Pure Sciences International Journal of Kerbala

Year:2024 Volume : 1 Issue : 1 ISSN: 6188-2789 Print 3005 -2394 Online

Maha Jassim Manshad [1] , Ala'a H.AL-ogaili [2], Hussein Hazim Al-Ghanimi [3], Ali H.Chafat [4] , Use of Pomegranate peel powder as a low cost Adsorbent for the Decolorization of Azure C dye, Pure Sciences International Journal of Kerbala, Vol. 1, No. 1, (2024) 49-54

2024 ,Volume 1 , Issue 1 PSIJK 49-54

Pure Sciences International Journal of Kerbala

Journal Homepage:https://journals.uokerbala.edu.iq/index.php/psijk

Use of Pomegranate peel powder as a low cost Adsorbent for the Decolorization of Azure C dye

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P A P E R I N F O

Paper history:
Received 28 February 2024
Accepted 16 March 2024
Published 31 March 2024

Keywords:
Azure C , adsorption, isotherms , modified Pomegranate peel powder , Langmuir and freundlich

A B S T R A C T

In the current research, the modified pomegranate surface was used.It showed good results and high efficiency in removing pollutants from aqueous solutions. It was used to remove the azure C dye from its aqueous solutions, which is considered one of the harmful dyes.The following conditions were studied(equilibrium time, weight, pH function, temperature), The removal rate was 99.17% at a time of 10min, a weight, a temperature of 25^0C, and an acid pH 8, Thermodynamic constants(ΔS, ΔH, ΔG) and adsorption isotherms(Langmuir, Freundlich) were also examined.

1. INTRODUCTION

As a result of the technological improvements that have followed our everyday lives, pollution is a serious problem that affects both individuals and the environment. Pollution may take many forms, contaminating soil, water, and the air[1].Certain components normally present in the environment in balanced proportions might grow or decrease in quantity when harmful organic or inorganic compounds are introduced into it by human activity or natural events [1,2] Many different sectors, including textiles, paper, rubber, plastics, cosmetics, and more, use dyes as colorants for their products.Accordingly, it is common for these colors to accumulate in industrial effluent and then leak into sources of surface water. It is important to remember that most of these colors are inactive and non-toxic [3].

However, some dyes poison and harm people. Depending on their chemical makeup, dyes can be categorized as acidic, basic, direct, active, or fatty [4] . Various methods, including ion exchange, sedimentation, adsorption, oxidation, ozonation, coagulation, flocculation, and biological processes, have been used to eradicate water pollution. [5,6].When molecules, atoms, or ions from a gas or liquid phase form bonds with solid surfaces, the process is known as adsorption [7]. An adsorbent is a material that exhibits adsorption behavior; examples of such materials include phenols, ammonia, dyes, and other contaminants. Conversely, the substance known as the adsorbent—such as activated carbon—is the surface where adsorption takes place. [8]. In recent times, several scientists have worked to create novel adsorbents by altering or using certain naturally occurring materials [9]. This technology is used to remove organic contaminants, hazardous chemicals, and colors from wastewater that are present in extremely low quantities and are difficult to remove using other techniques. fly ash, silica gel, and charcoal [10-12]. Because of its great effectiveness in filtering contaminants out of the water, the pomegranate's surface was employed in this investigation.

2.EXPERIMENTS

2.1.Materials

The chemicals used in the work are of global origin and without any purification, azure C dye was used , Pomegranate peel powder, melamine , formaldehyde, NaOH , HCl .

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2.2. Preparation of the dye

Azure C dye is considered one of the basic dyes. The dye was prepared at a concentration of 100 mg/L .A weight of 0.01 grams of Azure C dye was taken and dissolved with a small amount of distilled water in a Beaker's. Then it was placed in a volumetric bottle with a capacity of 100 milliliters and supplemented with distilled water up to the mark.Next, the range of concentrations is taken in order to extract a calibration curve. Figure. (1) shows the structure.

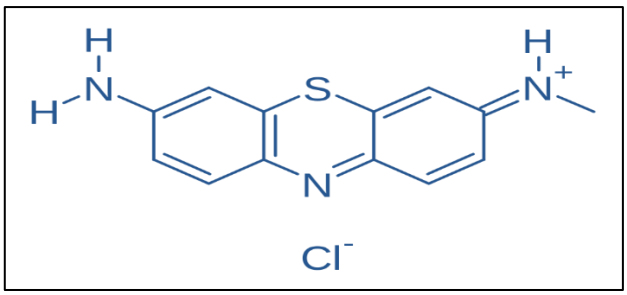

Figure 1. Structural formula of azure C dye [13]

2.3. Preparation the adsorbent (Pomegranate peel powder -melamine-formaldehyde polymer)

After weighing the PPMC, a conical flask was filled with the polymer to be prepared. To finish the union process between the formaldehyde and PPMC, 3 mL of formaldehyde was added, and the combination was left for 30 minutes. After that, the mixture was submerged in water heated to 900 C for two hours.

