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SUSTAINABLE ENERGY TRANSITION: CHALLENGES AND OPPORTUNITIES

Surfactant-modified coconut coir powder (SMCCP) as a low-cost adsorbent for the treatment of dye-contaminated wastewater: parameters and adsorption mechanism

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Abstract
The dye-contaminated wastewater discharged from various industries such as dye manufacturing, paint, textile, paper, and cosmetic is a prime source of surface water pollution having serious detrimental effects on both the environment and human beings. These hazardous dyes when exposed to water obstruct the penetration of sunlight into the water and thus restrain aquatic plants from generating photosynthetic compounds. Moreover, some dyes are potential cancer-causing and also negatively impact the human nervous and respiratory systems. In this current study, modification of coconut coir powder (CCP) was carried out through cationic surfactant treatment and was successively utilized as the adsorbent for decoloring anionic dye (acid blue 185 (AB 185)) containing waste stream. Further, a comparative investigation of the dye removal efficiency of raw CCP and surfactant-modified coconut coir powder (SMCCP) as the adsorbent was studied. On surfactant treatment, using a very minimal SMCCP dosage of 8.3 g/L, a very high percentage dye removal of 98.4% is possible, whereas with raw CCP, even after using a higher dosage of 14 g/L, only 70.1% dye removal can be achieved. Characterization of SMCCP adsorbent was done by Fourier transform infrared, thermogravimetric, X-ray, and scanning electron microscope analyses. Furthermore, the optimization of critical operating parameters was investigated for the effective adsorption of AB 185 dye in batch mode. The adsorption of AB 185 onto SMCCP was a thermodynamically spontaneous endothermic process, following the Langmuir isotherm and pseudo-second-order kinetic model. Moreover, regeneration of exhausted SMCCP by 0.1 (M) NaOH was achieved with a satisfactorily high recovery of 97% in the first cycle. Subsequently, SMCCP can be successfully reutilized for five consecutive cycles with a loss of 17.6% in the total adsorption capacity. With all such advantages, the present study delivers a new paradigm to utilize the novel adsorbent SMCCP as a promising eco-friendly adsorbent aided by its advantage of regeneration and reusability for the treatment of dye-contaminated wastewater.

Keywords Adsorption · Anionic dye · Surfactant modification · Cationic surfactant · Response surface methodology (RSM) · Adaptive neuro-fuzzy inference system (ANFIS)

Introduction

The enhancing levels of urbanization, industrialization, and contemporaneity induce substantial challenges for water in terms of quality, which is of utmost necessity for the sustenance of all living things. Not only water quality, but also varied anthropogenic activities including clearing forests, cultivating land, development, destruction of ecosystems, and excessive groundwater processing, have an explicit effect on the various components of hydrological cycles. Depletion in conventional water resources and consequent water pollution are becoming serious threats due to uncontrolled population expansion, rising living standards, and concurrent industrial development (Pradhan et al. 2023). On an annual basis, a disease transmitted through water outbreaks results in thousands of deaths worldwide, especially in impoverished regions having inadequate access to clean water and poor water treatment facilities. As an outcome, it is of paramount significance in the recent years

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