Extraction of Acid Blue-25 using Nano Emulsions from Textile Effluent

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Abstract

Textile industry produces effluent containing dyes which is dangerous to the whole ecosystem and environment. Their concentration must be reduced to acceptable levels before discharging into the main streams. In this research nano emulsion is used to study the removal of Acid Blue-25 (AB-25) dye from textile effluent using reverse micelles of Cetyl trimethylammonium bromide (CTAB). Reverse micelles are nanometer-sized aggregates of surfactant molecules surrounding microscopic water-core in non-polar solvents. As this dye is anionic in nature so cationic surfactant CTAB is used for the extraction of dye into solvent phase. The parameters examined in this study were effect of equilibration time, effect of pH, effect of temperature, effect of surfactant concentration and effect of initial dye concentration.

Key words: Solvent Extraction, Acid Blue-25, Reverse micelles, cationic surfactant, CTAB

Introduction

The development of textile industry and improvement of human life has led to high demand for dyes. Textile industries are facing number of complex environmental problems, due to substantial number of dyes released in the wastewater[1]. In the textile industry, the largest volume of water is used for mainly for dyeing, fixing and washing process. The presence of even small amount of dye in water is highly visible and intolerable which affects water transparency and aquatic life by blocking the passage of sunlight through water[2]. The concentration of dyes present in textile effluent is normally between 10 to 50 mg/L and the existence of dye in wastewater is visible at dye concentration above 1mg/L[3]. Dye effluent is responsible for many water borne diseases exhibiting symptoms like hemorrhage, nausea, dermatitis, ulceration of the skin, kidney damage, loss of bone marrow leading to anemia[4,5]. There are several alternative techniques that have been employed by textile industry to treat the textile effluent. Some of these are adsorption[6-8], flocculation-coagulation[9,10], membrane separation[11], ozone oxidation[12,13], biological treatments [14-16] etc. The conventional biological treatment processes are also unable to achieve adequate color removal.

The solvent extraction method is cheap and convenient method for the purification, separation and analysis of various compounds in mixtures. It is based on the principle that a solute distributes itself in certain ratio between two immiscible solvents. Thus, efficiency of extraction process depends on its mass transfer rate. The advantage of solvent extraction includes high through put, ease of automatic operation and high purification[17-18].

This paper will present the application of reverse micelles in removing acid blue-25 dye from simulated textile effluent by solvent extraction process. Several parameters such as effect of equilibration time, pH of solution, temperature, surfactant concentration and initial dye concentration were studied.

Materials and Methods

Materials

Simulated effluent was prepared in the lab by mixing dye AB-25 in known volume of distilled water. The cationic surfactant CTAB was used to prepare reverse micelles. The solvent used for removal of dye from aqueous phase was isoamyl alcohol. Analytical grade HCl and NaOH were used for the variation of pH. A UV-Visible spectrophotometer (Systronics 2201) was used to measure the absorbance and concentration of dye in the aqueous phase. A simple stirrer was used for mixing of the solvent and aqueous phase.

Experimental method

50ml of effluent was added to a known volume of the organic solvent containing known quantity of cationic surfactant. The concentration of surfactant used is at its critical micelle concentration level. The two phases were then mixed thoroughly using a stirrer at a fixed rpm for about 15 min. The two-phase dispersion was then transferred to the separating funnel to separate organic layer and the aqueous phase.

A sample of the aqueous layer was then analyzed for the absorbance and concentration measurement of dye in the aqueous phase. The wavelength of maximum absorbance (λ_{max}) for AB-25 was 639.2nm. The structure of CTAB surfactant is shown in Fig. 1. The distribution ratio (D) and the percentage of extraction (E) were calculated using equations (1) and (2).

$$D = {[Dye]_{org}} / {[Dye]_{aq}} \qquad (1)$$

$$E = 100 \times \frac{[Dye]_{aq0} - [Dye]_{aq}}{[Dye]_{aq0}} \qquad (2)$$

Where $[Dye]_{org}$ is the dye concentration in organic phase (mg L^{-1}), $[Dye]_{aq0}$ is initial dye concentration of aqueous phase (mg L^{-1}) and $[Dye]_{aq}$ the dye concentration of aqueous phase after extraction (mg L^{-1}).

cetyl trimethyl ammonium bromide

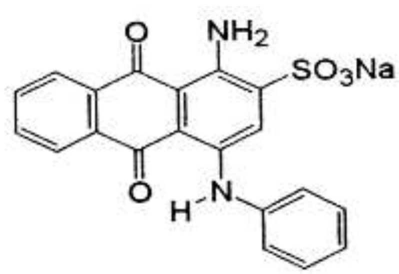

Fig. 1 (a) Structure of CTAB (cetyl trimethylammonium bromide) surfactant (b) Acid Blue-25

Results and Discussions

Effect of Equilibration time

The removal of Acid Blue-25 dye from the effluent was studied by varying the time between 1- 60min. From the Fig. 2 it is shown that maximum removal of dye about 85 % occurs at 1.0 min. at 15.0 min above 90% dye was extracted and remains constant upto 60 min.

