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Adorption Isotherms Penicillin by Activated Carbon and Graphene with model Langmuir, Freundlich and Temkin.

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ABSTRACT

The purpose is of this investigation the adsorption isotherm Penicillin as a antibiotic drug by Activated Carbon and graphene with the model Langmuir, Freundlich and Temkin . Assistance spectrophotometer (UV / VIS) model JENWEY wavelength maximum ,were obtained for various concentrations of dissolved made and adsorbed by the diagram obtained and was plotted. Results of experiments with matched three model and various parameters of the models, respectively. The results showed that Impact of the concentration of the fraction of the surface covered by Freundlich model for carbon graphene by penicillin with amount of 99% and Langmuir model for activated carbon by penicillin with amount of 95.2% and Freundlich model for activated carbon by penicillin with amount of 98.3% and Freundlich model for graphene by penicillin with amount of is 99.3%

Keywords: Isotherms, Adsorbed, Graphene, Activated Carbon, Penicillin

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INTRODUCTION

Activated carbon, also called activated charcoal, activated coal, or carbo activatus, is a form of carbon processed to have small, low-volume pores that increase the surface area available for adsorption or chemical reactions [1]. *Activated* is sometimes substituted with *active*. Due to its high degree of microporosity, just one gram of activated carbon has a surface area in excess of 500 m^2, as determined by gas adsorption. An activation level sufficient for useful application may be attained solely from high surface area; however, further chemical treatment often enhances adsorption properties. Activated carbon is usually derived from charcoal and, increasingly, high-porosity biochar. Activated carbon is used in gas purification, decaffeination, gold purification, metal extraction, water purification, medicine, sewage treatment,air filters in gas masks and respirators, filters in compressed air and many other applications.

One major industrial application involves use of activated carbon in the metal finishing field. It is very widely employed for purification of electroplating solutions. For example, it is a main purification technique for removing organic impurities from bright nickel plating solutions. A variety of organic chemicals are added to plating solutions for improving their deposit qualities and for enhancing properties like brightness, smoothness, ductility, etc. Due to passage of direct current and electrolytic reactions of anodic oxidation and cathodic reduction, organic additives generate unwanted breakdown products in solution. Their excessive build up can adversely affect the plating quality and physical properties of deposited metal. Activated carbon treatment removes such impurities and restores plating performance to the desired level. Activated carbon is used to treat poisonings and overdoses following oral ingestion. It is not effective for a number of poisonings including: strong acids or alkali, cyanide, iron, lithium, arsenic, methanol,ethanol or ethylene glycol [2].

Tablets or capsules of activated carbon are used in many countries as an over-the-counter drug to treat diarrhea, indigestion, and flatulence. Incorrect application (e.g. into the lungs) results in pulmonary aspiration which can sometimes be fatal if immediate medical treatment is not initiated [3]. The use of activated carbon is contraindicated when the ingested substance is an acid, an alkali, or a petroleum product. Graphene [4,5] is an allotrope of carbon in the form of a two-dimensional, atomic-scale, hexagonal lattice in which one atom forms each vertex. It is the basic structural element of other allotropes, including graphite, charcoal, activated carbon and fullerenes. It can also be considered as an indefinitely large aromatic molecule, the limiting case of the family of flat polycyclic aromatic hydrocarbons (Figure1).

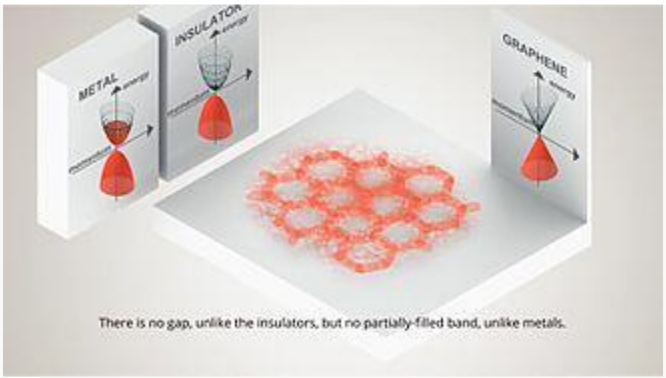

Figure 1: Graphene and its band structure and Dirac Cones, effect of a grid on doping.

Graphene has many extraordinary properties. It is about 100 times stronger than steel by weight,[6]conducts heat and electricity with great efficiency and is nearly transparent [7]. Researchers have identified the bipolar transistor effect, ballistic transport of charges and large quantum oscillations in the material. Scientists have theorized about graphene for decades. It is quite likely that graphene was unwittingly produced in small quantities for centuries through the use of pencils and other similar applications of graphite, but it was first measurably produced and isolated in the lab in 2003 [8]. Research was informed by existing theoretical descriptions of its composition, structure and properties [9]. High-quality graphene proved to be surprisingly easy to isolate, making more research possible. Andre Geim and Konstantin Novoselov at the University of Manchester won the Nobel Prize in Physics in 2010 "for groundbreaking experiments regarding the two-dimensional material graphene"[10].

