Recovery of Rare Earth Elements with Ligand-Functionalized Polymers in Fixed-Bed Adsorption Columns

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Conventional solid phase extraction using ion exchange resins lacks selectivity for rare earth elements (REE), which makes separation of REE from dilute aqueous media challenging. In this study, polymeric functionalized resins were synthesized by grafting different selective ligands for the separation and recovery of rare earth elements from aqueous media, whose properties vary by ionic strength, pH (acidity) and chemical composition. The performance and durability of the functionalized resins were evaluated through batch, and continuous-flow, fixed-bed adsorption experiments. Functionalized resins showed improved performance after 1-2 use cycles and consistent REE adsorption was observed through five cycles. Column experiments with multi-element mixtures containing REE and competing ions revealed that REE uptake was over an order of magnitude higher for the functionalized resins than the non-functionalized resins. Separation factors were determined for REE over competing metals from multi-element competitive adsorption isotherms and values for functionalized resins were up to 700 times higher than the non-functionalized resins. Kinetic studies revealed that the functionalized resins followed pseudo-second order binding kinetics with rates limited by intraparticle diffusion. Attaching ligands to the aminated resin surfaces greatly improved REE binding capacity and selectivity.