التوازن الحراري لأزالة الكروم من المياه الملوثة بوساطة النباتات المائية بطريقة الامتزاز

محمد صادق سلمان
مركز الحاسبة الالكترونية ، جامعة بغداد

الخلاصة

اجريت الدراسة في بغداد (الجادرية) عام 2006 من خلال استخدام نبات القصب المائي في عملية ازالة العناصر الثقيلة (الكروم) من المياه الملوثة من خلال عملية امتزاز بطريقة الحجم الثابت (الوجبة) مع أخذ بنظر الاعتبار اختيار محلول ذي طبيعة حامضية وثبوت كل من التركيز الاولي للكروم(60 ملغرام/لتر) ، و سرعة الرج (300 دورة بالدقيقة) ، ودرجة الحرارة (30 درجة مئوية) ،و زمن التلامس (4 ساعات) مع أختلاف اوزان المادة الصلبة (القصب) (4 ، 3 ، 2 ، 1، 0.5) غرام لكل أنموذج ذي حجم 100 مل من محلول الكروم . وكانت نسبة الازالة لكل وزن من المادة الصلبة (50% ،40% ،31% ، 17.5% ، 8%) على التوالي. وكان منحني التوازن للتزكيز لكل وزن مع كمية المادة الممتزة يطابق موديلات لانكمير و فريندلش بقيمة مربع عامل الارتباط (0.93 ، 0.97) على التوالي. وتبين نتائج الدراسة امكانية استخدام نبات القصب المائي مادة امتزاز لازالة الملوثات من المياه الملوثة.

The Equilibrium Isotherm Removal OF Chromium From Waste Water By Aquatic Plants Using Batch Process Adsorption

M. S. Salman
Computer Center,University of Baghdad

Abstract

This study was carried out in Baghdad (Al-Jadiriya) in 2006 by detecting ability of aquatic reed plant to remove heavy metals (Chromium) from waste water by batch process of adsorption with considering that acidic solution is best selection for such process with constant initial chromium concentration(60 mg/l),speed of shaking(300 rpm), temperature (30 C^o) and constant contact time (4 h) but with different weights of adsorbent (reed) (0.5 ,1 ,2 ,3 and 4)gm for each 100 ml volume of sample .

The results showed that the percentage of the removed chromium were (8% ,17.5% ,31% ,40% and 50%) respectively for each sample according to the mass of adsorbent used. Equilibrium isotherm curve showed a good fitting with langmuir model and frendlich model with square regression value for both of them(R^2 =0.93) (R^2 =0.97) respectively. The study results showed that aquatic reed plant can be used as an adsorbent to remove the pollutants from contaminated waste water.

Key words equilibrium isotherm , Adsorption , Reed , Chromium , langmuir model , frendlich model .

Introduction

At least 20 metals are classified as toxic and half of these are emitted in to the environment in quantities that pose risk to human health (1) .
Chromium has both beneficial and detrimental possessing properties. Two tables oxidation states of chromium persist in the environment, Cr(III) and Cr(VI) which have contrasting toxicities motilities and bio availabilities. Herd on Cr (III) is essential in human nutrition (especially in glucose metabolism). Most of the hexavalent compounds are toxic. While Cr(III) is relatively innocuous and immobile. Cr(VI) moves readily through soils and aquatic environment and is a storage oxidizing agent capable of being absorbed through the skin (2).

Chromium and its compounds are widely used in electroplating, leather tanning cement , dyeing, metal processing , wood preservatives , paint and pigments , textile steel fabrication and canning industries. Wide range of physical and chemical processes is available for the removal of Cr(VI) from waste water, such as electro-chemical precipitation, ultra filtration, ion exchange and reverse osmosis (2) and (3).

A Major drawback with precipitation is sludge production. Ion exchange is considered a better alternative technique for such a purpose. However it is not economically appealing because of high operational cost .Adsorption using commercial activated carbon (CAC) can remove heavy metals from waste water such as cadmium, nickel, chromium, and cupper. However (CAC) remains an expensive material for heavy metal removal .

The technique of adsorption is where a solid surface in contact with a solution has the tendency to accumulate a surface layer of solute molecule ,because of the imbalance of surface as –an adsorption takes place. The adsorption results in the formation of molecular layer of the adsorbate on the surface of adsorbent (solid).often an equilibrium concentration is rapidly forward .

The surface is generally followed by a slow diffusion on to the particles of the adsorbent (4)

Using natural adsorbent for removing heavy metals from waste water with clays and betonies (5) because of there permeability which plays an important note as physical barriers.

