



## Comparative Study of Adsorption Isotherms Steroidal Anti-Inflammatory Drug Dexamethasone on Carbon Nanotube and Activated Carbon

MEHDI VADI\* , NAJAF HOSSINIE and ZAHRA SHEKARI

Department of Chemistry, Gachsaran Branch,  
University of Gachsaran, Kohgiluyeh va Boyerahmad, Iran  
\*Correspondence author E-mail: mahdi\_vadi@iaufasa.ac.ir

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### ABSTRACT

In this research we have studied aimed to compare the adsorption of dexamethasone by two adsorbent; multi-wall carbon nanotube and activated carbon with the help of UV/VIS spectrophotometer Jenway 6505 model. Adsorption chart based on the wavelength of dexamethasone has been obtained and the relevant graph is plotted by considering factor of concentration. Four different concentrations necessary for adsorption of dexamethasone on multi wall carbon nanotube and activated carbon the maximum adsorption rate was determined. Study with on the results, the efficiency of that observation adsorption dexamethasone by multi wall carbon nanotube was more than activated carbon. The results can be useful in biological system and pharmacy.

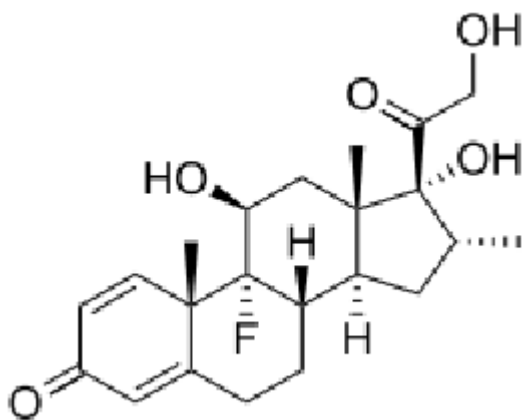
**Key words:** Adsorption; Isotherms; Activated carbon; Multi wall Carbon nanotube.

### INTRODUCTION

Carbon nanotubes (CNT) discovery by Iijima in 1991. Carbon nanotubes (CNTs) are hollow cylinders of graphite carbon atoms. These tubes are on the nano scale (10<sup>-9</sup> m), which is so small that 10,000 of them could fit within the diameter of one human hair. Carbon nanotubes are a new form of carbon with unique electrical and mechanical properties<sup>2</sup>. They can be considered as the result of folding graphite layers into carbon cylinders. Multi walled nanotubes (MWNT) consist of multiple rolled layers (concentric tubes) of grapheme. There are two model, sheets of graphite are arranged in concentric cylinders, e.g., a (0.8

single walled nanotube (SWNT) within a larger (0.17) single-walled nanotube<sup>3</sup>. Recent discoveries of various forms of CNTs have stimulated research on their applications in varied fields. The nature of bonding in carbon nanotubes (CNTs) is described by applied chemistry, specifically, orbital hybridization<sup>4</sup>. This chemical bonding is composed entirely of sp<sup>2</sup> bonds, similar to those of graphite. This bonding structure, which is stronger than the sp<sup>3</sup> bonds found in diamond, provides the molecules with their particular strength<sup>5</sup>. CNTs are the strongest and hard materials on earth, in terms of supple strength and elastic modulus respectively. This strength results from the covalent sp<sup>2</sup> bonds formed between the individual carbon atoms<sup>6</sup>. As for

thermal conduction, the CNT surpasses even that of diamond, reaching almost double the value diamond. Carbon nanotubes (CNT) possess many particular characteristics that promise to revolutionize the world of structural materials resulting in significant impact on our capability to build lighter, higher performance structures for aerospace and many other industrial applications<sup>7</sup>. Dexamethasone is a type of steroid drug known as a glucocorticosteroid. It is a man-made version of a natural hormone produced by the adrenal glands. Glucocorticosteroids have a wide range of actions on many parts of the body<sup>8</sup>. The ways in which they cause these many different effects aren't exactly clear. The main effects of dexamethasone and steroids like it seem to be due to their anti-inflammatory properties and their ability to alter immune system responses. For example, dexamethasone helps prevent white blood cells from traveling to areas of the body where they might add to swelling problems (such as around tumors)<sup>9-10</sup>. It also seems to help with the treatment of certain blood cancers (such as leukemia's) by causing some cancerous white blood cells to commit suicide. We studied adsorption of some drugs on carbon nanotubes<sup>11-27</sup>. The reasons for some of its other actions (such as increasing appetite and reducing nausea) aren't as clear. Designated chemically as 9-Fluoro-11,17-dihydroxy-17-(2-hydroxyacetyl)-10,13,16-trimethyl-6,7,8,9,10,11,12,13,14,15,16,17-dodecahydro-3H-cyclopenta [a]phenanthren-3-one. The molecular weight is 392.461 g/mol. Its molecular formula is  $C_{22}H_{29}FO_5$ . The structural formula is:



Scheme 1:

## EXPERIMENTAL

### Substances

Ethanol (purity %96) as solvent, activated carbon and multi-wall carbon nanotube with 95% pure degree, production of neutrino Company. Dexamethasone with 99% pure degree production of Pharmaceutical companies daro pakhsh.

