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Giant mud crab shell biochar: A promising adsorbent for methyl violet removal in wastewater treatment

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ABSTRACT

Giant mud crab (*Scylla serrata* sp.) shell prepared through pyrolysis at various temperatures without any modification were characterized for physicochemical properties and methyl violet (MV) removal potential. Hence, this paper investigated the performance and mechanism of biochar derived from giant mud crab shell as adsorbent in the removal of methyl violet as well as the potential for regenerating adsorbents via hot water regeneration. The results show that CSB500 (produced through pyrolysis at 500 °C) exhibits a surface area of 59.73 m^2/g and mesopore size of 31.3 nm, favorable for methyl violet removal at 3139 mg/g. The equilibrium adsorption data agreed well with Langmuir and Redlich-Peterson isotherm models, indicating a monolayer adsorption of MV. The kinetics data fitted better with both pseudo-first-order and pseudo-second-order models. The intraparticle diffusion and Boyd's models revealed that both film and pore diffusion may be involved in the adsorption process. In hot water regeneration studies, CSB500 shown superior regeneration performance when using water with temperature of 70 °C rather than 30 °C for 9th regeneration cycles, with retained to achieve >90 % MV removal for 6th regeneration cycles. Biochar derived from giant mud crab shell has shown significant promise as a low-cost, effective, and ecologically friendly with reasonably good adsorption capacity and reusability for dye removal, and it can be considered as an environmental sustainability strategy in wastewater treatment.

1. Introduction

Globally, water quality has drastically deteriorated over the past few decades, mostly due to a diverse expansion in human population, rapid industrialization, unplanned urbanization, and unrestrained use of freshwater (Ahmed et al., 2020). The release of untreated agricultural and industrial runoff containing numerous hazardous and noxious pollutants, including inorganic and organic pollutants, dyes, heavy metals, and pesticides, is the leading cause of water pollution. The presence of these contaminants over the permissible limit in natural water bodies has a negative impact on the ecosystem and living beings. Among these pollutants, dyes are one of the most visible and detectable toxins (Nasar and Shakoor, 2017). Due to their molecular size and aromatic structure, which contribute to their great water stability and solubility, the disobedient nature of dyes is controversial. Many sectors, including cosmetics, textiles, paper, tanneries, plastics, pharmaceutical, paints, petroleum, and confectionaries, are the leading contributors to dye pollution, as they consume vast quantities of water and subsequently generate a massive amount of contaminated wastewater (Faizal et al., 2022).

Methyl violet (MV), also known as gentian violet B, basic violet 3, crystal violet, or hexamethyl pararosaniline chloride, is a cationic dye belonging to the triphenylmethane group (Faizal et al., 2022). MV is commonly used in printing ink, textile, and paint industries to color various materials such as acrylic, silk, nylon, coir, wool, leather, plastic wax, and cotton (Sabna et al., 2016; Verma et al., 2020). MV exhibits

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