Treatment of Textile Waste Water with Organoclay

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ABSTRACT: *In this study a sample of bentonite obtained from Semnan mines, was modified by a surfactant to prepare an organoclay with high surface area. BET analysis showed that the modification increased its surface significantly. The prepared sorbent was used for removal of dyes and other organic pollutants from a waste water obtained from Ekbatan textile company. Adsorption was studied in various times to obtain the saturation time. pH variation has significant effect on adsorption and led to variation of adsorbed pollutant. At pH=4.5 the pollutant concentration became minimum which showed the pH is optimum pH for adsorption. Increasing the sorbent to waste solution ratio up to 1.2 g/L also increased the sorption. Adsorption isotherm was investigated for fitting with Langmuir isotherm and it has good fitness.*

KEY WORDS: *Bentonite, Organoclay, Textile waste water, Treatment.*

INTRODUCTION

Bentonite, which is predominantly montmorillonite clay, is characterized by one Al octahedral sheet, placed between two Si tetrahedral sheets. This isomorphous substitution of Al^{3+} for Si^{4+} in the tetrahedral layer and Mg^{2+} for Al^{3+} in the octahedral layer results in a net negative surface charge on the clay. This charge imbalance is offset by exchangeable cations (typically Na^+ and Ca^{2+}) at the clay surface. The layered structure of the clay allows expansion after wetting. Na^+ and Ca^{2+} are strongly hydrated in the presence of water resulting in a hydrophilic environment at the clay surface. As a result, natural bentonite is ineffective sorbent for nonpolar and nonionic organic compounds in water even though it has high surface area. Surface properties of natural bentonite can be greatly modified by simply ion-exchange reactions. When large organic cations (cationic surfactant) such as $(CH_3)_3NR^+$, exchange with cations (where R is a large (C-12 or greater) alkyl hydrocarbon), converts it from hydrophilic to hydrophobic [1].

Large volumes of colored aqueous effluents are discharged by various industries, such as textiles, leather, printing, laundry, tannery, rubber, plastic, painting, drilling operation, detergent, etc [2]. Presence of very low concentrations of these effluents potentially leads to inhibit the photosynthesis.

Owing their chemical structure, dyes are resistant to fading when exposed to light, water and chemicals [3].

Reactive dyes are most widely used dyes, in the textile industry. These types of dyes are colored compounds that are highly soluble in water and have reactive groups which are able to form covalent bounds between dye and fiber [4].

Removal of color from dye-house waste waters is currently one of major problems faced by the textile dyeing industry. Various physical, chemical and biological treatment methods have been used for treatment of these textile effluents. However, these methods have certain disadvantages such as high capital cost and operational

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costs or secondary sludge disposal problems. Instead of these methods, the adsorption technique can be applied to remove these kinds of textile effluents.

The surface of the natural clays should be modified by a cationic surfactant for dye adsorption experiments. By the ion-exchanged mechanism, the inorganic cation could be exchanged by the organic surfactant cations. Thus this modification is termed as organoclay and the introduction of organic cation leads to increase of its capacity comparing with natural clay mineral, so it can be used as adsorbent for the adsorption of dyes [5].

The aim of the present work is to study the adsorption capacity of surfactant modified bentonite for removal of dye from textile industry waste water. Real waste water from Ekbatan textile industry was used for this purpose. This waste includes a wide range of chemical pollutants such as dyes, detergents and additives which are environmentally harmful.

EXPERIMENTAL SECTION

A waste water obtained from Ekbatan textile company was used as pollutant. The waste was obtained from dying and washing units which are collected in the same zone and contains blood, sulphurous and reactve paints, polymers, NaOH & detergents. COD was higher than 1000 ppm and the pH was 13. Waste water concentration was determined by a Jenway 6305 UV-vis spectrometer in wavelength rang of 200-620 nm which is shown in Fig. 1. Organoclay was prepared by modifying the surface property of bentonite obtained from Semnan mines using the methods explained elsewhere[1,5,6] and it was used for removal of dyes and other pollutants. Surface area of the bentonite was increased from 82 to 579 m^2/g by modifying which led to significant increase of adsorption property.

500 ml of the waste solution was put in a 1L beaker for treatment. Sulfuric acid was added slowly and stirred with a magnet stirrer to have acidic media. It should be mentioned that industrial sulfuric acid was used instead of pure one because of economical considerations. Experiments were done at various pH of 2, 4, 6, 8 and 10 and adsorbent to solution ratios of 0.5, 0.7, 1, 1.2, 1.5 and 2 g/L. Different adsorption times of 10, 20, 30, 40 and 50 minutes were also investigated at room temperature. As the high speed of stirring can lead to some problems in large scales, the stirring was done at 350 rpm which is a moderate speed.