### Devices used

In this researcher spectrophotometer UV / VIS Jenway 6505 model England, magnetic stirrer (Heidolph, Mr3001 Model), Analytical balances (Sartorius Model), Filter paper (Albet), were used.

### Adsorption experiments

In order to provide dexamethasone solution, twice distilled water was used. Multi-walled carbon nanotube was used as an adsorbent. First 50 ppm of dexamethasone was provided using this sample, some solutions with different concentrations of 4 to 12 mg/lit of pure dexamethasone were prepared. Specific amount of carbon nanotube (0.005 gr) was added to flasks containing dexamethasone, as an adsorbent. It was stirred, using a magnetic stirrer for 10 minutes. Then liquid and solid phase were separated by means of a filter paper. The concentration of dexamethasone was measured by using a spectrophotometer tool. Adsorption rate, gained for dexamethasone. All tests have been performed at the lab with the temperature of  $(25 \pm 2^\circ\text{C})$ . In a two component system consisting of adsorbent solution, a graph of the concentration of dissolved solid phase  $q_e$  (mg / g) was dissolved in the solution concentration  $C_e$  (mg/L) in an equilibrium adsorption isotherm is expressed. In a liquid-solid adsorption from solution on to the surface of the separation of dissolved solids remaining dissolved in the solution until the solution reaches the dynamic equilibrium on a solid surface. The Freundlich, Langmuir and Temkin models are employed to analyze adsorption occurred in the experiment. Adsorption isotherms to describe the adsorption capacity to facilitate the process of evaluating the feasibility of the intended application and is useful for the analysis and design of adsorption systems.

### Langmuir model

The Langmuir adsorption model is the

most common model used to quantify the amount of adsorbs ate on an adsorbent as a function of partial pressure or concentration at a given temperature. This equation expressed by relation.

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

In this equation,  $q_e$  (mg.g<sup>-1</sup>) is the solution was adsorbed 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.1<sup>-1</sup>) Is solution in equilibrium state?

**Freundlich model**

The Freundlich equation or Freundlich adsorption isotherm is an adsorption isotherm, which a curve is 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 equation.

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

In this equation,  $q_e$  (mg.g<sup>-1</sup>) 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 equation (3) and generally applied in the form:

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

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 equation:

$$b = RT/B \quad \dots(4)$$

$T$  is the absolute temperature in Kelvin.

**RESULTS**

Table 1 shown the absorbance of dexamethasonein the absent of activated carbon and carbonnanotube in 238 nm wavelength. As seen, table1 shown the amount of absorbance isincreased when concentrations are increased. Table2 shown the increasing absorbance of dexamethasone against the concentrations in the presence ofcarbon nanotube,Table3 also shown the increasing absorbance of dexamethasone

**Table 1: Absorbance of Dexamethasone in the absent of Carbon nanotubesand Activated carbon**

Concentrations (Mg.L <sup>-1</sup> )	Absorbance of Dexamethasone(nm)
8	0.51482
10	0.61285
12	0.71986
14	0.82025

**Table 2: The amount of Dexamethasoneon 0.005 grams of carbon nanotubes**

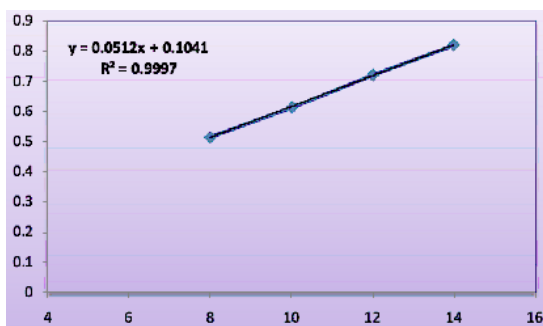
Concentrations (Mg.l <sup>1</sup> )	Material adsorbed on 0.01 grams of carbon nanotubes(mg.g <sup>-1</sup> )
8	0.31128
10	0.459911
12	0.56124
14	0.66988

