DECOLOURIZATION OF TEXTILE AZO DYES BY USING LOW COST ACTIVATED TEA WASTE

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ABSTRACT

Adsorption of two azo dyes Eriochrome Black T (EBT) and Methylene Blue from synthetic water onto H_2SO_4 activated tea waste was studied for the successful and effective removal of dyes. Simple process was used for preparation of H_2SO_4 activated tea waste. The chemical composition and properties of activated tea waste were characterized by scanning electron microscopy and FTIR. Adsorption efficiency of activated tea waste was examined using two azo dyes EBT and methylene blue as adsorbates. Dyes removal was studied by two parameters contact time and amount of adsorbent. It was observed that maximum adsorption was reported with 7g/l adsorbent for both dyes. Maximum percentage removal of EBT was found to be 97% at 30 min and 98% for methylene blue at 45 min.

Key Words: Azo dyes, Decolourization, EBT, Methylene blue.

I. INTRODUCTION

Whole world is suffering with ever increasing problem of contaminated waste water. It is estimated that annually 10,000 different dyes are produced for various industrial processes [1]. Dye effluent generated from various textile industries are becoming a major source of environmental pollution. Over last few years, the demand of azo dyes has increased in textile dying industries because of low cost and wide range of color availability. US food and drug administration (FDA) in year 1991 allowed 30,000 tons of azo dyes for use in food, drugs and cosmetics. Azo dyes contain reactive group which make stable covalent bond with fabrics and thus result in intense and lasting color to fabric. Due to their high solubility and low degree fixation on fiber, it results in considerable release of these dyes in waste water. From past few decades, hazardous effects of azo dyes have been investigated and number of azo dyes has been reported as toxic [2]. These dyes can cause number of health issues in human beings such as skin irritation, dermatics, and carcinogenicity [3]. These dyes interrupt with photosynthetic activity and thus affect aquatic organism [4]. Dye contaminated waste water shows low biodegradability because of light and heat stability [5]. An animal study showed that few azo dyes are responsible to cause human bladder cancer, splenic sarcomas and hepatocarcinomas [6]. Numbers of methods have been involved for removal of azo dyes from waste water such as flocculation, filtration, precipitation and oxidation [7-11]. Among all these techniques, adsorption processes have been considered the best and economical method for adsorption of dyes from water. Numbers of agricultural waste materials are widely used as adsorbent for removal of different azo dyes. It includes rice husk [12-16], peanut shells [17], corn cobs [18], saw dust [19], barks and dry tree leaves[20-21], tea and coffee waste[22-23], rice and wheat bran[24].

The main aim of the present research work is to investigate efficacy of tea waste as low cost adsorbent for removal of azo dyes from waste water. Tea waste largely consists of cellulose, hemicellulose, lignin, tannins and

amino acids. Tea waste is a domestic waste available in large amounts. Biodegradability of waste tea takes lots of time. Whereas when the tea waste used as adsorbent reaches to saturation, it is burnt and ash generated could be again used as adsorbent. Hence tea waste is low cost and eco-friendly adsorbent. The present research work focuses on removal of two azo dyes (Eriochrome black –T and Methylene blue) on activated tea waste as adsorbent. Tea waste was activated with H_2SO_4. In this study contact time and amount of adsorbent were examined to determine highest dye removal capacity.

II. MATERIAL AND METHODS

2.1 Reagents and Chemicals

EBT, Methylene blue and H_2SO_4 were procured from Merck (Bangalore, India). Throughout the experiment triple distilled water was used. 100 ppm stock solutions of dyes were prepared by dissolving the 25 mg powdered dyes in 250 ml triple distilled water.

2.2 Collection and Preparation of Adsorbent

Tea Waste was obtained from college cafeteria. The samples collected were washed with distilled water to remove dirt and impurities. It was then boiled three to four times at 90^0C to remove color pigments and tannin and then washed several times with distilled water until pH reaches to7.0. Cleaned tea waste was dried at room temperature for 24 hour and later dried in oven at 100^0C for two days.

