

Study the adsorption of lignin on surface of poly vinyl chloride

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Abstract

In this work, polyvinyl chloride(PVC) was utilized as a strong adsorbent for the expulsion of lignin from fluid arrangement utilizing a shower techniques. The got an outcome infer that the lignin adsorbs onto PVC are driven by entropy impact, exothermic and nonspontaneous forms, additionally, the outcomes have as demonstrated that Freundlich isotherm fitted a harmony information well. as per Dubinin – Radushkevich isotherms the adsorption limit of PVC (q_{max}) is 2.8303 mg/g, the mean free vitality (EDR) esteem an ascertained by examinations of a balance information with Dubinin – Radushkevicha condition show that the adsorption components are hydrogen holding .the lignin was expelled by (39.2%) at PH measure up to 2 and at 30 C° .

Key word: lignin, poly vinyl chloride, adsorption

Introduction

Lignin as a standout amongst the most bounteous natural polymers on the earth is the by – result of paper and rising cellulose ethanol enterprises .it is a nebulous (i.e. it has no long-run request of molecules), profoundly cross – connected and a sweet-smelling polymer of phenyl propane joins together ,with a complex basic heterogeneity that makes up its specific protection from microbial debasement .besides it might contain hydroxyl, ether and carbonyl gatherings. Many investigations have demonstrated that lignin can possibly act like an adsorption material because of its high adsorption limit^(1,2) . Also, lignin adsorption limit can be improved by concoction techniques, for example, the expansion of practical gatherings or cross-linking⁽³⁾ .

In this way the surface lignin has attracted expanding consideration late years. Surface lignin focus has been accounted for to be three to five time higher than the comparing mass lignin fixation for both Kraft softwood and Kraft hardwood pulp^(4,5) . These high surface lignin fixations have incited various discourse and theory about the impact if surface lignin on ensuing procedures, for example, fading and between fiber holding. Lain and Stenius⁽⁶⁾ found that surface lignin strongly affected fading stages. The adsorption of material, for example, Xylan and lignin on mash filaments

amid pulping has been accounted for in a few studies⁽⁷⁾.however, the instrument of this procedure isn't yet evident. it has been named as re-testimony retake, sorption, and precipitation, which demonstrates some shows some irregularity in understanding the essentials included. The goal of this examination to acquire a comprehension of the balance and thermodynamic adsorption of lignin on PVC. The Freundlich, Dubnin – Radishkeich and summed up isotherm conditions were utilized to analyze the harmony information. The impacts of time, temperature, fixation and PH of the arrangement are examined. The point of this work to think about the capacity of PVC as a surface to expel the lignin as mechanical waste from the contamination water.

Experimental materials and methods

The lignin utilized was (B.D.H Co.),as abundant of dirty was without facilitate purging .the adsorption isotherm share been dictated by permitting contamination arrangement of know starting focus to be blended with precisely weighted measure of PVC in a firmly shut cup at a specific temperature and PH. The measure of PVC in the slurry has been (0.7) gm/10 ml arrangement. A consistent blending at a steady temperature and PH was accomplished utilizing a shaker water shower. The pre-arrangement have been balance for one 60 minutes. Polymer subjected to examination utilizing ultra violet-noticeable system (UV-VISBLE) at (218) nm, the same exploratory was accounted for at various starting focus , temperatures and PH.

The measure of lignin adsorbed in mg/g was computed utilizing the accompanying condition 2:

$$Q_e = V(C_0 - C_e) / m_s \dots \dots \dots (1)$$

Where Q_e is the amount of adsorbed Cr(VI) on lignin mg/g. C_0 and C_e are the initial and equilibrium concentration in solution mg/L respectively, and m_s is the mass of PVC.