The global market for graphene is reported to have reached $9 million by 2014 with most sales in the semiconductor, electronics, battery energy and composites industries [11]. Penicillin (sometimes abbreviated PCN or pen) is a group of antibiotics derived from *Penicillium* fungi [12], including penicillin G (intravenous use), penicillin V (oral use), procaine penicillin, and benzathine penicillin (intramuscular use).Penicillin antibiotics were among the first drugs to be effective against many previously serious diseases, such as bacterial infections caused by staphylococci and streptococci. Penicillins are still widely used today, though misuse has now made many types of bacteria resistant. All penicillins are β-lactam antibiotics and are used in the treatment of bacterial infections caused by susceptible, usually Gram-positive, organisms. Several enhanced penicillin families also exist, effective against additional bacteria: these include the antistaphylococcal penicillins, aminopenicillins and the more-powerful antipseudomonal penicillins. Figure 2.

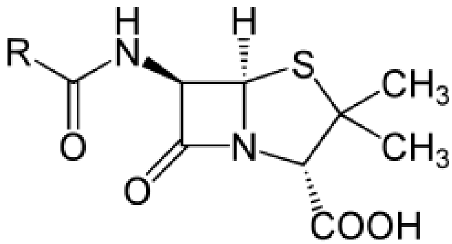

Figure 2: Penicillin core structure, where "R" is the variable group.

Medical application

Florey, Fleming and Chain shared a Nobel Prize in 1945 for their work on penicillin. In 1930, Cecil George Paine, a pathologist at the Royal Infirmary in Sheffield, attempted to use penicillin to treat sycosis barbae, eruptions in beard follicles, but was unsuccessful. Moving on to ophthalmia neonatorum, a gonococcal infection in infants, he achieved the first recorded cure with penicillin, on November 25, 1930. He then cured four additional patients (one adult and three infants) of eye infections, and failed to cure a fifth [13-15]. In 1939, Australian scientist Howard Florey (later Baron Florey) and a team of researchers (Ernst Boris Chain, Arthur Duncan Gardner, Norman Heatley, M. Jennings, J. Orr-Ewing and G. Sanders) at the Sir William Dunn School of Pathology, University of Oxford made progress in showing the in vivobactericidal action of penicillin. In 1940 they showed that penicillin effectively cured bacterial infection in mice [16, 17]. In 1941 they treated a policeman, Albert Alexander, with a severe face infection; his condition improved, but then supplies of penicillin ran out and he died. Subsequently, several other patients were treated successfully [18]. In this research, Penicillin as antibiotic drug on multi walled activated carbon and graphene were studied and tried to find out how this drugs can be adsorbed by activated carbon and graphene. We also want to find out if we can affect the penicillin molecule by putting these drugs on adsorbents without damaging the safe molecules.

MATERIALS AND METHODS

Penicillin with purity of 95% was purchased from Merck Co., Germany. Activated carbon and graphene are high purity of 99%, and were purchased from Aldrich. Adsorption experiments a stock solution of about 100 mg/L Penicillin was prepared. The range of Penicillin concentration used is from 1o to 80 mg/L. Equilibrium adsorption experiments were performed using 40 ml screw-capped glass centrifuge tubes as batch reactor systems. Each tube containing 0.05 g Activated carbon was filled with 25 ml Penicillin 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, except for the adsorption experiments, in which temperatures of 300 and 305 K were adjusted. After equilibration, all tubes were placed vertically for 4 h at the same temperature to ensure complete sedimentation of Activated carbon from the bulk solutions by using spectrophotometer tool adsorption rate. This experimental method used for Penicillin with Graphene.

Modeling of the adsorption isotherms

Equilibrium study on adsorption provides information on the capacity of the adsorbent. An adsorption isotherm is characterized by certain constant values, which express the surface properties and affinity of the adsorbent and can also be used to compare the adsorptive capacities of the adsorbent for different pollutants. Equilibrium data can be analyzed using commonly known adsorption systems. Several mathematical models can be used to describe experimental data of adsorption isotherms. The Freundlich, Langmuir and Temkin models are employed to analyze the adsorption that occurred in the experiment.

Langmuir model

The Langmuir model assumes uniform energies of adsorption onto the surface and no transmigration of adsorbate in the plane of the surface. The Langmuir equation may be written as:

$$C_e/q_e = 1/q_m b + 1/q_m * Ce \qquad (1)$$

Where q_e is the amount of solute adsorbed per unit weight of adsorbent (mg/g), C_e the equilibrium concentration (mg/L), q_m is the monolayer adsorption capacity (mg/g) and b is the constant related to the free energy of adsorption. The Langmuir model considers several assumptions: the adsorption is localized, all the active sites on the surface have similar energies, none interaction between adsorbed molecules exist, and the limiting reaction step is the surface reaction as in the heterogeneous catalytic reaction.

