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Adsorption Isotherms of Some Non-Steroidal Drugs on Single Wall Carbon Nanotube

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The objective of this work was to study the adsorption behaviour of non-steroidal antiinflammatory drugs (NSAIDs) *e.g.*, aspirin, diclofenac and naproxen by single walled carbon nanotube as the function of initial concentration of adsorbate through adsorption isotherms. The amount of NSAIDs adsorbed from aqueous solution increases with the increase of the initial NSAIDs concentration. The adsorbent capacity was determined using the parameters of Langmuir, Freundlich and Temkin adsorption isotherm models that the NSAIDs adsorption isotherm data fit best to the Freundlich isotherm model. The results showed that aspirin has maximum adsorption rate of single wall carbon nanotube.

Key Words: Adsorption, Aspirin, Diclofenac, Naproxen, Single wall carbon nanotube.

INTRODUCTION

Carbon nanotubes (CNTs) are allotropes of carbon with a cylindrical nanostructure. Nanotubes have been constructed with length-to-diameter ratio of up to 132,000,000:1[1], significantly larger than for any other material. These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. In particular, owing to their extraordinary thermal conductivity and mechanical and electrical properties, carbon nanotubes may find applications as additives to various structural materials. Multiwalled carbon nanotubes (MWCNTs) can adsorb many atoms and molecules on their surface such as adsorption of metallic elements like lithium[2], potassium[3], rubidium[4], cesium[5] and non-metallic such as hydrogen[6], oxygen[7], nitrogen[8] and methanol[9]. Adsorption characteristic of MWCNTs is breather for adsorption of gases such as hydrogen and other gases[10]. All of the compounds on the surface of MWCNTs adsorbed two main covalent bonds and non-covalent bonds[11,12].

Non-steroidal drugs (NSAIDs) are drugs that inflammation, pain and reduce fever. These drugs are among the most widely used drugs that are prescribed to treat various diseases and conditions. In addition to relieving pain and reducing fever, inflammation reducing properties, it is important. These drugs relieve pain, including transient muscle pain, migraine headaches, pain associated with menstruation, pain after surgery or to relieve inflammation in diseases that require prolonged treatment are prescribed. The most prominent members of this group of drugs are aspirin, diclofenac and naproxen, all of which are available over the counter in many areas[13,14].

In this research, some non-steroidal antiinflammation on single walled carbon nanotube were studied and tried to find out how this drugs can be adsorbed by carbon nanotube. We also want to find out if we can affect the inflammable molecules by putting these drugs on carbon nanotube without damaging the safe molecules.

EXPERIMENTAL

First solution concentration of 100 mg/L of sample prepared and dilution of the solution, solution concentrations (10, 20, 25 and 35) mg/L were prepared.

Each tube containing 0.1 g SWCNTs was filled with 10 mL NSAIDs solution of different concentrations. All tubes were immediately sealed with PTFE-lined caps and were then mechanically shaken for 24 h in a thermostated rotary shaker at temperature of 295 ± 1 K, were adjusted. After equilibration, all tubes were placed vertically for 4 h at the same temperature to ensure complete sedimentation of carbon nanotubes from the bulk solutions. By using on spectrophotometer tool adsorption rate, gained for NSAIDs.

Adsorption isotherms: Equilibrium sorption isotherm studies are fundamentally important in the design of sorption systems. Equilibrium relationships between sorbent and sorbet are described by sorption isotherms, usually the ratio between the quantity sorbed and that remaining in the solution at a fixed temperature at equilibrium. Equilibrium studies are described by sorption isotherm characterized by certain constants

whose values express the surface properties and affinity of the sorbent. The analysis of our results involved the establishment of the proper isotherm description for the adsorption process.

Langmuir model: The Langmuir adsorption model[15] is the most common model used to quantify the amount of adsorbate on an adsorbent as a function of partial pressure or concentration at a given temperature. This equation expressed by relation (1).

$$\frac{c_e}{q_e} = \frac{1}{q_m b} + \frac{1}{q_m} c_e \quad (1)$$

In this equation, q_e (mg g^{-1}) is the solution was absorbed the surface and q_m is equilibrium constant of adsorption and b is the capacity of adsorption in saturated single layer and C_e (mg L^{-1}) is solution in equilibrium state.

Freundlich model: The Freundlich[16] equation or Freundlich adsorption isotherm is an adsorption isotherm, which is a curve relating the concentration of a solute on the surface of an adsorbent, to the concentration of the solute in the liquid with which it is in contact. In 1909, Freundlich gave an empirical expression representing the isothermal variation of adsorption of a quantity of gas adsorbed by unit mass of solid adsorbent with pressure. This equation is known as Freundlich adsorption isotherm or Freundlich adsorption equation. This model is specified with eqn. 2.

$$q_e = k_f c_e^{1/n} \Longrightarrow \ln q_e = \ln k_f + \frac{1}{n} \ln c_e \quad (2)$$

In this equation, q_e (mg g^{-1}) is amount of absorbed material in absorbent surface, K, n in arrangement are adsorption capacity and adsorption intensification.

