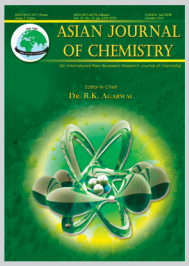
Asian Journal of Chemistry; Vol. 24, No. 4 (2012), 1618-1620

ASIAN JOURNAL OF CHEMISTRY

www.asianjournalofchemistry.co.in



Investigation of Adsorption Isotherms of 2-Naphthol on Carbon Nanotube

MAHDI VADI* and FATEMEH SAYBANKHIRABADI

Department of Chemistry, Firoozabad Branch, Islamic Azad university, Firoozabad, Fars, Iran

*Corresponding author: E-mail: mahdi_vadi@iaufasa.ac.ir

(*Received*: 22 March 2011; *Accepted*: 23 November 2011) AJC-10727

This paper has studied equilibrium adsorption isotherms of 2-naphthol on carbon nanotube. And also results of experiments through Freundlich, Temkin and Langmuir models have been studied and it has found different parameters of these models for carbon nano-tube absorbent. According to the error rate for each model, we abstained a good agreement between these data which it showed the best agreement by Freundlich model. With the spectrophotometer (UV/VIS) the adsorption diagram was obtained based on wavelength for 2-naphthol. Experimental result showed that by increasing concentrations of 2-naphthol therefore adsorption rate will increase too. The highest adsorption rate is for 6 ppm concentration of 2-naphthol.

Key Words: Isotherm, Adsorption, Carbon nanotubes, 2-Naphthol.

INTRODUCTION

After the carbon annotates discovery by lijma in 1991; these compounds have used in many physical and chemical applications[1]. Synthesis techniques developed quickly world-wide[2] carbon nano-tubes can adsorbed some atoms or molecules such as metal adsorption like lithium[3], potassium[4], rubidium[5], cesium[6] and non-metallic elements such hydrogen[7], nitrogen[8], oxygen[9] and methane[10]. Adsorption features provides the opportunity for gas adsorption like hydrogen and the other gases[11], sensors[12], catalysts[13] and batteries with lithium ion[14]. Single-wall carbon nano-tubes chemistry (SWNTC) has been interested for many years[15].

In recent years it has paid much attention to electrochemical surfaces of these compounds because they have high energy surface density and also their life period and their recycle is high. In other hand, the porous crystalline structure and their high surface area have been resulted these compounds become as a proper absorbent for polymers. Usually, the polymers adsorption rate on carbon nanotubes studied by SEM and STM methods. In the early years, all carbon nanotubes were multi-wall carbon nanotube (MWCNT) the good properties of this material has made much interest among scientific community and it results in various carbon nano-tubes synthesis in the worldwide. Therefore in 1996, Richard from Rice University developed the single-wall carbon nanotubes (SWCNT) production through graphite laser evaporation method. This new technique could produce better quality carbon nano-tubes, so in 1998 the first carbon nanotubes transistor was made at the Delft Technical University in Netherlands by Cess Derker.

Since that time, many projects have presented but it must mentioned that in fact the work on carbon nanotubes is very difficult even todays there isn't an effective way to get the carbon nanotubes correct orientation. However, despite these problems, there were many developments about carbon nano-tubes for example zettl group at the Erkeley University built first nano motors in 2003.

EXPERIMENTAL

The 2 naphthol (Merck Co.) solutions it has been used 94 % alcohol from the used adsorbent was carbon nanotube with 5-10 nm outer diameter, 40-600 m^2/g surface area and the purity above 95 % fore Merck company at the all of tests to prepare solution, it has been used from 96 % ethanol solvent.

Adsorption test: The solution was prepared by dissolving 2-naphthol in ethanol. The concentration of 100 mg L^{-1} prepared and then it dilute and different concentrations (6.5-4.3 ppm). Certain quantities of carbon nanotube (0.01 g) have been added as absorbent to 100 mL glasses containing 10 mL of 2-naphthol solution, then it was stirred by mixer for 24 h (optimal time),after mixing process then solution into 10000 rpm speed for 20 min until the solid and liquid phases are separated. The concentration of 2-naphthol was measured before and after adsorption by atomic adsorption machine all tests have been performed at room temperature (20 - 22 ºC).

