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Body Text

Adsorption has been proven as an effective process for the separation of metal ions, especially at relatively low concentration. However, conventional chelating polymer adsorbents suffer limitation of selectivity. Metal ion-imprinted polymer has been receiving great attention due to its selective recognition of targeted ion in solution via cavity imparted into the polymers. This research proposed a new concept of imprinting in the synthesis of surface ion-imprinted polymer (IIP) by using radiation induced graft polymerization and crosslinking techniques. The concept of surface imprinting in this study is based on the usage of polyethylene coated polypropylene non-woven fiber (PE/PP-NWF) as the polymer substrate and the creation of an imprinted layer grafted onto the surface of the substrate via two different approach, namely ‘ex-situ’ and ‘in-situ’ template impregnation. In the ‘ex-situ’ approach, an amine-based monomer, 2-(Dimethylamino)ethyl methacrylate (DMAEMA) was covalently bonded onto the PE/PP-NWF through graft polymerization (denoted as P-DMAEMA) and followed by template, thorium complexation through adsorption. Afterwards, polymerization with crosslinker, divinylbenzene (DVB) was carried out onto the substrate to form the cavity and finally the template was removed. The effect of operational parameters such as pH, initial adsorbate concentration, contact time and temperature were investigated in batch adsorption experiment. The experimental data was correlated with several isotherm and kinetic models for the determination of the adsorption potential. It was found that P-DMAEMA showed favorable adsorption towards uranium (U(VI)) compared to thorium (Th(IV)). However, the selectivity of Th(IV) adsorption improved using IIP. The highest selectivity coefficient ratio of Th(IV) over U(VI) for IIP was 3.09, while the relative selectivity ratio of IIP over NIP was 11.41. However, based on the overall results, the selectivity ratio is still not satisfactory. Thus, another attempt has been made to investigate the ‘in-situ’ approach in the synthesis of IIP and by replacing amine with a phosphoric functional group to improve the selectivity of the adsorbent. In this approach, firstly the complexation of Th(IV) with the polymerizable monomer, 2-hydroxyl methacrylic phosphoric acid (2-HMPA) was prepared. Next, Th(IV) was trapped by creating a three-dimensional crosslinked network surrounding the complex and simultaneously it was grafted onto PE/PP-NWF with the aid of DVB. Lastly, the template ion was leach out, leaving a cavity of the template. The stability of 2-HMPA emulsion containing Th (IV) template required to achieve optimum grafting yield was investigated. Consequently, the effect of radiation dose towards crosslinking process and Th(IV) was investigated to understand the reaction. The mechanism of imprint molecules interaction was demonstrated by theoretical prediction and experimental. Both results agreed that the carbonyl and phosphate group are predominant to construct the metal ion-monomer complex. The IIP achieved maximum distribution coefficient of 3.293 g/L and selectivity coefficient ratio of Th(IV) over U(VI) was 9.5 at 90 minutes of contact time at pH 3.5. The adsorption kinetics of IIP followed the pseudo-second-order kinetic model for both Th(IV) and U(VI) adsorption and the IIP can maintained about 80% regeneration efficiency up to four cycles.

Photos

Receptance of Ph.D degree

Introduction of the developed materials to the public