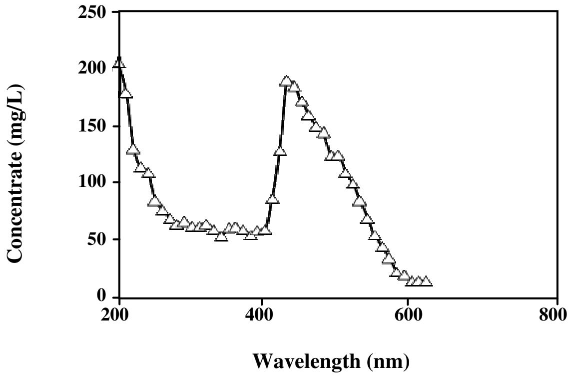

Fig. 1: Pollutants concentration in waste.

At the end and when the optimum conditions were founded an experiment was done by aeration of waste solution using an air pump. The results showed that aeration has positive effect on COD decrease.

RESULTS AND DISCUSTION

BET isotherms of the samples are shown in Figs. 2 and 3. Specific surface area of bentonite was increased significantly by modifying it using surfactant. It was 82 m^2/g for unmodified bentonite and 579 m^2/g for modified one. Pore volume of the modified samples was also increased significantly which causes to increase of adsorption property up to several times comparing with natural bentonite.

Fig. 4 shows the concentration variation of waste at different pH. As can be seen in figure the adsorption is higher at acidic pHs and it is maximum at pH=4. By increasing the pH the adsorption is decreased which can be because of negatively charged surface of adsorbent or functional groups on dyes.

Fig. 5 shows the concentration decrease in different amounts of adsorbent. As can be observed in the figure the best adsorption was occurred at 1.2 g/L of adsorbent to solution ratio. There is no significant change observed in pollution adsorption by increasing the adsorbent amount. So it is the best amount of adsorbent.

The result of pollutions and dyes adsorption on organoclay in different times is shown in Fig. 6. As it can be seen in the figure the adsorption capacity of the organoclay was saturated in 30 min and there is no significant increase by increasing the time.

Fig. 7 also shows the pollutants concentration at different concentration of adsorbent and pH=4.5. Fig. 7 shows that by increasing the adsorption time and also

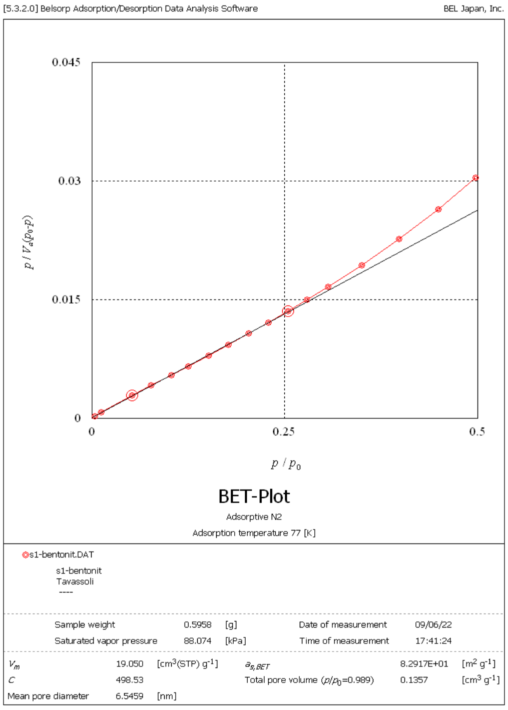

Fig. 2: BET isotherm of bentonite.

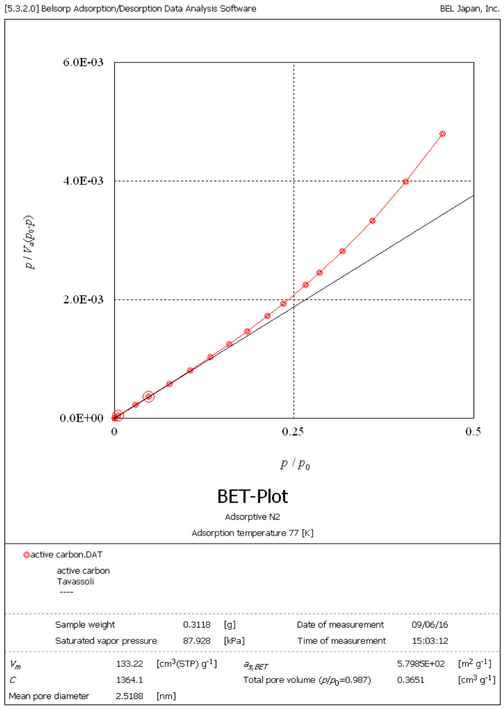

Fig. 3: BET isotherm of organoclay.

