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Removal of Acid Yellow-17 Dye from Aqueous Solution using Turmeric Industrial Waste Activated Carbon

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Abstract

Several textile industrial effluents has various dye traces and causes so many health issues to human life and also creates various ecological problem to environment. The removal of such dye traces has made by using effective and economic adsorption technique is one of the alternative requirement compare to other expensive treatment methods. Removal of acid yellow-17 (AY17) dye, a monoazo acid dye, was prepared using Turmeric Industrial Waste Activated Carbon (TWAC) as an adsorbent in a batch system with respect to initial dye concentration (20,40 and 60 mg/L), temperatures (303,318 and 333K), particle size (75-180 µm, 180-250 µm and 250-355 µm) and pH (2,5.5 and 8). The investigation clearly shows that the maximum percentage of dye removal is above 98% at 333K, the dye concentration of 20 mg/L, particle size of 75-180 µm and the pH range of 2-6. The percentage of dye removal increases as the dye concentration, particle size decreases and time increases. A comparison of kinetic models applied to adsorption of acid yellow-17 dye on Turmeric Waste Activated Carbon was evaluated for pseudo first–order, pseudo second-order and Elovich models respectively. Results prove that the pseudo second order kinetic model was found to correlate the experimental data well. Langmuir and Freundlich adsorption isotherm studies were also measured and to propose plausible mechanism of adsorption involved in this process. The adsorption study indicated that the adsorbent like turmeric waste are really effective as well as economical for the removal of acidic dyes such as acid yellow-17 from textile industrial wastewater.

Keywords: *Acid yellow 17 dye; Batch system; Dye removal; Elovich model; Industrial effluents; Turmeric waste.*

1. INTRODUCTION

The presence of Acid Yellow 17 dye in the effluents from various industries like textile industries, dyeing, paper industries and food industries creates severe environmental issues to the living things and also they are highly toxic to human beings and animals.

Azo dyes are the most problematic pollutants of textile wastewaters. It is known that high potential health risk is caused by adsorption of azo dyes and their breakdown products (toxic amines) through the gastrointestinal tract, skin, lungs, and also formation of hemoglobin adducts and disturbance of blood formation.

It is highly undesirable and causes so many health issues to human life and also creates various ecological problems to environment due to the presence of even a very low percentage of this dye in aqueous media. In order to avoid this it is very much essential to remove even the traces of this dye from the industrial

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effluents. The biological treatment methods are not a conventional method for the removal of this dye, since they possess a complex aromatic structure and their stability towards aqueous media. So this work was carried out by utilizing a very good economic adsorption technic by using activated carbon. Activated carbon is one of the effective adsorbent for the removal of dyes from industrial effluents due to their large surface area, micro porous character and chemical nature of their surface.

Many reports were explored on the development of lowest activated carbon adsorbents prepared from cheaper and available waste materials (Babel and Kurniawan, 2003).

The adsorptive properties of active carbon for removal of pollutants are well documented (Macias *et al*. 1993). Adsorption of hazardous soluble chemicals from wastewater into surface of a solid adsorbent has provided a new dimension to wastewater technology (Benefield *et al*. 1982). To minimize the treatment expenses incurred by using activated carbon, the research work was carried out by using waste materials as alternative to activated carbon.Spent Brewery Grains (Jaikumar and Ramamurthi, 2009), Cellulosic precursor (Bangash and Alam, 2006), Rice husks (Youseff *et al*. 1990), fruit stones (Namasivayam and Periyasamy, 1993; Lopez *et al*. 1984; Gharaibeh *et al*. 1998), coconut shells (Alaerts *et al*. 1989; Manju *et al*. 1998), (Chen *et al*. 2001), ferronia shell (Karthikeyan *et al*. 2008) and *ipomoea carnia* stem waste (Karthikeyan *et al*. 2007) are some of the waste materials which have been tried for this type of treatment. In the same way for this work, Turmeric industrial waste activated carbon (TWAC) was prepared from Turmeric industrial waste material and used to remove Acid Yellow 17 (AY 17) from aqueous solution with respect to initial dye concentration, temperatures, particle size, pH and contact time as parameters.

