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# Comparative Study of Isotherms Adsorption of $B_{12}$ By Single-wall Carbon Nanotube and Multi-wall Carbon Nanotube

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**ABSTRACT**

This experimental study aimed to compare the adsorption of $B_{12}$ by twoadsorbent; SWCNTs and MWCNTs by use of Uv-Vis spectrophotometer Jenway 6505model. In this study, four different concentrations of $B_{12}$ in the range of 212.nm were used. In all conducted experiments, the values of adsorbents, exposure time, temperature, andpH were assumed constant. Based on the results, under similar conditions the efficiency of adsorptionof $B_{12}$ by MWCNTs was more than SWCNTs. The results can be beneficial inpharmaceutical, oil and construction industries, biology and advanced water and wastewater treatmentplant.

**Key words:** Adsorption, Adsorbent, $B_{12}$, MWCNTs, SWCNTs.

## INTRODUCTION

The first serious attempt to understand thestructure of carbons produced by the pyrolysis oforganic materials was made by Rosalind Franklinin the 1950s [1]. She showed that these carbons fallinto two distinct classes, which she calledgraphitizing and non-graphitizing. Carbon nanotubes are a new form of carbon with unique electrical and mechanical properties[2]. They can be considered as the result of folding graphite layers into carbon cylinders. Nanotube oxidation of the double tube begins that will open tube. Tubes have high capillarity and can solve liquids and gas in itself[3-4]. All compounds on the surface of carbon nano-tubes are adsorbed by two major covalent and non covalent links[5-8]. They can be planted there without causing ulcers in the point and they can release the drugs slowly over the time in the point. The application part of carbon nano tube are: Precise photography of biological, chemical and biological sensors have a reliable and long life, gene therapy through gene transfer into cells by them, removing bacteria and.….[9] Multi-wall nano-tubes discovered in 1991 would create incentives for broader research inengineering science based on entirely carbon nanotubesand their applications[10]. Multiwalled carbonnanotubes (MWCNTs) can adsorb many atoms and moleculeson their surface such as adsorption of metallic elements like lithium[10], potassium[11], rubidium[12], cesium[13] and non-metallic such as hydrogen[14], oxygen[15], nitrogen[16] and methanol[17]. Adsorption characteristic of MWCNTs is breather for adsorption of gases such as hydrogen and other gases[15]. All of the compounds on the surface of MWCNTs adsorbed two main covalent bonds and non-covalent bonds[19-20]. This largely due to the favorable combination of properties such havingfaultles structure, a small, low-density, highhardness and strength of the carbon nano-tubes.

Antioxidantsare substances that prevent the formation of free radicalsin cells. Antioxidants play an important rolein preventing cancer. Cobalaminor Vitamin $B_{12}$ is is the protype member of a large family of Antioxidant substances. Designated chemically as α-(5,6-dimethylbenzi-midazolyl) cobamid cyanide. It is one of the eight B vitamins. It is normally involved in the metabolism of every cell of the human body, especially affecting DNA synthesis and regulation, but also fatty acid synthesis and energy production[21]. The molecular weight is 1355.37 g/mol. Its molecular formula is$C_{63}H_{88}CoN_{14}O_{14}P$ . Considering the role of vitamins in the diet and its importance in energy metabolism on how to attract them much research has been done with extraordinary properties of carbon nano-tubes as vitamin $B_{12}$ soluble in water which has particular importance.

## EXPERIMENTAL

### Chemicals materials

We used the carbon nanotube single wall with 95% and multi wall nanotube with 97% pure degree, production of neutrino Company.Water is distilled twice to prepare vitamin$B_{12}$ solution.

### Methods

**At first Solutions used was prepared by solving**

Vitamin$B_{12}$ and distilled water is used twice. Then, 50ppm of $B_{12}$ was provided using this sample,

some solutions with different concentrations of (8.10.12.14) mg/lit of pure $B_{12}$ were prepared.

Absorbance of four standard solutions was measured by spectrophotometer and calibration curve was plotted. 10 ml of four standard solutions were added separately to 0.005 grams of carbon nanotube single wall and carbon nanotube multi wall as adsorbent and after60 minutes mixing by magnetic mixer solutions. Then liquid and solid phase were separated by means of a filter paper. The concentration of $B_{12}$ was measured by using on spectrophotometer tool adsorption rate gained for $B_{12}$. All tests have been performed at the lab with the temperature of (293 ± 1°C).

