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PREPARATION OF CLAYS AS POISON ANTIDOTS

ABBAS. H. AL-SHUKRY

Chemistry Department, College of Science, Al-Nahrain University, Baghdad, Iraq
*Corresponding Author: a_alshukry@yahoo.com

Abstract

Adsorption of excessive amounts of the drug sulphamethaxazole was carried out using attapulgite and bentonite Iraqi clays as poison antidote, adsorption processes were shown very efficient within 15 minutes with no back ward redsorption, ΔH , ΔG , ΔS were also calculated and reported.

Keywords: Adsorption,sulphamethaxazol, attapulgite and bentonite.

Introduction

Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid (adsorbate) to a surface of a solid materials (adsorbent) therefore the process is occurred through different isotherms such as Freundlich or Langmuir when forming a film of single layer or multilayer of adsorbate due to different species of adsorbates and adsorbents on basis of Brunauer, Emmett and Teller's model of multilayer adsorption which is random distribution of molecules on the material surface [1,2].

Clays and activated charcoals were normally used as poisons antidotes since ancient times for their acceptable adsorption capacity for hydrophobic materials [3 ,4] nowadays they try to use them to detox radiation contaminants therefore clays were of the recommended components used to bury the Chernobyl reactor for their known ability to reduce the escape of radiation through their protective barrier [5,6,7].
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Clays and activated charcoals antidotes act via different ways such as an inert formation complex , accelerate detoxification , reduce toxic effects , receptor site competition , receptor site blockade and toxic effect bypass [7] .

Recently nanoclays are extensively used in modern technology to produce reinforced polymer nanocomposites for automotive industry , paints , inks, greases, cosmetics formulations, in medicines such as drug delivery vehicles, waste water treatment and textile industry to compensate the accelerating growing needs for peoples all over the World. The development of multifunctional nanoparticles for biomedical and biotechnological applications may improve cancer therapy, DNA transfection, intravital imaging, targeted drug delivery, and enzyme [8-16].

The aim of this work is to examine the capability of Iraqi clays (attapulgite and bentonite) for treatment of poisoning by drugs if taken in quantities higher than the required usual dose [17 – 21].

Experimental Part

(a) Instruments

The instruments used in were: uv/vis spectrophotometers (UV – VIS Spectrometer RF1501 Shimadzu Japan , Cuvette / Quartz B.S. 3875, Centrifuge BS – 11 Hettich EBA -20 Germany Thermostated shaker bath BS – 11 Jeio Tech. / South Korea, PH meter (HANA/Romania) HI – 9811 -5 Digital balance Sarturius Lab. L 420 B.W. Germany and Oven / Heraeus (D-6450) Hanau and a muffle furnace (Phonenix).

(b) Materials

Chemicals: HCl 36% w/w, sp.gr. (1.18) , BDH, England., Sulphamethaxazole was obtained from the State Enterprise from the drug Industries and Medical Appliances (SDI) , Samarra , Iraq . Attapulgite andBentonite clays were obtained from the (General Company for Geological Survey and mining), Baghdad, Iraq.

(c) Methodology

Clays were washed with excessive amounts of demineralized water many times to remove the soluble impurities, dried at 115̊C for three hours (constants weight), crushed with crusher machine, sieved by molecular sieves to the grades of 75, 80,150, 200 and 250 µm then stored dry in sealed plastic containers.

Adsorption experiments were carried out by shaking the each clay (0.1 gm of 75 µm particle size) with 10 ml of sulphamethaxazole solution with concentrations $5x10^{-5}$, 5×10^{-4}, $5x\ 10^{-3}$ and 10^{-3} M/L respectively in a thermostatic shaking water bath at 150 rpm.

Series of experiments were carried out to determine the best residence time for adsorption process at 37.5̊ C, then to determine the kinetic physical constants of Gibbs free energy (ΔG), enthalpy (ΔH) and entropy (ΔS).

Samples for spectrophotometric analysis were centrifuged for 2 X 2 minutes at 5000 rpm, filtered by filter paper no. 42 then centrifuged again to get rid of any suspended particles in order to obtain accurate absorbency readings.

The samples of the clays were ignited at 1100 ̊C with the aid of a muffle furnace to determine the weight loss of each clay.

Results and Discussion

Attapulgite and bentonite clays proved to be very efficient adsorbents for the excess toxic dose of sulphamethxazole drug within 15 minutes contact time at 37.5 ̊C and showing no re desorption (reverse reaction) during all the reaction time which last 120 minutes (Figs.1 & 2).