2. EXPERIMENTAL

Adsorbent

Turmeric is one of the largest cash crops in South India particularly in Erode, Coimbatore districts. The solid waste generated is thrown out as waste material from the industries causes' environmental problem. In view of this, an effort has been made to collect these solid wastes and converted into useful activated carbon adsorbents. The study of Turmeric industrial waste material is used as adsorbent is expected to be economical, environmentally safe and it has practical importance.

To develop adsorbents, the material was first ground and washed with doubly distilled water and then dried. The dried material thus obtained was treated with hydrogen peroxide (30%W/V) at room temperature for about 24 hrs to oxidize the adhering organic matter. The resulting material was thoroughly washed with doubly distilled water and then subjected to the temperature of 120 °C for the moisture removal.

The above material was soaked well with 10% of H_2SO_4 solution for a period of 24 hours. At the end of 24 hrs the excess of H_2SO_4 solution were decanted off and air-dried. Then the materials were placed in the muffle furnace carbonized at 400 °C. The dried materials were powdered and activated in a muffle furnace kept at 800 °C for a period of 60 minutes. After activation, the obtained carbons were washed sufficiently with Na_2CO_3 to remove cations. Then the obtained material was washed with plenty of water to remove excess of acid, dried then to desired particle size tight lid container. The resulting carbons named as Turmeric industrial waste activated carbon (TWAC). The N_2 adsorption-desorption isotherms of activated carbons were measured at 77K using a gas sorption analyzer (NOVA 1000, Quanta Chrome corporation) in order to determine the surface areas and the total pore volumes. The surface areas were calculated using the BET equation.

Batch adsorption studies

All reagents used were of AR grade (E Merck). 50 ml of Acid Yellow 17 solution of known concentration (C_0) and initial pH was taken in a 100 ml screw-cap conical flask with a required amount of adsorbent and was agitated at a speed of 200 rpm in a thermostatic shaker bath at 27 °C for a specified period of time. Then the solution was filtered through a 0.45 μm membrane filter.

Determination of Acid Yellow 17

Acid Yellow 17 was estimated spectrophotometrically using Elico UV- Visible Spectrophotometer. The maximum absorption wavelength (λ max) for Acid Yellow 17 is measured to be 402.

The amount of Acid Yellow 17 adsorbed in mg/L at time t was computed by using the following equation.

$$q_t = \frac{C_0 - C_t}{m_s} \times V \tag{1}$$

where, C_0 and C_t are the Acid Yellow 17 concentration in mg/L initially and a given time t, respectively, V is the volume of the Acid Yellow 17 solutions in ml and m_s is the weight of the activated carbon (TWAC).

The percentage of removed Acid Yellow 17 (R %) in solution was calculated using eqn. (2)

$$\%\ Removal = \frac{C_0 - C_t}{C_0} \times 100 \tag{2}$$

The initial concentration of Acid Yellow 17, pH, particle size of TWAC and temperature was investigated by varying any one parameters and keeping the other parameters constant.

Adsorption dynamics

The study of adsorption dynamics describes the solute uptake rate and evidently this rate controls the residence time of adsorbate uptake at the solid-solution interface. The kinetics of Acid Yellow 17 (AY 17) adsorption on the activated carbons were analyzed using pseudo first order (Lagergren, 1898), pseudo second order (Ho *et al.* 2000) kinetic models and Elovich equation (Chien and Clayton, 1980). The conformity between experimental data and the model predicted values were expressed by the correlation coefficients (r^2 values closer or equal to 1). A relatively high r^2 value indicates that the model successfully describes the kinetics of Acid Yellow 17 (AY 17) adsorption.

The pseudo first – order equation

The pseudo first - order equation (Lagergren, 1898) is generally expressed as follows.

$$\frac{dq_t}{dt} = k_1(q_e - q_t) \tag{3}$$

where, q_e and q_t are the adsorption capacity at equilibrium and at time t, respectively (mg g^{-1}), k_1 is the rate constant of pseudo first –order adsorption, 1/min.