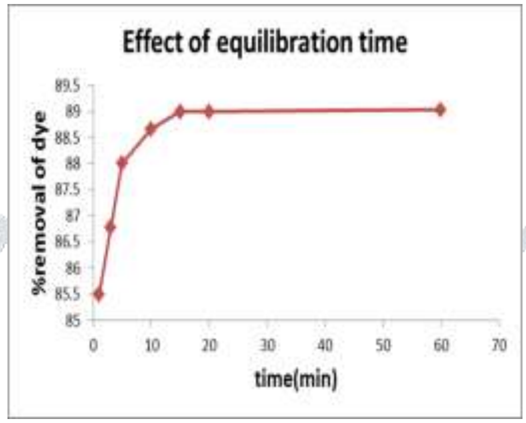

Fig. 2 Effect of Equilibration time on removal of AB-25 from aqueous solution

Effect of Surfactant Concentration

It is shown from Fig. 3 that removal of AB-25 from effluent without surfactant is less than 15%. It is clear from the figure that percentage removal of dye increases with increase in concentration of surfactant at fixed volume of solvent.

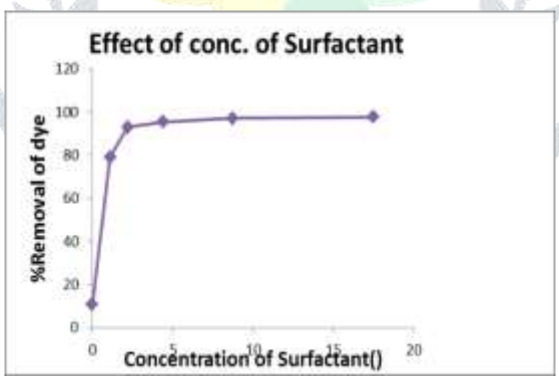

Fig. 3 Effect of Surfactant concentration on removal of AB-25 from effluent

Effect of Initial Dye Concentration

Fig. 4 show the experimental results for the percentage removal of AB-25 dye using CTAB surfactant and isoamyl alcohol as solvent. It was observed that % removal of dye decreases with increase in the dye concentration.

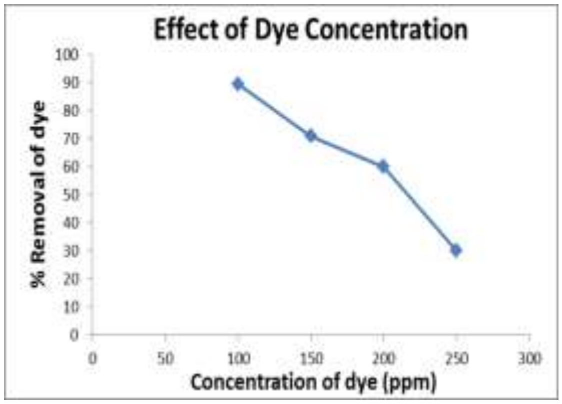

Fig. 4 Effect of initial dye concentartion

Effect of pH

Fig. 5 shows the effect of pH on the percentage removal of dye from effluent. The effect of pH on the removal of of AB-25 present in textile effluent was investigated at different pH values 2.0 to 9.0 at 303K. The results show that percentage of dye removal increases with increase of pH. It was maximum at pH 5.0 and then decreases.

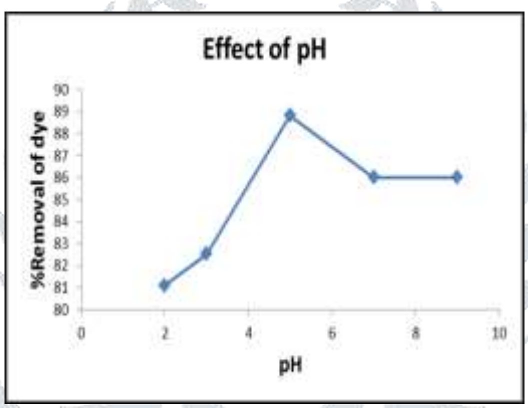

Fig. 5 Effect of pH on percentage removal of AB-25 dye from effluent

Conclusion

Anionic dye Acid Blue-25 used in textile industry is extracted from aqueous solution by solvent extraction method using CTAB surfactant. Experimental results show that different parameters like dye concentration, surfactant concentration, pH, equilibration time etc. affect the removal of dye. Almost complete removal of dye is possible from effluent using solvent extraction method. Solvent used can also be recovered and reused.

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