

Equilibrium, kinetic, and thermodynamic studies on biosorption of Cd(II) from aqueous solution by biochar

Abstract

The present investigation describes the use of biochar derived from an agricultural waste: the maize cob for the biosorption of Cd(II) ion. The biochar was characterized using scanning electron microscopy, surface area analysis, and Fourier transform infra-red spectroscopy. Batch experiments were performed to investigate the effects of parameters such as pH (2.0–8.0), dosage (0.2–1.2 g), contact time (5–300 min), initial metal concentration (10–100 mg L⁻¹), and temperature (20–50 °C). Kinetic data were properly fitted with the pseudo-second-order model, with the q_e (cal) value (17.21 mg g⁻¹) closer to the q_e (exp) value (18.82 mg g⁻¹). The adsorption data conforms best to the Langmuir isotherm as revealed by the lower non-linear Chi square (χ^2) value of 0.15 and a higher correlation value of 0.98 when compared to the Freundlich with a high χ^2 value of 2.65 and lower correlation value of 0.96. The maximum adsorption capacity for the biochar was 33.0 mg g⁻¹. The thermodynamic parameters ΔG^0 , ΔS^0 and ΔH^0 confirmed that the biosorption was feasible, spontaneous, and endothermic. The results obtained suggest that using a low-cost biochar biosorbent for removing trace metals in contaminated water treatment plants may have great ecological and environmental significance.