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Adsorption isotherm study on Removal of Triton X 100 from Waste Water Using Agro waste of Nelumbonucifera

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Abstract
Removal of higher concentration of Triton X 100 from waste water, using carbonized Nelumbonucifera(NS) as an adsorbent bed has been discussed in the present investigation. Carbonized Nelumbonucifera stem has been prepared in the lab by using muffle furnace at high temperature. Efficiency of removal of Triton X 100 is measured by pH meter using batch technique. Various concentration of Triton X 100 solutions from 200ppm, 400ppm, 600ppm, 800ppm and 1000ppm have been prepared and their pH values assessed after adsorption on carbonized NS. Adsorption Isotherms Langmuir adsorption Isotherms, Freundlich adsorption Isotherms and Temkin adsorption Isotherms are discussed and compared. R^2 values of Freundlich adsorption Isotherms is best fit in an adsorbent bed.

Index Terms— Adsorption Isotherms, Triton X 100, Surfactant, Carbonization, Adsorption, Freundlich Adsorption Isotherms, Temkin Adsorption Isotherms.

INTRODUCTION

Surfactants are widely used in pharmaceutical industries and having potential applications in agriculture, cosmetics, pharmaceuticals, detergents, personal care products, food processing, textile manufacturing, laundry supplies, metal treatment and processing, pulp and paper processing and paint industries[1,2]. They reduces the water quality and cause short term as well as long term change in eco system[3,7]. The common method to remove surfactant from water environment involve process such as chemical and electrochemical oxidation [8,9] adsorption by double hydroxide [10] minral oxide alumina [11] coagulation process [12] physico-chemical removal process [13,14] $FeCl_3$ use as catalyzed in the presence of polythiophene [15] biodegration by ozonation [16]. Generally detection of surfactant used high-performance sophisticated analytica Generally the removal of detergents from wastewater is favored by chemical methods. But these methods simply transform the problem from one phase to another. I try removal of surfactant from waste water by eco-friendly method.

Method & Materials

Preparation of adsorbent from agro-waste

Nelumbonucifera stem was obtained from the local wet area. It was washed with de-ionized water to remove dirt and metallic impurities after which it was dried in sunlight 4 to 5 days. The dried Nelumbonucifera stem

(NS) was grinded and sieved in the mesh in the range between 250μm and 150μm in order to increase its surface area.

5g of blended dried Nelumbonucifera stem was weighted into pre weight crucibles.They were introduced into a muffle furnace at 600°C for 4 minutes. After that carbonized were poured into 250 ml ice cold water, than filtered and washed twice with distilled water and further dried in the oven at 100−110°C and stored in air tight container.

Reagent preparation

All chemicals used are of analytical grade. Double distilled water had been used for the preparation of dilution of Triton X 100 solution 200ppm, 400ppm, 600ppm, 800ppm and 1000ppm .

Determine the pH values

The pH values of each solution were determined using a digital pH meter before and after adsorption. The determination of pH of Triton X 100 from each solution on NS was carried out using a batch technique by adding 1.0 gram NS to 50 ml of each solution in 250 ml conical flask, with shaking for 35 minutes using an electric shaker for the same time and speed, then each solution was filtered through filter paper.

Adsorption of Triton **X 100**

Adsorption of no. of moles of surfactant (Triton X 100) by per one gram NS is calculate by the formula shown in Eq. (1)

$$x = Ce\ .V\ .\ Eq\ /\ 1000 \qquad (1)$$

Where, x = No. of moles of Triton X 100, V = Volume of test solution in ml, Eq= Equivalent weight of Triton X 100 in the gm.

Langmuir Adsorption Isotherm: The Langmuir isotherm is valid for monolayer adsorption onto a surface containing a finite number of identified sites. The model assumes uniform energies of adsorption onto the surface and no transmigration of the adsorbate in the plane of the surface. Langmuir represented the following equation: (2)

$$\frac{1}{q_e} = \frac{1}{Q_O} + \frac{1}{Q_O K_L K C_e} \qquad (2)$$

Ce = concentration of adsorbate (mg/L-1) qe = the amount of metal adsorbed per gram of the adsorbent at equilibrium (mg/g). Qo = maximum monolayer coverage capacity (mg/g) K_L = Langmuir isotherm constant (L/mg)[17].

