Competitive biosorption of Pb(II), Cr(III), and Cd(II) from synthetic wastewater onto heterogeneous anaerobic biomass in single, binary, and ternary batch systems

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ABSTRACT

Biosorption of lead, chromium, and cadmium ions from aqueous solution by dead anaerobic biomass (DAB) was studied in single, binary, and ternary systems with initial concentration of 50 mg/l. The metal-DAB affinity was the same for all systems. The main biosorption mechanisms were complexation and physical adsorption of metallic cations onto natural active functional groups on the cell wall matrix of the DAB. It was found that biosorption of the metallic cations onto DAB cell wall component was a surface process. The main functional groups involved in the metallic cation biosorption were apparently carboxyl, amino, hydroxyle, sulfhydryl, and sulfonate. These groups were part of the DAB cell wall structural polymers. Hydroxyle groups (–OH) were responsible for 37, 52, and 31% of the removal of Pb(II), Cr(III), and Cd(II) by DAB through complexation mechanisms; whereas carboxylic groups (C=O) were responsible for 21, 14, and 34% of the removal of Pb(II), Cr(III), and Cd(II), respectively. Biosorption data were fitted to four isotherm models. Langmuir model was best fitted to the experimental data than Freundlich, Sips, and Redlich–Peterson models for single system. While for binary and ternary metal systems, extended Langmuir model were fitted experimental data better than interaction factor, a combination of Langmuir–Freundlich and Redlich–Peterson models. The maximum uptake capacities were 54.92, 34.78, and 29.99 mg/g for Pb(II), Cr(III), and Cd(II), respectively. Optimum pH was found to be 4.

Keywords: Biosorption mechanisms; Dead anaerobic biomass; Isotherms; Heavy metals; FT-IR; Uptake capacity

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