RESEARCH ARTICLE

Kinetic Study of Adsorption of Murexide Dye Polluting the Aquatic Environment Using one of the Industrial Wastes, Antimony Trioxide, and its Applicability to Freundlich Isotherm

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ABSTRACT

The study concerted on the adsorption of (Murexide dye). It was used in analytical chemistry such as evidence and used as coloring of tissue, animal cells, and plant cells—the effective method, which could use verity concentrations range. Adsorption is often applied to surfaces with pores; widely available industrial wastage produced Antimony trioxide Sb_2O_3, is chosen such as an adsorbent to Murexide dye. From 303 to 313 K. The application of Freundlich isotherm models was tested as part of the research. The study used UV-vis. spectroscopy of adsorption of dye. It was observed that the reaction kinetics apply to pseudo-second-order kinetics.

Keywords: Adsorption, Antimony trioxide, Murexide dye, Pollution, Pseudo second order, Wastewater.

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INTRODUCTION

The problem of water pollution with industrial dyes from organic sources is one of the essential dilemmas facing the environment. It is considered one of the most critical factors of danger to the environment and human health.[1] Because of its detrimental effects on human health and environmental contamination, particularly aquatic pollution.[2] Adsorption, precipitation, filtration, coagulation, and membrane separation are some of the approaches that have been developed in this area. Adsorption is often regarded as one of the most appropriate techniques since it is a simple procedure, inexpensive in cost, simple to conduct, and abundant adsorbent material. However, the adsorption effectiveness is determined by the capacity of the adsorbent employed. Nowadays,[3] Several low-cost and environmentally friendly adsorbents, such as, have been explored to remove colors from wastewater. Zeolite, natural clay, activated carbon, and layered double hydroxides are some ingredients.[4,5] Egyptians employed charcoal to absorb odorous vapors around 1550 BC, which was the earliest effort to utilize an adsorption method to remove an undesirable chemical. wounds and the intestine. The Phoenicians noticed in 460 BC that charcoal filters were used to cleanse water.[6-8] One of the biggest difficulties that the world faces is providing easy access to clean, inexpensive water that can keep up with constantly rising demand. Water supply systems confront the most serious issues: population expansion, global climate change, and water pollution. Water shortage is worsened in both developing and developed nations by human activities, which are the most responsible for polluting natural water resources by releasing energy, chemicals, and other pollutants that degrade water quality for other users.

Furthermore, nature may be a source of pollution, such as water storm runoff, animal feces, and so on.[9-13] One of the problems facing adsorption processes is that the absorbent surfaces are damaged because they are difficult to use again and cannot be recycled. As a result, they become secondary pollutants.[14] Researchers are developing new absorbent materials with a large surface area to overcome this challenge. Therefore, it was directed towards the manufacture of materials with a high surface area, such as modified silica and zeolite, in addition to ZnO and TiO.[15]

Adsorption Isotherms: Adsorption is often represented as an isotherm at a constant temperature. The quantity of adsorbed substances is determined by the pressure in a gas state or

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concentration.[16] in a liquid state at a constant temperature, i.e., it may be described as a description of the connection between the amount of adsorbed substances and pressure. The adsorbent QE and the adsorbent concentration at equilibrium Ce several isotherms exist at a constant temperature.[17]

Isotherm Freundlich

Freundlich created a model of isothermic adsorption in 1909, which is an equation that correlates the quantity of gas adsorbed on the steel surface and pressure, and this equation is known as Freundlich's equation. This resulted in the development of an isothermic linear equation named after him, as seen in the equation.[18-20]

$$\log qeq = \log K + 1/n \log Ceq \qquad ...(1)$$

n: Freundlich's constant,

QE: Amount of adsorbent in units of mg/g,

Ceq: Concentration of adsorbed time during adsorption in units of mg/L, the value of Freundlich's constant depends on the nature of the adsorbent, the adsorbent surface, and the temperature.

Pseudo Second Order

This equation describes the adsorption capacity at equilibrium and can be expressed as

$$t / q_t = [1/ K_{2p}q_e^2 + 1 / q_e]t \qquad ...(2)$$

qe: the amount of adsorbed at equilibrium (mg/g). The amount absorbed over time (mg/g). K_2 adsorption rate constant adsorption rate ($mg.g^{-1}.min^{-1}$).[20]

MATERIALS AND METHODS

The following compounds were utilized, along with some of their physical characteristics, as given in Table 1.

