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Comparative Investigation of Indigo Blue Dye Removal Efficiency of Methylmethacrylate/Sodium-Y-Zeolite Composite and Amidoximated Acrylonitrile / Na-Y-Zeolite Composite

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Abstract

Objectives: The adsorption of indigo dye onto methylmethacrylate/sodium-Y-Zeolite composite and amidoximated acrylonitrile / Na-Y-Zeolite composte has been evaluated in watery solutions studying some different parameters namely, contact period, measure of the acidity or alkalinity of a solution, adsorbent dosage and thermal factor was also examined.
Methods: Two sorption isotherm imitations namely, Langimuir and Frendlich sorption imitations had been utilized for descriping equilibria isotherm. Evaluation of the activating forces of sorption were carried out regarding sorption of indigo dye on both composites. Kinetics of the sorption model were studied and two kinetic imitations were utilized in an attempt for descriping the kinetics of the process with regard to the practically obtained information.
Key findings: Regarding both composites, the psodo-second order kinetics imitation was suitable and is consistent with the practically obtained information. The activating force (Ea), difference in liberated energies (ΔG), entalpy (ΔH) and enthropy (ΔS) of sorption methodology had been determined regarding the sorption of the indigo dye via both composites. The termodynamics of the sorption proved that the process regarding both composites had been both spontaneously and endothermically happening.
Conclusion: The practically obtained information indicated that both of methylmethacrylate/sodium-Y-Zeolite composite and amidoximated polyacrylonitrile/sodium-Y-Zeolite composite might serve well as inexpensive, efficient and reproducible adsorbants to get rid of indigo dyes from wastewaters.

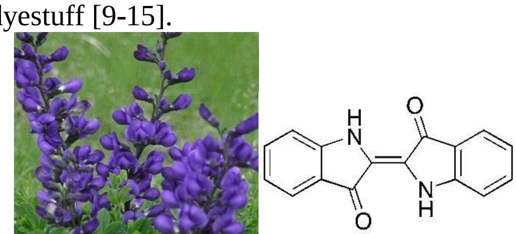
Keywords: *Indigo dye, sodium-Y-Zeolite composite, adsorption, kinetics, thermodynamically factors.*

Introduction

Dyes are colored substances that could impart color to textile, leather, paper, or other materials via forming actual chemical bonds with the materials to which they impart colors. This is the major difference that distinguish dyes from pigments. Dyes could be considered as ionizing aromatic and/or heteroaromatic compounds with electron system that is delocalized in a resonance system. They are applied for the dying process in aqueous solutions [1-3].

Dyes are colored because they can absorb light in the visible region that usually at wavelength of the range of (300-750 nm). It was assumed that dyes are capable to absorb light due to the presence of a chromophore which is responsible for imparting the light absorption character to the dye. In addition, an auxochrome may be present to impart depth to the color. Recent theories suppress this assumption by the fact that dyes are colored due to the delocalized electron system of the aromatic and heteroaromatic ring systems [4-8].

Back to 3000 BC, indigo dye was used by Egyptians and Persians. This is proved by the presence of blue-colored belts discovered within ancient tombs of Egypt. Moreover, a cuneal writing explaining the methodology adopted for the dying fleece to be blue-colored had been discovered in ancient Meso-potamia. The technique was explained via repeatedily and continuously soaking and leaving the fleece textiles to dry in air. Some archaeological excavations showed the application of indigo on the Indian sub-continent for over four thousand years. It seems that indigo plant cultivation spread from India. Historically, indigo dye was obtained from a natural source where it was initially obtained from the organic extract of the leaf of a number of vegetations belonging to the genus namely, *Indigofera* genius. *Indigofera tinctorial* is one of the most widely used species (figure 1). This is a dye-bearing plant that was widely planted and utilized worldwide, especially in the Asian continent, because of its economical benefits. This is due to the fact that it was not an easy task to find the indigo dyestuff [9-15].



Indigo

Figure 1: Indigo plant and structure of indigo dye.