RESULTS AND DISCUSSION

Balance study

Freundlich adsorption isotherms: Freundlich adsorption isotherms equation is described below:

$$q_e = k_f C_e^{1/n} \quad (1)$$

where q is adsorbate rate in term of mg g^{-1} and C_{eq}, 1/n and k_f are adsorbate concentration into solution at the balance moment, freundlich constants, respectively. These constants are the adsorption severity and adsorption capacity, respectively the linear equation is following:

$$\ln q_e = \ln K_f + 1/n \ln C_e \quad (2)$$

To calculate the constants of Freundlich equation, we draw ($\ln q_e$) curve in term of ($\ln C_e$) according to the presented equation (eqn. 2) it is found that if its value (slope of this curve -1/n- is greater therefore the adsorption amount is more too. There are the related diagram in Fig. 1 and 1/n-k_f parameters are given in Table-1.

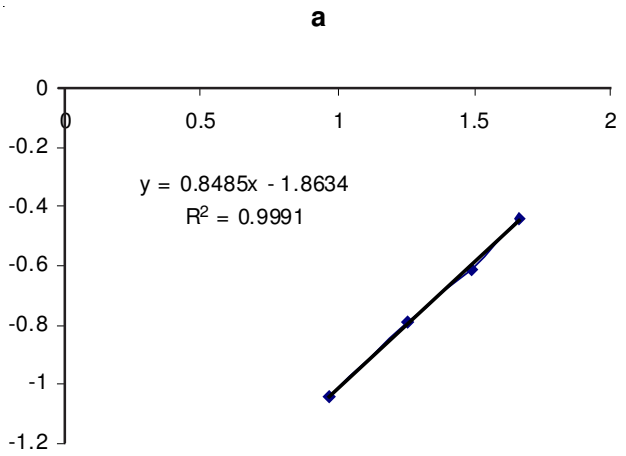


Fig. 1. 2-Naphthol adsorption diagram based on Freundlich adsorption model

TABLE-1
EXPERIMENTAL RESULTS OBTAINED FROM EQUILIBRIUM DATA OF TEMKIN, LANGMUIR AND FREUNDLICH MODELS

	Temkin	Langmuir	Freundlich
2-Naphthol	$R^2 = 0.96$	$R^2 = 0.98$	$R^2 = 0.99$
	B = 0.3	$1/q_m = 0.4$	= 0.841/n
	B In A = 6.79	$Q_m = 2.45$	n = 1.1
	ln A = 417	$1/q_m b = -0.05$	In k_f = -1.86

Langmuir model: This adsorption model which is used usually by following equation is described:

$$q = \frac{a_m b C_{eq}}{1 + bfC_{eq}} \quad (3)$$

Here q is amount of dissolved adsorbate (mg g^{-1}), C_{eq}, qe and b are and C_{eq}, q_m and b are solution concentration (mg L^{-1}) and Langmuir constants, respectively. q_m is adsorption balance constant and b is also adsorption capacity a saturated layer. We can obtain the following relation by rearrangement of eqn. 3:

$$\frac{1}{q} = \frac{1}{q_m} + \frac{1}{q_m b C_{eq}} \quad (4)$$

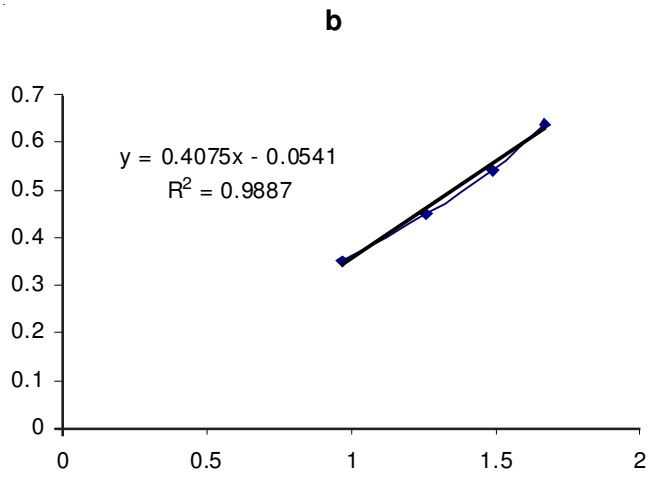


Fig. 2. Adsorption diagram of 2-naphthol based on Langmuir model

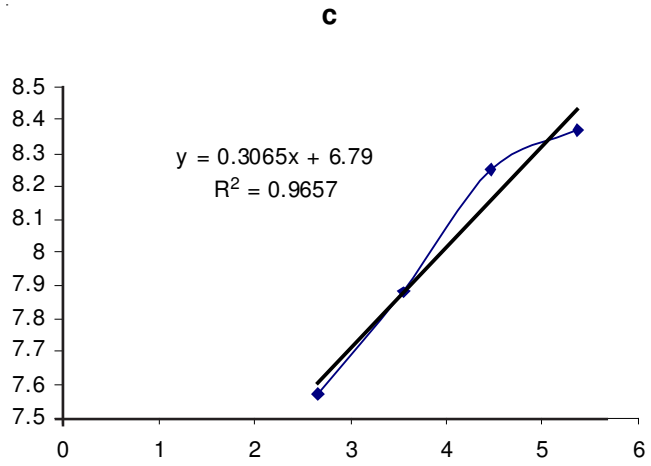


Fig. 3. Adsorption diagram of 2-naphthol based on Temkin adsorption model

To calculate Lagmuir relation constants; we draw C_e/q_e curve in term of C_e which here $1/q_m$ and b are slop and width of origin, respectively (Table-1).

Temkin isotherm: Temkin isotherm contain a factor wish it shows interactions between absorbent and absorbed clearly. Temkin isotherm would obtain in this way:

$$q_e = \frac{RT}{b} \ln(AC_e) \quad (5)$$

by considering:

$$\frac{RT}{b} = B$$

A linear form of Temkin isotherm would be as following

$$Q_e = B_1 \ln A + B_1 \ln C_e$$

in this relation, A (L/mg) is equal bond constant relate to maximum bond energy. B (J/mol) is Temkin isotherm constant and constant B is proportional to adsorption term adsorption data can be derived form eqn. 6.

To calculate we draw Q_E curve in term of $\ln C_e$ which its slope, width are B and -B ln A, respectively.

According to diagrams, it is observed that adsorption of aromatic alcohols follows form Freundlich isotherm model with more correlation.

Table-2 shows adsorption rate by 2-naphthol at the carbon nanotube absence upon ethanol solution in 300 nm wavelength (λ_{max} = 300 nm) of UV system. Table-2 presents adsorption rate of 2 naphthol on ethanol. Using data from Table-2, it can be calculated adsorption value of 2-naphthol on 0.01 g (Table-3).

TABLE-2
ADSORPTION RATE OF 2-NAPHTHOL
WITHOUT CARBON NANO-TUBE

Concentration (ppm)	Adsorption	Concentration (ppm)	Adsorption
3	0.432	5	0.636
4	0.546	6	0.669

TABLE-3
ADSORPTION RATE OF 2-NAPHTHOL ON
0.01 g CARBON NANO-TUBE (mg/g)

Concentration (ppm)	Adsorption on 1 g carbon nanotube (mg g^{-1})	Concentration (ppm)	Adsorption on 1 g carbon nanotube (mg g^{-1})
3	0.35	5	0.54
4	0.45	6	0.64

Fig. 4 shows q_e diagram based on concentration where q_e is:

$$q_e = \frac{(c_i - c_e)v}{M}$$

here q_e is the absorbed rate upon absorbent surface (mg g^{-1}), also C_i and C_e, are the initial concentration and equilibrium concentration (mg L^{-1}), respectively. V is volume of balanced solution (L) and (M) is adsorbent mass in term of gram.

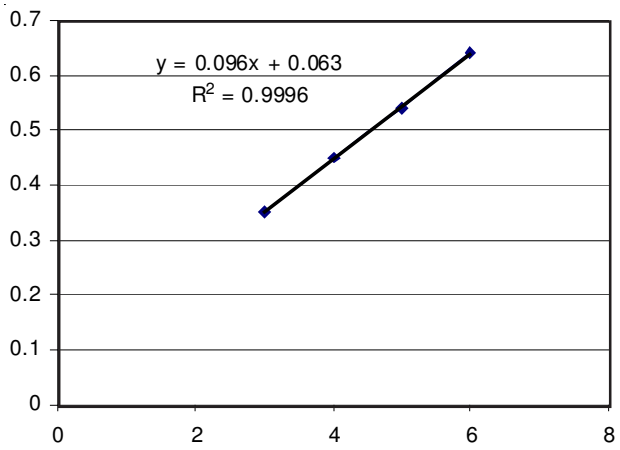


Fig. 4. Adsorption rate of 2-naphthol upon carbon nanotubes

Operating groups-which are decomposed on carbon nanotube surface by FTIR, have been shown in Fig. 5. There are The peaks associated with (OH) at the range of (3500-3000 cm^{-1}) and (C-H) aromatic is at the range of 3050 cm^{-1}. (C=C) aromatic peaks and (C-O) stretching peaks are in the range of 1380-1475 and 1000-1200 cm^{-1}, respectively.