A stock solution with a concentration of 50 mg/L was made by dissolving a weight of 0.1 gm in a particular amount of distilled water and then completing the volume to the desired concentration (1000 mL). Different solutions were produced with varying concentrations of The dye, which obeys Lambert-law, Beer's, and the wavelength was measured max for maximum absorption using pure water as blank.[21]

Spectra of Dye Absorption and Calibration Curves: Dye absorption spectra and calibration curves.[14] The wavelength obtained in maximum absorption retrieved use UV-vis spectroscopy, cells made of quartz substance have 1-cm thickness. Table 3 displays the maximum values for the dye under consideration. Murexid day has been observed in 515 nm (Figures 1 and 2).

From the equilibrium in minutes for dyes adsorbed on different surfaces, Equilibrium Sb_2O_3 30 minutes. Adsorption isotherms for each dye were determined by producing five concentrations of the adsorbent in 100 mL volumetric flasks ranging from 5 mg/L to 52 mg/L. It is placed in a conical flask with a capacity of (50 mL), which is then placed in a temperature-controlled water bath fitted with a vibrator and shaken for a specific amount of time. The solutions are then filtered again with filter sheets to remove the adsorbent surface particles. The findings were then examined using a spectrophotometric instrument. The concentration at equilibrium (Ce) mg/L was estimated using the calibration curve at the maximum wavelength of each dye and knowing the absorbance values.[22]

$$q_e = (C_o - C_e)V_{sol} / Co \qquad ...(3)$$

$$\% \text{ Removal} = [C_o - C_e/C_o] \times 100 \qquad ...(4)$$

The Influence of Temperature

The prior adsorbent quantity was determined again with a temperature change and a record. 313–303K The effect of each

Table 1: Chemical properties and physical properties of Murexide dye

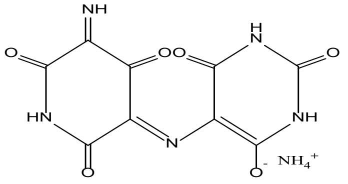
MUREXIDE		
Properties		*Dye Structural*
Formula	$C_8H_5N_5O_6 \cdot NH_3$	
M.m	284.19 g·mol−1	
MP.	>300 °C/L	
Source	BDH	
Solubility	H_2O	ammonium E-5-5-imino-2,4,6-trioxopiperidin-3-ylidene)amino-2,6-dioxo-1,2,3,6-tetrahydropyrimidin-4-olate

Table 2: Some physical properties of antimony oxide

Antimony trioxide	
Structure	Sb_2O_3
Source	BDH
Color	White
Melting point	656°C
Boiling point	1425°C

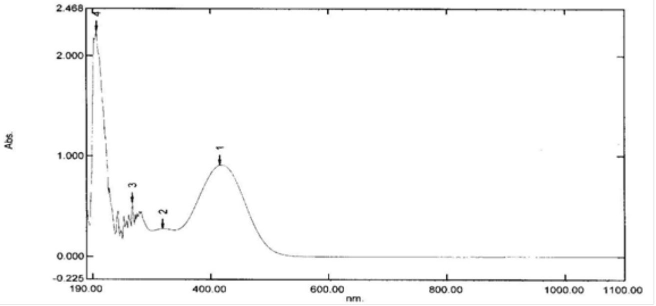


Figure 1: Murexide Lambda max

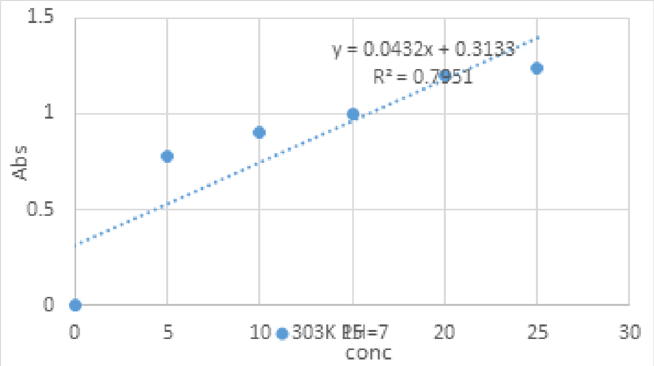


Figure 2: Titration curve for murexide at 303 K and pH = 7

adsorbent's temperature on the adsorbent surface within the thermal range on the dye adsorption process.

