

Application of the Freundlich , Langmuir, Temkin and Harkins-Jura Adsorption Isotherms for Some Amino Acids and Amino Acids Complexation with Manganese Ion(II) on Carbon Nanotube

Mehdi Vadi^{1*}, Marjan Abbasi², Marjan Zakeri², Bita Jafari Yazdi²

1) Department of Chemistry, Fasa Branch, Islamic Azad University, Fasa, Iran

2) Department of Chemistry, Firozabad Branch, Islamic Azad University, Firozabad, Iran

*Corresponding author: mahdi_vadi@iaufasa.ac.ir

Abstract—In this paper, we can see adsorption of some amino acids and their complexation with manganese (II) ion on carbon nanotube (MWCNT) with uses of four relations Langmuir, Freundlich, Temkin and Harkins –Jura isotherms. From this relation, Freundlich and Temkin relations can be predicted good equilibrium diagram in isotherm condition. We could compute the theory constants with uses of excel software. By considering these constants, it became known that among amino acids used and also amino acids with manganese that produce complexation, L-phenylalanine and L-systeine in comparison with others show the most adsorption on carbon nanotube.

Keywords—Adsorption; Isotherm; Amino acids; Complexation; Carbon nanotube

I. INTRODUCTION

Basic nitrogen-containing compounds , amino acids , is formed in plant , microbial , and animal cells under the action of microorganisms . These are biologically important compounds, and the formation of many of them precedes the synthesis of alkaloids and hormones, neuromediators, phospholipids, vitamin components, and initiators of numerous enzymatic reactions [1-5]. Here we would like to show that amino acids can be adsorbed on carbon nanotubes. The problem of evaluating the surface heterogeneity of adsorbents from the experimental overall isotherm has a long history in physical chemistry. It suffices to recall Langmuir's work of 1918 [6] , the two fundamental articles by Sips[7] of 1948 and 1950 , and the recurrence method proposed by Adamson and Ling[8] in 1961 . Of all the“classic isotherms” only some can be explained or have been proposed on statistical mechanical grounds, others on the contrary, cannot be justified by simple models. This is the case of the important isotherms empirically proposed by Freundlich, Dubinin and Radushkevich, Temkin [9-10].

II. RESULT AND DISCUSSION

A. Study of equilibrium

We can compute experimental results from equilibrium experiences by several adsorption isotherm models that were like linear by means of excel software.

1) Freundlich's model

We often use this model for heterogeneous adsorption that has acceptable harmony with experimental data which expresses with n-order.

To commutate Freundlich equation constants, we can design $\ln Q_e$ diagram based on $\ln C_e$ the slope of this diagram is n and the intercept is $\ln K_f$.

Distribution coefficient K_f displays ion adsorption addiction. By increasing K_f amount, adsorption amount will be increased and vice versa. This relation is expressed by equation 1.

$$Q_e = X/m = K_f C_e^n$$

Eq.1 $\ln Q_e = \ln K_f + n \ln C_e$

By paying attention to the correlation coefficient from data, we could observe acceptable accommodation between data and models from figures 1 and 2.

2) Langmuir model:

This model was obtained from assumption of similar energy of adsorption sites, absorbent surface. It expresses with following equation that is linear form. in a this equation by paying attention to the equal of amount of adsorption and repelling on surface , we can consider these velocities equal to each other and from this equivalent we can obtain equation 2.

$$N = Q_e/Q_m = K_L C_e / (1 + K_L C_e)$$

$$Q_m K_L C_e = Q_e + K_L C_e Q_e$$

Eq.2 $C_e/Q_e = 1/Q_m K_L + C_e/Q_m$

K_L and Q_m parameters were computed with design of diagram C_e based on C_e/Q_m , slope of this diagram is $1/Q_m$ and intercept is $1/K_L Q_m$ which Q_m is maximum adsorption based on(mg/kg) and K_L constant depends on dsorption energy and based on (L/mg). By paying attention to the correlation coefficient that was mentioned in figures (1,2), this model hasn't a good corresponding but commutating the parameters has a good application for expressing several adsorption.

3) Temkin's model:

The linear form of this model at Eq.3

$$Q_e = B \ln K_T + B \ln C_e$$

Eq.3

This model was obtained with consideration of adsorption interaction and adsorption substances which was attained by designing diagram LnCe based on Qe. By considering the correlation coefficient at Figures (1, 2). We observe that there is an accessible competition between this model and Freundlich model.

4) Harkins-Jura

We are going to discuss this model with equation 4:

$$1/Qe^2 = [B/A] - [1/A] \log Ce$$

By considering Figures (1, 2) we observed that correlation coefficient in this model hadn't a good corresponding with experimental data. We ignored to study the Henderson and Bet models because of multilayer adsorption and sigmodial Langmuir model which is in diagram 1/Q based on 1/C². This is because of nonlinear figures [11].

