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ADSORPTION ABILITY STUDY OF YELLOW (W6GS) DYE FROM AQUEOUS SOLUTION BY IRAQI SILICEOUS ROCKS

AMMAR J. MOHAMMED AND JUMAN A. NASER

Chemistry Department , College of Education for Pure Sciences (Ibn Al – Haitham) , University of Baghdad, Baghdad, Iraq

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ABSTRACT

Removing of terasil yellow (W-6GS) dye it was studied by using Iraqi Siliceous Rocks Powder (SRP). The study included adsorption isotherms and some effects: temperature, salty medium and the acidity the study that the adsorption isotherms obeys to Temkin equation more than other equations the results showed that the adsorption increased with increasing temperature (Endothermic process. Based on the results, thermodynamic functions (˜H, ˜G, ˜S) were estimated. The amount of adsorbent on the surface increasing with increasing the acidity solution. The kinetics study of the adsorption treated according (Lagergren equation). The kinetic data of experiments properly correlated with the first order kinetic equation.

KEY WORD : Adsorption, Siliceous rocks, Yellow (W6GS) dye

INTRODUCTION

Defined the adsorption as the attachment of particles to a surface (Atkins, 2002). Some methods (advanced oxidation and biological process, membrane, coagulants, oxidizing agents, electrochemical, and adsorption techniques) have been proposed to get rid of pollutants (Sun *et al.,* 2002; Solozhenko *et al.,* 1995; Lin and Peng, 1994). The adsorption method was applied to many chemicals using different surfaces, such as (silica, Zeolite, Plant material, Ash and clays) (Murray, 2000); Kuntari and Priwidyanjati, 2017; Fatihaa and Belkacem, 2016). Dyes discharge from industries cause water pollution. Dyes are mainly used in the textile, plastic, paper, food and cosmetic industries. This discharge in wastewater leads to pollution, which affects the aquatic life (Gita *et al.,* 2017; Carmen, and Daniela, 2012). The work to remove the colored materials from the water is not an aesthetic aspect, but rather to treat the problem of inhibiting the penetration of sunlight into the water, which affects the water ecosystem (Lellis *et al.,* 2019). Moreover, many dyes are toxic to microorganisms and adversely effect on their catalytic capacity (Elass *et al.,* 2010; Bilal *et al.,* 2019). Consider the Siliceous Rocks Powder is a good surface in adsorption and has been used in many previous studies because it is characterized by high porosity and great ability to adsorb organic molecules (Ali, 2009; Tawfeeq , 2019). The dyes removal from water has great attention in the last few years ((Wang *et al.,* 2005; Alouani *et al.,* 2018; Oluchukwa, 2018).

The aim of our work was a study of the ability of adsorption of yellow (W6GS) dye from aqueous solution on Iraqi siliceous rocks powder (SRP)

EXPERIMENTAL

Materials W6GS obtained from textile industry of Hilla. HCl and NaCl were supplied by (BDH) and deionized water had been used. (Figuer 1) shows the structures of (W6GS).

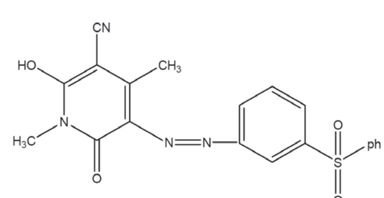

Fig. 1. Structures of W6GS[20]

Rocks The Siliceous Rocks Were provide by (The State Company of Mining and Geological Survey). The rocks were brought from Ukashat west of Iraq. (Figuer 2) shows the (SRP), the chemical composition of the rocks as it showed in Table 1 by the company and The rocks powder it was washed by deionized water to get rid of the soluble materials and dried for (6 hours) at 60Co (Hollander, 1980). The surface was then cracked into small parts. The particle size of (90 ^{o}m) was used for the surface.

Fig. 2. SRP

Table 1. Result of the Rocks Analyses

Constituent	%wt
SiO_2	66.01
Al_2O_3	2.12
Fe_2O_3	0.63
TiO_2	0.05
P_2O_5	0.93
CaO	8.44
MgO	6.47
Na_2O	0.62
K2O	0.13
Loss on ignition	14.61

METHODS

1. Technique: UV technique was used to determine the absorption as function for concentration. the wavelength of absorption was (487nm). The calibration curve is shown in (Fig. 3)
2. Contact time : to determine required time for equilibrium between adsorbent and adsorbate, some certain concentration were mixed with (0.02gm) of SRP and they were put into water bath shaker under 20Co, samples were taken from the solution in different sequenced times to determine the change in the concentration with time passing.
3. Adsorption isotherms: to determine the absorption isotherms for dyes solutions, (0.02gm)of the surface six round flask was weighed and then added to each (50 mL) flask of dye with certain concentration. These flasks were putting in a water bath at (20 Co) for (60min). After the separation of the mixture, adsorption was absorbed by UV.