Equilibrium isotherms

The equilibrium data of lignin adsorption were correlated with the models of Freundlich, Dubinin - Radushkevich and Generalized isotherem equations. The linearized Freundlich equation is shown below:

$$\text{Log } q_e = \text{log } K_f + 1/n \text{ log } C_e \dots \dots \dots (2)$$

Where q_e is the measure of lignin adsorbed per unit mass of adsorbent(mg/g), C_e is the balance grouping of lignin is the arrangement (mg/L). The Freundlich recipe in an experiential condition and in like manner, the model accept that the measure of adsorbate on the adsorbent surface increments by expanding the adsorbate fixation. The most extreme

adsorption limit with regards to the Freundlich condition can be controlled by utilizing the articulation given by:

$$kf = \frac{qm}{ce^{1/n}} \dots\dots\dots(3)$$

Where $\log q_m = \log q_e$ when $C_e = C_o$.

Dubinin-Radushkevich isotherem

The linearized Dubinin-Radushkevichequation is shown below:

$$Lnq_e = lnq_m - k\varepsilon^2 \dots\dots\dots(4)$$

The parameter ε can be found from the equation :

$$\varepsilon = RT \ln[1+1/C_e] \dots\dots\dots(5)$$

Where q_e is the measure of lignin adsorbed per unit mass of adsorbent(mg/g), q_m is the most extreme adsorption capacity(mg/g).

R is the gas consistent (8.314 J.mol-1.K-1) and T is the total temperature .in this way, the Dubinin – Radushkevich isotherm can be utilized anticipate balance adsorption information at deferent temperatures. the model depicts the adsorption of subcritical vapors onto miniaturized scale pore solids following a pore filling system. The mean free vitality adsorption (E) is the free vitality of progress when one mole of particle moved from vastness in the answer for the surface of the sorbent ⁽⁸⁾.

E is computed from the estimation of K utilizing the condition : $E = \frac{1}{\sqrt{(2K)}}$
(6)

Generalized isotherm equation:

The linearizedGeneralized isotherm⁽⁹⁾ equation is shown below.

$$\log \left[\frac{qm}{qe} - 1 \right] = \log k_G - N_b \log C_e \dots\dots\dots(7)$$

Where q_e is the measure of lignin adsorbed per unit mass of adsorbent(mg/g), C_e is the balance convergence of lignin in arrangement (mg/L), q_m is the greatest adsorption capacity(mg/g). k_G is the immersion steady (mg/L), N_b the helpful restricting consistent, the plotted $\log[(qm/qe) - 1]$ of versus $\log C_e$ was utilized to decide the estimations of k_G and N_b from the slant and the block separately.

Result and discussion:

Adsorption study:

The result concerning lignin adsorption by PVC are presented in figure (1) at (303) k and PHs (4,7and 9).

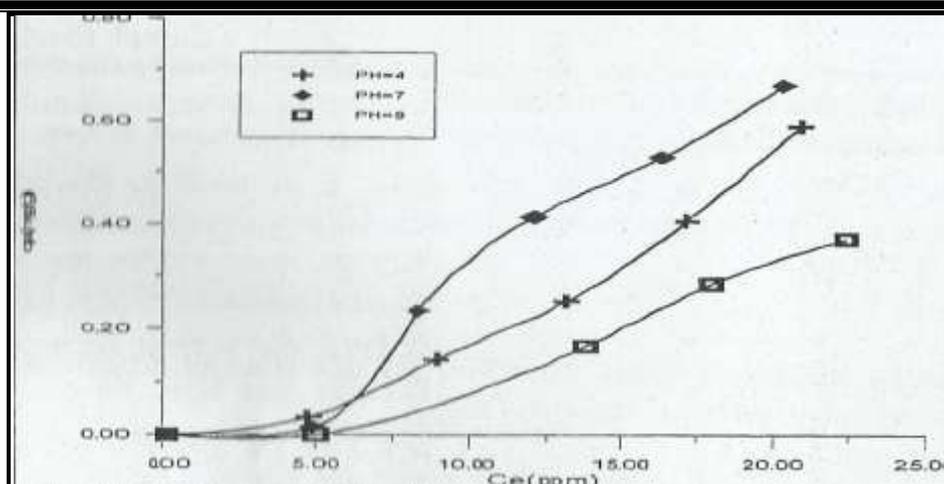


Figure (1): adsorption isotherm of lignin on PVC at different PHs and at 303 k

This figure demonstrates that the solid power of connection amongst lignin and PVC at PH=7. The outcomes got demonstrated that the adsorption limit (q_e) of the two colors diminished with expanding PH and indicated comparable adsorption design.

