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# Removal of Methylene Blue Dye From Aqueous Solution Using Natural Boron Ore And Leach Waste Material: Adsorption Optimization Criteria

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**KEYWORDS**

Adsorption, boron leach waste, methylene blue, natural boron ore, color removal

**A B S T R A C T**

Colored wastewater damages the esthetic nature of water and the photosynthetic activity of aquatic organisms. Many industries, such as plastics, textile, paper and printing use dyes in order to color their products. We used Methylene Blue (MB, Basic Blue 9, C.I. 52015 ) in our study. The studies showed that some natural mine materials have the highest adsorption capacity for decolorization type of basic dyes compared with other adsorbents. The effects of contact time, stirring speed, pH, initial concentration, adsorbent dose, and temperature on the adsorption of methylene blue onto boron was investigated in this study. Natural boron ore was tested as an adsorbent for the removal of Methylene Blue (MB) dye from aqueous solutions at different operating conditions; initial dye concentration (100 mg/L). The influences of temperature, stirring speed and solution pH were examined at 25, 35 and 45 ºC, 100 to 400 rpm and in the pH range from 2 to 12. Experiments were carried out by using 200 mL methylene blue solution. In accordance with the results of this study, it can be concluded that adsorption capability of natural boron ore and leach waste for the removal color from aqueous solutions is quite high.

## Introduction

Environment Protect is concerned with wastewater treatment, water treatment, sanitary landfill, air pollution, industrial waste treatment etc. in todays. The most important of these issues is the wastewater treatment for environmental engineering. Wastewaters from dying and finishing operations in the textile industry are generally high in both color and organic content.

Color removal from textile effluents has been the target of great attention in the last few years, not only because of its potential toxicity, but mainly due to its visibility problems (Yu-Li and Thomas 1995; Morais et al, 1999). Dye pollutants from the textile industry are one of the most important sources of environment contamination. Once the dyes enterwastewater, they become more

stable and are more difficult to biodegrade because of their complex chemical structures (Forgacs et al, 2004). Industries such as textile, leather, paper, plastics, etc., use dyes in order to color their products and also consume substantial volumes of water. As a result, they generate a considerable amount of colored wastewater (Ravi et al, 2005). The conventional treatment methods for dye effluents, such as oxidation (Arslan et al, 2000; Thangamani et al, 2011), coagulation (Panswed et al, 1986; Szygula et al, 2009; Verma et al, 2012), flocculation (Wang et al, 2012), photochemical destruction (Deng et al, 1997), ion exchange, and membrane filtration (Ciardelli et al, 2000), are complicated and costly, in particular as some methods require additional chemicals or produce toxic products (Wang et al 2013). Among these methods, adsorption has been shown to be an efficient and economical alternative for the removing of dyes from aqueous solutions (Madrakian et al 2012).

## Experimental

In our laboratory, the work is in process to evaluate the possibility of the compose of synthetic dyestuff for wastewater pollution and use boron ore and boron leach waste as a absorbent.

### Sorbent preparation

In our study, as adsorbent boron ore and boron leach waste material was used in laboratory. Boron ore is a completely natural adsorbent and a ore substance. A natural mineral material, boron ore used as absorbent. Boron leach material is consist from boron ındustrial's enrichment waste. Absorbent natural boron ore the Balıkesir region and boron leach of ındustrial's enrichment waste (boron enrichment plants waste), Eti Mine Works General Management, Bigadiç Boron Operations Management, than is provided.

### Sorbate preparation

Methylene Blue (MB, basic blue 9, C.I. 52015; chemical formula, ($C_{16}H_{18}ClN_3S{\cdot}3H_2O$; MW, 373.90 g $mol^{-1}$) was used as the adsorbate in this study. The obtained chemical formule was shown from the Fig.1. The dye solutions used in the experiments (1000 mg/L) were prepared by dissolving the required amount of dye in distilled water. The working solutions were prepared by diluting the stock solution with deionised water to give the appropriate concentration of the working solutions. The volume of colored solution (sample) was 200 mL. The MB 9 concentration was determined spectrophotometrically at λmax = 661 nm using a double beam UV VIS spectrophotometer (Shimadzu, Japan). The concentration of the residual dye was measured using UV/visible spectrometer at a λmax corresponding to the maximum absorption for the dye solution (λmax= 661 nm) by withdrawing samples at fixed time intervals, filtered, and the supernatant was analysed for residual MB.

