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Woody biomass fly ash as a low-cost sorbent for the removal of ionic dye from aqueous solution: isotherm, kinetic modelling and thermodynamics

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ABSTRACT

The main goal of this work was to investigate a possible application of woody biomass fly ash (WBFA) as a low-cost sorbent for the removal of ionic, toxic and carcinogenic diazo dye (Congo red [CR]) from aqueous solutions. Biomass fly ash is a by-product generated during mixed wood biomass combustion in the 1 MW electric power facility in Udbina, Croatia. Batch sorption experiments were carried out to evaluate the influence of experimental parameters, such as initial dye concentration, contact time and temperature on the sorption process. The experimental data were analyzed using different isotherm and kinetic models. The best fit was achieved by the Langmuir isotherm equation ($R^2 > 0.9904$). Results of the kinetic studies showed that the CR dye sorption onto the WBFA was best described by the pseudo-second-order kinetic model. The Weber–Morris intraparticle diffusion model indicated that the intra-particle diffusion is not the rate-limiting step, while the Boyd model suggested that the film diffusion might be rate-limiting. The calculated thermodynamic parameters ($\Delta G°$, $\Delta H°$ and $\Delta S°$) showed that the sorption of CR is feasible, spontaneous and endothermic. Experimental results confirmed that the WBFA had the potential to be utilized as a low-cost sorbent material for the removal of CR dye from aqueous media.

Keywords: Sorption kinetics; Thermodynamic; Congo red; Woody biomass fly ash

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