Study of performance amount of zeolite in the removal of Direct Blue 151 dye from aqueous solutions

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Abstract: In the case of Direct Blue 151 dye was observed causes numerous adverse environmental effects such as carcinogenesis, mutagenesis and chromosomal damage. Therefore the aim of this research is to investigate amount of dye analysis DB-151 by zeolite. Effect dye concentrations (25-75 mgL-1), contact time (5-15 min), adsorbent dosage (0.3-0. 9 g) and pH (4-10) were investigated in the removal of dye. The results show that the process of DB-151 has a high ability to remove of dye and dye degradation efficiency by increasing adsorbent dosage, pH and time increases and has inverse relationship with increasing concentration of dye.
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1. Introduction

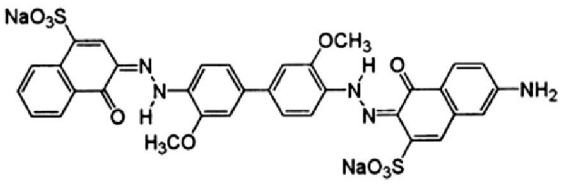
Degradation of dyes available in effluents of textile manufactures is one of the most important and most controversial environmental problems are considered [1, 2]. There are in terms of chemical structure of different dyes in various types are classified such as acid dyes, reactive, basic, disperse, azo, diazo, anthraquinone, metal, sulfur, Triphenylmethane and Phthalocyanine. Textile wastewaters are mainly consists of this dyes that are damaging to the environment [3-5]. About 60 to 70 percent of the total dyes production is azo dyes that is contain one or more bonds azo [6, 7]. The inherent toxicity of some of azo dyes has harmful effects on fish and microorganisms and is even causing their death. Some other of these dyes is also cause eczema and cancer in humans [8, 9]. For removal of dye from wastewater, different methods are presented such as ion exchange, advanced oxidation, electrochemical degradation and adsorption are pointed [10-13]. Adsorption process among these techniques in terms of initial cost, simplicity and flexibility, easy operation, insensitivity to toxic compounds, the ability to remove organic compounds and inorganic such as dyestuff materials and odor-producing compounds, more than other methods are considered [14, 15]. Immense natural zeolites are easily, accessible and also cheap. Zeolite to remove many contaminants, including dyes, ammonium ions and heavy metals from solutions of azo group dyes from aqueous solutions have been used [16-18]. So according to Content that mentioned, the main purpose of this study is to investigate the removal of dyes DB-151from aqueous solutions and compare the amount of removal by zeolite.

2. Experimental

2.1. Chemicals

The materials is used in this study include zeolites, HCl and NaOH. For preparation of zeolite, specific weight of intended zeolite washed several times with distilled water and was dried at a temperature of 105°C. Then size particles zeolite test are determined using of sieve shakers and size of 1 mm in this test was selected. To reach the volume of solution of double distilled water was used. General characteristics desired dye is shown in Table 1.

Table 1. General characteristics of Direct Blue 151.

Chemical stracture	
Molecular Formula	$C_{34}H_{25}N_5Na_2O_{10}S_2$
Molecular weight ($gmol^{-1}$)	773.70

2.2. Adsorption experiments

DB-151 dye removal studies were conducted in closed conditions. The effect of four variables on amount of dye removal was investigated. The value of each variable is presented in Table 2. In this study, stock solution of 1000 mgL-1 of DB-151 dye was prepared. Tests with the addition of 0.3-0.9 g sorbent to 100 ml dye solution in epithelial 200 ml was done. PH samples were adjusted by solution of NaOH 0.1 M and HCl 0.1 M. To create the proper mix between adsorbateand absorbent materials from shaking machine was used with 400 rpm. Concentrations of residual dyes in solution in the maximum absorption peak were measured by UV-Visible spectrophotometer. All of tests absorb thrice repetitionsand mean values for final results were used in the calculations. Dye removal percentage by equation (1) was calculated.

$$(\%)\ \text{Dye removal} = \frac{c_o - c_t}{c_o} \times 100 \qquad (1)$$

Where Co and Ct are the dye initial concentrations of dye and the concentration of dye at reaction time t (min), respectively [12].