And using biotechnology for such a purpose in bioreactor (6). Equate plouts is widly used as adsorbent because of its low cost materials. The removal of cadmium ,lead and zinc from waste water were 32%,30% and 71%, respectively when maize cob was used as solid in adsorption process.(7)

Using peat as adsorbent in process of clays removal of dyes on fixed bed columns of different variable (PH ,bed dept ,size range ,and control time) (8). Adsorption isotherm is to examine the relationship between the amount of sorbet material (qe) and aqueous concentration Ce at equilibrium in batch process of contact between solid and liquid at condition which must be fixed at the beginning of process.

Sorption isotherm model is widely employed for fitting the data of which the Longmuir and Frendlish equations are most widely used. The Longmuir model assumes that the uptake of metal ions occurs on homogenous surface by mono layer adsorption without any interaction between adsorbed ions. To get the equilibrium data initial concentrations Ci were kept constant . While the mass of adsorbent varied for at least 3hr of equilibrium periods for sorption. Longmuir equation as shown below (2) and (4).

$qe = K_L Ce/(1+a_L Ce)$

Where

qe (mg/g) is the amount of metal ions adsorbed in to unit mass of the adsorbent to complete monolayer on the surface .

K_L is the Longmuir equilibrium constant which is related to the affinity of binding site.

Ce the solution phase metal ion concentration and Langmuir constant, K_L and a_L are the characteristics of Longmuir equation and can be determined form linearzed from of the langmuir equation represented :-

$Ce/qe = 1/K_L + (a_L/K_L)\ Ce$

therefore a plot of the Frendlich equation in an equation is based on adsorption on heterogeneous surface. The equation is commonly represented by

qe= aCe

where a and b are the Frendlich constant of the system indicating the adsorption capacity and the adsorption intensive respectively to simplify the derivation of a and b, the above equation can be linearized as

Ln qe=b Ln Ce+ Lna

Therefore a plot of Ln qe versus Ln Ce to determine b as slop and (1/b) must be (>1) and a as an intercept. (9)

Experimental Work

The experiment have been carried out in Baghdad (Al-Jadiriya) in 2006 and all materials were prepared locally as shown below.

-adsorbate

The solution of chromium was prepared by dissolving of (70.7) mg of Potassium Dichromate $k_2Cr_2O_7$ in 500 ml distilled water as shown in standard method 1995, at pH=5 by adding drops of Hcl (N 0.1) with stirring and measuring by pH meter. (2).

-adsorbent

Reed was collected from (Al-Jadiriya) location when it is grown naturally in Tigris river inside Baghdad . parts of this plant were cut into small parts (2 – 5mm) and washed by distilled water many times then dried by oven at 100 C^0 for 4hr.

Equilibrium uptake experiment:

The equilibrium experiment was carried out by using reed as adsorbent with mass (0.5, 1, 2, 3, 4) gm in five flask filled with 100 ml of the Cr stock solution with initial concentration 60 mg/l. The experiment was carried out by using shaker for mixing adsorbent with adsorbate at speed 300 rpm contact time 4hr, temp. at 25C^o and fixed concentration 60 mg/l, pH=5 of stock and varied mass of adsorbent (reed).

After the time of shaking the samples were filtrated and the concentration of chromium was analyzed by flam Atomic absorption .

Result and Discussion

Fig(1) shows that increasing of the percentage adsorbed Cr with increasing of adsorbent mass was due to increasing in the surface area at number of sites.

Equilibrium isotherm Fig(2) shows that the type of curve is favorable (4) due to its non linear relation.

Equilibrium isotherm fits with Langmuir and Freundlich model Fig (3) & (4) because the (R^2=0.93, 0.97) respectively and (1/b) constant is (1.85) when 1/b must be more than (1). (9)

Both of theoretical and empirical equilibrium isotherm are acceptable as shown in the value of constant in Table (1) .

Conclusion

1-Removal of Cr is increased with the increase of adsorbent mass. Because of the increase of surface area (5% - 50%)

2-Equilibrium isotherm is fitted with Langmuir and Frendlich models.

3-Possibility of making continuous experiment is fixed bed column but with low flow rate.

4-Low uptake (qe) which is because of the unknown surface area need.

5-Low cost process is compared with the costly process by using commercial Activated carbon.

6-This method is achieved widely by wet land studies to decrease the pollutant in surface water.

