

Coal ash Derived Zeolite X for Cationic Dye Removal from Textile Wastewater

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Textile wastewater has been identified as a source of environmental pollution mainly due to the presence of synthetic dyes. Adsorption technology is considered a promising solution for treating textile wastewater. In the present study, Zeolite-X was synthesized from fly and bottom ashes generated in a coal-fired boiler. The alkaline fusion method used for the synthesis and processed Zeolite-X was characterized by FTIR, SEM, and XRD. Synthesized zeolite was subsequently employed for the adsorption of Methylene Blue dye from a synthetic dye solution. Adsorption conditions were optimized to obtain maximum dye removal efficiency using Response Surface Methodology combined with Central Composite Design. The influence of the independent variables on the percentage elimination was evaluated, focusing primarily on the solution pH (3-11), temperature (20-60 °C), adsorbent mass (2.5 -4.5 g/l), and initial dye concentration (10-50 mg/L). Maximum dye removal efficiencies of 93.01% and 98.15% were obtained for fly ash and bottom ash derived zeolite-X respectively at the same optimum condition (pH 9; temperature 50 °C; initial dye concentration 40 ppm; and solid to liquid ratio 4 g per 1L). Adsorption isotherms were developed at the optimum conditions and the data were fitted to Langmuir and Freundlich isotherm models. The potential of the adsorbent for dye removal was further evaluated by kinetic studies. FAZ data fitted the Langmuir model implying a favorable monolayer adsorption, while BAZ data aligned with the Freundlich model indicating that multilayer adsorption is favorable.

Keywords: Adsorption, Coal fly ash, Coal bottom ash, Textile dyes, Ultrasound-assisted method, Zeolite-X

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