After integration and applying boundary conditions t =0 to t = t and q_t= 0 to q_t = q_t, the integration form of equation (3) becomes

$$\log(q_e - q_t) = \frac{\log(q_e) - k_1}{2.303} \times t \tag{4}$$

The value of log (q_e – q_t) were linearly correlated with t. The plot of log (q_e – q_t) Vs t should give a linear relationship from which k_1 and q_e can be determined from the slope and intercept of the plot, respectively.

The pseudo second – order equation.

The pseudo second – order adsorption kinetic rate equation is expressed as (Ho *et al.* 2000)

$$\frac{dq_t}{dt} = k_2(q_e - q_t)^2 \tag{5}$$

where, k_2 is the rate constant of pseudo second order adsorption (g. mg^{-1}. min^{-1}). For the boundary conditions t = 0 to t = t and $q_t = 0$ to $q_t = q_t$, the integrated form of equation (5) becomes.

$$\frac{1}{q_e - q_t} = \frac{1}{q_e} + k_2 t \qquad (6)$$

Which is the integrated rate law for pseudo second – order reaction.Equation (6) can be rearranged to obtain equation (7), which has a linear form.

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e}(t) \qquad (7)$$

If the initial adsorption rate h (mg g^{-1} min^{-1}) is

$$h = k_2 q_e^2 \qquad (8)$$

Then Equations (7) and (8) becomes

$$\left(\frac{t}{q_t}\right) = \frac{1}{h} + \frac{1}{q_e}(t) \qquad (9)$$

The plot of (t/q_t) Vs t of equation (9) should give a linear relationship from with a slopeof $1/q_e$ and an intercept of $1/k_2q_e^2$ of the plot, respectively.

The Elovich equation

The Elovich model equation is generally expressed(Chien and Clayton, 1980) as

$$\frac{dq_t}{d_t} = \propto \exp(-\beta q_t) \qquad (10)$$

where, α is the initial adsorption rate (mg.g^{-1} min^{-1}), β is the adsorption constant (g. mg^{-1}) during the experiment.

To simplify the Elovich equation, assumed ab_t>>1and by applying the boundary conditions $q_t = 0$ at t = 0 and $q_t = q_t$ at t = t, the Eqn. (10) becomes;

$$q_t = \ln(\propto \beta)\frac{1}{\beta} + lnt\frac{1}{\beta} \qquad (11)$$

If Acid Yellow 17(AY 17) adsorption fits the Elovich model a plot of qt vs ln t should yield a linear relationship with slope of (1/β) and an intercept of (1/β) In (αβ)

3. RESULT & DISCUSSION

Characterization of adsorbent

Physico-chemical characterization of the adsorbent was presented in Table 1.

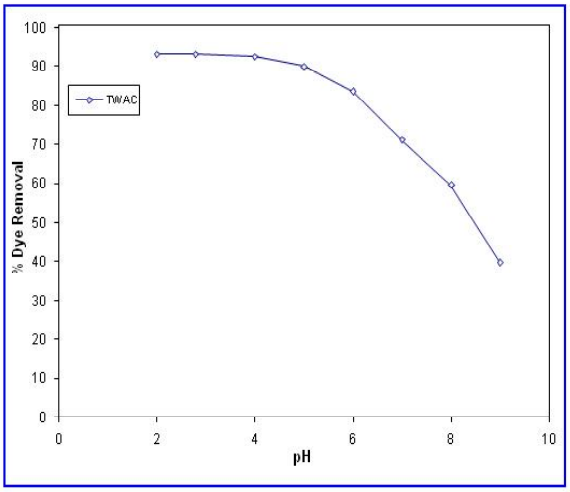

Fig .1: Effect of pH on the removal of Acid Yellow 17 (AY 17) by TWAC

Optimum pH

The adsorption behavior of Acid Yellow 17 on the adsorbent was studied over a wide pH range of 2.0 -10.0. Fig.1 depicts that the pH significantly affects the extent of adsorption of Acid Yellow 17 over the adsorbent and a reduction the amount adsorbed with increasing pH was observed in this study. Fig.1 also specifies that maximum uptake of the Acid Yellow 17 (AY 17) is observed from pH 2.0 – 5.5 and the removal