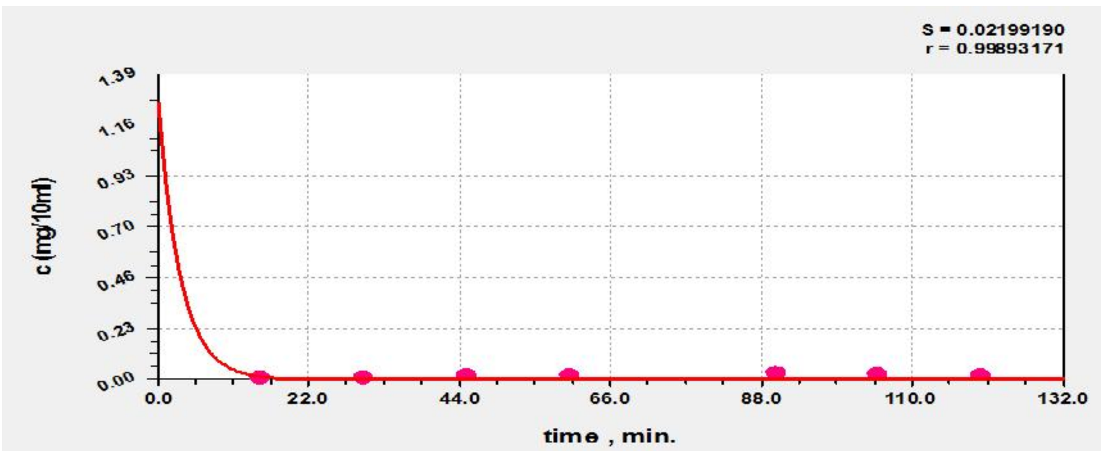

Fig. 1 Adsorption capacity for attapulgite along contact time .

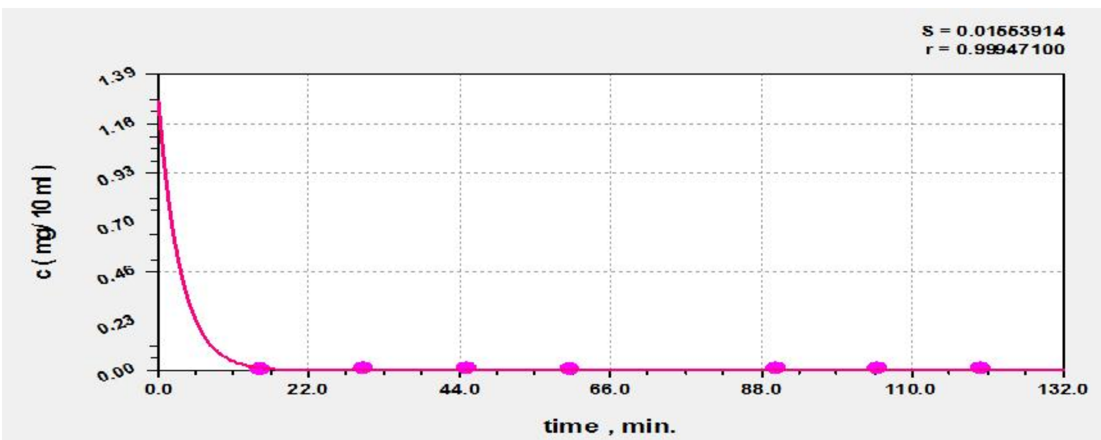

Fig – 2 Adsorption capacity for bentonite along contact time .

Adsorption process for attapulgite and bentonite clays as seen by Figures 3 & 4 was going along Freundlich and Küster isotherm (1894) since the relationship of Qe (mg of adsorbate /g of clay) against Ce (mg/L) the equilibrium concentration of the adsorption reaction showing a straight line for both clays according to the following empirical formula (Eq. 1 & 2) which could be applied for gaseous or solid adsorbates where C is the concentration of the adsorbate, (x / m) the mass ratio of adsorbate to adsorbent (Qe), k and n are empirical constants :