Temkin model: The Temkin model is linearly represented as eqn. 3 and generally applied in the form:

$$q_e = B \ln A + B \ln c_e \quad (3)$$

where A and B are the Temkin isotherm constant (L/g) and heat of sorption (J/mol), respectively. R is the gas constant (J/mol/k), b is the Temkin isotherm constant linked to the energy parameter, B, as shown on eqn. 4:

$$b = \frac{RT}{B} \quad (4)$$

T is the absolute temperature in Kelvin[17].

RESULTS AND DISCUSSION

Adsorption isotherms: The Langmuir, Freundlich and Temkin isotherms of the adsorption process of NSAIDs (aspirin, diclofenac and naproxen) on carbon nanotubes are shown in Figs. 1-3 and calculated parameters of these models are shown in Table-1. It was observed that the experimental data were well represented by Langmuir, Freundlich and Temkin models.

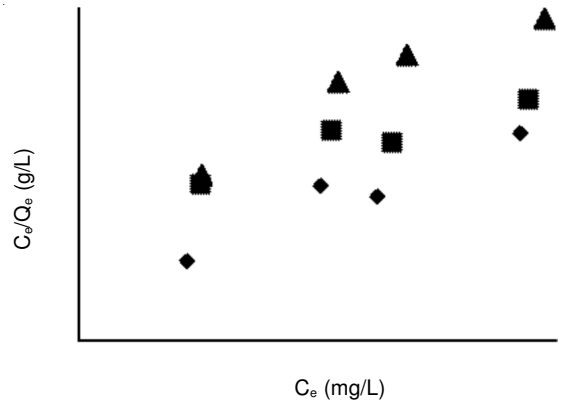

Fig. 1. Langmuir isotherm of NSAIDs on CNT. ◆: Aspirin ■: Diclofenac ▲: Naproxen

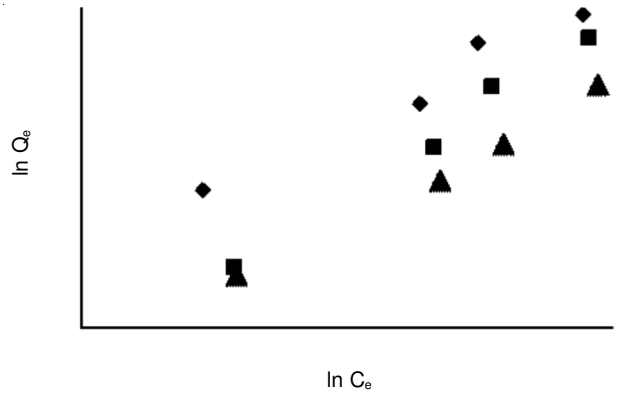

Fig. 2. Freundlich isotherm of NSAIDs on CNT. ◆: Aspirin ■: Diclofenac ▲: Naproxen

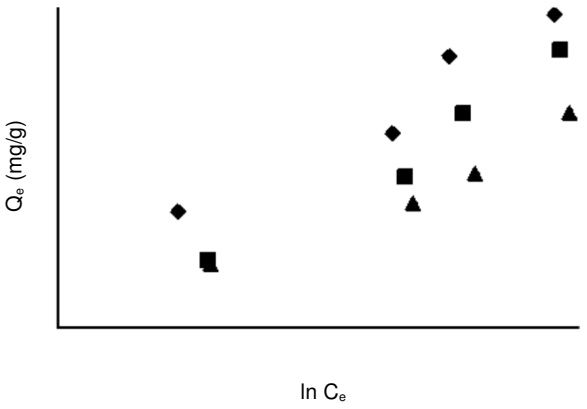

Fig. 3. Temkin isotherm of NSAIDs on CNT. ◆: Aspirin ■: Diclofenac ▲: Naproxen

Conclusion

The purpose of this work is to study the adsorption behaviour of non-steroidal antiinflammatory drugs, aspirin, diclofenac and naproxen by single wall carbon nanotube as the function of initial concentration of adsorbate through adsorption isotherms. The results show that aspirin has most amount adsorption rate of SWCNT because it can be attributed to lower the barrier of space in this material. In the process of adsorption of NSAIDs on the SWCNT showed traces of the adsorption capacity with increasing initial concentration of NSAIDs increases. The experimental results were analyzed by using the Langmuir, Freundlich and Temkin equations. The data were best fitted by the Freundlich model over the studied concentration range.

TABLE-1
PARAMETERS OF LANGMUIR, FREUNDLICH AND TEMKIN ISOTHERMS OF THE NSAIDS ADSORPTION

	Langmuir			Freundlich			Temkin			
	b	q	R^2	n	K (L g^{-1})	R^2	A (L mg^{-1})	B	b (J mol^{-1})	R^2
Aspirin	0.0538	10.355	0.932	1.812	1.008	0.967	0.271	2.412	10.027	0.948
Diclofenac	0.0196	15.630	0.886	1.316	0.445	0.990	0.470	2.704	8.943	0.967
Naproxen	0.0378	8.393	0.936	1.677	0.5921	0.994	0.378	1.853	13.053	0.956

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