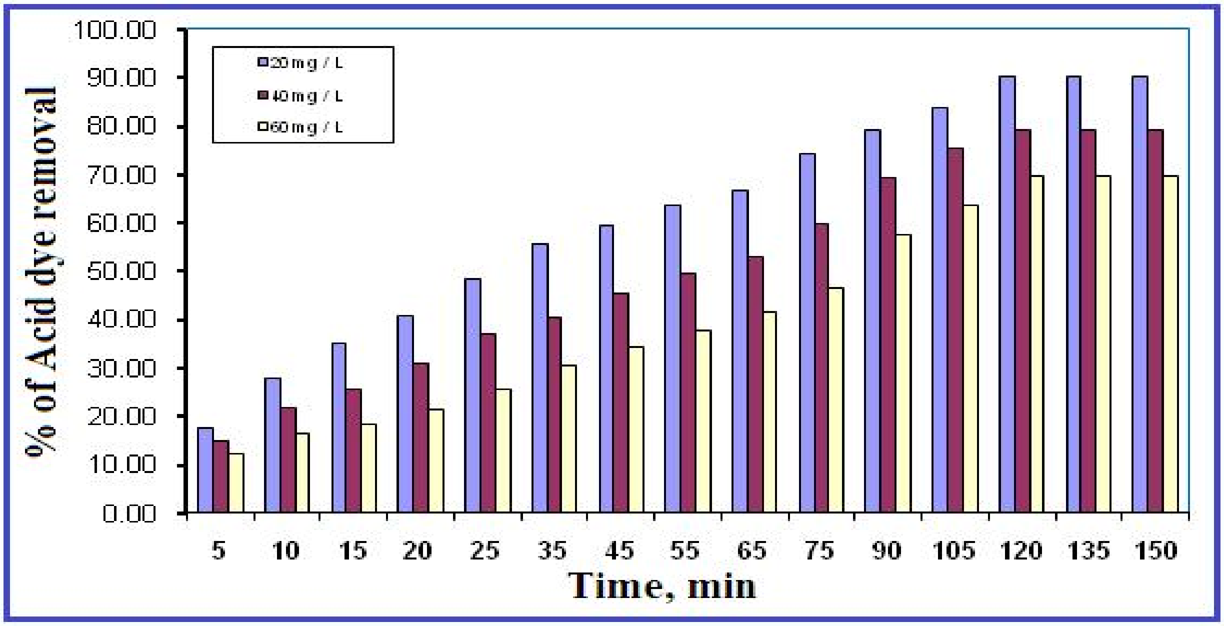

Fig. 2: Effect of concentration on adsorption of Acid Yellow 17(AY 17) over TWAC

Table 1. Physico-Chemical characteristics of TWAC

Parameter	TWAC
Bulk density (g/ml)	0.45
Ash content (%)	2.05
pH	6.9
Moisture content (%)	3.17
Surface area (m^2/g)	458
Solubility in water (%)	0.80
Solubility in0.25M HCl(%)	1.15
Decolorizing power(mg/g)	40.3
Iodine number(mg/g)	512
pH$_{zpc}$	5.9
Carbonyl (mmol/g)	0.00
Lactonic (mmol/g)	0.038
Phenolic (mmol/g)	0.013
Acidic (mmol/g)	0.019
Basic (mmol/g)	0.412

decreased thereafter on TWAC.This may be due to high electrostatic attraction between the positively charged surface of TWAC and also the pKa value of the anionic dye Acid Yellow 17 as 5.3. In general the acidic dye uptakes are much higher in acidic solutions than those in neutral and alkaline conditions.

Effect of concentration

The batch adsorption experiments were carried out by using three different concentrations of Acid Yellow 17 viz. 20 mg/L, 40 mg/L and 60 mg/L at pH 5.5, the particle size of TWAC at 180-250 µm and at the reaction temperature of 30 °C were selected for the adsorption study.

Fig. 2 clearly reveals that the extend of adsorption of Acid Yellow 17 on the adsorbent decreases as initial dye concentration increases.

