Sustainable detection and capturing of cerium(III) using ligand embedded solid-state conjugate adsorbent

ABSTRACT

The detection, adsorption and recovery of rare-earth elements specially the cerium (Ce(III)) on ligand based optical conjugate adsorbent was systematically studied. The functional ligand of 6-((2-(2-hydroxy-1-naphthoyl)hydrazono) methyl)benzoic acid (HMBA) was synthesized and then successfully anchored onto mesoporous silica by a direct immobilization method for the fabrication of conjugate adsorbent. The Ce(III) ion was detected by the charge transfer (π–π transition) transduction mechanism with high sensitivity and selectivity. The experimental conditions were optimized based on contact time, solution acidity, initial Ce(III) concentration and pH acidity and diverse metal salt concentrations. The conjugate adsorbent was highly sensitive, and the limit of detection was 0.33 µg/L for Ce(III) ions. The Ce(III) adsorption from synthetic aqueous solution also underwent in batch mode. However, the adsorption capacity depended on the solutions pH, initial concentration and to some extent on the competing ions. The experimental data revealed that the maximum Ce(III) adsorption was possible at pH 5.0. The presence of other cations and anions did not adversely affect the Ce(III) capturing by the conjugate adsorbent. The maximum adsorption capacity was determined to be as high as 179.16 mg/g. The extraction and recovery of Ce(III) ions from the saturated adsorbent was possible with 0.20 M HNO3. The regenerated adsorbent that remained maintained the high selectivity to Ce(III) ions and exhibited almost the same capturing ability as that of the original adsorbent. However, the adsorption efficiency was slightly decreased after several cycles. Therefore, the proposed conjugate adsorbent offered a cost-effective adsorbent and may be considered a viable alternative for effectively detection, capturing and recovery of Ce(III) ions from wastewater samples.