Table 2. Levels and variables used for removal of Direct Blue 151.

variables	Unit		Levels	
Adsorbent dose	g	0.3	0.6	0.9
Dye concentration	mgL^{-1}	25	50	75
pH	---	4	7	10
Contact time	min	5	10	15

3. Results

3.1. Effect of pH

In this study, dye concentration of 25-75 mgL-1, in pH 4-10 and in the presence of 0.9 g was adsorbent. The results of the effect of pH on dye removal are presented in Figure 1. Due to figure, increase in pH of 4 to 10 percent has increased dye removal.

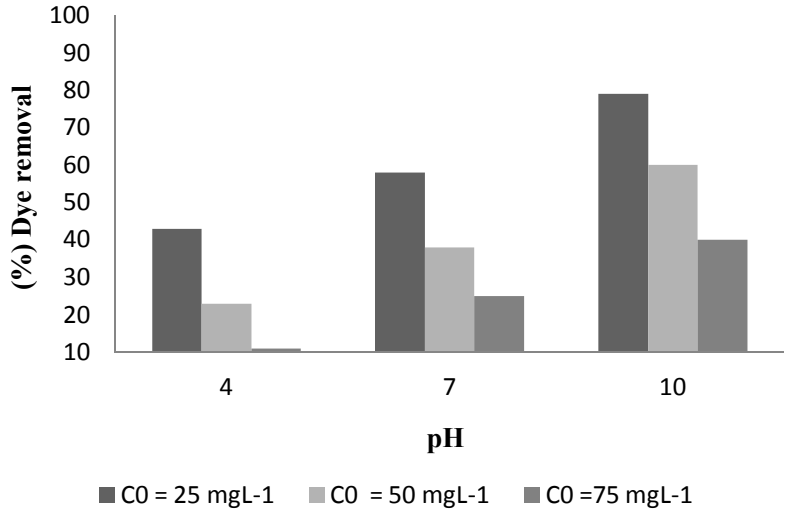


Fig 1. Effect of pH on the DB-151 dye removal (dye concentration=25, 50 and 75 mgL^{-1}, zeolite amount=0.9 g, contact time=10 min)

3.1. Effect of adsorbent dose

This study in dye concentrations of 25-75 mgL-1, pH = 7 and the contact time was performed 10 minutes. Absorbent amounts were 0.3-0.9 g, Figure 2 shows the effect of amount of adsorbent on amount of dye removal. The results show that by increasing the amount of absorbent from 3.0 to 9.0 g has increased amount of dye removal.

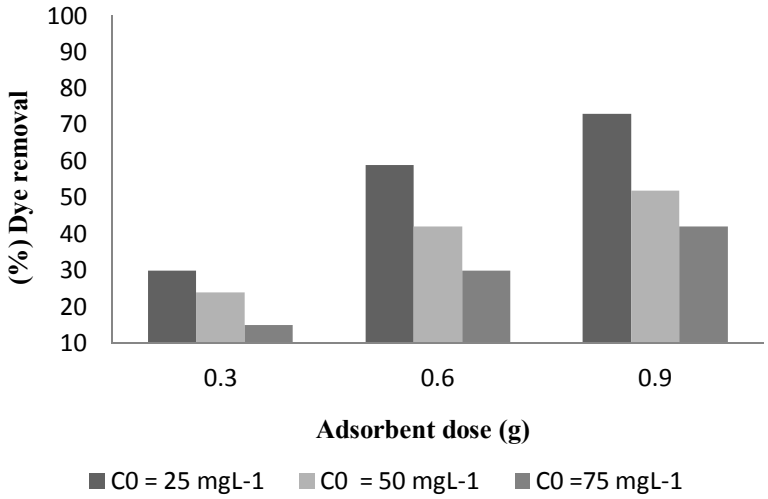


Fig 2. Effect of zeolite amount on the DB-151 dye removal (dye concentration=25, 50 and 75 mgL^{-1} and pH=7)

3.1. Effects of dye concentration and contact time

According to Figure 3 with the increasing dye concentrations of 25 to 75 mgL-1 is decreased amount of dye removal. While increasing contact time from 5 to 15 minutes in all concentrations have uptrend amount of dye removal.