Effect of Temperature on kinetic rate constant and rate parameters

For adsorption process, adsorption experiments were now carried out with fixed initial dye concentration (20mg/L), the particle size of TWAC at 180-250 µ, at pH 5.5 and at different temperature viz. 30 °C, 45 °C and 60 °C. The analysis of the data in Table.2 reveals that the influence of temperature of the AY 17 has very little influence on the pseudo first order rate constants. The table 2 also reveals that the influence of the temperature of AY 17 on Elovich and pseudo second order rate constant is neither appreciable nor little.

It is obvious that the adsorption of AY 17 on the turmeric industrial waste activated carbon is best described by second order rate equation with regression coefficient value is greater than 0.98.

Thermodynamic Parameter

The thermodynamic parameters obtained for the adsorption systems were calculated using the following equation (Inbaraj and Sulochana, 2002).

$$K_c = \frac{C_{Ae}}{C_e} \tag{12}$$

$$\Delta G = -RT \ln K_c \tag{13}$$

$$\log K_c = \frac{\Delta S}{2.303R} - \frac{\Delta H}{2.303RT} \tag{14}$$

K_C is equilibrium constant, C_{Ae} is the solid phase concentration at equilibrium, C_e is residual concentration at equilibrium, R is gas constant (J/mole) and T is the temperature in Kelvin.

ΔH and ΔS were obtained from the slope and intercept of Van't Hoff plot (1/t Vs $\ln K_c$). Table 4 gives the value of ΔG, ΔS and ΔH for the adsorption of TWAC. The negative values of free energy change (ΔG) indicate the feasibility and spontaneous nature of adsorption of TWAC. The positive value of ΔS is due to the increased randomness during the adsorption of adsorbent.

Mechanism

The high correlation coefficient obtained using pseudo first order and pseudo second order Models, it was impossible to concludes which adsorption mechanism actually occurred and was responsible for the ability of adsorbent to review other sources of information in an attempt to identify the specific adsorption mechanism.

In adsorption process of dye on the solid surface, the dye species migrate towards the surface of the adsorbent. This type of migration proceeds till the concentration of the adsorbate species, adsorbed, on to the surface of the adsorbent. Once equilibrium is attained, the migration of the solute species from the solution stops. Under this situation, it is possible to measure the magnitude of the distribution of the solute species between the liquid and solid phases. The magnitude of this kind of distribution is a measure of the efficiency of the chosen adsorbent in the adsorbate species.

When a powdered solid adsorbent material is made in contact with a solution containing dye species, the dye species first migrate from the bulk solution to the surface of the liquid film. This surface exerts a diffusion barrier. This barrier may be very significant or less significant. The involvement of a significant quantum of diffusion barrier indicates the dominant role taken up by the film diffusion in the adsorption process. Furthermore, the rate of an adsorption process is controlled either by external diffusion, internal diffusion or by both types of diffusions.

The external diffusion controls the migration of the solute species from the solution to the boundary layer of the liquid phase. However, the internal diffusion controls the transfer of the solute species from the

Table 2. The adsorption kinetic model rate constants for TWAC at different Temperature

Adsorbent	Initial Temp.	Pseudo first order		Pseudo Second order			Elovich Model		
		k_1 l min^{-1}	r^2	k_2 g mg^{-1} min^{-1}	h mg g^{-1} min^{-1}	r^2	βg min^{-1}	α mg g^{-1} min^{-1}	r^2
TWAC	30^0	-0.022	0.9702	0.002231	1.6657	0.9875	0.3368	1.5495	0.9697
	45^0	-0.021	0.9941	0.001436	1.3315	0.9886	0.2769	2.0429	0.9677
	60^0	-0.025	0.9749	0.001063	0.9113	0.9923	0.2490	3.3355	0.9812

Table 3. The adsorption kinetic model rate constants for TWAC at different particle size

Adsorbent	Particle Size in micron	Pseudo first order		Pseudo Second order			Elovich Model		
		k_1 l min^{-1}	r^2	k_2 g mg^{-1} min^{-1}	h mg g^{-1} min^{-1}	r^2	β g min^{-1}	α mg g^{-1} min^{-1}	r^2
TWAC	75-180	-0.024	0.9818	0.001013	1.4494	0.994	0.2128	1.5853	0.9871
	180-250	-0.023	0.9867	0.000899	2.1218	0.9905	0.2032	1.1185	0.9727
	250-355	-0.022	0.9484	0.0008	2.806	0.9543	0.2053	0.9134	0.9381

Table 4. Thermodynamic parameters for Acid Yellow 17 onTWAC adsorption.