Textile industry technologies and procedures require the utilization of massive amount of water and also utilize many toxic products. These effluents have hazardous effects as they badly affect the ecosystem by speeding the degradation process of the surrounding environment. This occurs *via* the release of contaminated industrial discharges in surrounding environments as a polluted residue. Ultimate discharge for these effluents still challenging risk regarding their toxicological effects. So, it is a crucial need to assess its ecotoxicological effects and hazards to minimize its environmental effects. The conventional treatment techniques of these toxic effluents do not completely remove and detoxicate the dye discharges. Indigo dye is considered as a widely used dyestuff that is utilized for dying of textile, papers, leathers, plastics. In addition, it is used for other specific applications such as foods, pharmaceutical agents, cosmetics and photo-chemical products. Textile industry discharges containing indigo dye and other dyestuffs cause the wastewater to be eco-toxic and unsuitable for human and animal usance. Moreover, it causes imbalanced aquatic eco-systems. Recently, many scientists identified different carcinogenic and mutagenic effects of samples of textiles' industries wastewaters. These results illustrated that the dyes used during the industrial processes are the main cause of both carcinogenic and mutagenic effects. The nature of the discharges from textile industry dyeing is complex, containing various dissolved and suspended solid substances, organic chemicals, and heavy metals. The exact composition of these discharges defines the extent to which they cause hazardous environmental impacts. So, indigos dye's complicated properties effluents are considered as the main cause of high toxic impacts in addition to the other xenobiotics found in the discharges [16-20].

It has been estimated that textile and dyeing industries comprises more than 70% of the discharged dyes in the environment. This might be attributed to the fact that not all the dye amount used in the process is taken up by the textile or the dyed material. Only about 80% of the added dye is consumed while the rest is discharged in the effluent wastewater. This discharged unfixed dye is then become a threat to the environment exerting its hazardous impacts on the eco-system [18-22].

Indigo is widely used in the denim and other textile industries. It has been estimated that about 40,000,000 kilograms of indigo dyes are synthesized each year for industrial purposes. This, in turn, necessitates the research for a suitable method for its removal from wastewater because the conventional primary treatment protocols are not enough. Otherwise, it would be discharged into the ecosystem causing various environmental and health impacts. For example, cornea and conjunctivas could be greatly harmed, may be completely damaged, if the dye comes in direct contact with these tissues. Moreover, indigo dye is very harmful for the human skin and respiratory tract, causing severe irritation to them. In fact, nourished denim industries in the Asia enhances the extensive application of indigo dyes in these regions. As a result, several serious environmental hazards were detected, especially water pollution and contamination because of the extensive use of indigo dyes in these regions. In addition to that, contamination of water with indigo dyestuff causes water to become turbid. This results in a great decrease of the photosynthetic processes which results in a dangerous threat to aquatic ecosystem [23-25].

Over the years, different methods of wastewater treatment had been developed. Among these methods, biotechnological applications were also reported and utilized such as fungal and bacterial depolarization methods. In general, treatment techniques are categorized in three main classes: biological, chemical and physical. Of course, each method of them has its pros and cons. Despite there are many reported methods for wastewater treatment, many conventional techniques could not be widely applied for the treatment of effluent discharges of the dye. This is mainly due to the high cost and sophistication of the technique. At the recent era, there is no single technique is globally approved and utilized that adequately for the treatment process. This is greatly attributed to the complex nature of the discharges, containing not only residual dye, but also different discharges such as heavy metals [26, 30].

The present study is a comparative investigation of the removal of indigo dye adopting the adsorption technique. Comparison was performed of adsorption by two different composites. For the determination of optimal circumstances towards the carrying out the adsorption technique using both composites, different parameters were investigated namely, firstly-added quantity of adsorbete, sorbent added quantity, interaction period, solution's pH value, and thermal effects had been investigated. Moreover, both dynamic and thermos-dynamic boundaries had been likewise determined for proper selection of the reaction consitants and sorption components. Exploratory information had been investigated for fitting in Langmuier and Frendlich conditions for figuring out what model of them correlates perfectly with trial information regarding both composites.

Experimental

Zero-charge mark

The mark of zero-charge (pH pzc) was resolved through strong expansion technique. Solutions of $1x10^{-1}$ Molar potassium nitrate of volumes of exactly fifty milliliters had been prepared and their pH's values were controlled via addition of $1x10^{-1}$ Molar hydrochloric acid and $1x10^{-1}$ Molar sodium hydroxide to a range of 1.0 to 11.0. then, $1x10^{-1}$ gram of methylmethacrylate/sodium-Y-Zeolite composite or amidoximated acrylonitrile / Na-Y-Zeolite composite were gradually incorporated into the mixture and the mixtures should be then, shaked and left for exactly forty eight hours. At predetermined periods, the mixtures were agitated. At the end of the experiment, final pH of the mixtures had been determined. This readings were plotted against the differenced pH (between initial and final reading) ΔpH . The intercept of that plot gave the pHpzc [31].

Establishment of solutions

All watery mixtures were prepared using distilled water. A stock solution (0.5 ml/L) of indigo had been ready in refined H_2O. Afterthat, predecided dilutions had been attained via diluting the mixtures with other solution. Hydrochloric acid ($1x10^{-2}$ to $1x10^{-1}$ N) or sodium hydroxide ($1x10^{-2}$ to $1x10^{-1}$ N) had been gradually added for proper adjustment of medium's pHvalue.

