ISSN: 0970-020 X; CODEN: OJCHEG
Oriental Journal of Chemistry
2011, Vol. 27, No. (3): Pg. 973-978

http://www.orientjchem.org

Comparative Study of Isotherms Adsorption of Oleic Acid by Activated Carbon and Multi-wall Carbon Nanotube

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(Received: July 10, 2011; Accepted: August 25, 2011)

ABSTRACT

This experimental study aimed to compare the adsorption of oleic acid (fatty acid) by two adsorbent; activated carbon and carbon nanotube by use of Uv-Vis spectrophotometer Jenway 6505 model. In this study, five different concentrations of oleic acid in the range of 282.47ppm to 847.41ppm were used. In all conducted experiments, the values of adsorbents, exposure time, temperature, and pH were assumed constant. Based on the results, under similar conditions the efficiency of adsorption of oleic acid by carbon nanotube was more than activated carbon. The results can be beneficial in pharmaceutical, oil and construction industries, biology and advanced water and wastewater treatment plant.

Key words: Adsorption, Adsorbent, Oleic acid, Activated carbon, Carbon nanotube.

INTRODUCTION

The first serious attempt to understand the structure of carbons produced by the pyrolysis of organic materials was made by Rosalind Franklin in the 1950s [1]. She showed that these carbons fall into two distinct classes, which she called graphitizing and non-graphitizing. The kind of carbon from which activated carbon is derived is non-graphitizing, meaning that it cannot be transformed into crystalline graphite even at temperatures of 3000°C and above. Franklin put forward a simple model of non-graphitizing carbon based on small graphitic crystallites joined together by cross-links, but did not explain the nature of these cross-links. A later idea was that the cross-links might consist of domains containing sp3-bonded atoms[2,3], but this had to be discounted when neutron diffraction studies showed that non-graphitizing carbons consist entirely of sp2 atoms[4]. Activated carbon is used on an enormous scale in gas and water purification, metal extraction, medicine and many other applications[5]. The activated carbon's adsorption capacity is not only related to the superficial area and to the pore structure, but also to the chemical nature of the adsorbate and to the pH of the solutions[6]. Other factors that can affect the adsorption in a significant way are the granulometric distribution, ash content, high mechanical resistance, the activation process to which the carbon was submitted[7,8], viscosity[9], temperature of the liquid phase[1,10,11,12], contact time of the adsorbent with the solution[1,11-14], and solubility of the adsorbate[15].

Carbon nanotubes (CNT(discovery by Iijima in 1991 [16]. Carbon nanotubes (CNTs) are hollow cylinders of graphite carbon atoms. These tubes are on the nanoscale (10^{-9} m), which is so small that 10,000 of them could fit within the diameter of one human hair. Carbon nano-tubes are a new form of carbon with unique electrical and mechanical properties. They can be considered as the result of folding graphite layers into carbon cylinders. These cylinders may be composed of single shell single wall carbon nano-tubes (SWCNTs), or of several shells multi-wall carbon nanotubes (MWCNTs). CNTs can be thought of as a rolled-up sheet of hexagonal ordered graphite formed to give a seamless cylinder. Due to the variety of extraordinary properties exhibited by CNTs, a large number of possible applications have been proposed[17]. Recent discoveries of various forms of CNTs have stimulated research on their applications in diverse fields[18]. The nature of bonding in carbon nanotubes (CNTs) is described by applied quantum chemistry, specifically, orbital hybridization. This chemical bonding is composed entirely of sp2 bonds, similar to those of graphite. This bonding structure, which is stronger than the sp3 bonds found in diamond, provides the molecules with their unique strength. CNTs are the strongest and stiffest materials on earth, in terms of tensile strength and elastic modulus respectively. This strength results from the covalent sp^2 bonds formed between the individual carbon atoms. As for thermal conduction, the CNT surpasses even that of diamond, reaching almost double the value diamond[19]. Carbon nanotubes (CNT) possess many unique characteristics that promise to revolutionize the world of structural materials resulting in significant impact on our capability to build lighter, smaller and higher performance structures for aerospace and many other industrial applications. Based on its unique properties, many applications of CNT have been proposed including quantum wires, tiny electronic devices[20, 21].

Oleic acid is a monounsaturated omega-9 fatty acid found in various animal and vegetable fats. It has the formula $CH_3\ (CH_2)_7CH{=}CH\ (CH_2)_7COOH$. It is colorless oil and water-insoluble.

MATERIAL AND METHODS

Substances

Ethanol (purity %96) as solvent, oleic acid, activated carbon and multi-wall carbon nanotube as adsorbent.