Adsorbent	$\Delta G \times 10^4$ (KJ mol^{-1})			ΔH (KJ mol^{-1})	ΔS (KJ mol^{-1})
	30 ^{0}C	45 ^{0}C	60 ^{0}C		
TWAC	-27959.4	-26280.8	-25802.1	-4.90358	3.78348

Table 5. D_p and D_f values for the chosen adsorbent - adsorbate system

Temp. ^{0}C	$t_{1/2}$, s	TWAC	
		$D_p \times 10^{-11}$, cm^2	D_f, $\times 10^{-9}$, cm^2
30	3.7463	9.25	4.22
45	4.1829	8.29	4.78
60	4.4615	7.71	5.33

external surface of the adsorbent to the internal surface of the pores of the adsorbent material (Gupta *et al.* 2005).

It is now well established, that during the adsorption of dye species over a porous adsorbent, the following three consecutive steps are taken place (Gupta *et al.* 2003).

(i) transport of the ingoing adsorbate species to external surface of the adsorbent (film diffusion).
(ii) transport of the adsorbate species within the pores of the adsorbent except for a small amount of adsorption, which occurs on the external surface (particle diffusion).
(iii)adsorption of the ingoing adsorbate species on the interior surface of the adsorbent.

Out of these three processes, the third process is considered to be very fast and is not the rate limiting step in the uptake of organic compounds (Weber Jr. *et al.* 1963). The remaining two steps impart the following three possibilities:

Case 1:External transport > internal transport, where rate is governed by particle diffusion.
Case 2:External transport < internal transport, where the rate is governed by film diffusion.
Case 3:External transport ≈ internal transport, which accounts for the transport of the adsorbate species to the boundary and may not be possible within a significant rate, which later on gives rise to the formation of a liquid film surrounded by the adsorbent particles with a proper concentration gradient.

In the batch-mode contact time adsorption experiments, rapid stirring is maintained. This Acid Yellow 17(AY 17) to the transport of the adsorbed species from the solution to the pores of the adsorbent material and this step may control the rate of the adsorption process.

According to Michelson *et al.* (1975) for film diffusion to be rate-determining step, the value of the film diffusion coefficient, $D_{f,}$ should be in the range $10^{-6} – 10^{-8}$ cm²/ sec. If pore diffusion were to the rate limiting, the pore diffusion coefficient, D_p, should be in the range 10^{-11}- 10^{-13} cm²/ sec. In order to find out the nature of the process responsible for adsorption on to chosen adsorbent, attempts were made to calculate the diffusion co-efficient of the process.

Assuming spherical geometry of the sorbents (Bhattacharya *et al.* 1984), the overall rate constant of the process can be correlated to the pore diffusion coefficient in accordance with the expression,

$$t_{1/2} = 0.03\frac{r_o^{\ 2}}{D_p} \tag{15}$$

$$t_{1/2} = 0.23\frac{r_o \partial}{D_f} \times \frac{\bar{C}}{C} \tag{16}$$

where, r_o is radius of the sorbent (cm), D_p and D_f are pore diffusion coefficient (cm²/sec) and film diffusion coefficient (cm²/sec) respectively, $\frac{\bar{C}}{C}$ is equilibrium loading of the adsorbent, Δ is the film thickness (cm) and $t_{1/2}$ is the time for half change (sec) .

Since the carbon particles used were of the size range (180 - 250 μm), the average diameter of the particle was taken as 0.0215×10^{-4} cm. Using these values, the film diffusion coefficients and pore diffusion coefficients were calculated.Then considering the pseudo first order rate constant k_L, for the adsorption of Acid Yellow 17.The values of D_p and D_f were calculated under the given set of operating conditions, and are presented in the Table 4.