Sorption investigations

Batched sorption investigations had been performed via agitation of mixtures of 0.25 gram of metnylmethacrylate/sodium-Y-Zeolite composite or amidoximated acrylonitrile / Na-

Y-Zeolite composite and twenty five milliliters of indigo dye's dilutions of predetermined concentrations controlling the value of solution's pH via magnetic stirrer device acting with capacity of two hundred rounds per minutes at 25ºC. pH's values were controlled via addition of $1x10^{-1}$ Molar hydrochloric acid and $1x10^{-1}$ Molar sodium hydroxide to a range of 1.0 to 11.0. When the sorption experiment was ended, the mixtures were filetred and the filterates were admitted to a specrto-photo-metery which was adjusted to 613 nm exact wavelength to determine the absorbance of them. This measurement gave the amount of indigo dye that is remaining in the clear filerate. Percentile of removed dye removal had been obtained via applying equation 1:

$$R = \frac{100\,(C_i - C_t)}{C_i} \qquad (1)$$

In this equation, C_i was the initial concentration of indigo dye in mg/ L, C_t was final concentration after certain period in mg/L. regarding sorption isotherms, various adsorbate's concentrations which were mixed with certain quantities of sarbates should be shaked till the system attains equilibriua. Equilibria sorption capacities, q_e that is measured in milligram of adsorbate for each gram of sorbent had been computed via applying equation 2:

$$q_e = \frac{V(C_0 - C_t)}{W} \qquad (2)$$

C_t (mg L^{-1}) is the measured quantity of indigo dye after equilibria states were attained, V is the volume of solution in liters while W was the weight of composite in grams.

The methodologies of kinetics were the same as that of equilibria experiments. Intermittent measyrements of the quantity of indigo dye remaining was estimated via extracting a specific volume of the mixture at specific tine intervals. The quantity of remaining indigo dye at specific time t, q_t (mg/g) has been estimated via the equation 3:

$$q_t = \frac{V(C_0 - C_t)}{m} \qquad (3)$$

C_0 was the first dye quantity at time = zero in mg/L, and C_t (mg /L) the dye amount at specific time interval t, while V the volume of the extracted mixture in liters and m was the weight of the added composite in grams.

The equilibrium sorption data of the investigation were fitted adopting various sorption isotherm imitates and kinetics equetions for the determining the analyses and designates of the sorption techniques. Various hypothetical imitates might been utilized to deal with practically obtained information, that is to decide a model that porperly expects kinetical and isothermal information. Validation of the designs had been performed via computing the coefficient of determination (r^2) [32].

Recovery productivity (RE, %) was determined by the accompanying condition:

$$\text{RE}\,\% = \frac{\text{Amount of sorbedmetal(mg) at run (n+1)}}{\text{Amount of sorbedmetal(mg) at run (n)}} \text{X} 100 \qquad (4)$$

Experimental Results

Sorption trials

Influence of pH

The values of pH of fluid arrangements was considered as a significant boundary influencing color sorption. Impact of pH upon sorption of indigo color on the methylmethacrylate/sodium-Y-zeolite composite and amidoximatedacrylonitrile/sodium-Y-Zeolite composite has been explored within the underlying pH scope of 1-8.

The removal of the tested dye applying various pHs has been investigated using starting concentrations of 0.5 ml/L of the colored substance at 25 ºC and 5 g/L sorbent quantities. pH's values regarding the mixture had been considered as a crucial determining factors concerning the sorption experiment. Both composites were shown tobe efficient sorbents for the dye's clearance. This had been performed by sorption of watery mixtures concerning methymethacrylate/sodium-Y zeolite and amidoximated acrylonitrile / Na-Y-Zeolite composite at pH 4 and 3, respectively (Fig. 2, 3). It was shown that sorption capacities of investigated dye on both composites elevates considerably by lowering the pH. Maximal sorption after period of two hours had been performed at pH 4 for methylmethacrylate/sodium-Y-zeolite composite. On the other hand, it was maximal sorption for contact period two hours have been perfomed at pH 3 regarding amidoximated acrylonitrile / Na-Y-Zeolite composite.

Generally, the sites that bear negative charges is directly proportional to pH of sorption mixture. Also, inversely proportional to number of sites bearing positive charges. Due to electrostatic repulsion, negative charges on the sites at the surfaces of composites do not aid the sorption of dye negatively charged ions. Moreover, reduced sorption of indigo in alkaline circumstances could be attributed to very high numbers of OH- that compete with the negatively charged ions for the sorption surfaces [33].

