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Adsorption Study of Drug Cefixime onto Surface Iraqi Attapulgite

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Abstract

In this study the adsorption of cefixime on Iraqi clay attapulgite. Quantitative estimation of the drug adsorption has been done by utilizing the technique of UV-Vis spectrophotometry at (λ_{max} = 273 nm) at different conditions of temperatures (25, 37 and 45˚C). It was found that, the adsorption decrease with increase the temperature. Study effect of pH (3, 5, 7 and 9) on adsorption of drug on attapulgite and it was found that, the optimum adsorption was achieved at (pH = 3). Study of clay weight of attapulgite in the range of (0.1-1.5 g.) and it was found that, the adsorption increase with increase of clay weight. Finally effect of ionic strength on adsorption process was investigated using a range of NaCl solution (0.1-0.3 M) and it was found that, there was a decrease in adsorption efficiency over attapulgite with increase of ionic strength. The results of adsorption isotherms that were obtained in this study were fitted with Langmuir adsorption isotherm.

Keywords: Adsorption, cefixime, attapulgite.

Introduction

A cefixime (CFX) molecular formula $C_{16}H_{15}N_5O_7S_2$ and has a molecular weight 453.452 g/mol is third-generation oral cephalosporin antibacterial [1]. It is used as antibacterial and especially against gram negative, gram positive and anaerobic bacteria pathogens including β-lactamase producing strains[2]. It is clinically used in the treatment of susceptible infections including gonorrhea, at it is media, pharyngitis, lower respiratory-tract infections such as bronchitis and urinary-tract infections[3].

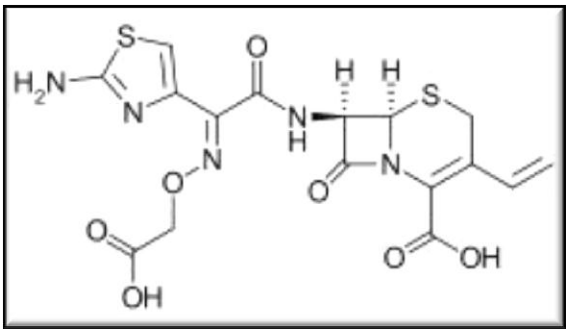

Fig. (1): Chemical structure of cefixime

Attapulgite is a complex magnesium (Mg) aluminum (Al) silicates with an open-channel structure, which forms elongate (needle-shaped) crystals[4]. Its chemical formula is $Mg_{1.5}Al_{0.5}Si_4O_{10}(OH).4H_2O$. Actual composition varies because of partial replacement of magnesium (Mg) and aluminum (Al), by iron (Fe), and other elements[5]. Attapulgite consists of double silica tetrahedral chains linked together by octahedral oxygen and hydroxyl groups containing Al and Mg ions in a chain-like inverted structure[6].

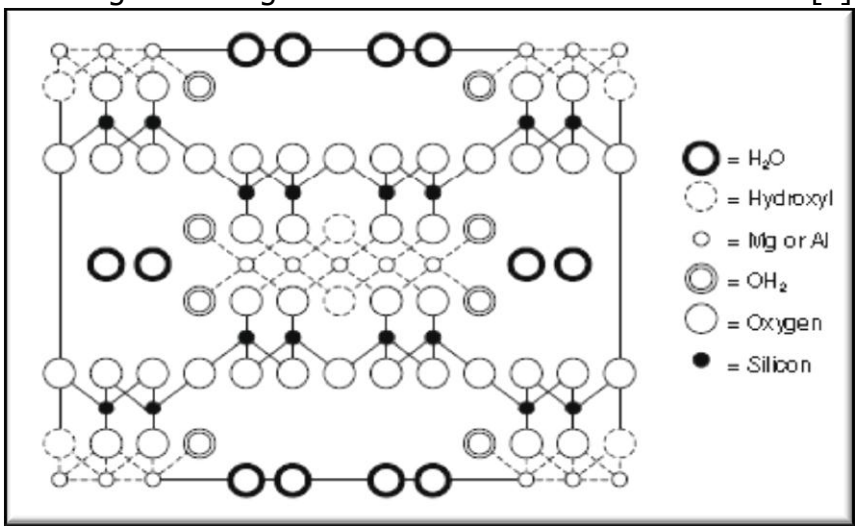

Fig. (2): Attapulgite structure

Virtually all drugs, especially in large doses or when taken over long periods of time, can initiate a toxic condition[7]. The major principles applied in the emergency treatment of accidental poisoning drug are dilution, emesis and adsorption[8]. Many types of adsorbents such as kaolin[9], attapulgite[10], and bentonite[11] in the prevention of further adsorption of drug are recognized in clinical practice and environmental treatment. Adsorption of cefixime was studied by means of multi-walled carbon nanotubes[12], on to MgO nanoparticles[13] and voltammetric determination[14].