### Adsorption isotherms

The adsorption isotherm described the relationship between the equilibrium concentrations of adsorbate in the solution and the amount of adsorbate on adsorbent. Which indicates how adsorbate molecules are distributed between the

liquid phase and solid phase when the adsorption process reaches equilibrium[22-23]. In this study, three isotherms were used for describing the experimental results, namely the Freundlich isotherm, the Langmuir isotherm and the Temkin isotherm.

### Langmuir isotherm

The Langmuir model assumes that theideal monolayer adsorption takes place at specific homogeneous sites within the adsorbent, i.e. once a molecule occupies a sit and no further adsorption

takes place [22].The Langmuir equation may be written as

$$\frac{C_e}{q_e} = \frac{1}{q_m} + \frac{1}{q_m b} c_e \qquad ...(1)$$

Where *qe*is the amount of solute adsorbed per unit weight of adsorbent at equilibrium (mg.g$^{-1}$), *C*e the equilibrium concentration of the solute in the bulk solution (mg.L$^{-1}$).

### Freundlich isotherm

The Freundlich isotherm was broadly usedto describe adsorption phenomenon in liquid andfor adsorption on heterogeneous surface with multilayer adsorption. This isotherm assumes that as the adsorbate concentration increases, the concentration of adsorbate on the adsorbent surface also increase[23,24]. The Freundlich isotherm is expressed by the following empirical equation:

$$q_e = k_f c_e^{1/n} \xrightarrow{\ln} qe = Ink_f + \frac{1}{n}\ln c_e \quad ...(2)$$

where qe and Ce are the equilibratedconcentration of the adsorbate in sorbent and solution, respectively, where $K_F$ is a constant indicative of the relative adsorption capacity of the adsorbent ($mg^{1-(1/n)}L^{1/n}g^{-1}$), and n is adsorption intensity related to the surface heterogeneity.

**Temkin model**

The Temkin isotherm equation assumesthat the heat of adsorption of all the molecules inthe layer decreases linearly with coverage due toadsorbent–adsorbate interactions, and that theadsorption is characterized by a uniform distribution of the binding energies, up to some maximum binding energy[27-28]. It is expressed by the relation:

qe=B1ln kT+B1lnCe ...(3)

where constant B=RT/bis related to theheat of adsorption, *R* the universal gas constant($Jmol^{-1} K^{-1}$), *T* the temperature(K), *b* the variation ofadsorption energy ($J mol^{-1}$) and KTis the equilibriumbindingconstant ($Lmg^{-1}$) corresponding to themaximumbinding energy.

## RESULTS AND DISCUSSION

Adsorption isotherms The adsorption data were analyzed accordingto the linear form of the isothermsThe linear plots are shown Fig. 1, 2 and 3.The fitting results, i.e. Isotherm parameters and the coefficient of determination, $R^2$, presented in Table 1. The value of correlation coefficient (293°K) for Freundlich equation (R2 = 0.9994) is higher thanLangmuir (R2= 0.9342) and Temkin (R2 = 0.989)suggesting that equilibrium data are well describedby Freundlich isotherm

## CONCLUSION

In this study we compare the adsorption isotherms of $B_{12}$ by carbon nanotube Single and multi wall. Base on obtained results we conclude that MWCNTs has more efficiency in removal of $B_{12}$ rather than SWCNTs.Therefore, in total, it is concludedthat correlation coefficient, (n and Kf) in

**Table 1: Parameters of Langmuir, Freundlich and Temkin isotherms of theVitamin B12 on MWCNTs and SWCNTs**

| | Langmuir | | | Freundlich | | | Temkin | | |
|---|---|---|---|---|---|---|---|---|---|
| | b | q | $R^2$ | n | $k(l.g^{-1})$ | $R^2$ | $A(l.gm^{-1})$ | B | $R^2$ |
| MWCNTs | 0.01 | 40.98 | 0.9342 | 0.91 | 2.20 | 0.99 | 2.71 | 4.09 | 0.98 |
| SWCNTs | 0.16 | 11.9 | 0.7407 | 1.89 | 2.30 | 0.84 | 1.282 | 2.93 | 0.79 |