Devices used

Spectrophotometer (Uv-Vis) model jenway6505

Methods

At first, stock solution of oleic acid was prepared in ethanol (2825 mg/l). Then, from stock solution of oleic acid, five standard solutions in concentration of 282ppm, 47, 423.7, 564.9, 706.17, and 847.41ppm were prepared. Absorbance of five standard solutions was measured by spectrophotometer and calibration curve was plotted. 10 ml of five standard solutions were added separately to Hundredth milligrams of activated carbon and carbon nanotube as adsorbent and after 10 minutes mixing by magnetic mixer solutions were filtered by filter papers. Absorbance of filtered solutions was measured by spectrophotometer

RESULTS

Table 1 shown the absorbance of oleic acid in the absent of activated carbon and carbon nanotube in 204.2 nm wavelength. As seen, table and Figure 1 shown the amount of absorbance is increased when concentrations are increased. Table 2 also shown the increasing absorbance of oleic acid against the concentrations in the presence of activated carbon and carbon nanotube.

Study of adsorption isotherm

Calculated parameters based on isothermic equations are shown in table 3. As seen, the values of correlation coefficient (R^2) for the

Table 1: Absorbance of oleic acid in the absent of AC and CNT

Concentrations	Absorbance of oleic acid
282.47 (0.001 M)	0.332
423.70 (0.0015M)	0.471
564.9 (0.002M)	0.621
706.17 (0.0025 M)	0.782
847.41 (0.003 M)	0.922

absorbance of oleic acid with the use of carbon nanotube for Temkin isothermic, Freundlich, and Langmuir models are 0.985, 0.951 and 0.712 and with the use of activated carbon are 0.95, 0.948 and 0.699, respectively. The results showed that the absorbance of oleic acid on both absorbent is in conformance with Temkin and Freundlich isotherm. The constant "n" is a function of absorbance. If n fall in 0.1 to 1, this determining the appropriate conformance with Freundlich isotherm and showing good adsorption (21, 22). Our study

Table 2: Absorbance of oleic acid in the present of AC & CNT

Concentrations	Absorbance oleic acid on CNT	Absorbance oleic acid on AC
282.47 (0.001 M)	0.318	0.322
423.70 (0.0015M)	0.447	0.459
564.9 (0.002M)	0.560	0.581
706.17 (0.0025 M)	0.693	0.720
847.41 (0.003 M)	0.813	0.854

Table 3: Isotherm parameters calculated for models

Isotherm Absorbent Parameter	Temkin			Freundlich			Langmuir			
	R^2	A	B	R^2	n	K_F	R^2	qm	b	R_L
CNT	0.985	3.86*10^{-3}	95. 93	1.17*10^{-5}	0.407	0.95	0/71	-21.7	-1.22*10^{-3}	R_L>1
AC	0.95	3.73*10^{-3}	63.98	1.65*10^{-6}	0.371	0.948	0/699	-12.6	-1.20*10^{-3}	R_L>1

