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Thorium Extraction with Cyanex272 Coated Magnetic Nanoparticles

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Abstract : In the Magnetically Assisted Chemical Separation (MACS) process, tiny ferromagnetic particles coated with solvent extractant are used to selectively separate radionuclides and hazardous metals from aqueous waste streams. The contaminant-loaded particles are then recovered from the waste solutions using a magnetic field. In the present study, Cyanex272 or C272 (bis (2,4,4-trimethylpentyl) phosphinic acid) coated magnetic particles are being evaluated for the possible application in the extraction of Thorium (IV) from nuclear waste streams. The uptake behaviour of Th(IV) from nitric acid solutions was investigated by batch studies. Adsorption of Thorium (IV) from aqueous solution onto adsorbent was investigated in a batch system. Adsorption isotherm and adsorption kinetic studies of Thorium (IV) onto nanoparticles coated Cyanex272 were carried out in a batch system. The factors influencing Thorium (IV) adsorption were investigated and described in detail, as a function of the parameters such as initial pH value, contact time, adsorbent mass, and initial Thorium (IV) concentration. Magnetically Assisted Chemical Separation (MACS) process adsorbent showed best results for the fast adsorption of Th (IV) from aqueous solution at aqueous phase acidity value of 0.5 molar. In addition, more than 80% of Th (IV) was removed within the first 2 hours, and the time required to achieve the adsorption equilibrium was only 140 minutes. Langmuir and Frendlich adsorption models were used for the mathematical description of the adsorption equilibrium. Equilibrium data agreed very well with the Langmuir model, with a maximum adsorption capacity of 48 mg.g-1. Adsorption kinetics data were tested using pseudo-first-order, pseudo-second-order and intra-particle diffusion models. Kinetic studies showed that the adsorption followed a pseudo-second-order kinetic model, indicating that the chemical adsorption was the rate-limiting step.

Keywords : Thorium (IV) adsorption, MACS process, magnetic nanoparticles, Cyanex272
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