2.3 Preparation of H_2SO_4 Activated Tea Waste

Activated tea was synthesized according to following method: H_2SO_4 (10ml) and triple distilled water (10ml) was mixed together in ratio 1:1. Then, 20g of dried tea was added and mixture was mixed properly and left overnight. The sample was washed with distilled water until sample is free from acid and reaches a pH of 7.0 and dried in oven at 50 ^{0}C for 24 hours. Dried activated tea waste was then crushed with mortar and pestle and sieved with 300 µm (Stainless steel Sieve).

2.4 Dye Removal Procedure

Adsorption study was done by adding varying concentrations of activated tea waste from 3 g/L to 9g /L to the 20 ml stock solution of different dyes taken in 50 ml of Erlenmeyer's flasks at temperature 30^0C and pH 7. Solution was stirred for time varying from 15-60 min for both the dyes. After shaking reaction mixture, it was centrifuged at 10000 rpm and then the concentration of dye in filtrate was measured at wavelength of maximum absorbance i.e. 530 nm (for EBT) and 664nm (for Methylene blue) using UV-Vis Spectrophotometer(Shimadzu, Model UV-1800, Japan). Due to adsorption by activated tea waste percentage of dye concentration decreased with time.

III. RESULT AND DISCUSSION

3.1Characterization of Adsorbent

Scanning electron microscope (SEM) images were used to examine the surface morphologies of waste tea leaves before and after surface modification .The images are given in Fig. 1. The surface of tea leaves was found smooth and with uniform micro- porous structure which was changed after acid treatment indicating the surface

modification of the adsorbent. The surface of acid treated tea leaves shows irregularly distributed pores which enhance the adsorption of metal ion

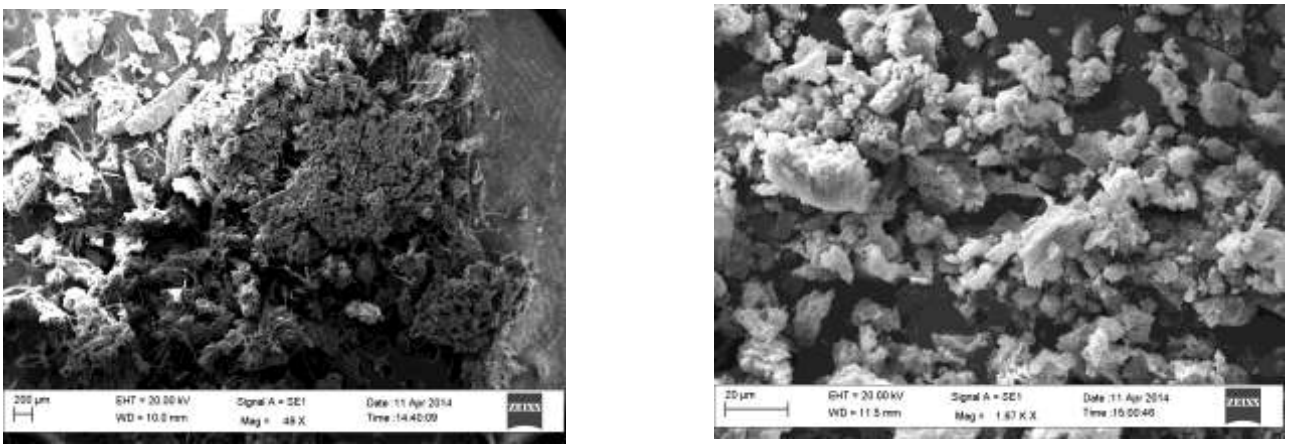
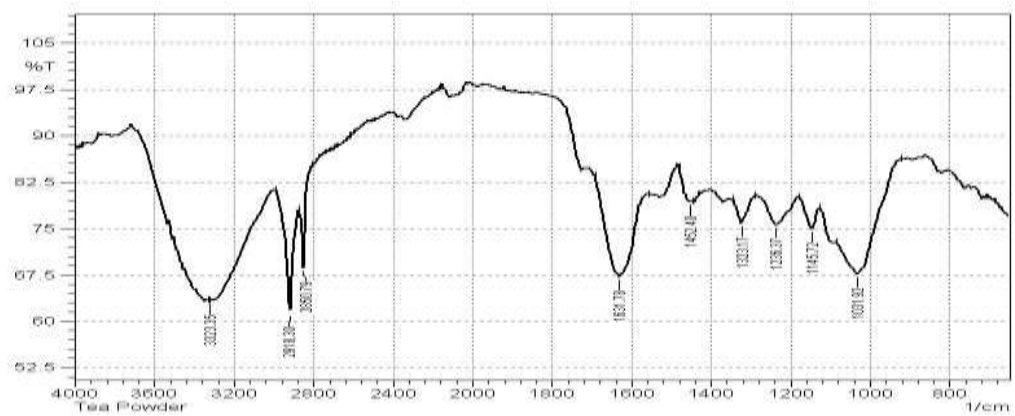
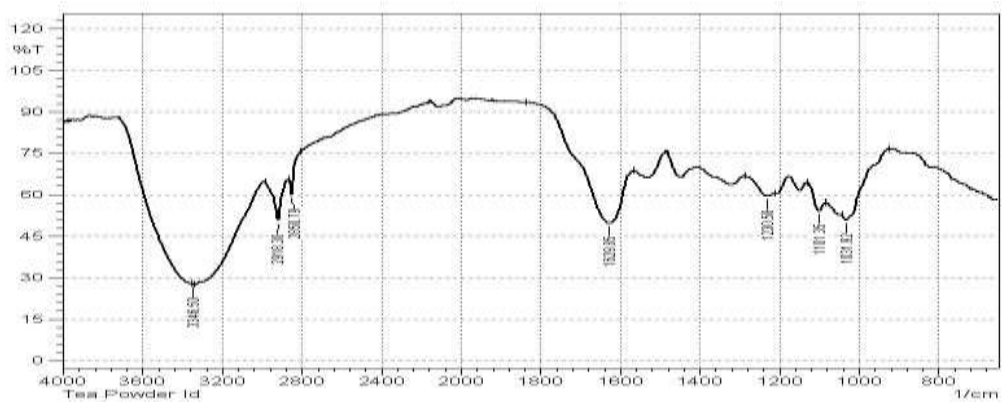


