
2	100	39.8	60.2	1.7795	19.9	1.2988	3.0251
3	150	42.3	107.7	2.0322	21.2	1.3263	5.0801
4	200	46.5	153.5	2.1861	23.3	1.3673	6.5879
5	250	52.3	197.7	2.2960	26.2	1.4183	7.5458

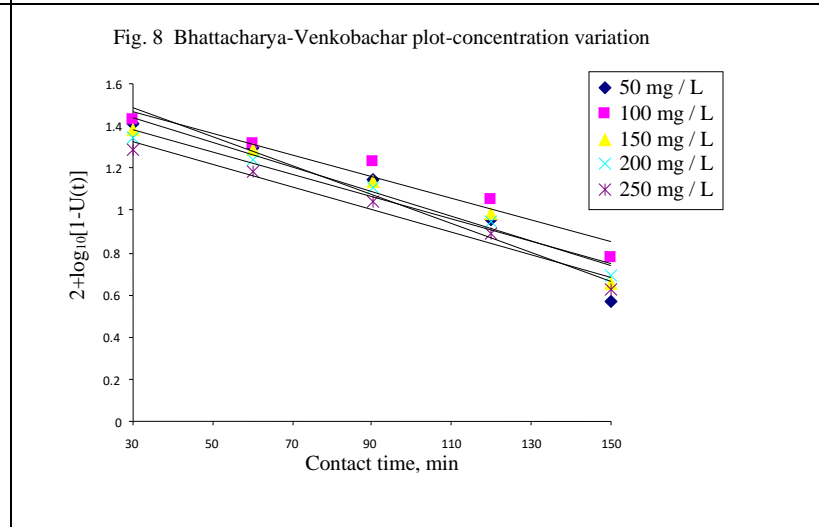
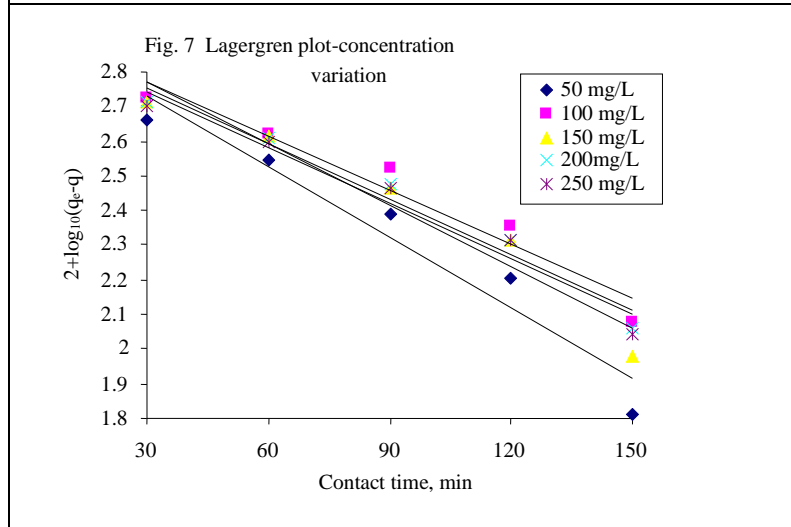
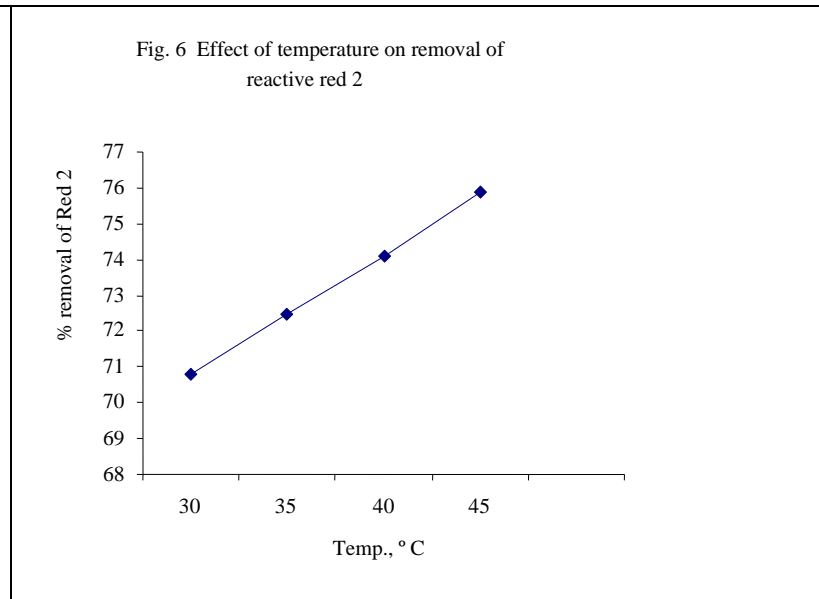
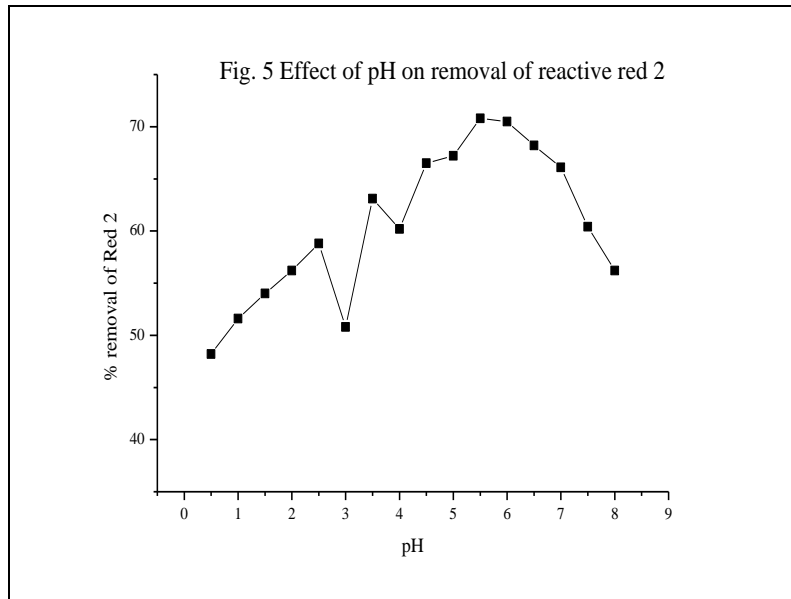
TABLE-19
ISOTHERM CONSTANTS FOR ADSORPTION OF REACTIVE RED 2 ON AZSC

