Research Article

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Mesoporous chitosan/activated charcoal powder and bead modified in 1-butyl-3-methylimidazolium acetate for the adsorption of acid blue 25 from an aqueous solution

Ismaila Olalekan Saheed,[a,b] Wen-Da Oh,[a] Ahmad Faiz Abdul Latip[a] and Faiz Bukhari Mohd Suah[a]*

Abstract

BACKGROUND: A green synthesis approach involving 1-butyl-3-methyl imidazolium acetate (BmimA) medium was utilised to prepare mesoporous chitosan/activated charcoal composite powder (ChA) and bead (ChB) for the removal of acid blue 25 (AB25) dye from aqueous solution. The composite's characteristics were examined using Fourier transform infrared (FTIR), scanning electron microscopy (SEM), energy dispersive X-ray analysis, X-ray diffraction and Brunauer–Emmett–Teller (BET) analysis. The influence of initial concentration of the dye, pH, contact time and adsorbent dosage on the adsorption and the composite's stability in acidic and basic solutions was also examined.

RESULTS: FTIR revealed that chitosan and activated charcoal were connected through O—H, N — H, C—O and C═O, while AB25 adhered to ChA and ChB through the hydroxyl and amino functional groups. SEM images of ChA and ChB revealed rough-like surfaces with randomly distributed pores. BET analysis revealed that ChA and ChB are mesoporous, with pore sizes of 2.18 and 2.26 nm. The composites were stable in acidic and basic solutions, and adsorption of AB25 onto the adsorbents was more effective at pH 2. Regeneration of the adsorbents was also influential in NaOH solution. The amount of BmimA used in the composite's preparation has limited influence on the effectiveness of ChA and ChB for AB25 uptake. The adsorption is best described by Langmuir isotherm in both ChA and ChB with q_{max} of 3030.3 and 3703.7 mg g^{-1} respectively, although ChB also conforms to the Freundlich isotherm. The adsorption kinetics fitted well into the pseudo-second-order model.

CONCLUSION: The prepared modified chitosan/activated charcoal powder and bead were able to adsorb the AB25 dye better than other chitosan-based materials.
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Keywords: 1-butyl-3-methyl imidazolium acetate; acid blue 25; adsorption; chitosan beads

INTRODUCTION

Anthraquinone dyes are among the widely applied and essential classes of commercial dyes often used for dyeing wool, polyamide and leather. Anthraquinone dyes are rich in colour and are primarily used for dyeing textile materials.[1,2] Untreated textile effluents from textile industries contain high concentrations of organic dyes such as anthraquinone type and other organic pollutants.[1,3] The presence of organic dyes in textile effluents discharged into the environment significantly affects the amount of oxygen in the water body, thereby decreasing the penetration of light through water. It also increases the level of harmful aromatic functional groups that are carcinogenic and teratogenic.[2] This situation threatens the survival of living organisms inhabiting the aquatic and terrestrial environment, which affects the natural ecosystem, leading to long-term adverse effects.[4] Acid blue 25 (AB25), a water-soluble anionic dye, is among the commonly applied anthraquinone dyes used for dyeing textile materials, and it is also known for its application as a model compound for investigation relating to the removal of anthraquinone dyes from aqueous medium;[3] it can therefore can serve as a representative compound for anthraquinone dyes.

* *Correspondence to: Faiz Bukhari Mohd Suah, Green Analytical Chemistry Laboratory, School of Chemical Sciences, Universiti Sains Malaysia, 11800 Minden, Pulau Pinang, Malaysia. E-mail: fsuah@usm.my (Suah)*

a *Green Analytical Chemistry Laboratory, School of Chemical Sciences, Universiti Sains Malaysia, Minden, Pulau Pinang, Malaysia*

b *Department of Chemical, Geological and Physical Sciences, Kwara State University, Malete, Ilorin, Nigeria*