The outcomes demonstrated that ,the greatest expulsion of lignin with PVC was seen at the lower PH esteems where the holding between lignin with PVC expanded while this holding diminished at higher PH .the measure of lignin adsorbed at harmony is expanded from 10.38% to 16.5% with diminishing the PH from 9 to 4, while the present evacuation of lignin in common PH was 18.724%.

Adsorption isotherms:

The examination of harmony information is critical to outline and enhance a working system ,and furthermore with a specific end goal to build up a condition that can be utilized to looked at changed adsorption materials under various operational conditions. in the present study, various two parameters adsorption isotherms models; Freundlich and Dubinin-Radushkevich (D-R), conditions 2 and 4 were utilized to think about the connection between that harmony focus C_e (ppm) and the sorption balance q_e (mg/g), (figure 2 and 3). table(1) portrays the isotherm constants and relationship coefficients (R^2) of these isotherms for the adsorption of lignin on PVC.

Table (1): Isotherm constants for the adsorption of lignin on PVC

Freundlich isotherm constants			
Kf(mg/g)	1/n	Q_e (mg/g)	R^2
9.4645×10^{-3}	1.494	1.9479	0.9642
Dubinin-Radushkevich isotherm constants			
K(mol ² KJ ²)	E(KJ/mol)	Q_m (mg/g)	R^2
8×10^{-5}	0.012649	2.8303	0.9631