The aim of this study is to find a new sorbent to act as physical antidotes in treatment of poisoning if the drug is taken in quantities higher than the recommended dosages, hence to understand that the effect of some parameters on the sorption process was studied.

Experimental part

Apparatus

- UV-Vis spectrophotometer
A shimadzu double beam UV-Vis spectrophotometer model UV-1601 (Kyoto, Japan) working at wavelength of 190-1100 nm.
- pH meter
A micro processor pH meter 211 model (Triup International crop, Italy) pH-meter.
- Shaker bath (Labtech. Daihaiv. LTD).

Reagents

- Sodium chloride (Fluka AG Buchs SG)
- Sodium hydroxide (Fluka AG Buchs SG)
- Hydrochloric acid (Riedel-Dehaen AG)
- Cefixime (Iraq samara)
- Attapulgite employed in this study were obtained from (the Geneva Company for Geological Survey and Mining), Baghdad.

Cefixime (1000 mg/L)

A stock solution of (1000 mg/L) of cefixime was prepared by dissolving (0.1 g.) in distilled water and then made up to (100 ml) in a volumetric flask with the same solvent working solution of (100 mg/L) was prepared by simple dilution for primary stock solution and was kept ambient bottle a way from sunlight.

Sodium hydroxide (0.1 M)

This solution was prepared by dissolving (0.4 g.) of sodium hydroxide in distilled water and diluted to (100 mL) in a volumetric flask with the same solvent.

Hydrochloric acid (0.1 M)

This solution was prepared by diluting of (1.54 mL) of concentrated hydrochloric acid (37%) and diluted to (250 mL) in a volumetric flask by distilled water.

Sodium chloride (1 M)

This solution was prepared by dissolving (0.585 g.) of sodium chloride in distilled water and diluted to (10 mL) in a volumetric flask with the same solvent (0.1, 0.2 and 0.3 M) was prepared by simple dilution for (1 M) solution.

Batch experiments

Batch experiments were performed in (100 mL) a volumetric flask included (25 mL) of cefixime solution with concentration (20 mg/L) and (0.5 g.) of adsorbent surface. Experiments were performed in constant temperature of 37 °C to determine the equilibrium concentrations and the effect of contact time on cefixime adsorption on attapulgite. pH values of cefixime solutions were adjusted by 0.1 N HCl and NaOH in the range between 3 to 9. Solution temperature was set between 25 to 45 °C to understand the temperature influence on adsorption process. The influence of ionic strength on bond and free salt solution was determined by adding (0.1, 0.2 and 0.3 M) of sodium chloride. Concentration in solution before and after adsorption according to the equation:

$$Qe = \frac{(Co-Ce)V}{w} \quad \ldots\ldots (1)$$

And the percentage of drug removal was determined using the equation:

$$\% \text{ of removal} = \frac{Co-Ce}{Co} X\ 100 \quad \ldots\ldots (2)$$

Where Co and Ce are the initial and final concentration in (mg/L), V is the solution volume in (L) and W is the mass of clay sample that were used in gram[12].

Results and Discussion

Absorption spectra

The drug of cefixime giving maximum absorbance at λ_{max} = 273 nm as shown in Fig. (3):

