Rapid and Simultaneous Determination of Neptunium and Plutonium in Environmental Samples Using Anion Exchange Chromatographic and Sequential Injection Setup Combined with Inductively Coupled Plasma Mass Spectrometry

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Abstract

This paper presents an automated analytical method for the rapid and simultaneous determination of Pu and Np in the environmental samples. Anion exchange chromatographic column was incorporated in a sequential injection system to actualize the automated separation of Pu isotpes along with ^{237}Np from the matrix elements and interfering radionuclides. $K_2S_2O_5$-conc. HNO_3 was applied as redox reagents for the valence adjustment and stabilization of Pu(IV) and Np(IV). ^{242}Pu preformed well as a tracer for both Pu isotopes and ^{237}Np. It was observed that the cross-link and particle size of the resins had significant effluence on the separation efficiency and anion exchange resin Bio-Rad AG 1 × 4 with the particle size of 100-200 mesh was chosen as the optimum. The investigation on the capacity showed small-sized column packed with 2mL resin sufficed up to 50g of soil sample, which provides an advantage of low consumption of the resin and low generation of acid waste after the column washing. The analytical results for Pu and Np in three reference materials showed good agreement with the certified or reference values at the 0.05 significance level. Chemical yields of Pu and Np equally range from 80% to 100%, and the decontamination factors for uranium, thorium and lead were in the range of 10^3 to 10^4. The total time of separation for a single sample was < 2.5 hours, which extremely improve the analysis efficiency and reduces the labor intensity, as well as enables a rapid determination of Pu and Np in emergency situations.