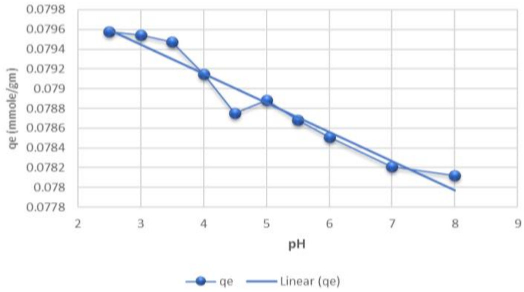


Figure 2: Effect of pH on the adsorption of the dye onto MMA/ Na-Y-Zeolite Composite

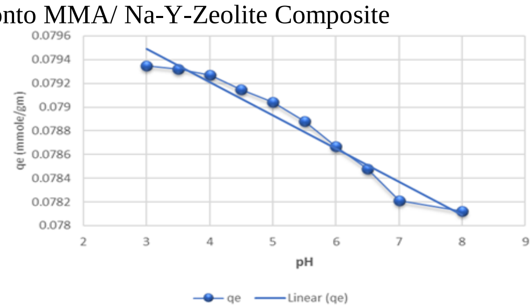


Figure 3: Effect of pH on the adsorption of the dye onto amidoximated Polyacrylonitrile/ Na-Y-Zeolite composite

Kinetic studies

Sorption kinetics of indigo dye utilizing both investigated composites are illustrated in (Fig. 4, 5). It very well may be seen that adsorption cycle for the color is quick at introductory stage and diminishes continuously arriving at harmony at 95 and 75 min. for methymethacrylate/ Na – Y zeolite and amidoximated acrylonitrile / Na-Y-Zeolite composite, respectively. This might be because of the way that at starting stage there are enormous number of dynamic destinations accessible for expulsion of color, and evacuation is troublesome as time expands due to repugnance among solutes and strong.

Uptake kintics of dye adsorbtion by these two sorbents had been studied using two models namely, so-called pseodo-first order rate equation (PFORE) [34] in addition to the psedo-second order rate equation (PSORE) [35]. These imitations plus the linearity forms were illustrated in Table 1 for methymethacrylate/sodium-Y zeolite and amidoximated acrylonitrile /sodium-Y-Zeolite composite (see Supplementary Material Section) k_1 was the pseudo-first- order-rate constant measured in 1/min., q_e and q_t both were measured in mg/g were the quantities of sorbed dyes at equilibria's and time t, respectively, k_2 was the pseudo-second order rate constant measured in g/mg.min. validation of the data was studied via correlate coefficient of the computed linear form. The finest model for explaining the kinetic information could be chosen on a condition that R2 is about 1. The factors included in the various applied models for the investigated sorbents were illustrated in Table 2. Regualrily, the finest correlating coefficients had been fitted applying PSORE isotherm; that was assured via plotting the practically obtained information concerning the linear arrangements for these models: (Figure 6, 7) for PFORE and PSORE, models with respect to both composites showed a finest fitting f kinetic profiles by PSORE. Moreover, comparing equilibria's sorption capacity regarding computed values and the practically obtained data were compatible with the PSORE. Regarding methylmethacrylate/ sodium -Y- Zeolite composite, the equilibrium sorption capacities were found to be 0.07913, and PSORE modeling gave value of 0.07948, closer from experimental value than PFORE 1.9039. while regarding the amidoximated acrylonitrile /Na-Y- Zeolite composite, the equilibrium sorption capacities are found to be 0.08, and PSORE modeling gave value of 0.0799, closer from experimental value than PFORE 1.77815. In any case, the PSORE depicts motor information through a worldwide methodology, and doesn't consider the commitment of dispersion components in the control of the energy. Under these circumstances, the active boundaries ought to be considered as obvious rate coefficients.

Equilibrium sorption isotherms

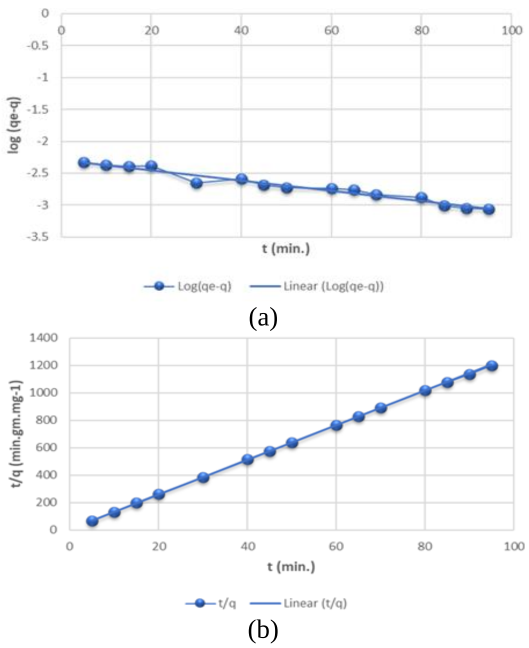
Different sorption isotherm uncover the particular connection between the grouping of adsorpate and the adsorbtion limit of an adsorbant at a specific consistent temperature. sorption isotherms give valuable data on how a sorption cycle continues, and decide the way in which adsorbate atoms interface with adsorbent. A few imitation models were utilized to portray exploratory information for adsorption isotherms. The Langmuir [36] and Freundlich [37] imitations have been utilized for explaining adsorption of the dye onto both tested composites. These models and their linearized forms were summarized in Table 2, qe was the sorbed quantity of the indigo dye when equilibrial conditions were attained measured in mg/g, $q_{m,L}$ was the maximal adsorption capacities, measured in mg/g and K_i is the Langmier binding constant that was connected to the forces of adsorption measured in liter per gram, C_e stands for the equilibrial situation of the indigo dye in mixtures, measured in milligram per liter. Finally, n stands for the Freindlich constant that is attributed to adsorption capacities and intensities.