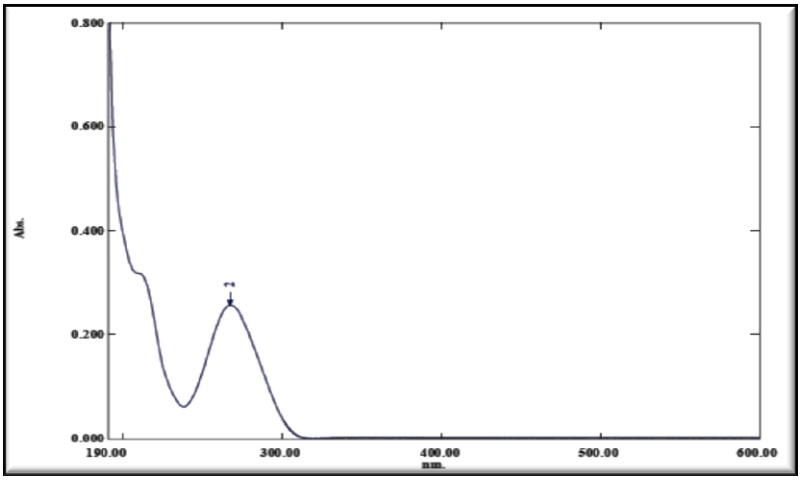

Fig. (3): Absorption spectrum of (20 mg/L) of cefixime

Calibration graph

Employing the conditions as described in the above procedure, a linear calibration graph for cefixime is obtained as shown in Fig. (4). This shows that, Beer´s law is obeyed over the concentration range of (2-30 mg/L).

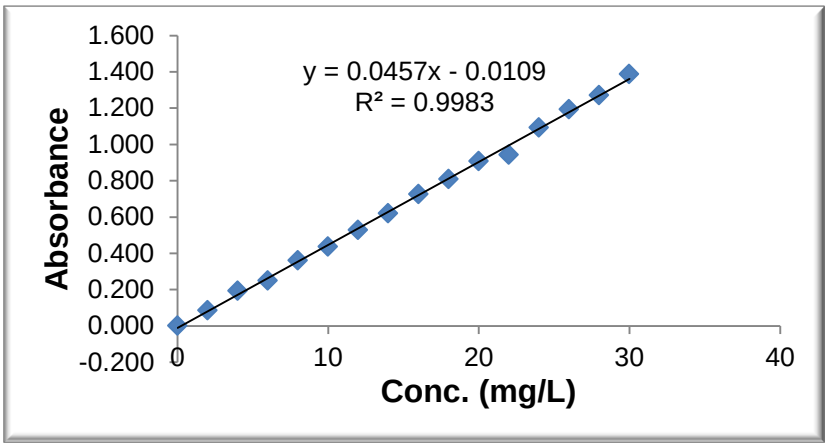

Fig. (4): Calibration graph of cefixime

Factors affecting efficiency of cefixime adsorption on attapulgite

Effect of contact time

Table (1) and in Fig. (5) show the relation between contact time and adsorption of cefixime on attapulgite. As a result, a direct association is observed among these two factors at first, which means that, adsorption efficiency was increased with time increase and after some time adsorption rate changes more slowly and ultimately since reaching equilibrium time, it remained unmoving. From the obtained results in this study, time 30 min. was chosen as equilibrium time and other experiments were carried out at this time. These results are shown in Table (1) in Fig. (5).

Table (1): Effect of contact time on adsorption of cefixime on attapulgite, volume (25 mL), Co (20 mg/L), temperature (37 ˚C), weight of clay (0.5 g.)

Time (min.)	Ce (mg/L)	Qe (mg/g)	% Removed
15	5.0889	0.7456	74.56
30	4.8222	0.7962	75.89
45	5.3778	0.7311	73.11
60	6.6000	0.6700	67.00
75	9.2667	0.5367	53.67
90	7.3111	0.6344	63.44
105	7.7778	0.6111	61.11
120	8.2444	0.5878	58.78

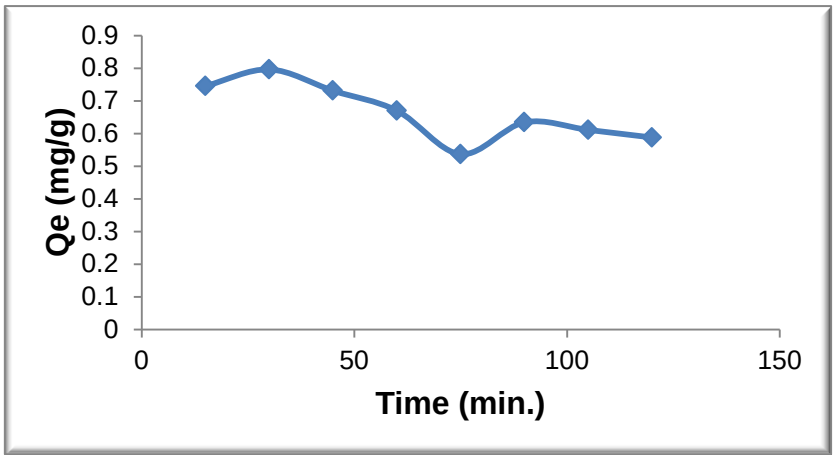

Fig. (5): Effect of the contact time on the adsorption of cefixime onto attapulgite surface