III. CONCLUSION

Study that was accomplished on liquid-solid system adsorption affected separating amino acids and dissolved dependant complexity from dilution on carbon nanotube surface. This process was continued as long as the dissolved residue in dilution on solid surface is arranged in dynamic equilibrium. At equilibrium state there is a limitation on dissolved distribution between liquid and solid phases. By means of isotherms we described adsorption capacity of them for analysis and designing adsorption system. By paying attention to the correlation coefficient R², Freundlich and Temkin isotherm displayed a good accommodation with

experimental data that was used respectively for computation thermodynamic and kinetic parameters. However on the whole we could consider Freundlich model as the best model for amino acids and their complex at ion with manganese (II) ion. Although in this study by paying attention to the adsorption capacity of L-cystein and L-phenylalanine that were greater on carbon nanotube adsorption, their complexation adsorption was done with greater power that was dependant on the maximum bonded energy between complexity with their adsorption.

REFERENCES

- [1] K. Bradley, M. Briman, A. Star and G. Gruner; Charge transfer from adsorbed proteins Nano Lett. 4(2004) 253-6
- [2] A. Star, J. C. P. Gabriel, K. Bradley and G. Gruner Electronic detection of specific protein binding using nanotube FET devices Nano Lett. 34(2003)59-63.
- [3] A. Bianco, K. Kostarelos and M. Prato; Applications of carbon nanotubes in drug delivery curr. Opin. Chem. Biol. 9(2005)674-9.
- [4] K. K. Jain.. Drug Discovery Today: Technologies 1(2), (2004) 75-78.
- [5] A. Bianco, J. Hoebeke, S. Godefroy, O. Chaloin, D. Pantarotto J. Briand, S. Muller, M. Prato, C. D. Partidos, a. Journal of the American chemical Society 127(1), (2005) 58-59.
- [6] I. Langmuir, J. Amer. Chem. Soc. 40(1918) 1361.
- [7] R. Sips, J. Chem. Phys. 18(1950) 1024.
- [8] A. W. Adamson, and I. Ling, Advan. Chem. Ser. 33(1961) 51.
- [9] M. I. Temkin, J. Phys. Chem. (Moscow) 14(1940) 1153.
- [10] H. Freundlich, Trans. Faraday Soc. 28(1932)195.
- [11] S. Brunauer, P. H. Emmet, E. Teller, "Adsorption of gases in multimolecular layers, J. Am. Chem. Soc., Vol. 60, No. 2, pp. (1938)309-319.

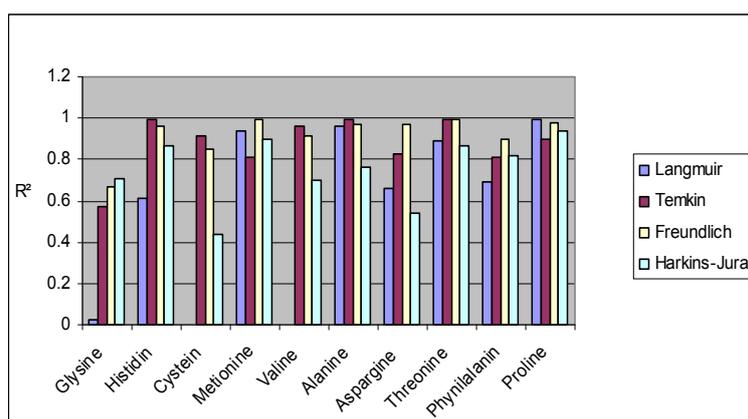


Figure 1. The correlation coefficients of amino acids

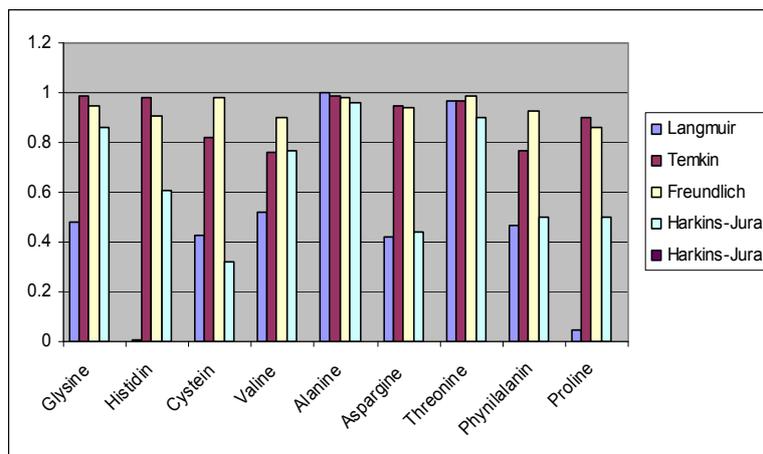


Figure 2. The correlation coefficients of complexation of amino acids with Mn (II)