RESULTS AND DISCUSSION

Adsorption on the surface of tertiary antimony oxide Equilibrium time effect Figure 3 shows the effect of the equilibrium time in minutes on the percentage values of murexide adsorption at 303 K. Effect of the amount of adsorbent surface on adsorption. At a temperature of 303 K, the influence of surface weight on the quantity of adsorption was investigated, as was the time necessary for the equilibration process to occur, and five different weights, 0.50, 0.40, 0.30, 0.20, and 0.10 were employed with an initial concentration of murexide of 15 mg/L, as demonstrated in Figure 4. Murexide adsorption is optimum at a weight of 0.5 g. The amounts of adsorption on the surface of antimony oxide within the experimental temperature range of 303 to 313 K for each of the murexide at a concentration range of 30-50 mg/L and an acidic function pH = 7 for each of the murexide at a range of concentrations 30-50 mg/L and an acidic function pH = 7, (Figure 5) that had been shown the correlation the amount of the adsorption at equilibrium, the equilibrium concentration and form of general adsorption isotherms indicates which it is from S-shape Gils category Adsorption Equilibrium and Adsorption Isotherms Models fi.[6] Table 3. The plasmotherm is the data of the adsorption capacity (the quantity of adsorbed material) for a range of concentrations in the liquid phase or molecular pressures of gas or vapor at a constant temperature that reflects the arrival of the equilibrium to the state of equilibrium. The isotherm is a mathematical relationship that is generated and altered to characterize a specific adsorption system to get some required data about the nature of adsorbents and adsorbents and to investigate adsorption ability. To compare the adsorption isotherm constants and correlation coefficients for murexide adsorption, use the Freundlich lines and Table 4.

Table 3: The amount of murexide adsorption by 0. 5 g, acidity parameter pH =7, and equilibrium time 30min

QE	*C_e*	*QE*	*C_e*	*Co*
313K		*303K*		
0	0	0	0	0
33	3.9	54	3.2	5
48	8.4	87	7.1	10
84	12.2	75	12.5	15
60	18	30	19	20
90	22	51	23.3	25

Table 4: The adsorption quantities of Freundlich's equation for murexide adsorption on 0.5g of Sb2O3 at temperature range (303-313K) and acidity parameter pH =7

Freundlich Isotherm			
313K		*303K*	
lnq_e	*lnc_e*	*lnq_e*	*lnc_e*
3.496508	1.360976553	3.988984	1.16315081
3.871201	2.128231706	4.465908	1.960094784
4.430817	2.501435952	4.317488	2.525728644
4.094345	2.890371758	3.401197	2.944438979
4.49981	3.091042453	3.931826	3.148453361

Kinetics of Adsorption

Kinetics of adsorption of this research shows mechanism adsorption process, as the amount of the adsorbent material increases with time. The adsorption is faster in its beginning due to the abundance of sites prepared for the adsorption process. Still, it decreases with the passage of time due to the saturation of most sites and becoming more occupied, which leads to the difficulty of attaching new molecules to the surface or difficulty Provides vacancies and adsorption kinetics give

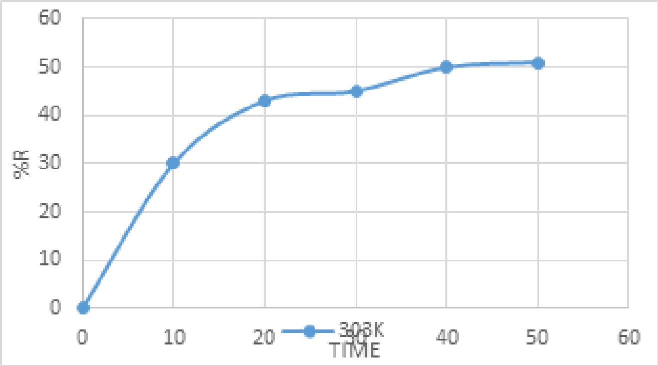


Figure 3: The percentage of dye removed is affected by the length of time spent in contact with antimony oxide.