Nomuelctures

- a Frendlich constant
- a_L Langmuir constant
- b Frendlich constant
-Ce Initial conc. Of chromium (mg/l)
- K_L langmuir constant
-q_e Uptake of sorbet chromium (mg/gm)

References

1.KORtenkup, A; Casadevall ,Faux, S.P. (1996) Archives and Bio physics , 329 (2): 199-208
2.Saifudin, M.and Kumaran , P.(2005)J. of Biotechnology .8(1):
3.Goel, P.K. (1997) "Water pollution" New-age publishers, New dlebi

4.Johon,W.and Barry ,T . Crittenden(1998) "Adsorption Technology and design" Butter worth – Heinemann , Oxford, Uk.
5.Vega, J.L.and Ayala, J.(1995) 9th international main water congress ,Pero.
6. Jamews, A. J., water and waste water international, 1987, 2 (2): April pp 31 – 35,University of Piura,. Piuro, Peru, 9th international mine water concerners PP. 603-609.
7 Abia, A. A. and Igwe, J.C.,African journal of Biotechnology, June, 4 (6): 509 – 512, 2005.
8. Poots, V. J; Mckay, G. and Haely, J.J., (1975) Water research, 10:1061 – 1066
9.Casey, T. J."Unit of treatment processes of waste water" wiley serieo, New York, Industrial conferences on water and environ, 1992.

Table(1) Constant value of langmuir and frendlich models

langmuir isotherm curve	aL= 27.474 mg / l K_L = 0.434 gm/ mg R^2 = 0.9328
Frendlich isotherm curve	-a = 1.185 mg/gm - b =0.5398 (1/b = 1.85) R^2 = 0.9767