Freundlich model

The Freundlich model is an empirical equation based on sorption on heterogeneous surface through a multilayer adsorption mechanism. It is given as:

$$q_e = k_f C_e^{1/n} \qquad (2)$$

where q_e is the amount of solute adsorbed per unit weight of adsorbent (mg/g), C_e is the equilibrium concentration (mol/L), k_f is the constant indicative of the relative adsorption capacity of the adsorbent (mg/g(mg/L) and 1/n is the constant, indicative of the intensity of the adsorption. The linearized form of the Freundlich equation is:

$$Lnq_e = Lnk_f + 1/nLnC_e \qquad (3)$$

The value of k_f and n can be calculated by plotting $\ln q_e$ versus $\ln C_e$.

Temkin model

Temkin suggested that, because of the existence of adsorbent-adsorbate interactions, the heat of adsorption should decrease linearly with the surface coverage. The Temkin isotherm equation assumes that the adsorption is characterized by a uniform distribution of the binding energies, up to some maximum binding energy. The corresponding adsorption isotherm can thus be adjusted by the following equation:

$$q = B\ln A + B\ln C \qquad (4)$$

Where B is related to the heat of adsorption (L/g) and A is the dimensionless Temkin isotherm constant. The Temkin parameters (B and A) can be determined from the linear plots of qe and lnCe

RESULTS AND DISCUSSION

Adsorption of the Langmuir, Freundlich and Temkin isotherms of the adsorption process of Penicillin on activated carbon and graphene are as shown in figures 1- 4. It was observed that the experimental data were well represented by Langmuir, Freundlich and Temkin models. The values of the constants of the isotherms of Langmuir, q and b, and of Freundlich, k and n, and of Temkin, B, A and b, are as shown in Table 1. The results of figures 3-8 show that in order to adsorb penicillin on activated carbon in the temperature range of 295 to 305 K, the Freundlich model is followed because they have more R^2.