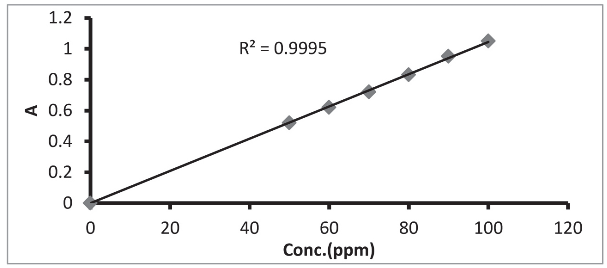

Fig. 3. The calibration curve at 487 nm

The adsorption quantities were calculated by used following equation [21] :

$$Q_e = \frac{(C_e - C_e)V}{m}$$

Qe= the quantity of adsorbate (mg/g).
V= volume of solution (L).
C%= initial concentration (mg/L).
Ce= equilibrium concentration (mg/L).
m= mass of the surfaces (g).
The previous step were repeated at different) temperatures, acidic medium and Saline medium (to follow the adsorption of the dye on the surface.

RESULTS AND DISCUSSION

Effect of contact time

for the increase of adsorption as a function of time , the result show the contact time for dye at (60min) respectively as shown in (Fig. 4).

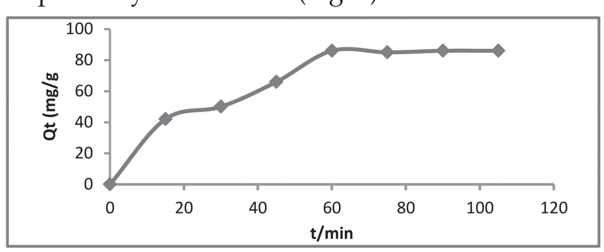

Fig. 4. Effect of time on adsorption on SRP (Temperature =20°C, rotations per minute=90 rpm, Concentration of dye = 100 ppm)

Adsorption isotherms

The adsorbed quantity (Qe) for each equilibrium

Concentration was calculated. Qe Vs Ce plotted to show the general scheme of adsorption isotherms as show in (Fig. 5).

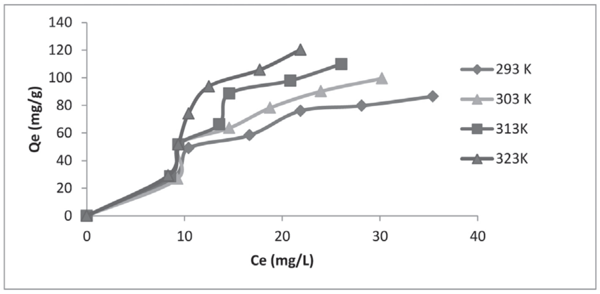

Fig. 5. Adsorption isotherms of W6GS dye on SRP at different temperature

The general scheme of adsorption isotherm pointing out that was of (S3) class according to Giles classification where the orientation of the adsorbate particles on the surface is bevel vertical (Hesselink, 1977).

Plotting the linear form of the adsorption equations (Temkin, Langmuir and Freundlich equations) found that the results were more applicable to Temkin equation as shown in (Fig. 6, 7 and 8).

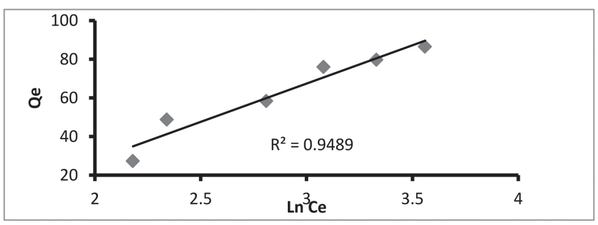

Fig. 6. Linear application of Temkin equation

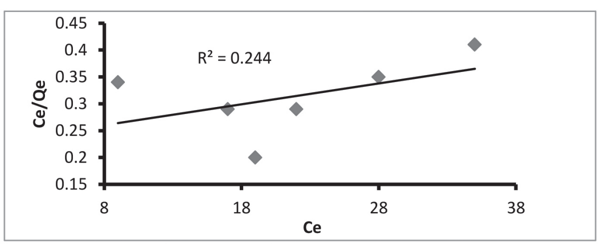

Fig. 7. Linear application of Langmuir equation

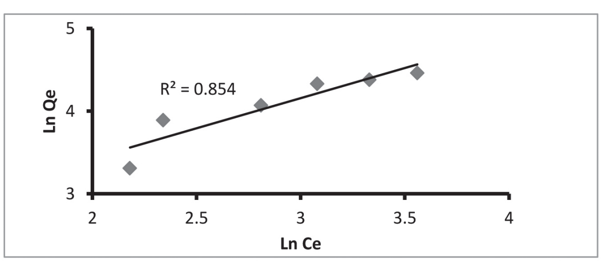

Fig. 8. Linear application of Freundlich equation

$Qe = b_T\, Lnk_T + b_T\, LnCe$ .... Temkin equation

The adsorption quantity increased when temperature increasing (Endothermic process). The value of (ΔH) calculated by using Vant Hoff-Arrhenius equation :

$$Ln\ Xm = \frac{-\Delta H}{RT} + \text{Constant}$$

Where Xm : Maximum adsorbed quantity .