Effect of temperature

The effect of temperature on the adsorption of cefixime on attapulgite at three different temperatures 25, 37 and 45 °C was investigated. The obtained results obtained are summarized in Table (2) and Fig. (6). The equilibrium adsorption capacities slightly decreased with an increase of temperature from 25 to 45 °C.

Table (2): Effect of temperature on the adsorption of cefixime on attapulgite, volume (25 mL), weight of clay (0.5 g.)

Co (mg/L)	25 °C		37 °C		45 °C	
	Ce (mg/L)	Qe (mg/g)	Ce (mg/L)	Qe (mg/g)	Ce (mg/L)	Qe (mg/g)
20	05.5000	0.7250	05.0000	0.7500	08.8222	0.55880
22	07.2000	0.7400	06.7556	0.7622	11.1111	0.54440
24	08.9000	0.7550	09.0000	0.7500	11.0667	0.64660
26	09.4222	0.8288	09.4889	0.8255	12.8444	0.65778
28	11.2220	0.8389	10.5778	0.8711	13.0222	0.74880
30	11.9333	0.9033	14.5111	0.7744	13.6222	0.81880

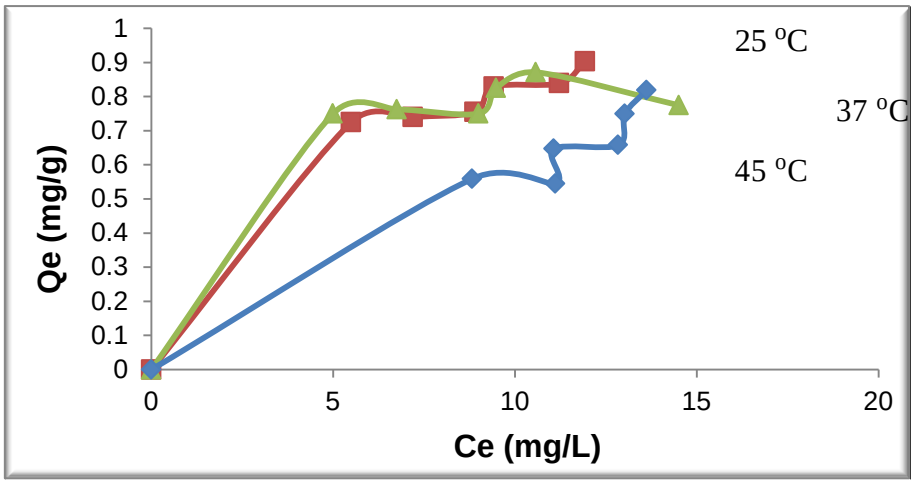

Fig. (6): Effect of temperature on adsorption of cefixime onto attapulgite surface

Effect of pH

pH is one of the most striking parameter on adsorption process. H^+ ions are competitive with probable existing cation to occupy the active sites, influence on sorbent surface properties and sorbate solubility are the main reasons for functionality of pH. The results of pH effect are shown in Table (3) and Fig. (7), pH = 3 is the optimum pH value in cefixime sorption.

Table (3): Effect of pH on adsorption of cefixime on attapulgite Co (20 mg/L), temperature (37 ˚C), volume (25 mL), weight of clay (0.5 g.)

pH	Ce (mg/L)	Qe (mg/g)	% Removed
3	5.5333	0.7233	72.330
5	8.7111	0.5644	56.444
7	8.0666	0.5966	59.667
9	7.1330	0.6433	64.335