Table 1: Kinetic parameters for indigo dye adsorption

	$q_{e,\,exp}$ (mg g^{-1})	PFORE			PSORE		
		k_1 (min^{-1})	$q_{e,\,calc}$ (mg g^{-1})	R^2	k_2 (g mg^{-1} min^{-1})	$q_{e,\,calc}$ (mg g^{-1})	R^2
MMA/Na-Y-zeolite composite	0.07913	-0.008	1.9039	0.9616	17.31301	0.079479	0.9949
Amidoximated acrylonitrile/ Na-Y-zeolite composite	0.08	-0.0122	1.778151	0.9035	28.5695	0.079917	0.9953

Table 2: Kinetics models and their linear forms

Kinetic model	Non-Linear form	Linear form	Plot	Author	References
Pseudo-First order	$q_t = q_e\,[1 - e^{-k_1 t}]$	$\log(q_e - q_t) = \log q_e - (\frac{k_1}{2.303})\,t$	$\log(q_e - q_t)$ *vs.* t	(Lagergren, 1898)	[34]
Pseudo-Second order	$q_t = \frac{k_2\,t}{1 + k_2\,q_e\,t}$	$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + (\frac{1}{q_e})\,t$	(t/q_t) *vs.* t	(Ho and McKay, 1999)	[35]

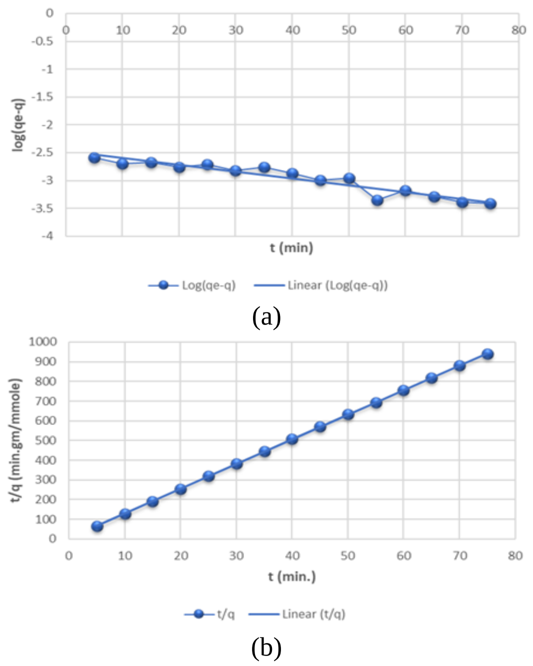


(a)

(b)

Figure 4: Indigo dye uptake kinetics using MMA/Na-Y-Z Composite

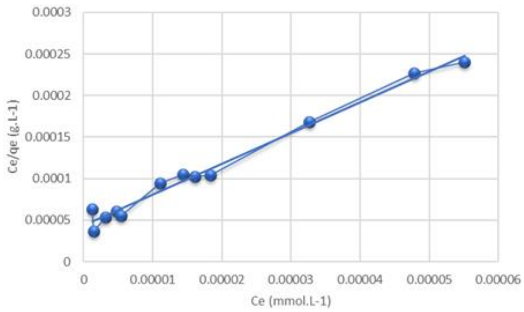
The Langmier isotherms had been proved to be mostly proper models for the description of the isotherm regarding sorption of the indigo onto both composites (Fig. 6a,b, and 7a,b (see Supplementary Material Section)). By comparing R2 combutes, the Langmier isotherm showed to be best fitted, with R_2 being more than 0.90 that were higher than that of Freundlich isotherms. Moreover, Q_m determined by applying Langmier isoterm has been closer to the practically obtained value of Q_{max}.