**Table 2: Absorbance of $B_{12}$ in the absent of SWCNT and MWCNT**

| Concentrations ($Mg.l^{-1}$ ) | Absorbance of B12(nm) |
|---|---|
| 8 | 0.24325 |
| 10 | 0.26432 |
| 12 | 0.28503 |
| 14 | 0.31713 |

**Table 3: Absorbance of $B_{12}$ in the present ofSWCNT and MWCNT**

| Concentrations On SWCNTs | Absorbance B12 | Absorbance B12 on MWCNTs |
|---|---|---|
| 8 | 0.17865 | 0.20502 |
| 10 | 0.198283 | 0.22453 |
| 12 | 0.22269 | 0.24301 |
| 14 | 0.23197 | 0.262 |

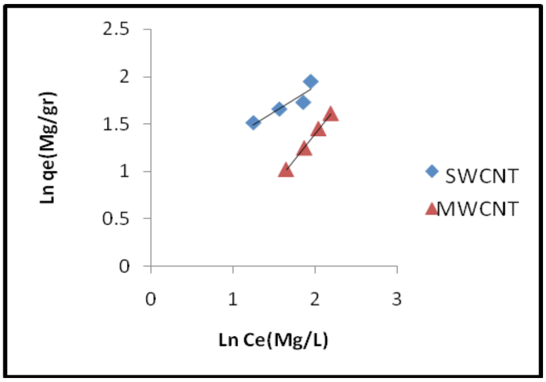


**Fig. 1: Freundlich isotherm of $B_{12}$ on MWCNT and SWCNT**

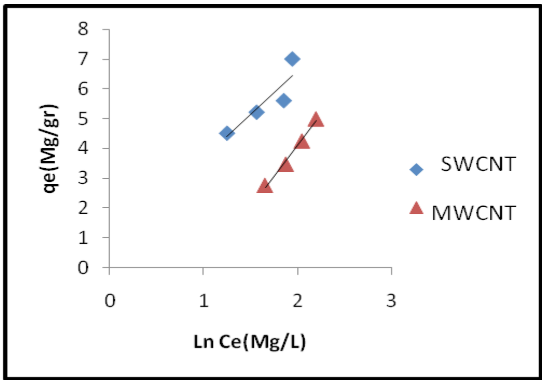


**Fig. 2: Temkin isotherm of $B_{12}$ on MWCNT and SWCNT**

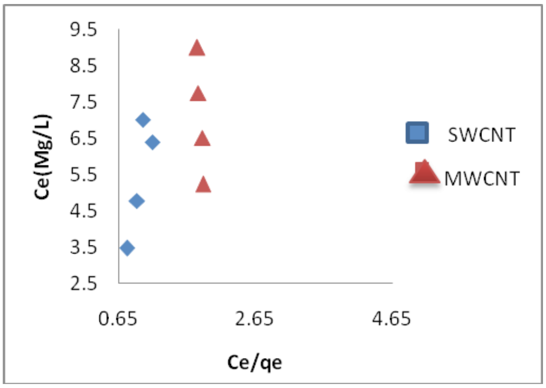


**Fig. 3: Langmuir isotherm of B12 on MWCNT and SWCNT**

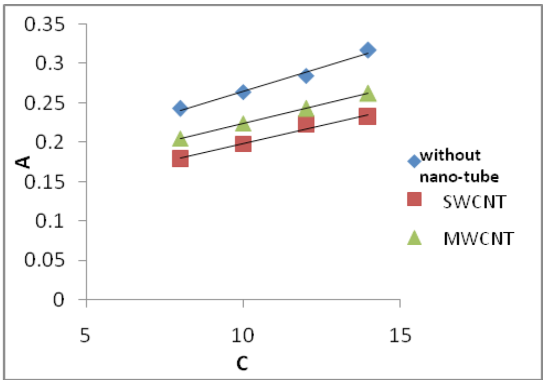


**Fig. 4: Adsorption rate without nano-tube B12&present ofSWCNTand MWCNT**

Freundlich isotherm model for MWCNT were higher and it's efficiency in the removal of $B_{12}$ is better than SWCNT.The results indicate that the Freundlich adsorption isotherm fits the data better than the other two models which suggests heterogeneity in the sorption sites.

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