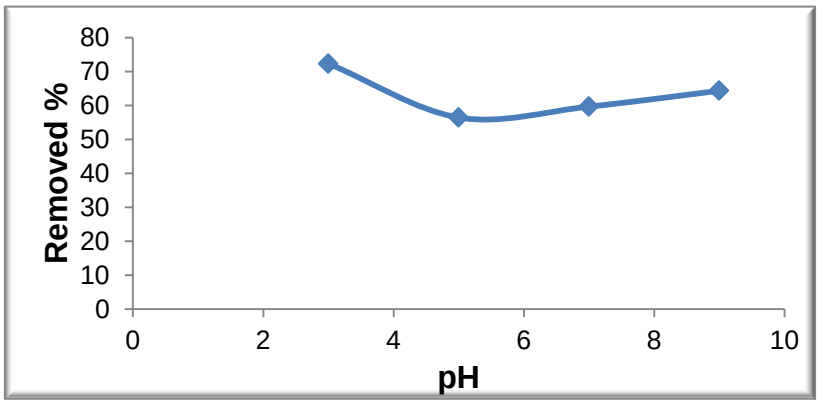

Fig. (7): Effect of pH on adsorption of cefixime onot attapulgite surface

Effect of weight of clay

Dependency of cefixime sorption process from different weight of attapulgite (0.1-1.5) gm at temperature (37 °C). These results are shown in Table (4) and Fig. (8). The examination of data reveals that sorption percentage increases with increases of weight of attapulgite in solution.

Table (4): Effect of weight of clay on adsorption of cefixime on attapulgite, Co (20 mg/L), temperature (37 °C), volume (25 mL)

Weight of clay (gm)	Ce (mg/L)	Qe (mg/g)	% Removed
0.1	12.8000	1.8000	36.00
0.3	10.7111	0.7741	46.44
0.5	5.0000	0.7500	75.00
0.7	3.3778	0.5937	83.11
0.9	1.0000	0.5278	95.00
1.1	0.9110	0.4338	95.45
1.3	0.8889	0.3675	95.56
1.5	0.8667	0.3189	95.67

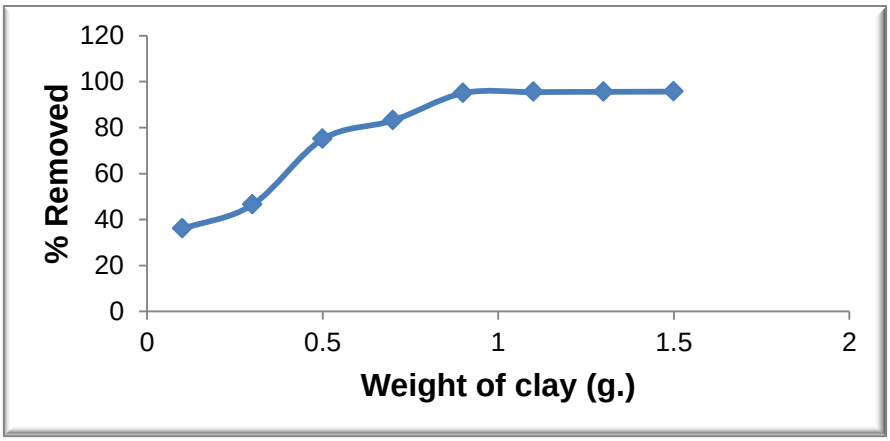

Fig. (8): Effect of weight of clay on adsorption of cefixime onto attapulgite surface

Effect of ionic strength

The result obtained for both free and supported catalyst are shown in Table (5) and Fig. (9). The clay supported catalyst appears significantly less active at high ionic strength than the free salt solution (aqueous solution) and the percentage of removal will decrease Table (5). Hence, the adsorption of catalyst given less stabilization to the active site against electrostatic interactions. The influence of ionic strength on bond and free salt solution was determined by adding (0.1, 0.2 and 0.3 M) sodium chloride to the reaction medium at constant pH and temperatures. These results show that

when the ionic strength was increased, the activity of the immobilized catalyst reduced more than the activity of the free catalyst.

Table (5): Effect of ionic strength on adsorption of cefixime on attapulgite, Co (20 mg/L), volume (25 mL), temperature (37 ˚C), weight of clay (0.5 g.)