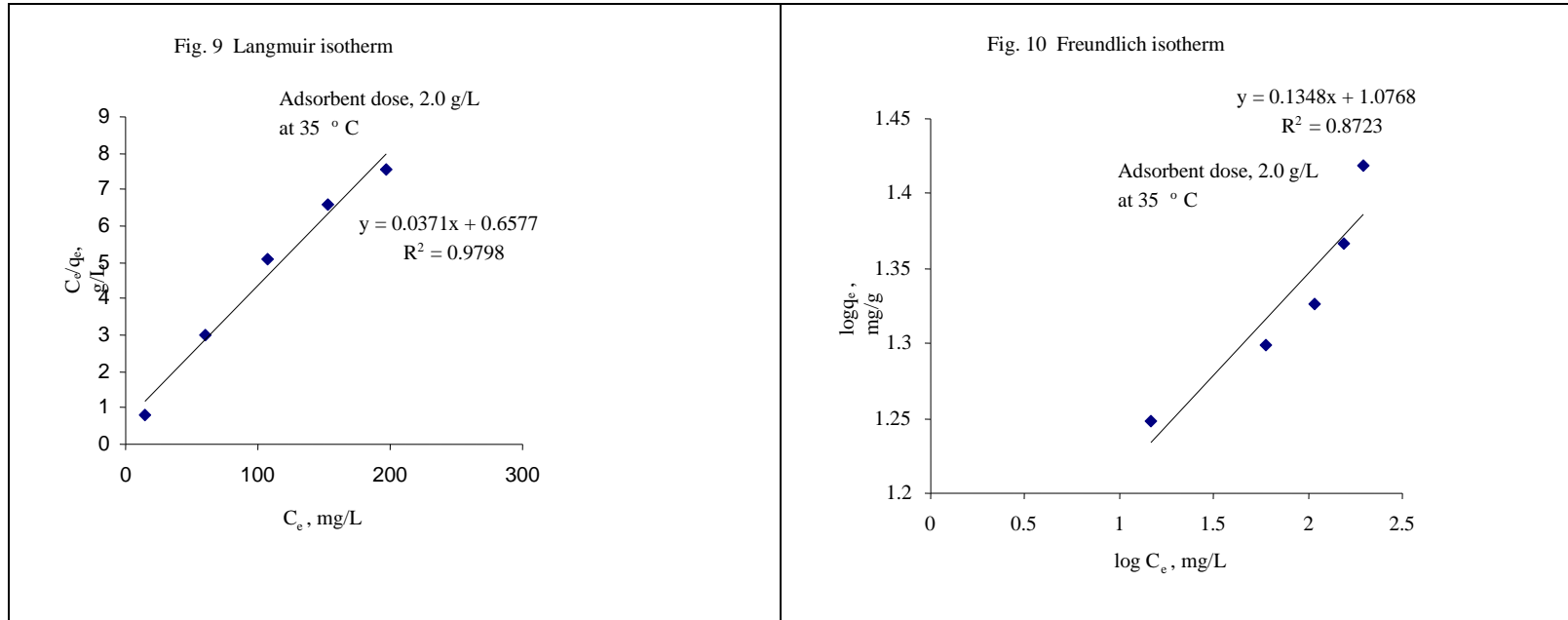
Langmuir Isotherm Constants			Freundlich Isotherm Constants		
Q_m (mg/g)	b (L/mg)	Correlation Coefficient (R^2)	K_F (mg/g)	n (L/mg)	Correlation Coefficient (R^2)
26.95	0.0564	0.9798	0.0739	7.418	0.8723