(a)

(b)

Figure 5: Indigo dye uptake kinetics using amidoximated polyacrylonitrile/ Na-Y-Zeolite composite



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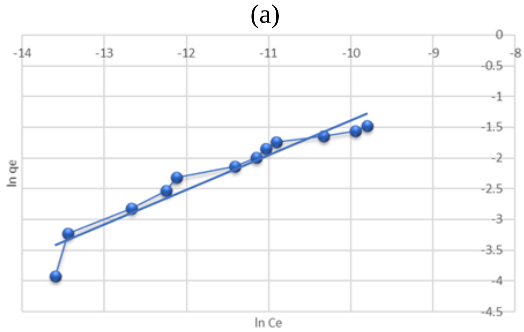
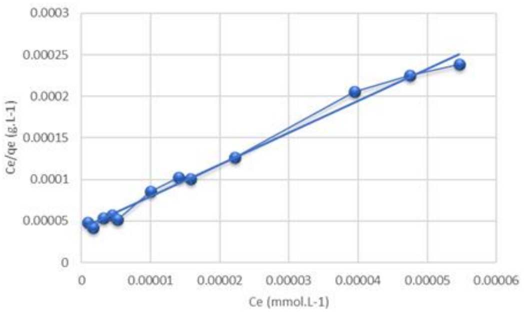
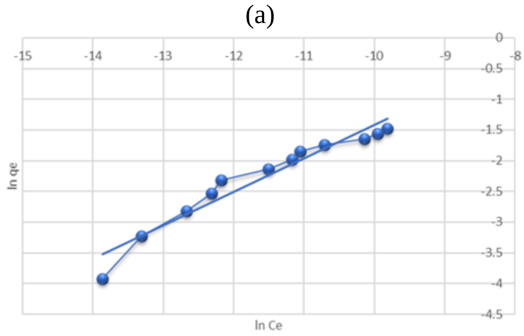


(b)

Figure 6: Dye sorption isotherms onto MMA/Na-Y-Z Composite: (a) Langmuir isotherm (b) Freundlich Isotherm



(a)



(b)

Figure 7: Dye sorption isotherms onto amidoximated Polyacrylonitrile/ Na-Y-Zeolite composite: (a) Langmuir isotherm (b) Freundlich Isotherm

Influence of temperature

Researching the thermal impact regarding sorption in a perspective on commonsense utilization is significant. Sorption tests have been completed for six different thermal degrees namely, 25, 30, 35, 40, 45 and 50 ºC. The adsorption capacity slightly increases with the increase in the temperature from 25 to 50 ºC. that attitude of results assured the endothermical nature of the sorption method. The sorption equilibrial constent, K_c was calculated via applying equation 7 and combined with the van't Hoff equation 10 and regular thermodynamical equation 10 for assessing the thermodynamical constants of the adsorbents. These constants includes ΔH^o which stands for the standerd entalpy changes, ΔG^o which stands for standerd free Gibbs energy, in addition to ΔS^o which stands forthe standard entropical change.

$$K_c = \frac{q_e}{C_e} \qquad (7)$$

In this equation, q_e was the equilibrial concentration of adsorbant and C_e stands for the concentration of adsorbat.

$$\Delta G^o = - RT \ln K_c \qquad (8)$$

$$\Delta G^o = \Delta H^o - T\Delta S^o \qquad (9)$$

As a consequence, vant's Hoff equation became:

$$\ln K_C = \frac{-\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R} \qquad (10)$$

The upsides of standardized entalpy changes (ΔHo) and standard enthropy change (ΔSo) for the sorption not set in stone from the incline and block for the plotting that represents ln Kc against 1/T (Fig. 8, 9). Values of thermodynamical factors were illustrated within Table 5. Positive values of enthalpy assured that the process was endothermic. In addition, its negitive values proved exothermic reaction. Moreover, positive values of ΔG^o indicate that the sorption reaction is nonspontaneous. In the present study, as could be concluded for both composites under investigation, the adsorption process is endothermic, spontaneous one.