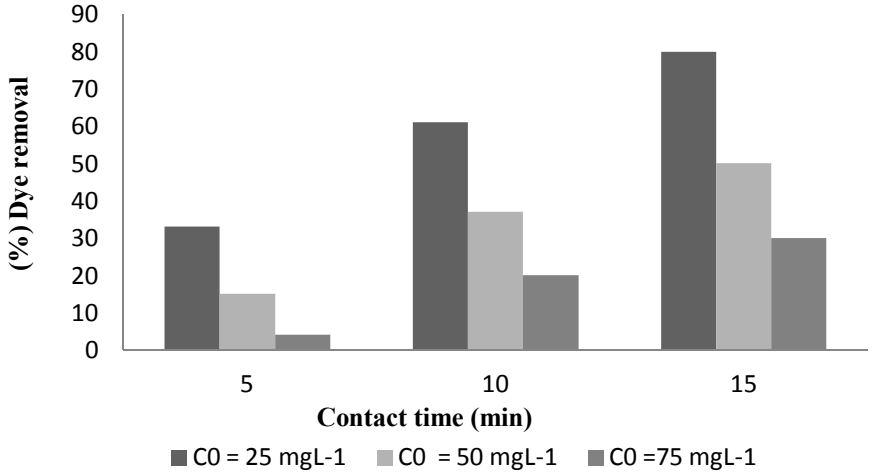


Fig 3. Effects of dye concentration (25, 50 and 75 mgL^{-1}) and contact time (5 – 15 min) on DB-151 dye removal by zeolite.

4. Discussion

According to Figure 1, the results of this study indicate that pH of base is for reach to maximum in effective dye removal. This point has been demonstrated in previous studies that the solution pH could on absorbent surface charge, the degree of ionization of different pollutants and separate of applications groups on absorbing active sites and also dye molecules structure are affect [19-21]. Since the DB-151 dye is a cationic dye and absorbent level in pH base has a negative charge, it helps to remove cationic dyes. As shown in Figure 2, percentage of dye removal DB-151, and adsorbent dosage function was applied and increased with adsorbent dosage to a certain value increases dramatically. This result can be explained by this fact that absorb site, during

adsorption process for the remaining unsaturated and however, the number of sites available for absorb sites increases with increasing adsorbent dosage. Based on the results in Figure 3, dye absorption was very rapid during the early times then absorption rate decreases As time goes and is proportional to the time, the upward trend has equilibrium state. It is due to this fact that at the beginning and in the early stages of absorption, a large number of empty surface sites been available with time for carrying out absorption and remains in empty surface site and confronted with trouble in the absorption of pollutants that this could be due to deterrent forces between molecules adsorbates on the surface absorbent and liquid mass [22, 23]. Initial dye concentrations, providers a driving force substantially to overcome on all resistance result of colors mass transfer between liquid and solid phases [24, 25]. Obtained results for both adsorbents showed that increasing concentrations dye decreases its removal percent that this could be due to occupancy absorbing levels by color molecules and less access absorbing molecules to dye molecules [26, 27].

5. Conclusion

In the present study for dye adsorption was used from zeolite. The effects of four independent variables including dye concentration (25-75 mgL-1), contact time (5-15 min), the amount of adsorbent (0.3-0.9 g) and pH (4-10) on the dye adsorption was studied. Optimal values were obtained for dye concentration, contact time, adsorbent dosage and pH respectively 50 mgL-1, 10 min, 0.9 g and 7. The results showed that the adsorption efficiency increases with increasing adsorbent dosage, pH and time and has inverse relationship with increasing concentration of dye.

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