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Partitioning of minor An(III) and Ln(III) by the 1,2,4-triazine extracting compounds

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Partitioning of trivalent minor actinoids from lanthanoids and mutual separation of minor actinoids is a current issue studied within reprocessing of irradiated nuclear fuel and nuclear reactors of the IVth generation, i.e. closing of a nuclear power cycle. The objective of this contribution is to summarize results obtained for various liquid-liquid or solid-liquid extraction systems, and/or hydrophilic masking agents based on 1,2,4-triazine extracting compounds (BTP, BTBP, BTPhen) proposed for separation of the above mentioned groups of elements. Properties of new monohalogenated CyMe₄-BTBP were compared with the reference molecule of r-SANEX, CyMe₄-BTBP. The monohalogenated BTBP were much better soluble in octan-1-ol and cyclohexanone. Obtained values of Am/Eu separation factor ($SF_{Am/Eu} > 110$) were similar to the reference molecule but without the need to use a phase transfer agent. The best results for mutual separation of minor actinoids were obtained in extraction system with CyMe₄-BTPhen where a kinetic separation effect $SF_{Am/Eu} = 7.9$ was observed in the mixture of octan-1-ol with toluene, while in cyclohexanone $SF_{Am/Eu}$ was equal to 5.5–6.7. This effect was explained by computational modelling. Hydrophilic sulfonated ligands were tested for their ability to complex Am(III) and prevent its extraction by TODGA within the i-SANEX process. Four various tetrasulfonated BTBP or BTPhen ligands were able to selectively complex Am(III) in 0.28–0.77 mol/L HNO₃; $SF_{Am/Eu} = 138–934$ was achieved by extraction to TODGA. The described system provides a possible alternative to the American TALSPEAK process as it works at higher HNO₃ concentrations and without the use of any buffer. The highest value of $SF_{Cm/Am} = 4.6$ for mutual minor actinoids separation was obtained with tetrasulfonated BTPhen in aqueous phase. TODGA-PAN composite sorbent performed well for chromatographic Cm(III) and Am(III) partitioning with $SF_{Cm/Am} = 4$ when tetrasulfonated BTPhen was used as an eluting agent. The best system for solid-liquid extraction was the BTPhen-SiO₂-Fe₂O₃ MNP. It can be used for selective separation of Am(III) at higher acidities with values of $SF_{Am/Eu} \approx 1670$, and as a non selective extraction system for Am(III), Eu(III), and Cm(III) at lower acidities with values of mass distribution coefficient $D_w > 700$.

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