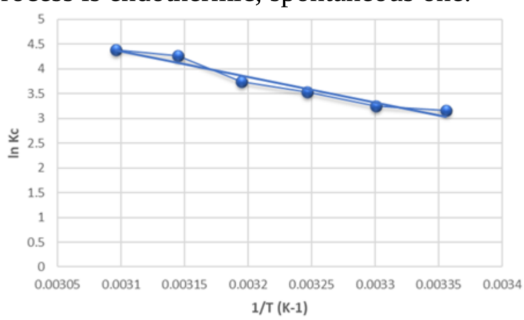


Figure 8: Effect of temperature on dye sorption using MMA/Na-Y-Z composite

Table 3: Parameters of the models for adsorption isotherms

	Langmuir model				Freundlich model		
	$q_{m, exp}$ (mmol g^{-1})	$q_{m,L}$ (mmol g^{-1})	K_L (L $mmol^{-1}$)	R^2	n	K_F (mmol g^{-1}) (L $mmol^{-1})^{1/n}$	R^2
MMA/Na-Y-zeolite composite	0.22898	0.363	92610	0.9846	1.776199	4.2372	0.9122
Amidoximated acrylonitrile/ Na-Y-zeolite composite	0.3808	0.47372	84407.46	0.99416	2.040233	1.84717	0.94688

Table 4: Sorption isotherms and their linear forms

Isotherm	Non-Linear form	Linear form	Plot	Author	References
Langmuir	$q_e = \frac{q_{m,L}\, K_L\, C_e}{1 + K_L\, C_e}$	$\frac{C_e}{q_e} = \frac{C_e}{q_{m,L}} + \frac{1}{K_L\, q_{m,L}}$	$\frac{C_e}{q_e}$ *vs.* C_e	(Langmuir, 1918)	[36]
Freundlich	$q_e = K_F\, C_e^{1/n}$	$\ln q_e = \ln K_f + \frac{1}{n} \ln C_e$	$\ln q_e$ *vs.* $\ln C_e$	(Freundlich, 1906)	[37]

Table 5: Standard enthalpy, entropy and free energy changes for adsorption.

Composite	ΔH° (kJ mol^{-1})	ΔS° (J mol^{-1} K^{-1})	R^2	ΔG° (kJ mol^{-1})					
				298 K	303 K	308 K	313 K	318 K	323 K
MMA/Na-Y-zeolite composite	42.8296	0.16898	0.953	-7.53	-8.37	-9.22	-10.06	-10.91	-11.75
Amidoximated acrylonitrile/ Na-Y-zeolite composite	40.1884	0.18118	0.985	-7.80	-8.71	-9.61	-10.52	-11.43	-12.33

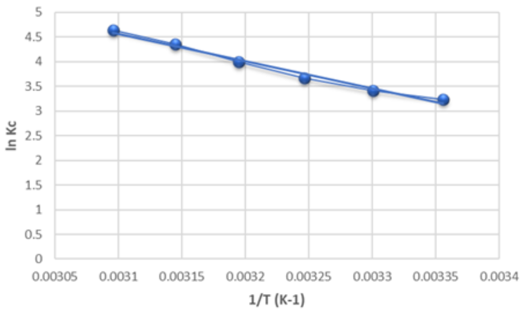


Figure 9: Effect of temperature on dye sorption using amidoximated polyacrylonitrile/ Na-Y-Zeolite Composite.

Influence of adsorbent dosage

Adsorption of the colored substance onto the surface of each of the investigated composites was investigated via varying the amount of adsorbent reach of $1x10^{-2}$ to $1x10^{-1}$ grams, while the dye concentration was fixed at $4x10^{-4}$ Molar at twenty five °C and pH 4 for methmethacrylate/sodium-Y-Zeolite composite, and pH 3 for amidoximated acrylonitrile/ sodium-Y- zeolite composite, respectively. The data in Figures 10, 11 proved dye sorption capacities as a behaviour of sorbent quantity. It was deduced that the sorption capacities reduced from 50 to 10 mg /g by elevating the quantity of composite from $1x10^{-2}$ to $1x10^{-1}$ gram. Based to the practically obtained data, maximum removal efficiency was 80% for methymethacrylate/sodium-Y-Zeolite composite, and 86% for amidoximated acrylonitrile/ Na-Y- zeolite composite.

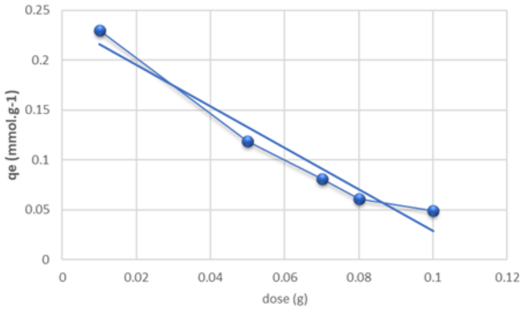


Figure 10: Effect of sorbent dose (SD) on dye sorption using MMA/Na-Y-Z composite

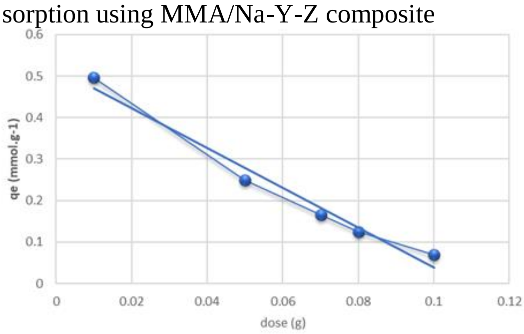


Figure 11: Effect of sorbent dose (SD) on dye sorption using amidoximated polyacrylonitrile/ Na-Y-Zeolite composite.