Fig 1.The SEM image of (a) pretreated tea waste and (b) H_2SO_4activated tea waste

Each specific chemical bond often shows a unique energy absorption band in FTIR (Shimadzu, Model IR Affinity-1) analysis and it has been used as a useful tool to identify the presence of certain functional groups of the bio sorbent. The FTIR spectra of untreated and treated tea are shown in **Fig. 2**. The surface of adsorbent contains numerous functional groups so their spectra are complex. The broad and intense peaks around 3323 cm^{-1} in the spectrum of tea waste (TW) correspond to OH stretching vibration. It indicates the free OH group on the surface of the adsorbent and confirms the presence of alcohols and polyphenols in cellulose and lignin. The peak observed at 2918 cm^{-1} corresponds to CH stretching, the peaks around 1631 cm^{-1} is due to C=O group and 1031 cm^{-1} due to C-O stretching.



(a)



(b)

Fig2 FT-IR spectra (a) tea waste and (b) Activated tea waste

After chemical modification the spectrum exhibits some significant changes. The peak at 1452 and 1323 cm^{-1} disappears which suggest reaction of acid with amino groups and making surface more porous.

3.2 Effect of Adsorbent Dose

The effect of different amount of adsorbent on dye removal was studied at room temperature at optimum pH by varying adsorbent amount from 3-9 g/L in contact with 20 ml of each dye solution. It was found that increasing amount of activated tea waste resulted in higher percentage removal of dyes from solution due to increase in contact surface of activated tea waste with dyes. Maximum adsorption was reported with 7g/l adsorbent for both dyes. Maximum percentage removal of EBT was found to be 97% and 98% for methylene blue.

