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Pd(II) and Pt(IV) sorption using alginate and algal-based beads

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Abstract

The incorporation of glutaraldehyde-crosslinked polyethyleneimine (GLA-PEI) in algal biomass beads (AB/PEI) substantially increases the sorption capacity for Pd(II) and Pt(IV) compared to pure algal beads (*Laminaria digitata*) prepared by an original one-pot synthesis procedure (using a homogeneous ionotropic Ca-gelation, without addition of supplementary alginate). The sorption properties are compared to a reference material (alginate beads). Sorption efficiency increases with pH in relation with deprotonation of carboxylate and amine groups, limitation of the competition effect of counter anions and effect of metal speciation. Sorption isotherms (fitted by the Langmuir equation) show maximum sorption capacities close to 1.28 mmol Pd g^{-1} and 0.59 mmol Pt g^{-1} for the composite sorbent at pH 2.5, with a marked preference for Pd(II) against Pt(IV) (sorption isotherms in bi-component solutions), especially for alginate and algal beads that are more selective than AB/PEI (an excess of chloride ions limits this selectivity). The uptake kinetics are controlled by the resistance to intraparticle diffusion though the kinetic profiles are well fitted by the pseudo-second order rate equation. The drying conditions have critical impact on the diffusion properties: freeze-drying limits the irreversible collapse of the porous structure (which happens with air-drying): the presence of cellulose-like fibers (and/or agglomerates of GLA-PEI) in AB and AB/PEI limits this impact.

Keywords: platinum group metals; alginate; algal beads; PEI/algal composite beads; sorption isotherms; uptake kinetics.