The treatment efficiency was evaluated by using Eq. (1) which was based on measured MB 9 concentrations:

The equilibrium amount of adsorbed dye per unit mass, qe (mg $g^{-1}$) were calculated using the following equations:

$q_e = \frac{(Co - Ce) * V}{W}$ here $C_0$ and $C_e$ (mg $L^{-1}$) are the initial and equilibrium concentrations of the dye solution, respectively. V is the volume of the dye solution (mL) and W is the amount of the adsorbent (g).

**Removal efficiency (%) = [ (Ct – Co ) /Co ]* 100**

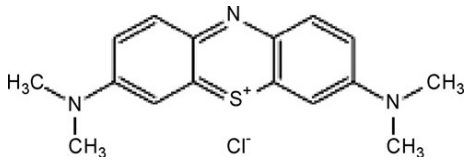


**Figure.1** Methylene Blue in the Formula

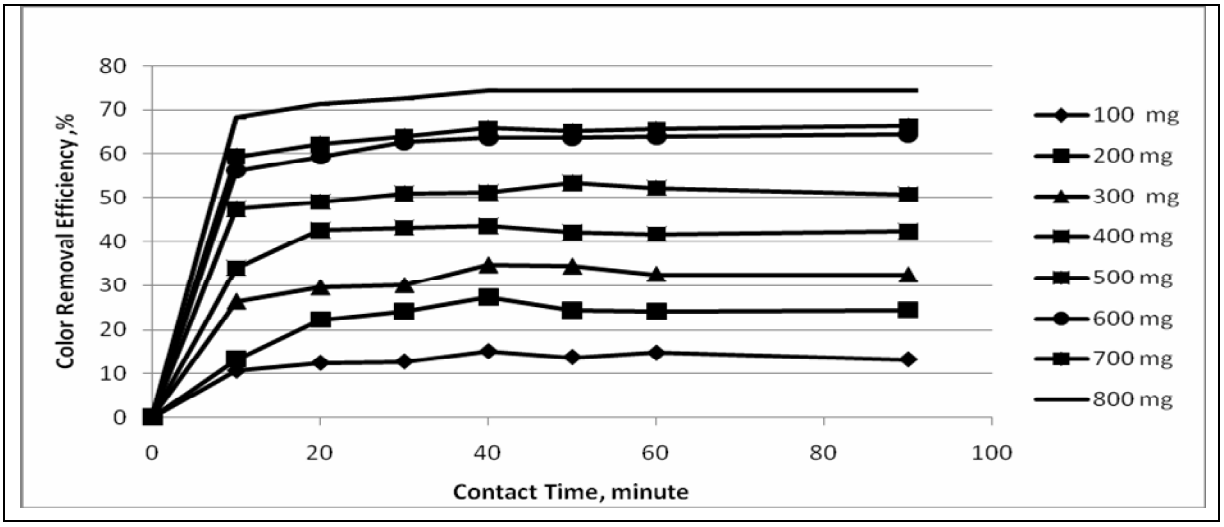


**Figure.2** Effect of contact time and adsorbent dosage (boron Ore) on Methylene Blue dye

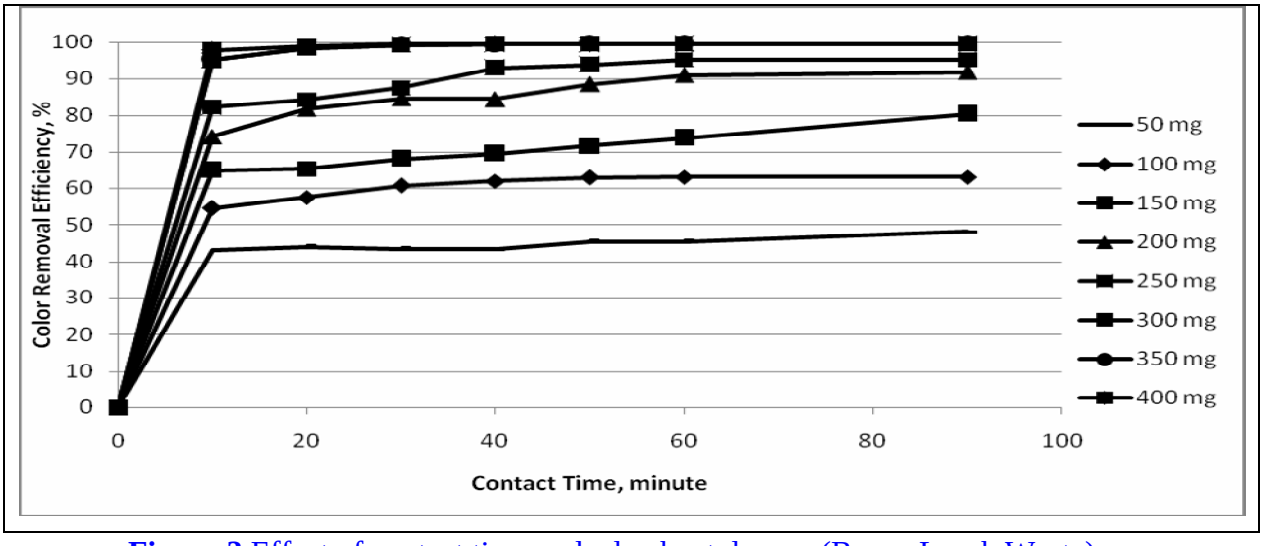


**Figure.3** Effect of contact time and adsorbent dosage (Boron Leach Waste) on Methylene Blue dye

### *Effect of pH*

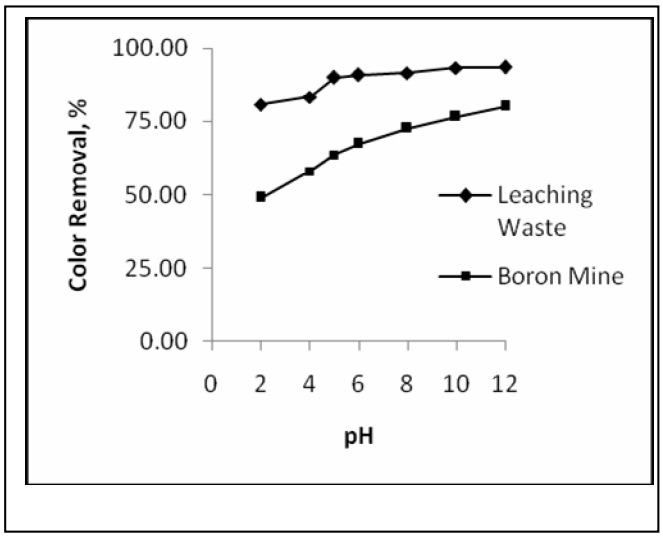


**Fig. 4** that the Boron Ore's operation conditional is 100 mg/L dye solution concentration, original temperature, 200 rpm stirring speed, 40 minutes contact time and 600 mg/200 mL adsorbent dosage. The operation condition was decided 100 mg/L dye solution concentration, original temperature, 200 rpm stirring speed, 40 minutes contact time and 150 mg/200 mL adsorbent dosage for Boron enrichment waste (leach waste). When the obtained results were examined, %76 efficiency was calculated for boron ore at pH 10 and % 78 efficiency was calculated in boron enrichment waste at the pH 8 value. In the study of boron enrichment waste (leach waste), removal efficiency increased in parallel with increasing pH. This value was accepted appropriate for not leading to a need for an extra consumption in the actual field application.