Conc. (M)	Ce (mg/L)	Qe (mg/g)	% Removed
without	5.0000	0.7500	75.00
0.1	7.8444	0.6078	60.78
0.2	8.2667	0.5867	58.67
0.3	8.7556	0.5622	56.22

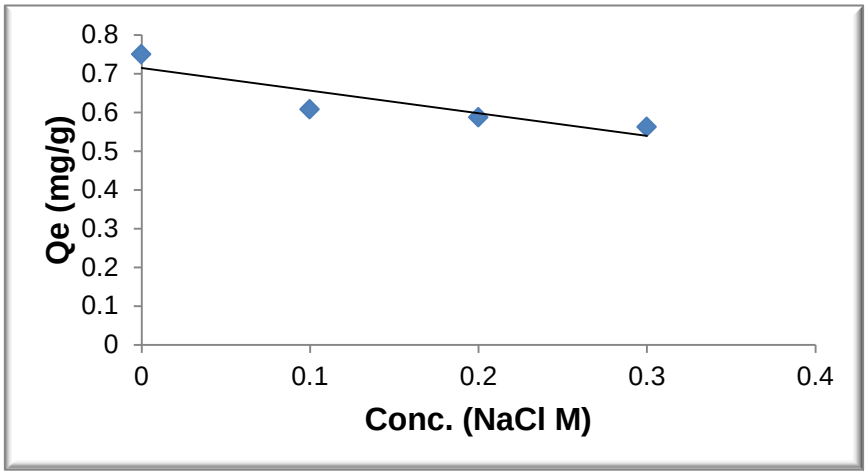

Fig. (9): Effect of ionic strength on adsorption of cefixime onto attapulgite surface

Adsorption isotherms

The adsorption isotherm are mathematical models that describe the distribution of the adsorbate species among liquid and adsorbent based on a set of assumptions that are mainly related to the heterogeneity/ homogeneity of adsorbents. The type of coverage and possibility of interaction between the adsorbate species. Langmuir and Freundlich are two common adsorption isotherms which are studied in present work, the drug sorption isotherm followed the linearized Langmuir model and the results are shown in Table (6) and Fig. (10).

Table (6): Experimental data of the adsorption isotherms

Langmuir		Freundlich	
Ce	Ce/qe	logCe	logqe
5.0000	6.6660	0.6989	-0.1249
6.7556	8.8632	0.8296	-0.1179
9.0000	12.0000	0.9542	-0.1249
9.4889	11.4940	0.9772	-0.0832
10.5778	12.1430	1.0243	-0.0599
14.5111	18.7380	1.1617	-0.1110

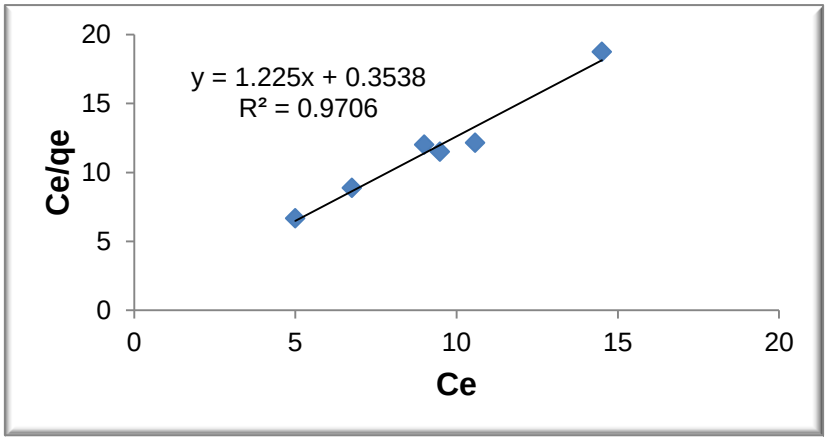

Fig. (10): Langmuir adsorption isotherm model

Table (7): Langmuir constants for adsorption of cefixime onto attapulgite surface

b (L/g)	qm (mg/g)	R^2
2.312	0.816	0.970

Conclusions

In this study, it was found that the attapulgite is a good surface for adsorption of cefixime and in treatment of poisoning if the drug is taken in quantities higher than recommended dosages, the effect of different parameters was studied, such as pH, temperature and ionic strength. The equilibrium sorption data fitted the Langmuir adsorption isotherm model.