Adsorption Experiments

On a thermally controlled shaking water bath operating at 150 rpm, 0.01 g of sorbent was combined with 25 ml of a 5 mg/L dye solution. At the wavelength corresponding to λ max, a Shimadzu UV-Vis 1800 digital dual-beam appliance was used to examine the reabsorption capacity of the remaining dye in each therapeutic solution. We looked at the influence of temperature, pH, and communication time. The quantity of adsorb ate retained (mg) based on the weight of the adsorbent (g) is known as the adsorption capacity. It is expressed as the ratio x/m.

Elimination %=[(C_0-Ce)/C_0]×100	(1)

Ce denotes the dye's residual concentration at equilibrium in milligrams per liter, while C0 is the dye's original concentration in milligrams per liter .[14]

3. RESULTS AND DISCUSSION EFFECT OF CONTACT TIME

It was investigated whether there was an association between the contact time and the percentage of azure C removed utilizing modified pomegranate peel powder., as shown in Figure.2. The subsequent information refers to the balance time where, concentration 5 mg/L dye concentration, and 0.01 g adsorbent weight were studied.

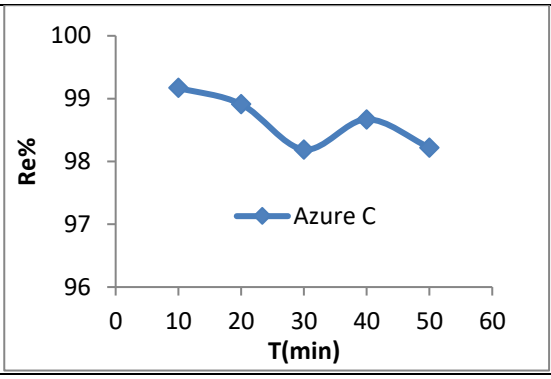

Figure 2. Effects of contact time on the adsorption of Azure C by modified pomegranate peel powder at 298 K

Effect of adsorbent weight

The experiment was conducted at 298 K with an initial dye concentration of 5 mg/L and an adsorbent weight range of 0.01~0.05) g. As weight increases, Figure 3 illustrates that removal efficiency rises as well. The increase in surface area of the adsorbent (modified pomegranate peel powder) results in an increase in its adsorption capacity. The pomegranate peel powder's active sites are then saturated when the efficiency reaches a constant value. Decide on 0.01 g as the ideal adsorbent material weight.

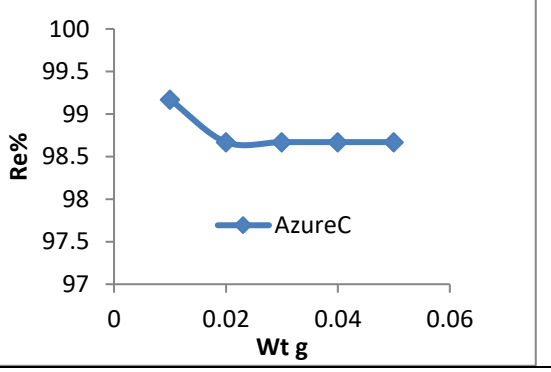

Figure 3. Effect of adsorbent weight on the adsorption of Azure C by modified pomegranate peel powder.

Effect of pH

Two, four, six, eight, and ten pH values were selected in order to comprehend the impact of acidity

on the clearance ratio. The investigated dye was generated at a concentration of 5 mg/L, and its pH was adjusted to fall within the stated pH range by adding 0.01N of HCL and NaOH. Thus, in the other trials, pH 8 was used.

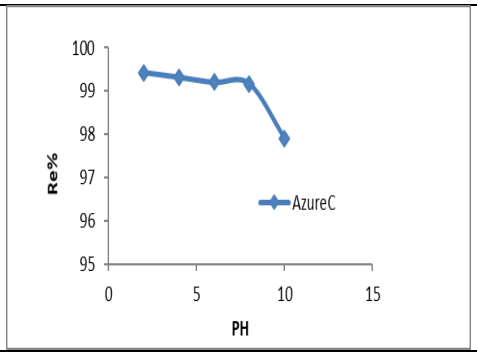

Figure 4. At 298K, the bearing of pH on the modified pomegranate peel powder's adsorption of Azure C was examined.