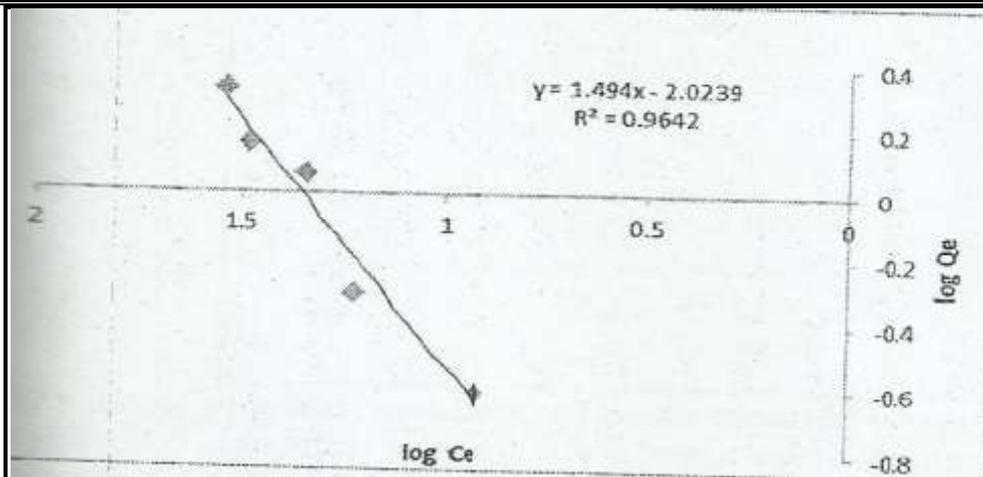


Figure (2): Freundlich isotherm model for adsorption of lignin on PVC

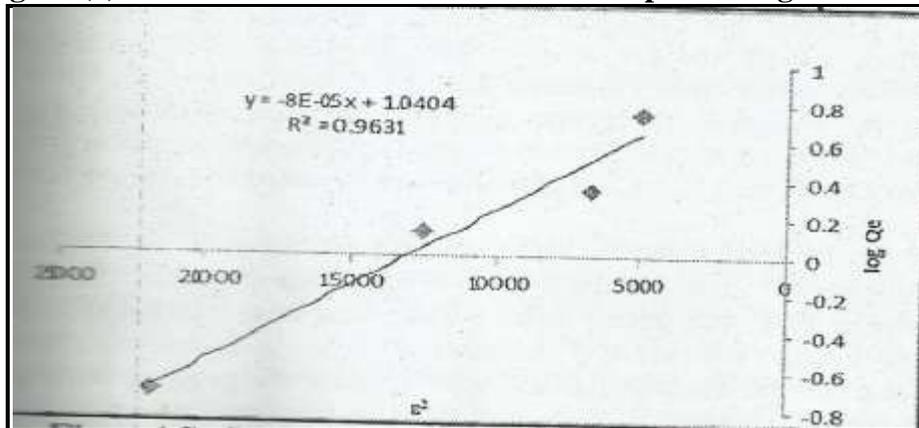


Figure (3): D-R isotherm model for adsorption of lignin on PVC

The experimental data were further analyzed using the generalized isotherm, figure (4) shows the plot of $\{\log (q_m / q_e) - 1\}$ versus $\log C_e$; the intercept gave $\log K_G$ and the slope gave N_b constants.

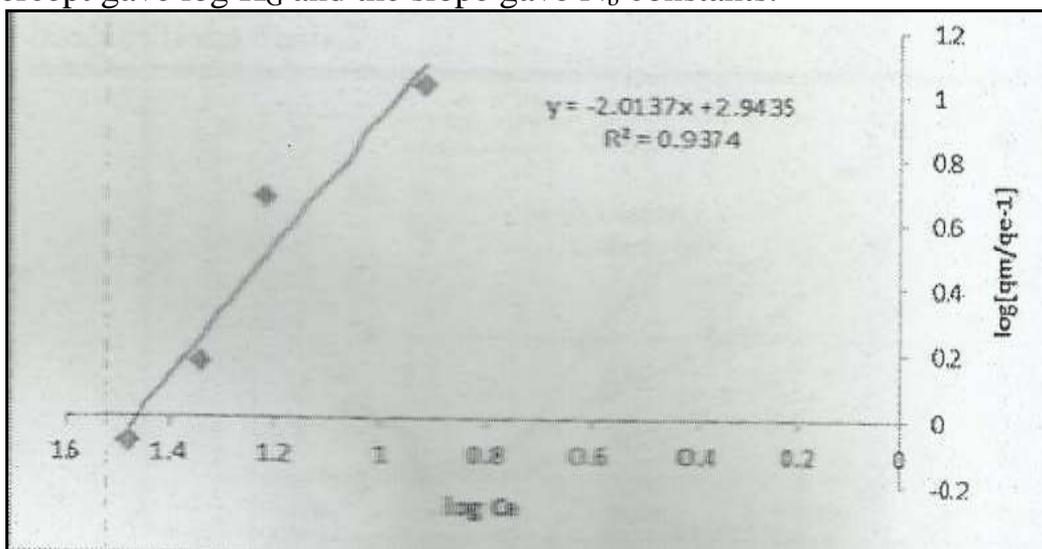


Figure (4): General isotherm model for the adsorption of lignin on PVC

The summed up isotherm display was observed to be plausible depicting the harmony information with a high connection coefficient ($R^2=0.9374$), the estimations of k_f and N_b were (878.011) and (2.0137) individually. The Freundlich isotherm condition presumes that the adsorbent surface is comprise of restricting site with various restricting vitality and the more grounded site gets involved first and that the coupling quality declines inside wrinkling level of locales occupation ⁽¹⁰⁾.

Results demonstrate that the model is fitting the exploratory – information well with high connection R^2 , the estimations of K_f and $1/n$ were acquired from the incline and the capture of the plot $\text{Log } C_e$ and $\text{log } q_e$ separately and revealed in table (1) and figure(2).

The incline $1/n$ means that the surface heterogeneity or surface intensity⁽¹¹⁾, the estimation of $1/n$ got from Freundlich isotherm for the adsorption of lignin on PVC was observed to be more prominent than one ,which demonstrates that the adsorption was agreeable adsorption ,which includes solid associations between the atoms of adsorbate⁽¹²⁾ and the percent evacuation (R%) of lignin by PVC was likewise assessed at beginning focus 50 ppm which equivalent to 39.2%.