**Table 3: The amount of Dexamethasoneon 0.005 grams of Activated carbon**

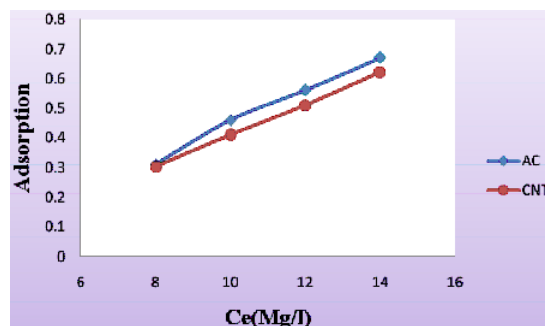
Concentrations (Mg.l <sup>1</sup> (0.01)	Material adsorbed on grams of activated carbon (mg.g <sup>-1</sup> )
8	0.3035
10	0.4100121
12	0.51036
14	0.62251

**Table 4: Parameters of Langmuir, Freundlich and Temkin isotherms of the Dexamethasone on Carbon nanotubes and Activated carbon**

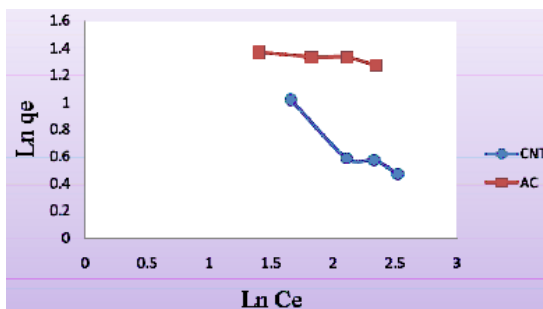
	Langmuir			Freundlich			Temkin		
	b	q	R <sup>2</sup>	n	k(l.g <sup>-1</sup> )	R <sup>2</sup>	A(l.mg <sup>-1</sup> )	B	R <sup>2</sup>
Carbon nanotubes	0.36	1.25	0.994	1.59	7.48	0.92	188	0.66	0.896
Aactivated carbon	1.5	3.38	0.996	10.5	4.55	0.82	268	0.36	0.8264



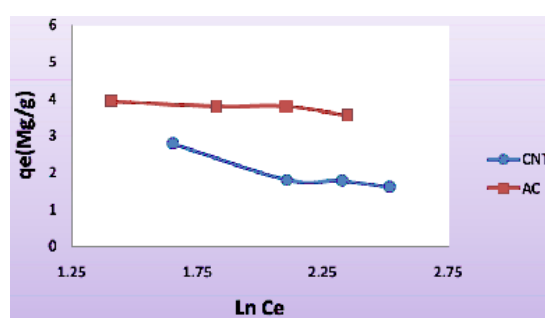
**Fig. 1: Absorbance of Dexamethasone in the absent of CNT & AC**



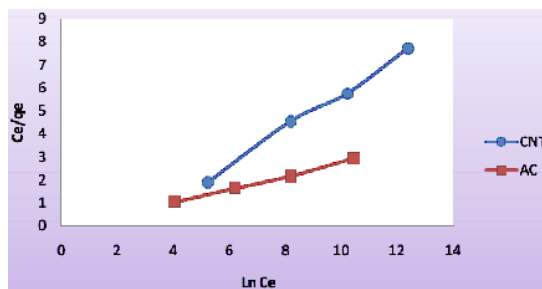
**Fig. 2: Effect of initial concentration on adsorbent CNT & AC Curve adsorption isotherm**



**Fig. 3: Freundlich isotherm of Dexamethasone on CNT& AC**



**Fig. 4: Temkin isotherm of Dexamethasone on CNT& AC**



**Fig. 5: Langmuir isotherm of Dexamethasone on CNT& AC**

against the concentrations in the presence of activated carbon. Calculated parameters of these models are shown in Table 4 and The Langmuir, Freundlich and Temkin isotherms of the adsorption process of dexamethasone on AC and CNT are shown in figures 3 to 5. It was observed that the experimental data were well represented by Langmuir Freundlich and Temkin models.

#### Study of adsorption isotherm

Calculated parameters based on exothermic equations are shown in table 4, As seen, the values of correlation coefficient ( $R^2$ ) for the absorbance of dexamethasone with the use of carbon nanotube for Langmuir, Freundlich and Temkin models are 0.994, 0.92 and 0.896 and with the use of activated carbon are 0.996, 0.82 and 0.8264, respectively. The results showed that the absorbance of dexamethasone on both absorbent is in conformance with Langmuir and Freundlich isotherm.

#### CONCLUSION

In this study we compare the adsorption isotherms of dexamethasone by activated carbon and carbon nanotube. Base on obtained results we conclude that nanotube has more efficiency in removal of dexamethasone rather than activated carbon. Results of isothermic experiments showed that the correlation coefficient of Langmuir isotherm's equation for carbon nanotube was more than activated carbon. The values of RL in carbon nanotube and activated carbon were less than 1, indicating that the absorbance is appropriate for both adsorbents. Therefore, in total, it is concluded that correlation coefficient (RL) in Langmuir isotherm model for carbon nanotube were higher and it's efficiency in the removal of dexamethasone is better than activated carbon.

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