Effect of Temperature

By examining the impacts of temperature variations, the study sought to understand the nature of the adsorption process. According to their respective formulae, Table 2 displays the computed values of the adsorption parameters, such as Gibbs energy (ΔG), enthalpy (ΔH), and entropy (ΔS). [15,16] .

$\Delta G = - R T \ln K_{eq}$	(2)
$\Delta S = (\Delta H - \Delta G) / T$	(3)

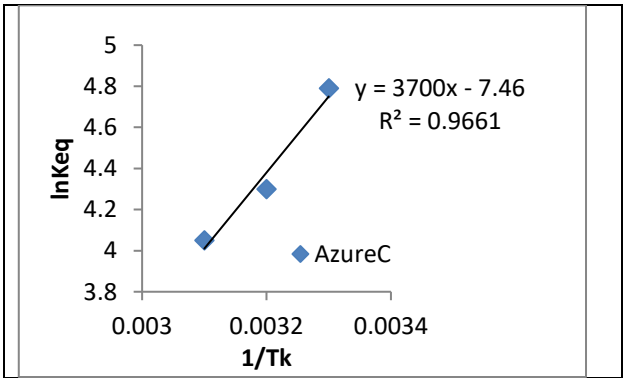

Figure 5. The effect of temperature on the modified pomegranate peel powder's adsorption of blue C dye.

TABLE 1. lists the temperature range in which the thermodynamic parameters ΔG, ΔH, and ΔS of the Azure C dye adsorbed on the modified surface of pomegranate peel powder were measured: 298 K to 318 K

(Adsorbate)	Temp. K	- ΔG (KJ/mol)	- ΔH (KJ/mol)	- ΔS (KJ/mol.K)
Azure C	**298**	11.86	30.76	0.063
	308	11.01		0.064
	318	10.70		0.063

We note that the functions "ΔG" and "ΔH" have negative values based on the values provided before. This implies an exothermic, spontaneous adsorption mechanism. Furthermore, during the adsorption process, the indications of ΔS show a reduction in the randomness of the adsorbed molecules. [17,18].

Adsorption Isotherm

The adsorption isotherms of Azure C on the modified pomegranate peel powder were depicted in Figure 6. The experimental conditions included pH 8.0, temperatures ranging from 298 K to 318 K, 0.01 g of adsorbent material, dye concentrations ranging from 1 mg/L to 9 mg/L, and a contact time of 10 minutes. These figures provide an evidence that the adsorption capacity increases with higher equilibrium concentrations of Azure C.

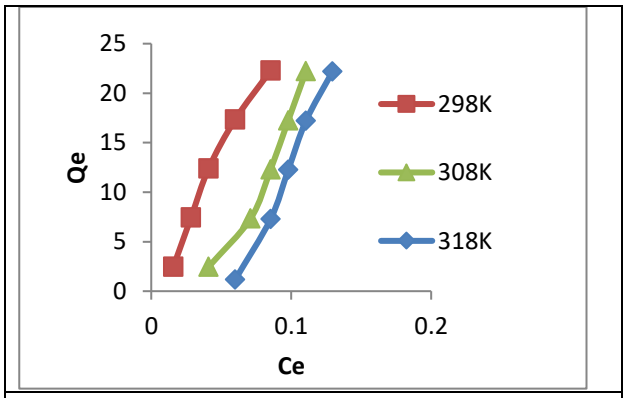

Figure 6. shows the adsorption isotherms of an aqueous solution containing Azure-C at different temperatures on modified pomegranate peel powder.

Langmuir isotherm

Based on the homogenous sites of the adsorbent, the Langmuir isotherm postulates that the adsorption process occurs[19].

$1/ab + Ce/a = Ce/Qe$	(4)

Where:

Ce is the equilibrium concentration of Azure C dye in the solution (mg/L), whereas Qe is the amount of Azure C dye that has been adsorbed at the equilibrium point (mg/g). A and B stand for the Langmuir constants. We can see the isotherm in Figure 7.

The connection between the Langmuir constant (b), the initial dye concentration in the solution (C0), and the Separation Factor (RL) is seen in equation (7). In particular:

$$R_L \text{ is } = 1 / (1 + b * Co) \quad (5)$$

Where:

The starting dye concentration in the solution is indicated by C_0 (mg/L).

Langmuir constant (L/mg) is denoted by b.

The Separation Factor is R_L.