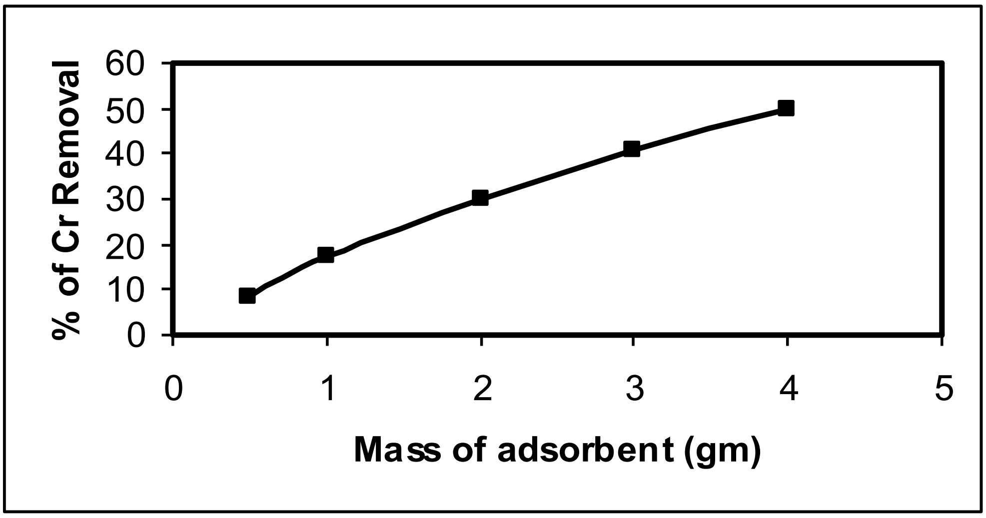

Fig. (1) percent of Cr removal at adsorbents mass

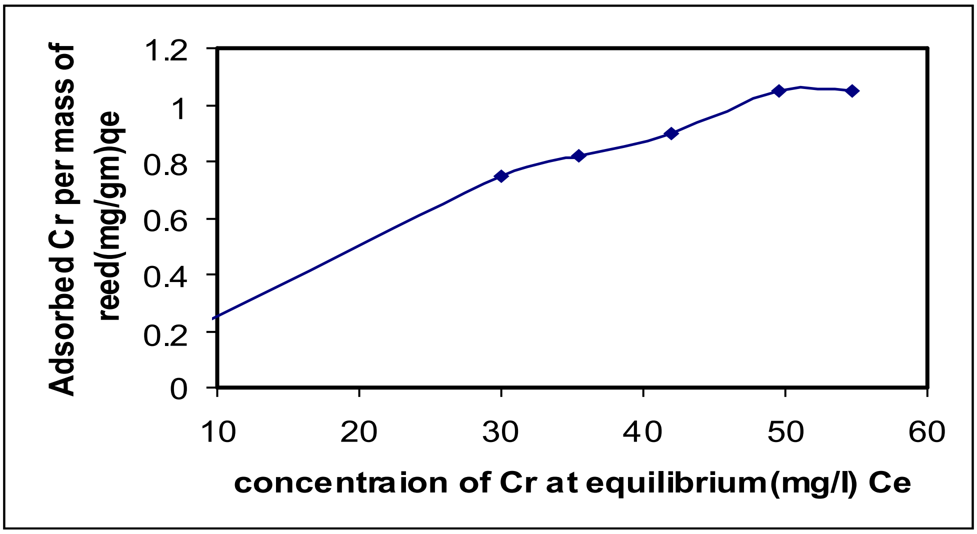

Fig.(2) Equilibrium isotherm curve

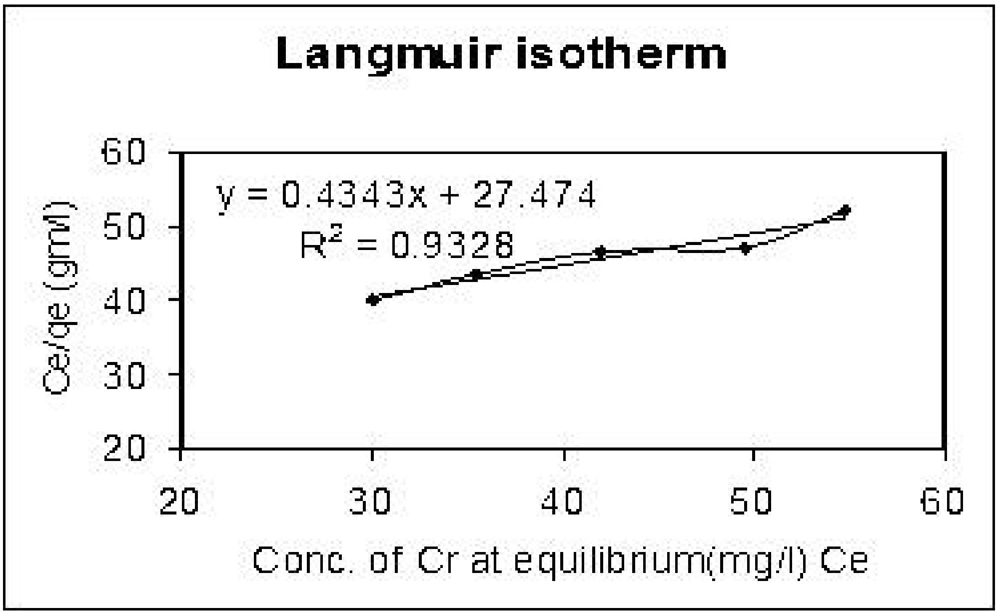

Fig. (3) langmuir model of equilibrium isotherm

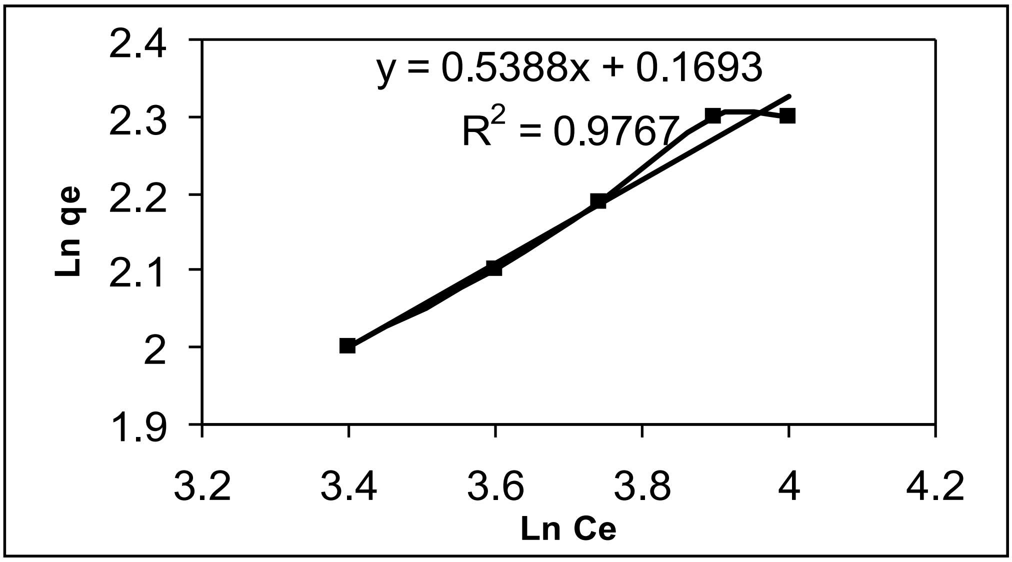

Fig.(4) Frendlich model of equilibrium isotherm