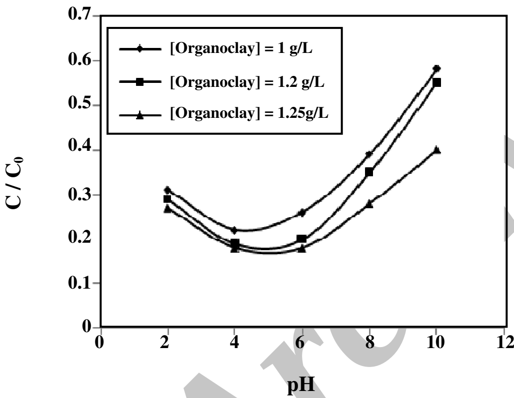

Fig. 4: pH effect on adsorption at 30 min.

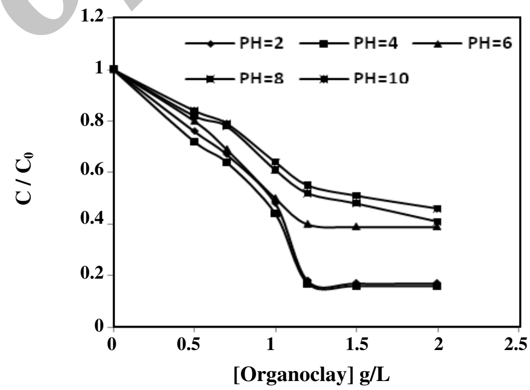

Fig. 5: Organoclay amount effect on pollution adsorption in 30 min.

organoclay amount, the removal amount is increased. However it is effective up to a certain value and then the slope of the curve becomes constant.

By investigating the above figures, It can be concluded that the best condition for removal of pollution from Ekbatan textile waste was 1.2 g/L of organoclay, in 30 min and pH=4.5. However it should be mentioned that as the waste concentration is different at various times of production, these condition can be variable in various period of production.

The amount of dye adsorbed per unit weight of an adsorbent, q, was calculated using the following equation:

$$q = \frac{(C_0 - C)}{m} V$$

Where C_o is the initial concentration of dye (mg/L), C is the equilibrium concentration of dye in solution (mg/L), m is the mass of the clay (mg) and V is the volume of solution (L).

The isotherm of sorption was compared with Longmuir isotherm in Fig. 8. As it can be observed the

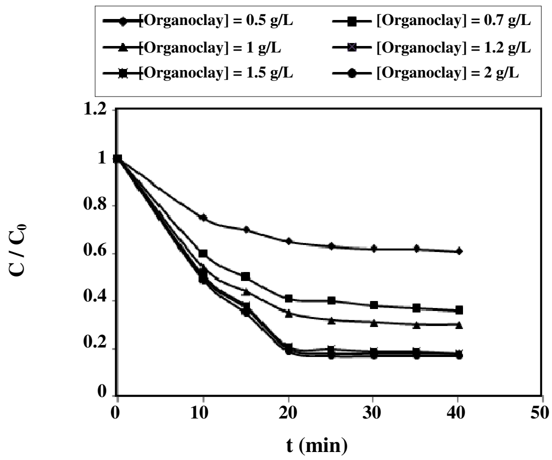

Fig. 6: Adsorption in different times and pH=4.5.

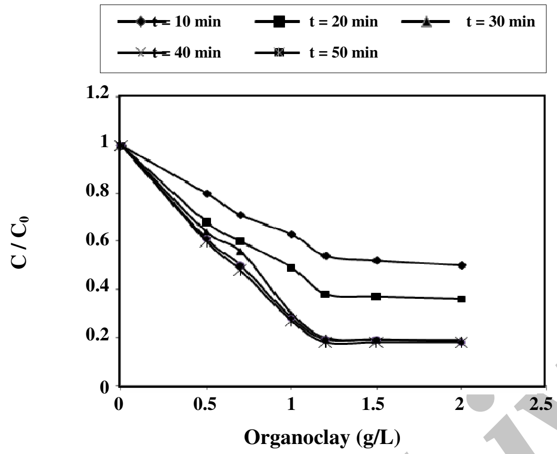

Fig. 7: Organoclay concentration on pollution adsorption at pH=4.5.

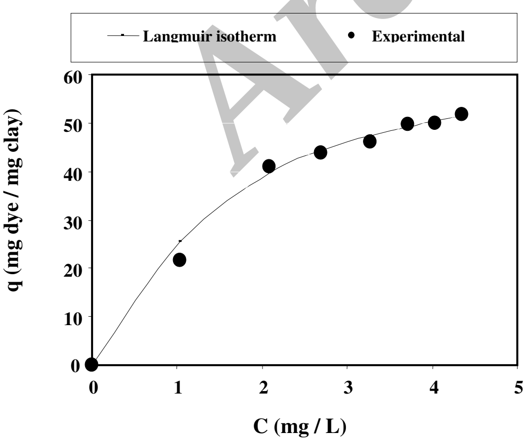

Fig. 8: Adsorption isotherm of industrial waste water on organoclay.

experimental points are distributed ideally in sides of the curve. So it can be concluded that the adsorption follows the Langmuir equation.

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