The R_L values show the kind of adsorption.is indicated by an R_L value of 0, favorable adsorption Irreversible adsorption is shown by an R_L value between 0 and 1, linear adsorption is indicated by an R_L value of 1, and unfavorable adsorption is specified by an R_L value larger than 1. [20,21]

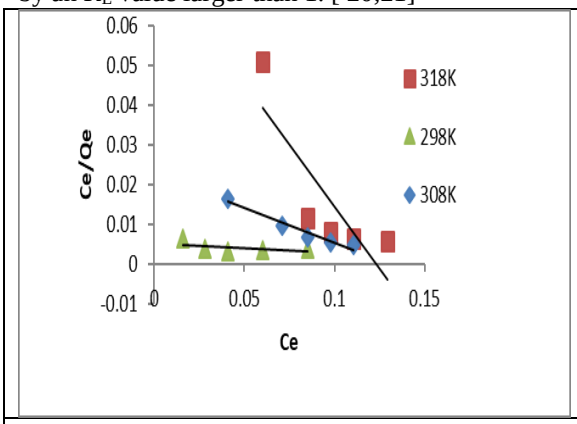

Figure 7. Using Langmuir isotherms, the adsorption of Azure C dye was investigated at different temperatures.

Freundlich isotherm

Log Ce and log Qe have a connection which described by the Freundlich isotherm, an empirical equation based on adsorption on a heterogeneous surface [22]. Figure 8 shows how these relationships work. The Freundlich isotherm may be expressed using this equation.

$$\log Kf + 1/n \log Ye = \log Qe \quad (6)$$

Where, Qe is the quantity adsorbed at equilibrium (mg/g), Ce is the adsorbate's equilibrium concentration (Azure C), Kf is the adsorption capacity, and n is the adsorption strength.An empirical equation based on adsorption on a heterogeneous surface is called the Freundlich model [23,24].

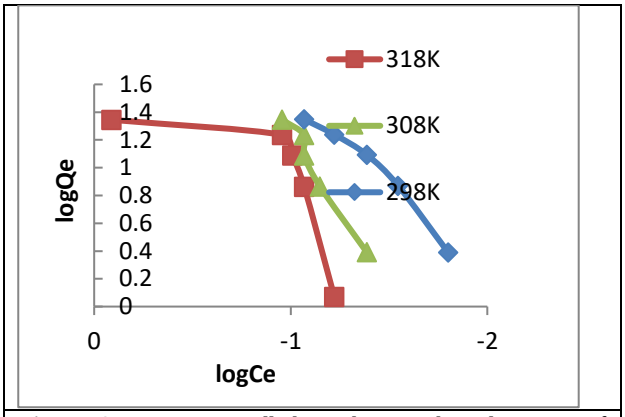

Figure 8. Using Freundlich isotherms, the adsorption of Azure C dye was examined at various temperatures.

TABLE 2. shows the analysis of Azure C's adsorption isotherms at temperatures between 298 and 318 K to find the Langmuir and Freundlich parameters.

	adsorbate azure C						
T	**langmuir isotherms**				**freundlich isotherms**		
	a(mg/g)	**b(mg/L)**	**r^2**	**R_L**	**Kf**	**n**	**r^2**
2	- 36.496	- 0.0806	0.3397	1.675	663.132	0.7663	0.9582
3	-5.787	- 7.6123	0.95	- 0.0269	3756.64	0.4348	0.9639
3	-1.603	- 0.1227	0.7104	0.2279	36.5510	1.3518	0.4233

4. CONCLUSION

This work shows that modified pomegranate peel powder works well as an adsorbent to remove Azure-C dye from aqueous solutions. The results provide more advantages for treating industrial wastewater than just cutting waste. The adsorption of blue C dye on the surface of pomegranate peel powder is a spontaneous isothermal process, as demonstrated by the thermodynamic function.

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Arabic Abstract

تم استخدام سطح الرمان المحورة والذي أظهرت نتائج جيدة وكفاءة عالية في إزالة الملوثات من المحاليل المائية. تم استعمال السطح لإزالة صبغة C الزرقاء من محاليلها المائية والتي تعتبر من الصبغات الضارة. وتمت دراسة الظروف التالية (زمن التوازن، الوزن، دالة الرقم الهيدروجيني، درجة الحرارة)، وبلغت نسبة الإزالة 99.17% عند زمن 10 دقائق، وزن، درجة حرارة25مئوية، وPH 8 ، والثوابت الديناميكية الحرارية (ΔS، ΔH، ΔG) وتمت دراسة ازوثيرمات الحرارة (Freundlich ،Langmuir).