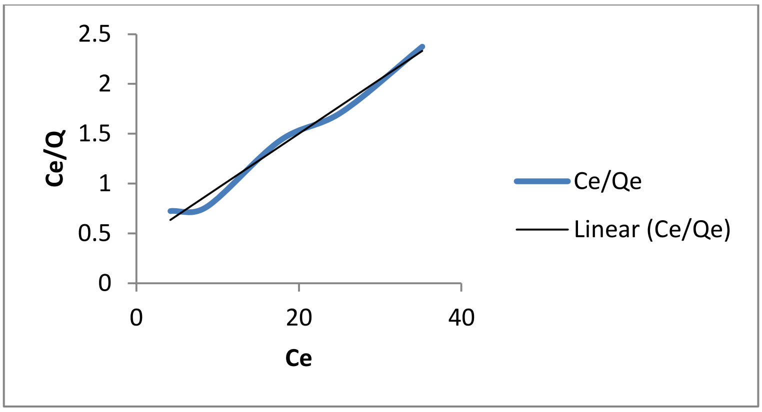

Figure 3: Langmuir adsorption isotherm of penicillin on activated carbon

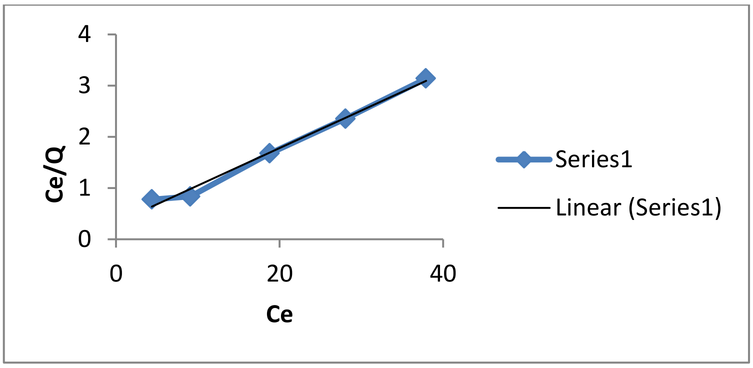

Figure 4: Langmuir adsorption isotherm of penicillin on graphene

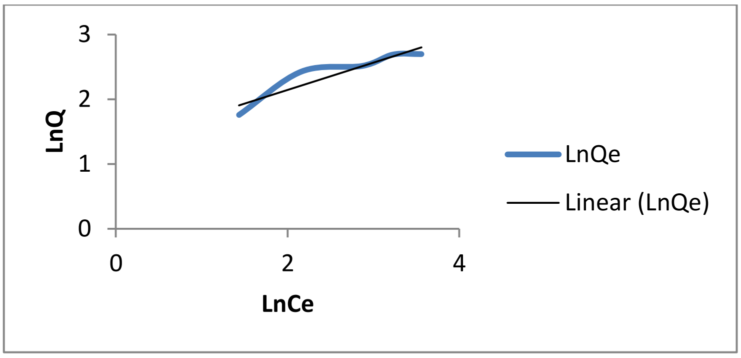

Figure 5: Freundlich adsorption isotherm of penicillin on activated carbon

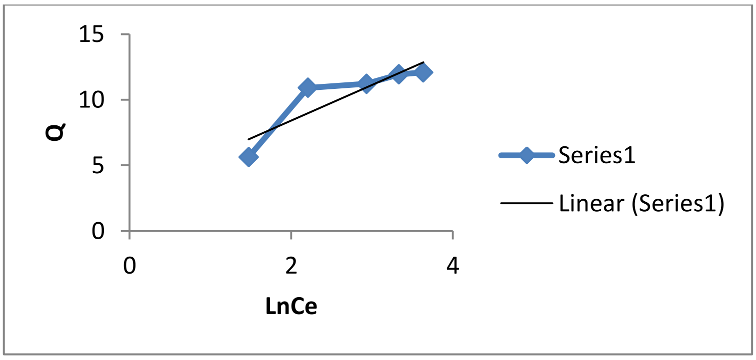

Figure 6: Freundlich adsorption isotherm of penicillin on graphene

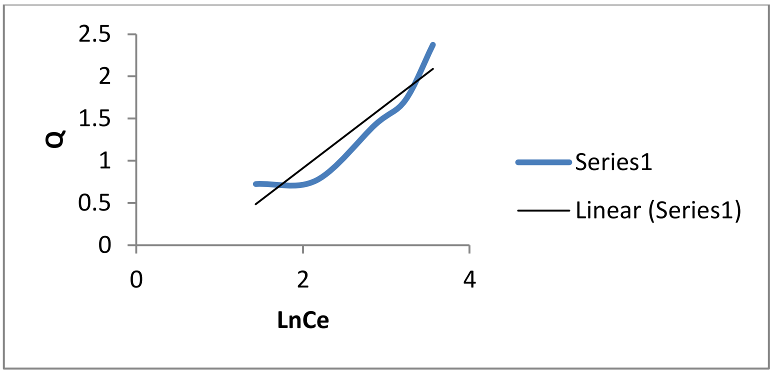

Figure 7: Temkin adsorption isotherm of penicillin on activated carbon

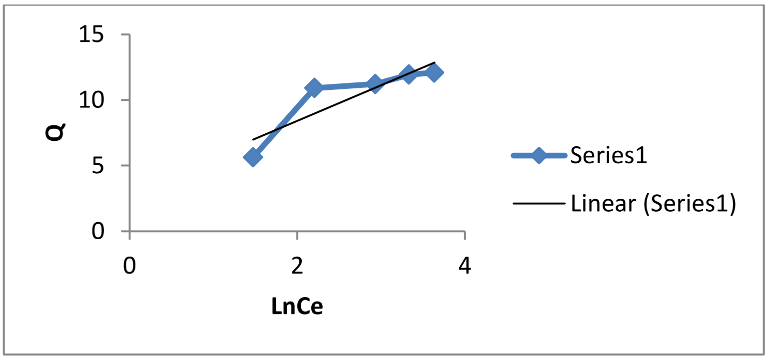

Figure 8: Temkin adsorption isotherm of penicillin on graphene

CONCLUSION

In this study we compare the adsorption isotherms of Penicillin by activated carbon and grapheme, table 1. Base on obtained results we conclude that nanotube has more efficiency in removal of penicillin rather than activated carbon. Results of isothermic experiments showed that the correlation coefficient of Freundlich model isothermic's equation for graphene was more than activated carbon. Also, the values of n and K_f for activated carbon were higher than graphene and indicating that the energy of adsorption is higher than activated carbon. Therefore, in total, it is concluded that correlation coefficient (n and K_f) in Freundlich isotherm's models for activated carbon were higher and it's efficiency in the removal of penicillin is better than grapheme.

Table 1: Parameters and correlation coefficients of isotherm models.

Adsorption	Langmuir model			Freundlich model			Temkin model		
	Q(mg/g)	R^2	b(L/mg)	K(mg/g)	n	R^2	B	R^2	A(L/mg)
Penicillin by graphene	62.5	0.982	0.065	9.183	2.33	0.991	13.82	0.977	0.63
Penicillin by Activated Carbon	76.92	0.952	0.103	17.17	2.9	0.901	14.92	0.894	1.43

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