$$\frac{x}{m} = k\, C^{1/n} \quad \text{.... Eq.- 1}$$

$$\text{Log } Q_e = \log K_f + \frac{1}{n} \log Ce \quad \text{..... Eq. 2}$$

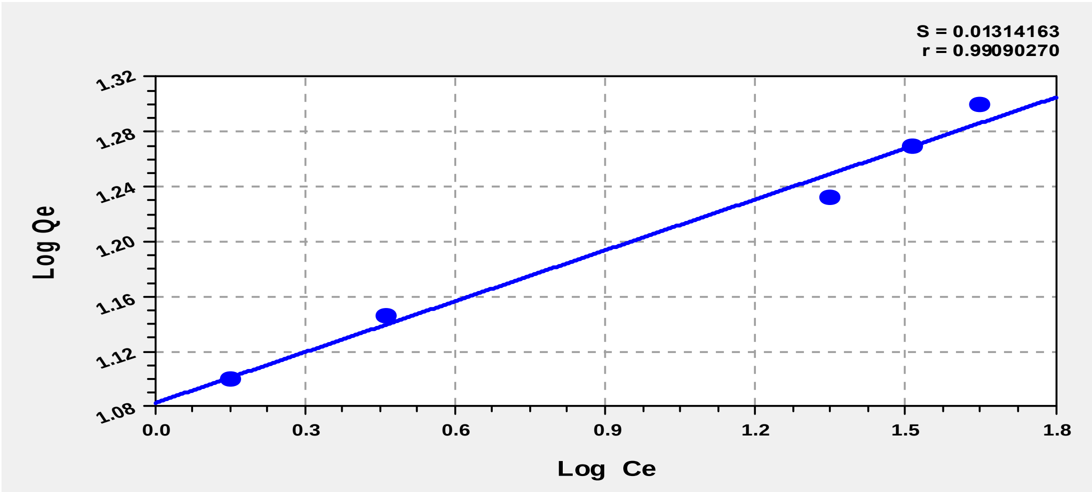

Fig 3 Adsorption isotherm for sulphamethaxazole by anabilgate clay .

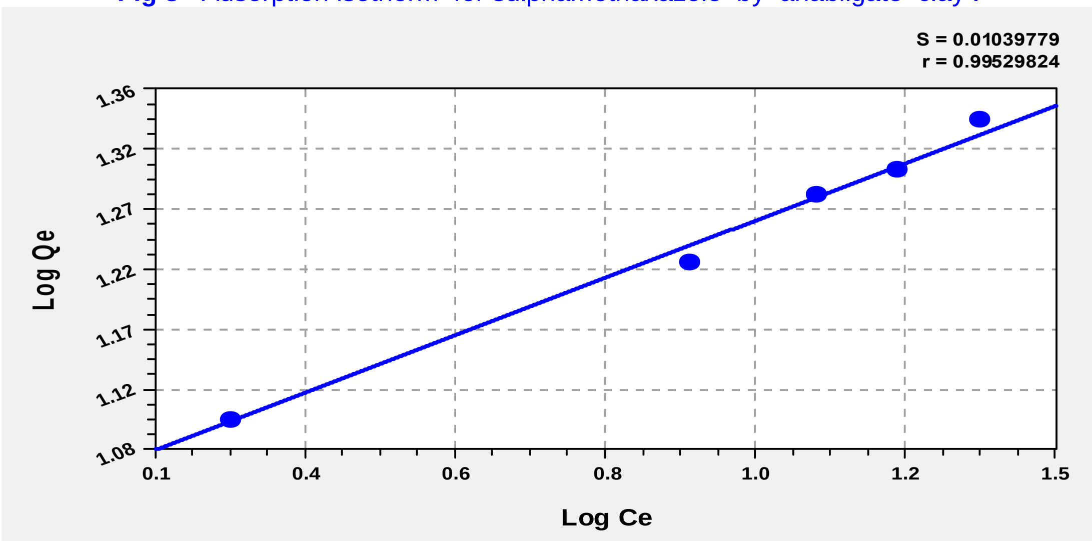

Fig.– 4 Bentonite adsorption isotherm for sulphamethaxazole

The empirical constants as seen in table – 1 reveals that adsorption of sulphamethaxazole depends greatly upon the active sites of the clay surface as Si ---O or Al----O as well as their hydrogen bonding formed there of by clays elemental compositions(Table -2) because the values of (1/n) is small therefore the drug concentration does not affect the adsorption rate extensively .

Table – 1 The empirical constants for attapulgite and bentonite for sulphamethaxazole adsorption

Clay type	1/n	K_f	n	r
Attapulgite	0.1234	12.445	8.104	0.991
Bentonite	0.20424	11.22	4.896	0.995

Table-2 Elemental compositions of attapulgite and bentonite

Clay	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	MgO	CaO%	NaO %
Attpulgite **	13.6-16.4	42.2-50.8	6.4-7.52	6	6.2-7.94	
Bentonite **	15.67	56.77	5.12	3.42	4.48	1.11

**The General Company for Geological Survey and mining, Baghdad, Iraq.

According to Vant Hoff – Arrenheus equation :

$$\log X_m = \frac{-\Delta H}{2.303\ RT} + \frac{\Delta s}{R} \ldots\ldots\ldots \quad \text{Eq. 3}$$

Enthalpy (ΔH) and entropy (ΔS) changes could be calculated using (Fig 5 & 6)

Where,
Xm= maximum adsorbed mass of the adsorbate (mg) in one gram of the adsorbent.