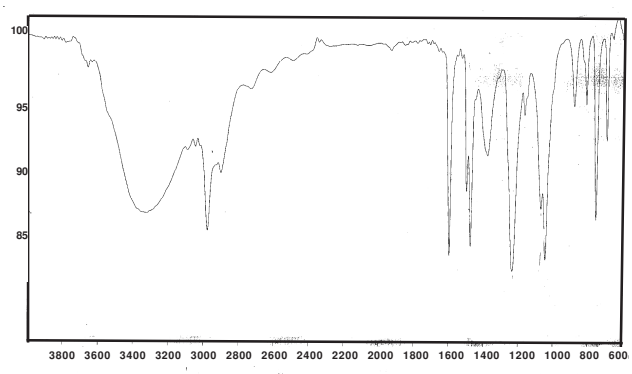


Fig. 5. Factor analysis of operating groups on carbon nano-tube by FIIR

Conclusion

In this research work, we have studied adsorption possible of aromatic alcohol on carbon nanotube surface. It was found that aromatic alcohol (2-naphthol) has an acceptable adsorption ability upon carbon nanotube. 2-Naphthol with high concentration has the better performance for adsorption carbon nanotube. Table-2 has shown adsorption rate of without carbon nanotube. It can be shown that by increasing 2-naphthol concentration so the adsorption rate will increase.

So that at the 3 ppm, adsorption rate is equal with 0.35-2-naphthol on 0.01 g carbon nanotube at the 6 ppm, adsorption rate has reached to 0.64 mg 2-naphthol on 0.01 g carbon nanotube. Therefore the most adsorption relate to concentration 6 ppm of 2-naphthol.

REFERENCES

1. S. Lijima, *Nature*, **354**, 56 (1991).
2. C.N.R. Rao, B.C. Satish Kumar, A. Govindaraj and M. Nath, *Chem. Phys. Chem*., **2**, 78 (2001).
3. N. Bendiab, E. Anglaret, J.L. Bantignies, A. Zahab, J.L. Sauvajol, P. Petit, C. Mathis and S. Lefrant, *Phys. Rev. B*, **64**, 245 (2001).
4. A.S. Claye, N.M. Nemes, A. Janossy and J.E. Fischer, *Phys. Rev. B*, **62**, 4845 (2002).
5. A.M. Rao, P.C. Eklund, S. Bandow, A. Thess and R.E. Smalley, *Nature*, **388**, 257 (1997).
6. A. Wadhawan, R.E. Stallcup II and J.M. Perez, *Appl. Phys. Lett*., **78**, 108 (2001).
7. A. Cao, H. Zhu, X. Zhang, X. Li, D. Ruan, C. Xu, B. Wer, J. Liang and D. Wu, *Chem. Phy. Lett.*, **342**, 510 (2001).
8. Q.H. Yang, P.X. Hou, S. Bai, M.Z. Wang and H.M. Cheng, *Chem. Phys, Lett*., **345**, 18 (2001).
9. X.Y. Zhu, S.M. Lee and T. Frauenheim, *Phys. Rev. Lett.*, **85**, 2757 (2000).
10. S. Talapatra and A.D. Migone, *Phys. Rev. B*, **56**, 45416 (2002).
11. A.C. Dillon and M.J. Heben, *Appl. Phys. A*, **72**, 133 (2001).
12. S. Peng and K. Cho, *Nanotechnology*, **11**, 57 (2005).
13. J.A. Nisha, M. Yudasaka, S. Bandow, F. Kokai, K. Takahashi and S. Lijima, *Chem. Phys. Lett*., **328**, 381 (2000).
14. J.M. Tarascon and M. Armand, *Nature*, **414**, 359 (2001).
15. V.M. Bermudez, *J. Phys. Chem. B*, **109**, 9970 (2005).