Regenerating the comosites

pH value is a crucial factor that was proved to control the de-sorption process of dyes regenerating the free composite to be used again for another treatment cycle. Regeneration process of composites usually is carried out in alkaline conditions. Desorption of methymethacrylate/sodium-Y-Zeolite composite and amidoximated acrylonitrile/sodium-Y- zeolite composite had been performed via allowing 20 mL of 0.1 N sodium hydroxide to be in contact with each composite for one hour. Application of equation 4 was then performed to obtain the regeneration effecincy. Washing of the regenerated composites using distilled waters is another important step to ensure that the regenerated composite is suitable for reusing them in other sorption experiments. Efficiency of regenerating composites had been calculated and it was 78% regarding methymethacrylate/sodium-Y- zeolite composite. While it is 84% for amidoximated acrylonitrile/ Na-Y- zeolite composite.

Estimation of point of zerocharge

The point of zerocharge demonstrates important huge data regarding the kind of surface-dynamic focuses. pH of methymethacrylate/ sodium-Y-Zeolite omposite had been viewed as 7.5 while it had been 4 for amidoximated acrylonitrile/ Na-Y- zeolite composite. This demonstrated that beneath that pH, both composites became positively charged because of that practical gatherings became protonated at this pH.on the other hand, outer layers of the composites became negativly charged.

Conclusion

This current investigation concentrate obviously at both MMA-Na-Y-Zeolite and amidoximated acrylonitrile/ Na-Y- zeolite composites as powerful adsorbents for the expulsion of indigo color from fluid discharges and dirtied water. Characterization of the tested composites was performed via effective discriminatory adsorption of the dye at approximated pH of 4 for methymethacrylate/sodium-Y-Zeolite and pH of 3 for amidoximated acrylonitrile/ sodium-Y-zeolite composite. Adsorption equilibrial information was fitted finely with Langmuir equation for the adsorption of the dye by both composites. In addition, kinetics of the adsorption process was found to be fitted perfectly with the pseudo-second-order kinetic models with high correlation coefficients again for both investigates. Moreover, the thermodynamical data of the sorption showed spontanous and endothermic reaction.

Regeneration investigates have been performed and the practically obtained data proved the composites could be used in sorption of the dye many times by the desobtion process using 0.1 N NaOH solution.

The obtained findings illustrated that the both composites represent a promising adsorbent for indigo dye from aqueous solutions and wastewaters of textile industry..

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الملخص العربي

عنوان البحث: تحقيق مقارن لكفاءة إزالة صبغة الانديجو للبوليمر المتراكب ميثيل ميثاكريلات / صوديوم- واى- زيوليت والبوليمر المتراكب أميدوكزيم أكريلونيتريل / صوديوم- واى- زيوليت

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الأهداف: تم تقييم امتزاز صبغة الانديجو على البوليمر المتراكب ميثيل ميثاكريلات / صوديوم- واى- زيوليت والبوليمر المتراكب أميدوكزيم أكريلونيتريل / صوديوم- واى- زيوليت في المحاليل المائية بدراسة بعض المؤثرات المختلفة وهي الفترة الزمنية، ومقياس الحموضة أو القلوية للمحلول كما تم فحص جرعة الممتزات والعامل الحراري.
الطريقة: تم استخدام طريقتان لوصف الامتزاز وهما لانجماير وفريندليش. تم تقييم القوى المنشطة لامتزاز الصبغة النيلية على كلا المركبين. تمت دراسة الخواص الحركية لنموذج الامتزاز في محاولة لوصف حركية العملية.
النتائج الرئيسية: فيما يتعلق بكلا البوليمرات المتراكبة، كان التقليد الحركي من الرتبة الثانية الزائفة مناسبًا ومتوافقًا مع المعلومات التي تم الحصول عليها عمليًا. أثبتت ديناميكيات الامتزاز أن العملية المتعلقة بكلا المركبين كانت تحدث تلقائيًا وبصفة ماصة للحرارة.
الخلاصة: أشارت المعلومات التي تم الحصول عليها عمليًا إلى أن كلاً من البوليمرات المتراكبة ميثيل ميثاكريلات / صوديوم- واى- زيوليت وأميدوكزيم أكريلونيتريل / صوديوم- واى- زيوليت يمكن أن يعمل بشكل جيد وغير مكلف وفعّال للتخلص من صبغة الانديجو من مياه الصرف.