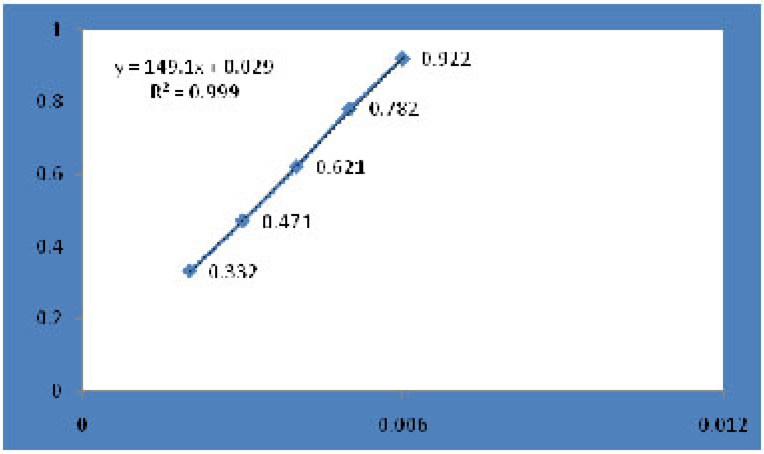


Fig.1: Absorbance of oleic acid in the absent of AC & CNT

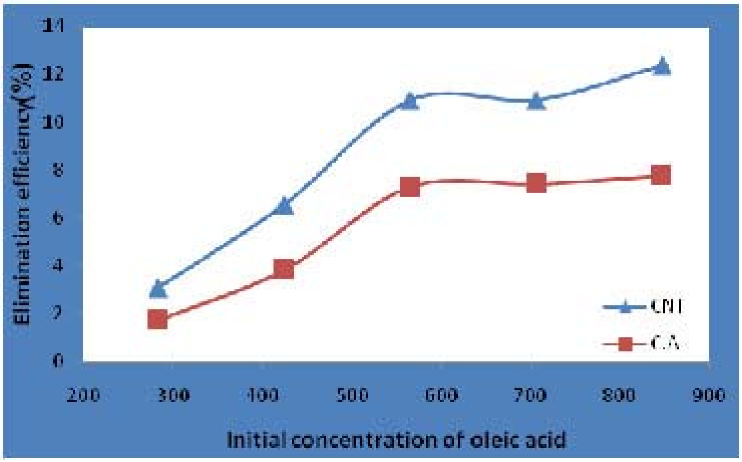
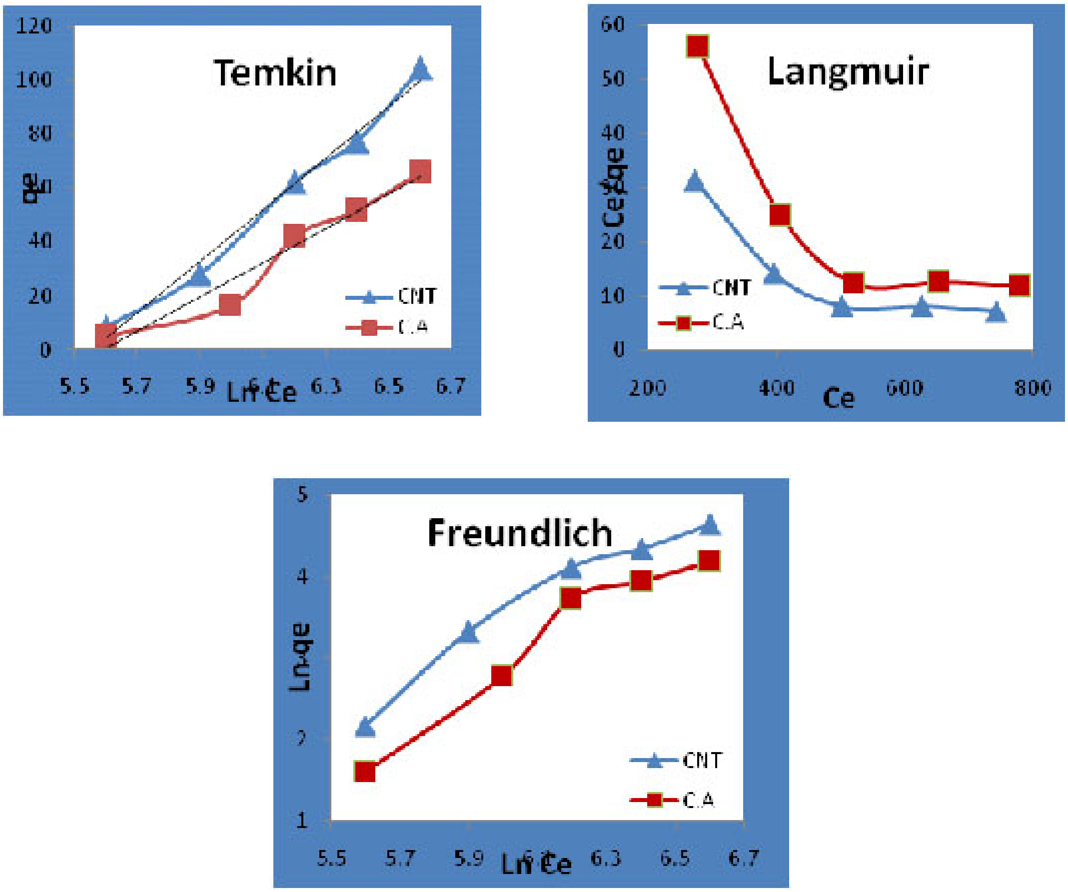


Fig. 2: Effect of initial concentration on absorbent CNT & AC

Curve adsorption isotherm



Curve 2: Adsorption of oleic acid on two absorbent based Temkin, Langmuir &Freundlich isotherms

also showed this fact. One of parameters in Langmuir's equation is non dimensional parameter "detachment coefficient" (R_L) that calculated from R_L=1/(1+bC). In this equation b is Langmuir constant and C is preliminary concentration in a series of experiment. If: R_L>1.0, not suitable; R_L=1.0, linear; 0<R_L<1.0, suitable and R_L=0 Irreversible