3.3 Effect of Contact Time

Different contact time was studied to determine the time taken by activated tea waste to remove 100 ppm dye solution at optimum pH. Activated tea waste 7g/L was added into 20 ml of dye solution. At different time interval, the absorbance of dyes solution at Λ_{max} was measured. Maximum removal of EBT was observed within 30 min as shown in Fig. 3 and after 30 min there was no further removal of dye indicating equilibrium condition. Maximum adsorption of methylene blue was observed at 45 min and after 45 min equilibrium was attained as shown in Fig. 4.Therefore contact time for 30 min for EBT and 45 min for methylene blue was selected for further works.

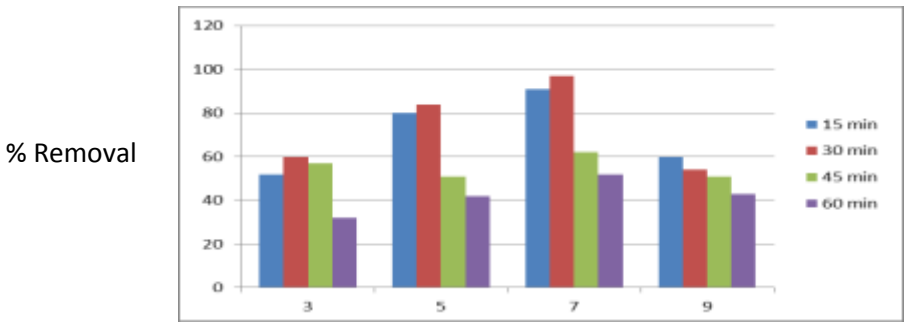


Fig. 3 Effect of contact time on the adsorption of EBT dye onto activated tea waste.

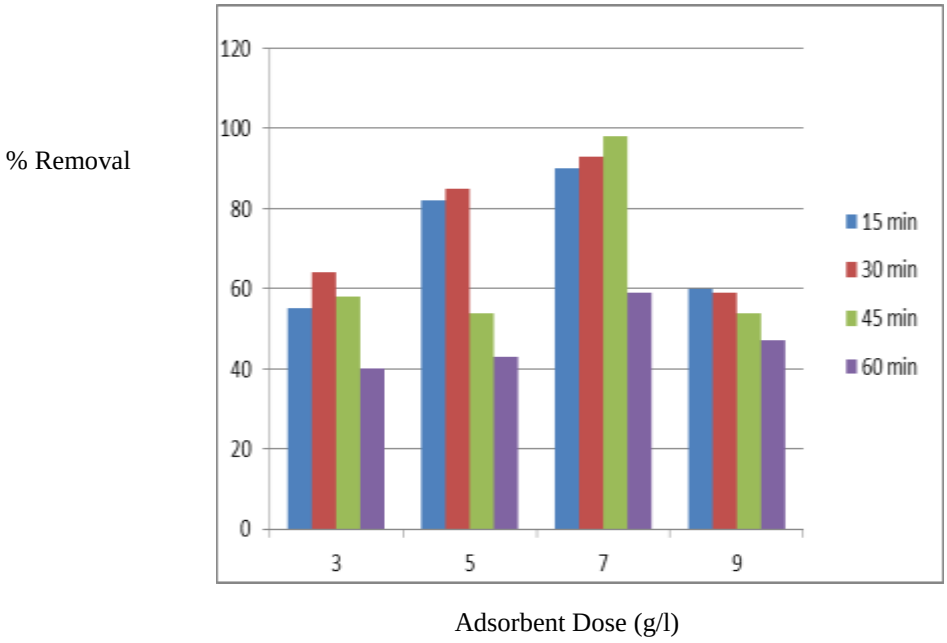


Fig. 4 Effect of contact time on the adsorption of methylene blue dye onto activated tea waste

IV. CONCLUSION

The efficiency of H_2SO_4 activated tea waste in removing EBT and Methylene Blue dye from synthetic water has been investigated at room temperature. It was observed that under optimized condition up to 97% and 98% of EBT and Methylene blue respectively, can be removed from solution by using activated tea waste. Results indicated that adsorption is completely depended on contact time and the amount of adsorbent. Removal efficiency increases with increasing contact time and amount of dose. These results show that H_2SO_4 activated tea waste could be beneficial agent for removal of azo dyes from waste water and can be effectively used as adsorbent for waste water treatment .

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