Effect of temperature

The underlying rate of adsorption is diminished by an expansion in temperature, the adsorption limit is diminished with increments of temperature the getting away inclination of particles from the interface , and in this way lessens the degree of adsorption, a decline in the rate of lignin adsorption from decreases the time required to achieve equilibrium⁽¹³⁾ as observed in figure(5).

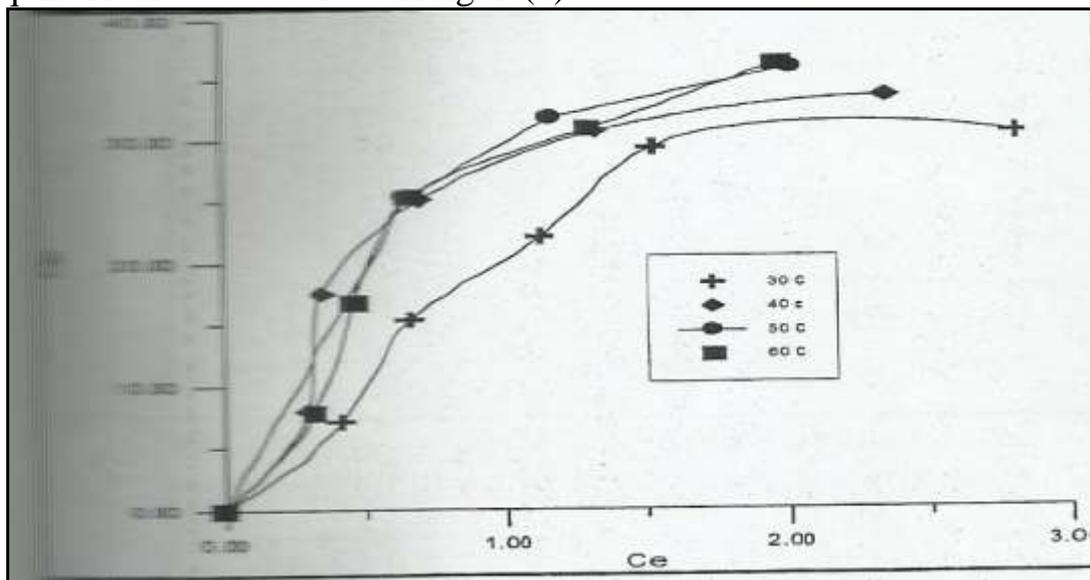


Figure (5): Adsorption of lignin on PVC at different temperature

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In order to evaluate the efficiency of the removal process of lignin by pvc ,thermodynamic parameters including ΔG° (KJ.mol⁻¹), ΔH° (KJ.mol⁻¹) and ΔS° (J.mol⁻¹.K⁻¹)were calculated by applying the following of equation⁽¹⁴⁾:

$$\ln K_d = \frac{-\Delta H}{RT} + \frac{\Delta S}{R} \dots\dots\dots(8)$$

$$K_d = q_e/C_e \dots\dots\dots(9)$$

$$\Delta G = -RT\ln K_d \dots\dots\dots(10)$$

Where kd is the adsorption conveyance coefficient, Ce is the focus (mg/L) of remained lignin in the arrangement at balance, R is the widespread gas steady (8.314J.mol-1. K-1) and T is the total temperature which lies in the range (303-333)k in this examination. The ΔG_o esteem shows the level of the immediacy of adsorption process and the little positive esteem reflects less vigorously ideal adsorption. The ΔH_o and ΔS_o esteems are gotten from the slant and block of the plot of ln Ko versus 1/T as appeared in figure (6). The estimations of relationship coefficients (R2) at acidic PH and the thermodynamic parameters are given in table(3).