CONCLUSION

In this study we compare the adsorption isotherms of oleic acid by activated carbon and carbon nanotube. Base on obtained results we conclude that nanotube has more efficiency in removal of oleic acid rather than activated carbon. Results of isothermic experiments showed that the correlation coefficient of tamkin isothermic's equation for carbon nanotube was more than activated carbon. Also, the values of n and K_f for carbon nanotube were higher than activated carbon and indicating that the energy of adsorption is higher than carbon nanotube. The values of RL in carbon nanotube and activated carbon were more than 1, indicating that the absorbance is inappropriate for both adsorbents. Therefore, in total, it is concluded that correlation coefficient (n and K_f) in Temkin and Freundlich isotherm's models for carbon nanotube were higher and it's efficiency in the removal of oleic acid is better than activated carbon.

REFERENCES

1 R E Franklin. *Proc. R. Soc*. A **209**: 196 (1951).
2 S Ergun and V H Tiensuu. *Acta Crystallogr.* **12**: 1050 (1959).
3 S Ergun and L E Alexander. *Nature* **195**: 765 (1962).
4 D F R Mildner and J M Carpenter. *J. Non-Cryst. Solids* **47**: 391 (1982).
5 H Marsh and F Rodr´ýguez-Reinoso. Activated Carbon (Oxford: Elsevier) (2006).
6 S.Y. Karakas, A. Aygu¨ n, M. Gu¨ nes, E. Tahtasakal, *Carbon*. **42**: 477-484 (2003).
7 M. Ahmedna, W.E. Marshall, R.M. Rao, Bioresour. Technol. 71(1999) 103–112.
8 B. Pendyal, M.M. Johns, W.E. Marshall, M. Ahmedna, R.M. Rao, *Bioresour. Technol*. **68**: 247-254 (1998).
9. D.Y. Ryu, M.L. Free, J. *Colloid Interface Sci*. **264**: 402 (2003).
10. S. Voyutsky, Colloid Chemistry, Mir Publishers, Moscow (1978).
11. S.I. Lyubchik, A.I. Lyubchik, O.L. Galushko, L.P. Tikhonova, J.Vital, I.M. Fonseca, S.B. Lyubchik, *Colloids Surf*. **242**: 151 (2004).
12. R. Qadeer, J. Hanif, Carbon 33: 215-220 (1995).
13. Z. Aksu, E. Kabasakal, *Sep. Purif. Technol*. **35**: 223-240 (2004).
14. A. Kumar, S. Kumar, *Carbon* **41**: 3015 (2003).
15. E.G. Furuya, H.T. Chang, Y. Miura, K.E. Noll, *Sep. Purif. Technol*. **11**: 69 (1996).
16. S.Iijima, Nature 354 (1991), P.56
17.] PG,Collins P.Avouris Nanotubes for electronics. Sci. A 2000; 283: 38 – 45.
18. CNR,Rao AK.Cheetham Science and technology of nano-materials: current status and future prospects. J Mater Chem 11:2887- 94.
19. W Hoenlein *et al*. Integration of carbon nano-tubes devices into microelectronics, Mater Res Soc Nanotube-Based Devices Symp. Proceedings. 772: 3 -15.
20. T. Hertel, R. Martel and P. Avouris, Manipulation of Individual Carbon Nanotubes and Their Interaction with Surfaces, *J. Phys. Chem.* B **102**: 910915(1998).
21. H. Dai, E.W. Wong and C. M. Lieber, Probing Electrical Transport in Nanomaterials: Conductivity of Individual Carbon Nanotubes*, Science*, **272**: 523-526 (1996).
22. K., Das D., Mohanty M. N.,Biswas. "Adsorption of phenol from aqueous solutions using activated carbons prepared from Tectona grandis sawdust by ZnCl2 activation", *Chemical Engineering J*., **115**: pp 121-131 (2005).
23. M., Radhika K., Palanivelu. Adsorptive removal of chlorophenols from aqueous solution by low cost adsorbent-Kinetics and isotherm analysis", *J. Hazardous Materials*, B**138**: pp 116–124 (2006).

24. M., Sarkar P. K., Acharya. "Use of fly ash for the removal of phenol and its analogues from contaminated water", *Waste Management J*., **26**: pp 559-570 (2006).
25. M., Ahmaruzzaman D. K., Sharma "Adsorption of phenols from wastewater", *J. Colloid and Interface Science*, **287**: 14-24 (2005).