References

[1] Mohammed M.A., Mezaal E.N. and Sadiq K.A. "Simultaneous determination of cephalexin and cefixime by first and second derivative ultraviolet spectrophotometry", Journal of the College of Basic Education, 2016, 22(93), 89-100.
[2] Bhangel P.G., Meherez A.P. and Katolkarz P.P., "Devlopment of UV spectrophotometer method of cefixime in bulk and pharmaceutical tablet dosage formulation", International Journal of Research and Development in Pharmacy and Life Sciences April-May, 2013, 2(3), 460-463.
[3] Budavari S. Eds. In. The Merck Index and Co., Inc; 13th Ed: Whitehouse Station, NJ; 2001, 1213 and 1229.
[4] Haden W.L.Jr., "Attapulgite: properties and uses", 10th ed., National Conference of Clays and Clay Minerals. NRC-NAS Monograph No., 12, 1963, 284-290.
[5] Harben P.W., "Attapulgite and sepiolite in the industrial minerals hand book", 4th ed., 2002, 22-26.
[6] Murry H.H. and Zhou H., "Clays palygorskite and sepiolite (hormites) industrial minerals and rocks", edited by Kogel J.E., Trivedi N.C., Barker J.M. and Krukowski S.T., 7th ed., 2006, 401-406.
[7] The Columbia encyclopedia, "drug poisoning", 6th ed., Columbia University press, 2006.
[8] Alkhazrajy O.S., Abdul Latif M.H. and Al-Abayaji M.A., "Adsorption of metoclopromide hydrochloride on to burned initiated Iraqi bentonite", Journal of Al-Nahrain University, June, 2012, 15(2),35-46.
[9] Algohary O.M.N., "In vitro adsorption of mebeverine HCl on to kaolin and its relationship to pharmacological effects of the drug in vivo", Pharm. Acta Helve, 1997, 72, 11-21.
[10] Algohary O., Lyall J. and Murry J.B., "Adsorption of antihypertensives by attapulgite, charcoal, kaolin and magnesrumtrisilicate", Pharm. Acta Helve, 1988, 63(1), 13-18.
[11] Figueroa R.A., Leonard A. and Mackay A.A., "Modeling tetracycline antibiotic sorption in clays", Environmental Science and Technology, 2004, 38, 476-483.
[12] Jafari M., Foad S. and Khaghanic G., "Batch adsorption of cephalosporins antibiotics from aqueous solution by means of multi-walled carbon nanotubes", World Applied Sciences Journal, 2011, 14(11), 1642-1650.
[13] Fakhri A. and Adami S., "Adsorption and thermodynamic study of cephalosporins antibiotics from aqueous solution on to MgO nanoparticles", Journal of the Taiwan Institute of Chemical Engineers, 2014, 45, 1001-1006.
[14] Jain R., Gupta V.K., Jadon N. and Radhapyan K., "Voltammetric determination of cefixime in pharmaceuticals and biological fluids", Analytical Biochemistry, 2010, 407, 79-88.

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دراسة امتزاز دواء السفكسيم على سطح الاتبلكايت العراقي

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جامعة بغداد / كلية التربية للعلوم الصرفة - ابن الهيثم / قسم الكيمياء

الخلاصة

يتناول موضوع هذا البحث دراسة امتزاز السفكسيم على سطح طين عراقي هو الاتبلكايت للبحث عن سطح انتقائي ذو فعالية في امتزاز هذه المادة الدوائية التي تسبب التسمم في حالة تعاطيها بجرعات تفوق الجرعات الاعتيادية. تم استخدام تقنية مطيافية الاشعة فوق البنفسجية عند طول موجي (٢٧٣) نانوميتر لمعرفة كميات امتزاز هذا الدواء على سطح الاتبلكايت وعند ظروف مختلفة من درجة الحرارة (٢٥، ٣٧، ٤٥) °م حيث وجد أن الامتزاز يقل بزيادة درجة الحرارة. تم دراسة تأثير الـ pH (٣، ٥، ٧، ٩) على الامتزاز حيث وجد ان اعظم امتزاز عند (pH = ٣). وتم دراسة تأثير وزن سطح الابتلكايت على الامتزاز وجد ان الامتزاز يزداد بزيادة وزن السطح من (٠.١-١.٥) غرام. واخيرا" تم دراسة الشدة الايونية باستخدام محلول NaCl بتركيز (٠.١-٠.٣) مولاري حيث يقل الامتزاز بزيادة تركيز الملح. ان نتائج ايزوثرمات الامتزاز تطابق ايزوثرم لانكماير.

الكلمات المفتاحية: أمتزاز، سفكسيم، الاتبلكايت.