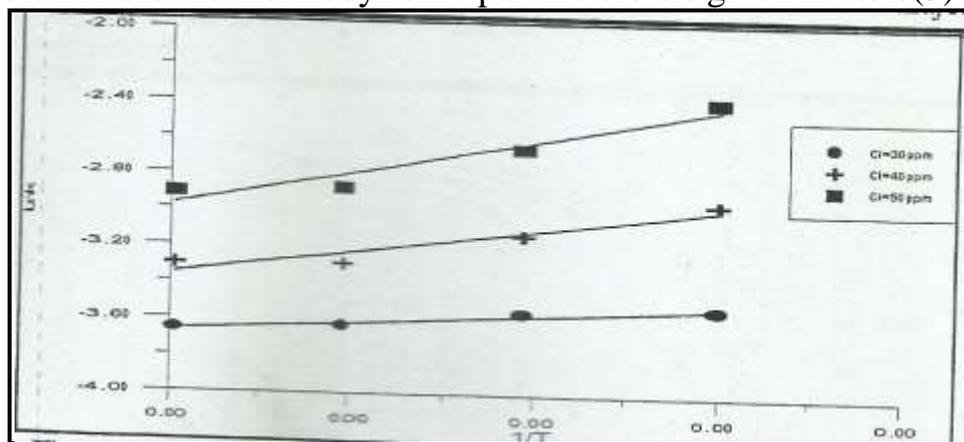


Figure (6): Plot of Vant Hoff equation for adsorption of lignin on PVC

Table (3): The thermodynamics parameters for the adsorption lignin on pvc

C _o (ppm)	ΔH° (KJ.mol ⁻¹)	ΔS° (J.mol ⁻¹)	ΔG° (KJ.mol ⁻¹)				R ²
			30C ^o	40C ^o	50C ^o	60C ^o	
30	-3.834	41.931	7.467	9.252	9.745	10.118	0.9579
40	-10.247	58.610	7.436	8.146	8.843	9.139	0.9151
50	-15.309	70.681	5.999	6.896	7.723	8.055	0.9369

As indicated by the outcomes recorded in the table (3), the estimation of ΔG_o demonstrates that the adsorption procedure of lignin happened non immediately. The negative estimations of ΔH_o affirm the exothermic idea of adsorption⁽¹⁵⁾.

The negative estimation of ΔS_o of lignin recommends positive adsorption⁽¹⁶⁾. The positive estimations of entropy describe the expanded issue of the framework, because of loss of the water which encompasses the lignin particles at the sorption of PVC. This could propose that the main

impetus of the adsorption procedure is by entropy impact. This perception was shown by another trial result⁽¹⁷⁾.

Conclusions:

This expulsion of lignin from their fluid arrangements by adsorption on PVC is led. The impact of contact time at various PH arrangement is resolved .the outcomes demonstrated a sharp increment in the take-up level in the initial 5 minutes. The rate of adsorption is then achieved balance inside a hour for lignin.

The direct connection coefficients of Freundlich and Dubinin-Radushevich were gotten and comes about have demonstrated that Freundlich isotherm fitted the balance information well.

Examination of adsorption limits is completed at various PHs.it was discovered that the expulsion limit of the lignin is higher in the acidic medium.

The thermodynamic parameters of the adsorption framework are assessed in the scope of 303-333K and at various pHs. The acquired outcomes demonstrated that the adsorption could happen non precipitously and is exothermic in nature. The estimations of ΔS_o gave a sign of the expansion in the confusion of the considered framework and proposed that, the adsorption procedure could be driven by entropy change.

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Study the adsorption of lignin on surface of poly vinyl chloride.....

Zainab Naeif Majeed

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دراسة امتزاز اللجنين على سطح البولي فاينيل كلورايد

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الخلاصة

تضمن هذه البحث استخدام فاينيل كلورايد كمادة مازة صلبة لازالة اللجنين من محاليه المائية بطريقة الوجبة الواحد. اشارت النتائج التي تم الحصول عليها ان امتزاز هذه الملوث على (PVC) يسير بتاثيرالانتروبي وان عملية الامتزاز هي عملية الامتزاز هي عملية لا تلقائية وباعثة للحرارة. من خلال ايزوثيرم Dubinin-Radushkevich وجد ان سعة امتزاز ال PVC (qmax) تساوي 2.8303 والطاقة الحرة المحسوبة من معادلة Dubinin-Radushkevich تشير ان ميكانيكية الامتزاز هي تاصرهيدروجيني. ان النسبة المئوية للجنين المزال كانت 39.2% عند دالة حامضية (PH) مساوي الى 2 و بدرجة حرارة 30 درجة مئوية.