TABLE-20
VALUES OF R_L FOR REACTIVE RED 2 ADSORPTION ON AZSC

[R2], (mg/L)	Temp., °C
	35
50	0.2617
100	0.1506
150	0.1057
200	0.0814
250	0.0662







BIOLOGICAL ACTIVITY

Aftereffects of the development hindrance investigation of the incorporated activated carbon showed superb antimicrobial [30-32] movement against a scope of microscopic organisms and growths. The distance across of hindrance zone reflects greatness of defenselessness of organisms. The strains powerless to silver nanoparticles showed bigger zone of hindrance, while safe strains display littler zone of restraint. The activated carbon indicate high resistance against the development of *Klebsiella pneumonia* (12mm) and *Aspergillus conicus* (10mm) in *A. paniculata* dissemination plate. At low fixation likewise the particles indicate compelling development restraint of the microorganisms. The consequence of the zone restraint were given in table 21 and 22.

Table 21: Antibacterial activity of the activated carbon

Bacteria Name	Zone of inhibition (mm)	Activated Carbon
<i>Bacillus subtilis</i>	17.1±0.03	7.6 ± 0.03
<i>Escherichia coil</i>	16.4±0.03	10.1 ± 0.03
<i>Klebsiella pneumonia</i>	17.8±0.03	7.7 ± 0.05
<i>Proteus mirabilis</i>	17.2±0.03	9.1± 0.02
<i>Streptococcus fecalis</i>	16.8±0.03	8.8 ± 0.03

Table 22: Antifungal activity of the activated carbon

Fungus Name	Zone of inhibition (mm)	Activated Carbon
<i>Aspergillus conicus</i>	13 ± 0.03	8.9 ± 0.03
<i>Aspergillus flavus</i>	15 ± 0.05	9.2 ± 0.05
<i>Aspergillus niger</i>	12 ± 0.03	7.9 ± 0.03
<i>Aspergillus terreus</i>	13 ± 0.05	7.2 ± 0.05
<i>Rhizopus</i>	14 ± 0.05	9.0 ± 0.05

CONCLUSION

The equilibrium time, 180min has all the earmarks of being adequate for the greatest adsorption of reactive red 2 species by AZSC, under the given arrangement of exploratory conditions and the most extreme measure of responsive red 2 adsorbed is discovered to be 70.8 %, with a portion of 2.0 g/L, for

a grouping of 50 mg/L, at 35°C, with the ideal pH of 5.5. The level of evacuation of reactive red 2 increments with the expansion of the portion of the adsorbent and diminishes when the underlying convergence of adsorbate arrangements increments. The ideal pH to be fixed for additional test work has been discovered to be 5.5. The relevance of the Lagergren model affirms the development of a monomolecular layer of reactive red 2 species on the outside of AZSC. The ends got from the investigation of the pertinence of Lagergren model to the current framework were affirmed by the investigation of the relevance of Bhattacharya-Venkobachar model. The outcomes have affirmed the first order kinetic nature of adsorption process. The adsorption cycle of reactive red 2 depicted by Langmuir isotherm and Freundlich isotherm models, shows a decent concurrence with the balance information and discovered to be an endothermic cycle. R_L esteem proposes the positivity of adsorption. All the above data uncovers that the chose AZSC might be utilized as an adsorbent for the expulsion of reactive red 2 from waste waters and good utilized as successful antibacterial and antifungal materials against different microorganisms which can low cost activated carbon.

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