Freundlich Adsorption Isotherm: This is commonly used to describe the adsorption characteristics for the heterogeneous surface . These data often fit the empirical equation proposed by Freundlich:

$$Qe = k_{f C_e^{1/n}} \qquad (3)$$

The constant K*f* is an approximate indicator of adsorption capacity, while 1/n is a function of the strength of adsorption in the adsorption process . If n = 1 then the partition between the two phases are independent of the concentration. If value of 1/n is below one it indicates a normal adsorption. On the other hand, 1/n being above one indicates cooperative adsorption[18].

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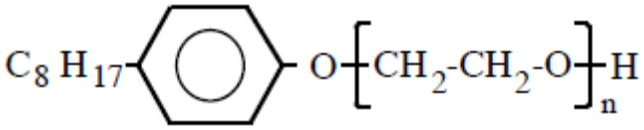
Temkin Isotherm This isotherm contains a factor that explicitly taking into the account of adsorbent–adsorbate interactions. As implied in the equation, its derivation is characterized by a uniform distribution of binding energies (up to some maximum binding energy) was carried out by plotting the quantity sorbed qe against lnCe and the constants were determined from the slope and intercept[19-20]. The model is given by the following equation [4]:

$$q_e = \frac{RT}{b} \ln(A_T C_e) \quad (4)$$

$$qe = B \ln A_T + B \ln c_e \quad (5)$$

Result and discussion

The salt Octylphenol Ethoxylate (Triton X 100)



Polyethoxylated Octyl Phenol

is an phenolic compound consisting of a 10 carbon chain attached to a polyethoxylated octa group. Which gives nonionic nature. These properties are essential for detergent. The mechanism and adsorption isotherm of adsorption of Triton X 100 on TS can be studied by measuring change in the pH values of the Triton X 100 solutions before and after adsorption for different initial concentrations Ci. Line A and line B in Fig. 1. The values indicate that an increase in the initial concentration Ci an increase of pH value. This trend obtained in both lines, which is having a good result obtained.

As per absorption mechanism one mole H will release after absorption of one mole of Triton X 100. So equilibrium concentration can be calculated according to the number of moles of Triton X 100 absorbed[16].

Langmuir Adsorption Isotherm: The values q_{max} and K_L of were computed from the slope and intercept of the Langmuir plot of 1/qe versus 1/Ce. The essential features of the Langmuir isotherm may be expressed in terms of equilibrium parameter R_L, which is a dimensionless constant referred to as separation factor or equilibrium parameter .

$$R_L = \frac{1}{1+(1+K_L\, Ci)} \quad (6)$$

Where: Ci = initial concentration R_L value indicates the adsorption nature to be either unfavorable if $R_L>1$, linear if $R_L=1$, favorable if $0< R_L<1$ and irreversible if $R_L=0$. the RL is greater than 0 but less than 1 indicating that Langmuir isotherm is favorable. From this research work, the maximum monolayer coverage, capacity (Qo) from the Langmuir Isotherm model was determined to be 0.00057 mg/g, K_L (Langmuir isotherm constant) is 2.2 L/mg, R_L is 0.133 indicating that the equilibrium sorption was favorable and the *R2* value is 0.975 proving that the sorption data fitted well to Langmuir Isotherm model.

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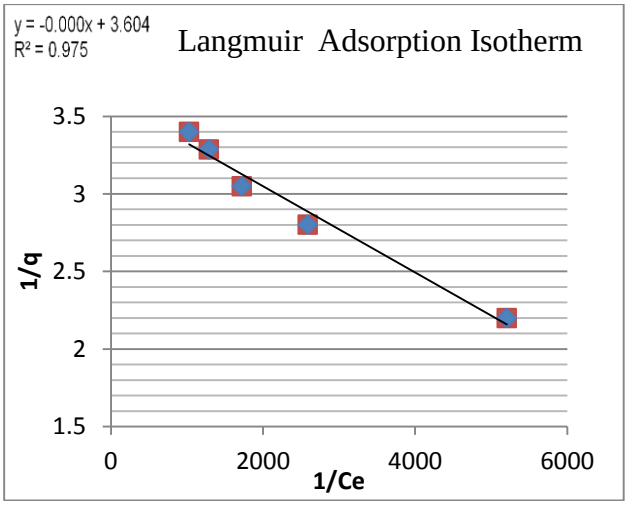
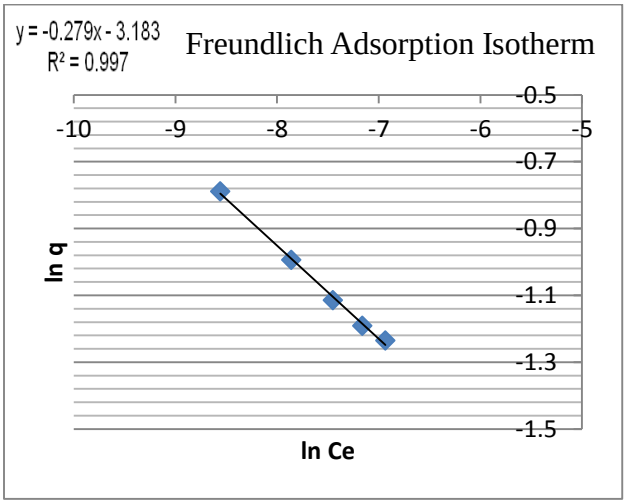
Freundlich Adsorption Isotherm: This is commonly used to describe the adsorption characteristics for the heterogeneous surface . These data often fit the empirical equation proposed by Freundlich:

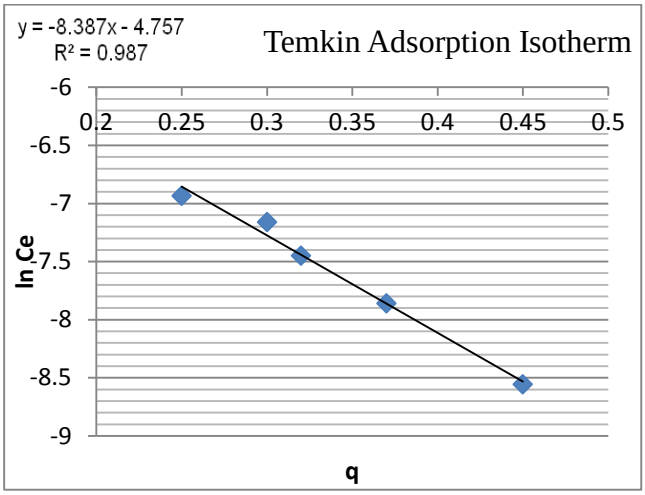
$$Qe = k_{fC_e^{1/n}} \quad (7)$$

The constant K*f* is an approximate indicator of adsorption capacity, while 1/n is a function of the strength of adsorption in the adsorption process . If n = 1 then the partition between the two phases are independent of the concentration. If value of 1/n is below one it indicates a normal adsorption. On the other hand, 1/n being above one indicates cooperative adsorption[18]. The function has an asymptotic maximum as pressure increases without bound. As the temperature increases, the constants *k* and *n* change to reflect the empirical observation that the quantity adsorbed rises more slowly and higher pressures are required to saturate the surface. Specifically, the linear least-squares method and the linear R transformed equations have been widely used. From the data in table 3, that value of 1/n = 0.219 while n=2.2 indicating that the sorption of Triton X 100 into TS is favourable and the *R2* value is 0.997.

Temkin Isotherm AT =Temkin isotherm equilibrium binding constant (L/g) bT = Temkin isotherm constant R= universal gas constant (8.314J/mol/K) T= Temperature at 298K. B = Constant related to heat of sorption(J/mol) From the Temkin plot shown in fig 3,the following values were estimated: AT = 9.5 L/g, B = 0.116 kj/mol which is an indication of the heat of sorption indicating a physical adsorption process and the *R2*=0.991.







Adsorption isotherm constant

Langmuir Isotherm				Freundlich Isotherm			Temkin Isotherm		
Q	K_L	R_L	R^2	1/n	n	R^2	A	B	R^2
0.00057	2.2 Lmg -1	0.0022	0.975	0.219	2.2	0.997	9.5	0.116 K_J/mol	0.991

CONCLUSION

In this paper, investigation of the equilibrium sorption was carried out at 30^0C and pH between 6.53 and 7.13. Other physico-chemical parameters were determined and three adsorption isotherm models were studied. The sorption data fitted into Langmuir, Freundlich and Temkin isotherms out of which Temkin Adsorption model was found to be have the highest regression value and hence the best fit. It proof that a uniform distribution binding energies between adsorbent and absorbed. It could be concluded that carbonized Nelumbonucifera Stem is a potential and active bio-sorbent for removal of Triton X 100 from its aqueous solution and industrial waste water remediation.

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