**Figure.4** Effect of pH on the adsorption of Methylene Blue by boron ore and boron leach waste

### *Effect of Agitation (Stirring) Speed*

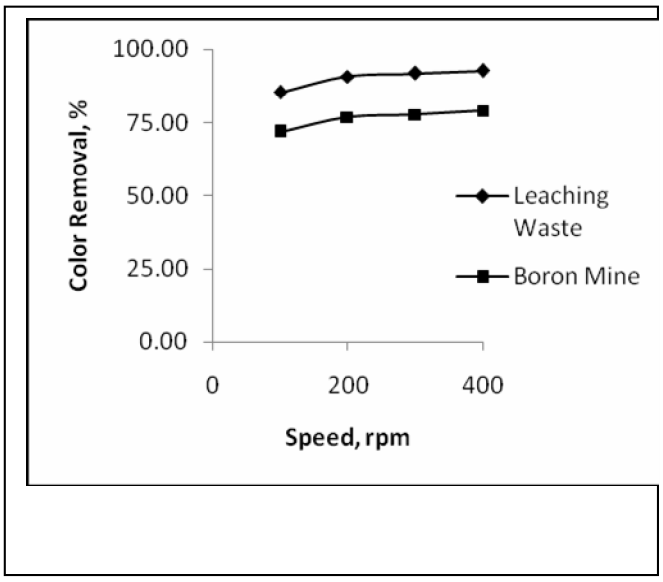


**Fig. 5** that the Boron Ore's operation conditional is 100 mg/L dye solution concentration, original temperature, pH 10, 40 minutes contact time and 600 mg/200 mL adsorbent dosage. The operation condition was decided 100 mg/L dye solution concentration, pH 8, 40 minutes contact time and 150 mg/200 mL adsorbent dosage for Boron enrichment waste (leach waste). As a result of laboratory studies, It was detected that both in boron ore and the use of boron enrichment waste, the pre-determined 200 rpm values provide the most appropriate removal. In both studies, when the speed rate was increased, colour removal increased, too. But, the fact that this is a negligible amount made this value acceptable. In conclusion, 77% color removal was obtained in boron ore at 200 rpm, and 80 % color removal was obtained in boron enrichment waste (leach waste).

**Figure.5** Effect of Stirring Speed on the adsorption of Methylene Blue by boron ore and boron leach waste

### *Effect of Temperature*

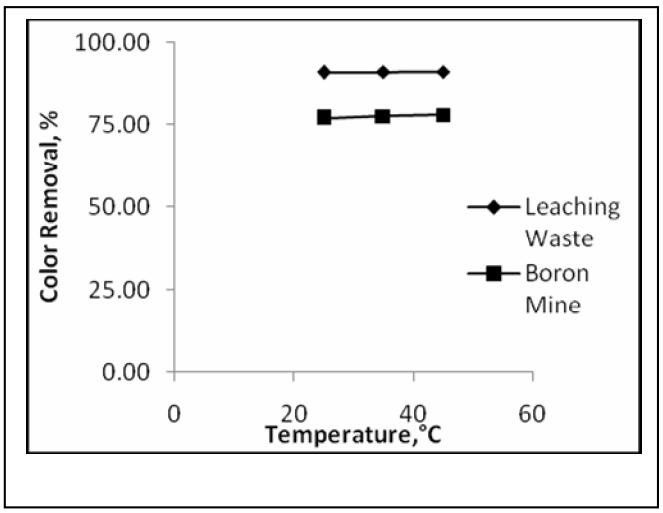


**Fig. 6** that the Boron Ore's operation conditional is 100 mg/L dye solution concentration, Stirring speed 200 rpm, pH 10, 40 minutes contact time and 600 mg/L adsorbent dosage. The operation condition was decided 100 mg/L dye solution concentration, pH 8, 40 minutes contact time and 150 mg/L adsorbent dosage for Boron enrichment waste (leach waste). The results made clear that the temperature does not have a significant effect in boron ore, nor during the adsorption of boron enrichment waste (leach waste). Accordingly, it was determined as 25 °C for the study.

**Figure.6** Effect of temperature on the adsorption of Methylene Blue by boron ore and boron leach waste

## Result and Discussion

The effects of contact time, stirring speed, pH, initial concentration, adsorbent dose, and temperature on the adsorption of methylene blue onto boron and boron leach waste was investigated in this study.

### *Effect of contact time and concentration*

The adsorbate concentration and contact time between adsorbent and adsorbate species play a significant role in the process of color removal from water and wastewater by adsorption at a particular temperature, stirring speed, and pH. The results of contact time investigation using with diffrent adsorbent dosage were analysed. It is observed that as the particle dosage increased the amount of adsorbed dye increased. Natural boron ore and boron leach waste was tested as an adsorbent for the removal of Methylene Blue (MB) dye from aqueous solutions at different operating conditions; initial dye concentration (100 mg/L). In this study, boron ore is examined range from 100 to 800 mg/200 mL and boron leach waste is examined range from 50 to 400 mg/200 mL as a adsorbent dosage. Contact time was investigated from 0 to 90 minutes respectively. Experiments were carried out by using 200 mL methylene blue solution. In accordance with the results of this study, it can be concluded that adsorption capability of natural boron ore and leach waste for the removal color from aqueous solutions is quite high. It is evident from Fig. 2 and Fig. 3 that the adsorption of Methylene Blue from a solution removal efficiency.

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