Xm = maximum adsorbed mass (mg) / 1g adsorbent

Gibbs free energy change is also calculated using the following equation at 310.5 K :

G = Δ H - T Δ S ……….. Eq. 5Δ

The values of the physical constants are shown in table – 3 conclude that the adsorption process occurred spontaneously for the negative values of ΔG, meanwhile ΔH is positive for attapulgite and is negative for bentonite, the overall free energy proceed the adsorption reaction readily spontaneously.

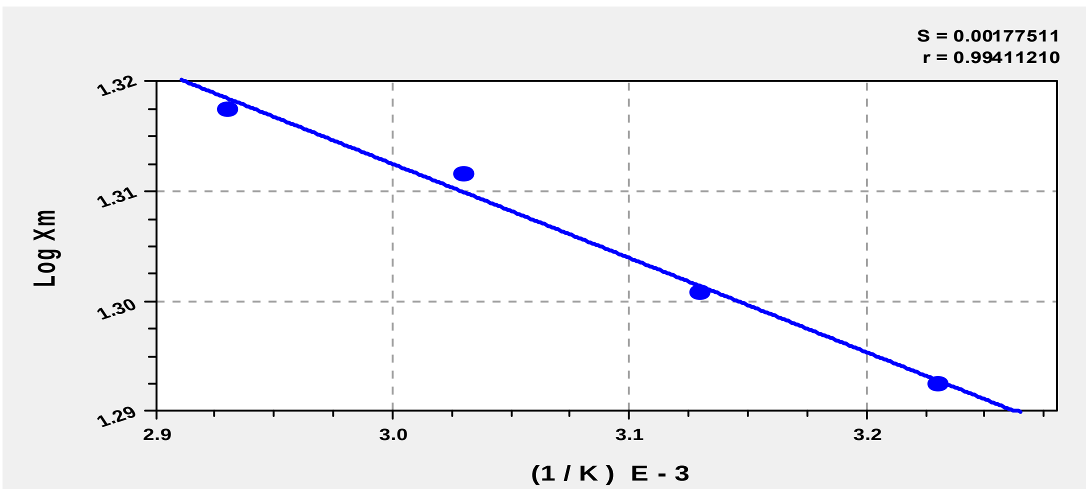

Fig. – 5 Adsorption capacity for sulphamethaxazole by anabilgate at different temperature degrees

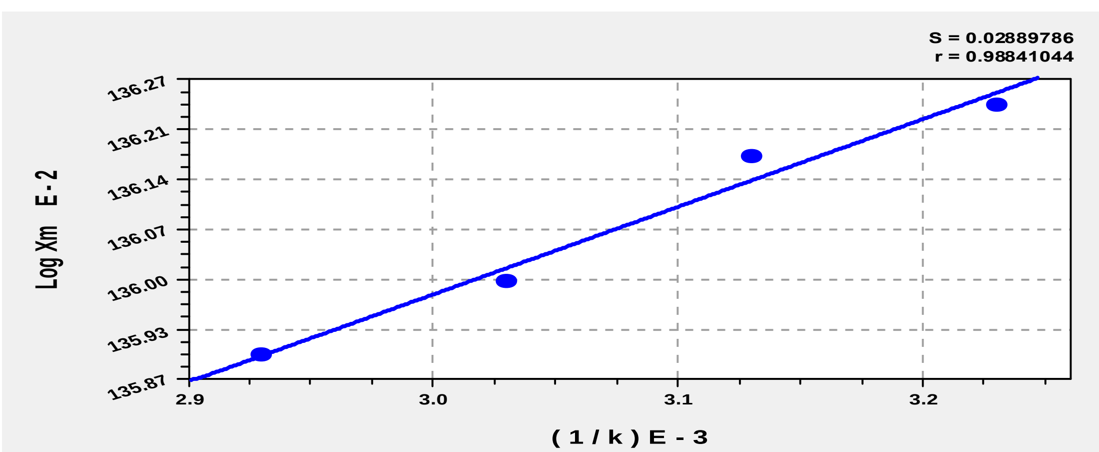

Fig.- 6 Adsorption capacity for Sulphamethaxazole by Bentonite at different temperature degrees

Table – 3 The physical constants values for adsorption of sulphamethaxazole by attapulgite and bentonite clays

Clay type	ΔH , Kj/M	ΔG , Kj/M	ΔS , J/M
Attapulgite	1.967	- 3.721	14.076
Bentonite	- 0.228	- 5.960	11.11

Conclusion

It is clearly seen from this research that the loading capacity of each clay (Qe) is up to 23 mg/g of adsorbent clay , which is acceptable value but it is worth to increase this ability up to hundreds folds by convert the clays to nanoparticles for surfaces area increase by thousands times fold therefore the adsorbing active sites of the clays which is responsible for attraction of adsorbate molecules and/ or ions are greatly increased.

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