The present study indicates the D_p values in the order of 10^{-11} to 10^{-10} cm/sec and the D_f values in the order of 10^{-10} to 10^{-9} for the respective Lagergren plots for Acid Yellow 17 (AY 17) and hence the investigator concludes that the mechanism of the removal of Acid Yellow 17 (AY 17) in the present study by adsorbent was complies.

Since the external Mass transfer and intraparticle diffusion constants varied with initial Acid Yellow 17 (AY 17) concentration indicating the occurrence of both film diffusion and intra particle diffusion, the sorption data were further analyzed by the kinetic expression given by Boyd *et al.* 1953 as

$$F = 1 - \frac{6}{\pi^2} \sum_{N-1}^{\alpha} \frac{1}{n^2} \exp\left[\frac{-Dit\pi^2 n^2}{r^2}\right] \qquad (17)$$

$$F = 1 - \frac{6}{\pi^2} \sum_{N-1}^{\alpha} \frac{1}{n^2} \exp\left[-n^2 \beta_t\right] \qquad (18)$$

Where F is the fractional attainment of equilibrium at time t and is obtained by using following equation and n. is the integer value

$$F = \frac{q_t}{q_e} \qquad (19)$$

Where q_t and q_e are the amounts adsorbed at time t and at equilibrium respectively.

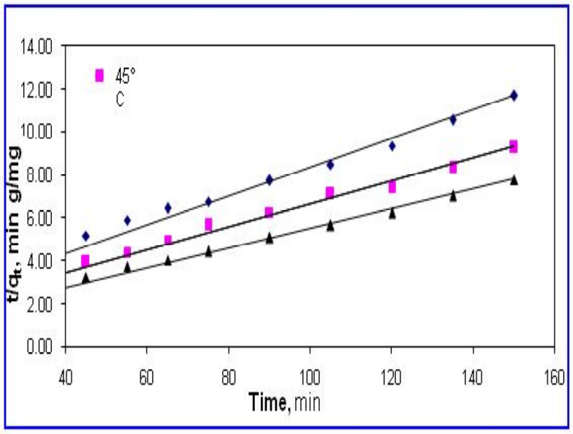

Fig. 3: Effect of Temperature on Pseudo Second Order Plot for Acid Yellow 17 Adsorption

On the basis of F values, corresponding values of B_t were obtained from eq.19 (Reichenberg, 1953).

The B_t vs time plots for the sorption of Acid Yellow 17 (AY 17) over TWAC (Fig.6) was found to be linear in beginning. Thus the process is seems to be particle diffusion controlled in this region, while during the later deviation from linearity occurs and they also did not pass through the origin throughout concentration range at 30, 45 and 60 °C. Thus the overall process can be interpreted as film diffusion.

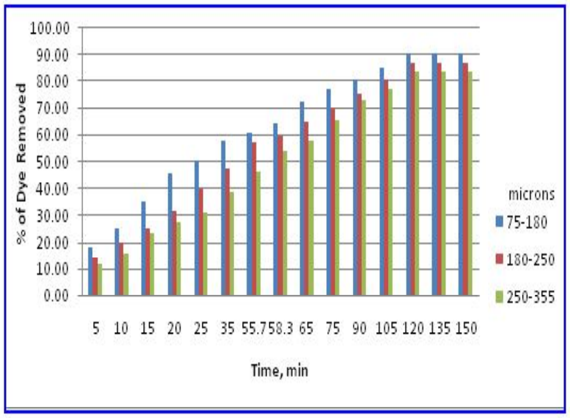

Fig. 4: Effect of particle size variation of TWAC on the removal of Acid yellow 17

From the slop of the straight line obtained from time versus B_t graph, the B value (time constant) were calculated. The values of effective diffusion coefficient (D_i) were calculated at different temperatures using the following Equation.

$$B = \pi^2 D_i / r^2$$

Here 'r' is the radius of the absorbent particle. The Di values are given in the Table 5.

The plot of 1/T versus log D_i was found linear (not given) with negative slope indicating thereby the increase in the mobility of species. This is due to the fact that with the rise in temperature the mobility of species increases, which consequently decreases the retarding force acting on the diffusing species.

