Fe3O4-loaded Ion Exchange Resin for Chromatographic Separation of Boron Isotopes: Experiment and Numerical Simulation

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Abstract

Fe3O4-loaded ion exchange resin composites (Fe3O4@Resin) were optimally constructed through ion exchange and co-precipitation of Fe2+ and Fe3+ on strong acid ion exchange resin. The as-synthesized Fe3O4@Resin composite was sophisticatedly characterized and investigated for 10B/11B separation including effect of pH, kinetics and isotherms through batch adsorption experiments which can be well described by pseudo-second order kinetics and Langmuir model. In the chromatographic column packed with Fe3O4@Resin, 10B was selectively retained with a high dynamic separation factor of 1.312. Considering the consistency between simulated and experimental breakthrough curves within Fe3O4@Resin packed column, chromatographic 10B/11B separation performance was simulated under various conditions which were further optimized by Box-Behnken design. Consequently, the annual yield of 10B reached the maximum of 612 g with feed concentration of 7.567 g·L-1, flow rate of 38.57 mL*min-1, and column size of 2.2x45 cm (I.D. x length). In addition, five-cycle adsorption/regeneration experiments demonstrated its merit of reusability.

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