R : gas constant.

T: temperature.

Ln X_m Vs Inverted temperature (1/T) was plotted as show in (Fig. 9) and (Table 2).

The value of (ΔG, ΔS) were calculated as shown in Table (3), depending on following equations:

$$\Delta G = \frac{-nRTLnQe}{Ce}$$

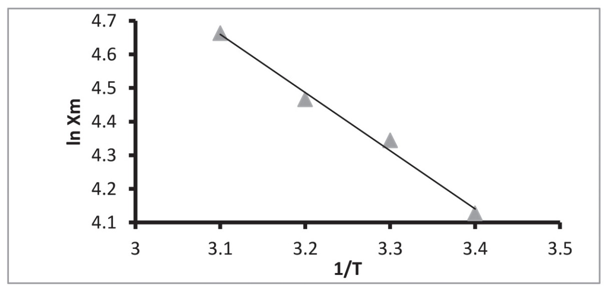

Fig. 9. Vant Hoff curves for adsorption of W6GS dye on the surface

Table 2. The value of Ln Xm, T for W6GS dye on SPR

T(K)	Xm (mg/g) When Ce = 18 (mg/L)	Ln Xm
293	62	4.127
303	77	4.344
313	87	4.466
		4.663

Table 3. The values of the thermodynamic functions at (293 K)

ΔG (J/mole)	ΔG (J/mole)	ΔG (J/mole.K)
20321	-2924.6	-92.43

$\Delta G = \Delta G - T\Delta S$

The positive value of (ΔH) while (ΔG,ΔS) were negative values it means that the process is endothermic, spontaneous and that the adsorbent molecules arranged on the surface (Panday *et al.*, 1985).

Effect of acidity

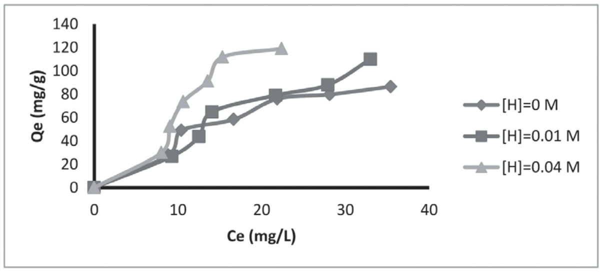

Fig. 9. Effect of acidity on Adsorption at T = 293 K

The adsorption was studied in different acidity range (0.01 M, 0.04 M) as shown in (Fig. 9). Increasing of adsorption with increase of acidity is refer to that the SRP surface is heterogeneous and contains negative charged group and positive charged group (Hillel, 1980). The negative charge in the dyes will be combined with positive charge on acid as a result, it will give greater liberty to the positive ion in dyes to bind with negative positives on the surface, thus adsorption will increase (Hollander, 1980).

Effect of salt

The adsorption was studied in 0.05M sodium chloride solution as shown in (Fig. 10).

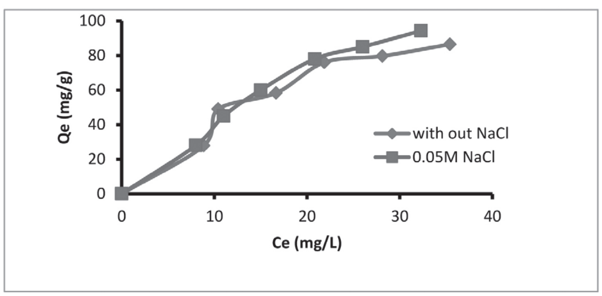

Fig. 10. Effect of salt on Adsorption at T = 293 K

Adsorption Kinetic

Kinetic studies for adsorption by using (Largergreen equation) was Investigated :

$ln\,(q_e - q_t) = lnq_e - k_{ad}$

where qe and qt : are the adsorption capacity at equilibrium and at time (t) respectively (mg/L).

k_{ad} : the rate constant of pseudo first- order kinetic (min^{-1}).

The results showed that the adsorption kinetics followed pseudo first- order kinetics model , the rate constant value was 0.003 min^{-1} as shown in (Fig. 11).

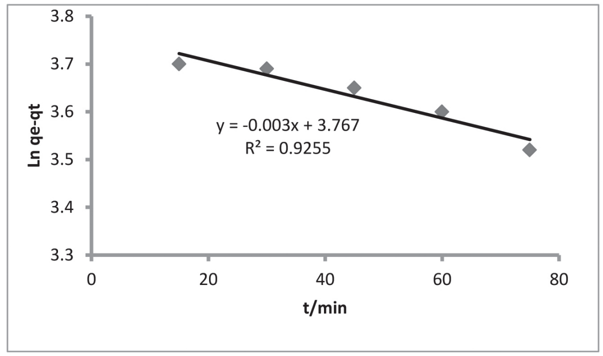

Fig. 11. Pseudo first- order kinetics model

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