The Values of energy of activation E_a, entropy of activation $\Delta S^{\#}$ and pre-exponential constant D_o were calculated using following Equations.

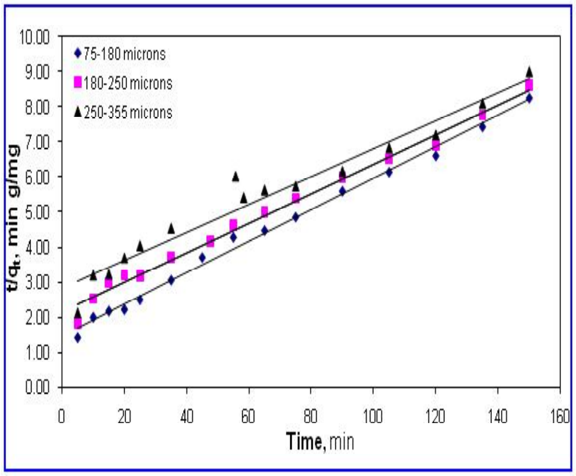

Fig. 5: Effect of Particle Size Variation on Pseudo Second Order Plot for Acid Yellow 17

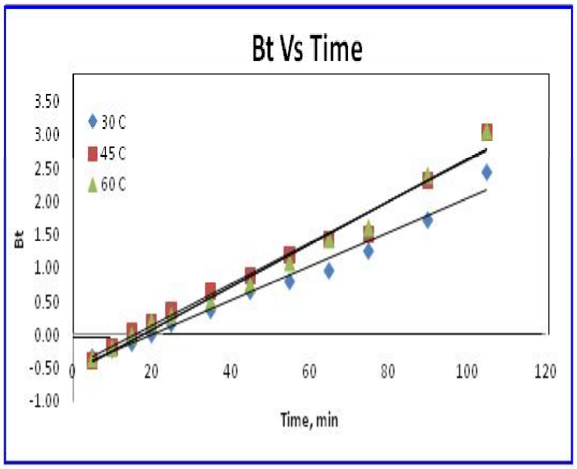

Fig. 6: Time vs B_t plots different temperature of Acid Yellow 17(AY 17) TWAC adsorption

Table 6. Effective diffusion coefficient (D_i) pre exponential constants (D_o), activation energy (E_a) and entropy of activation $\Delta S^{\#}$ for diffusion of Acid Yellow 17(AY 17) in TWAC

Adsorbent	D_I (m^2/s)			D_0 (m^2/s)	E_a, KJ/mol	$\Delta S^{\#}$ JK^{-1} mol^{-1}
	30^0C	45^0C	60^0C			
TWAC	2.57×10^{-11}	2.41×10^{-11}	2.98×10^{-11}	4.94×10^{-5}	-4031.8	-163.68

The values of energy of activation E_a, entropy of activation $\Delta S^{\#}$ and pre-exponential constant D_o were calculated using following equations.

$$D_i = D_o \exp[-E_a / RT]$$

$$D_o = (2.72\, d^2 kT/h) \,.\, \exp[\Delta S^{\#} / R]$$

Where 'd' is the average distance between the successive exchange sites and is taken as 5 A°. R, h and k are the Gas, Plank, and Boltzmann constants, respectively.

The values of E_a, D_i, D_o, $\Delta S^{\#}$ and other parameters are given in Table 6. The negative values of $\Delta S^{\#}$ reflects that no significant change occurs in the internal structure of chosen adsorbent during the adsorption process.

4. CONCLUSION

Removal of Acid Yellow 17(AY 17) from aqueous solution was possible using several abundantly available low cost adsorbents. The adsorption of Acid Yellow 17(AY 17) was found to be dependent on pH, temperature, particle size and concentration for the adsorbent. Thermodynamic parameters obtained for the adsorbent account for feasibility of the process at each concentration. Further the kinetic studies apparently reveal that the removal takes through a film diffusion process at all the concentrations and temperatures for TWAC. The percentage saturation was found to be almost 86 % for TWAC. The kinetics of Acid Yellow 17(AY 17) adsorption on the Turmeric industrial waste activated carbon (TWAC) adsorbent was found to follow a pseudo second -order rate equation.

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