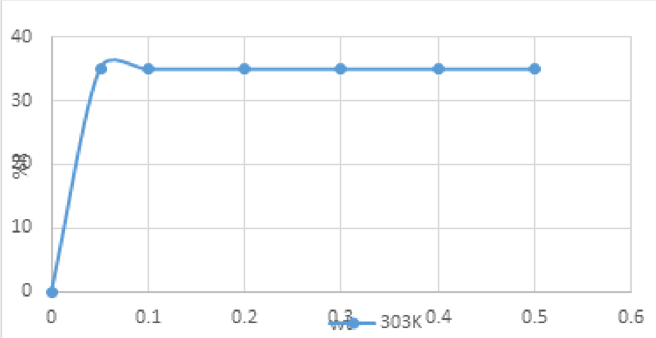


Figure 4: Surface weight effect on the percentage of hydroxide removal

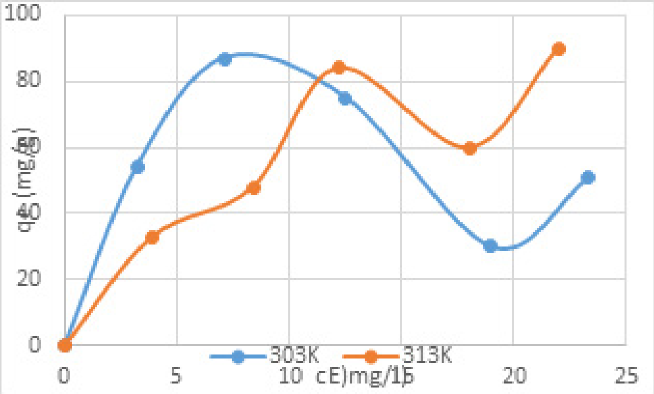


Figure 5: Murexide adsorption isotherm on Sb2O3 surfactant at temperatures ranging from 303 to 313K.

Table 5: Kinetic pseudo-second-order equation constants and the correlation coefficient for murexide adsorption at o.5g, PH=7 and an initial focus of 15 mg/L

Dye	*Linear equation of Kinetic model*	*Parameters*	*Temperature*	
Murexide	Pseudo second order		303K	313K
	$\frac{t}{q_t} = \frac{1}{k\,q_e^2} + \frac{1}{q_e}$	k(mg /g min^{-1})	0.0001	0.0004
		R^2	0.8441	0.98

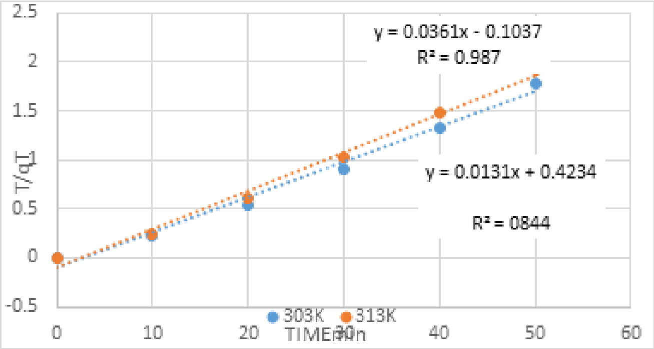


Figure 6: The linear relationship of the pseudo-second-order equation for peroxide adsorption under conditions 0.5g from Sb_2O_3 , Initial concentration 16mg/L, and thermal range 303 to313K

an idea about the design of the adsorption process. If Table 5 shows the constants of the pseudo-second-order equation, and Figure 6 shows the linear relationship of the equation. It was noted that a reaction leads to the pseudo-second-order equation.[7]

CONCLUSION

In this study, the possibility of using antimony oxide was tested in the adsorption of one of the wastes, which is the murexide dye polluting the environment. The process was successfully completed, and the possibility of solid oxide was proven. The adsorption kinetics was studied, and the kinetics of pseudo-second-order reactions were consistent.

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