

# CHON UNEX: a compact separation process for high decay heat emitters

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The sustainable management of radioactive waste is one of the main challenges that the nuclear industry has to face. The separation and recycling of the highest decay heat emitters could ease the treatment and reduce the volume of high level radioactive waste to be stored in the future deep geological repository. After the removal of U and Pu by the PUREX or similar process, the main heat emitters are minor actinides (mainly  $^{241}\text{Am}$ ) and some fission products (mainly  $^{137}\text{Cs}$  and  $^{90}\text{Sr}$ ). Several separation processes have been designed to treat part of these elements (DIAMEX-SANEX, TALSPEAK, FPEX, SREX...) or all of them either by successive steps (e.g. ARTIST) or by co-extraction (e.g. UNEX, CRAMEX) to decrease the number of steps. However, these latter processes use non-incinerable solvents, hence forming secondary liquid waste to be treated. Instead, we proposed the CHON UNEX [1], whose organic phase consists in a calixarene crown-ether solubilized by a diglycolamide in a mixture of kerosene and 1-octanol (phase modifier to prevent the 3<sup>rd</sup> phase formation).

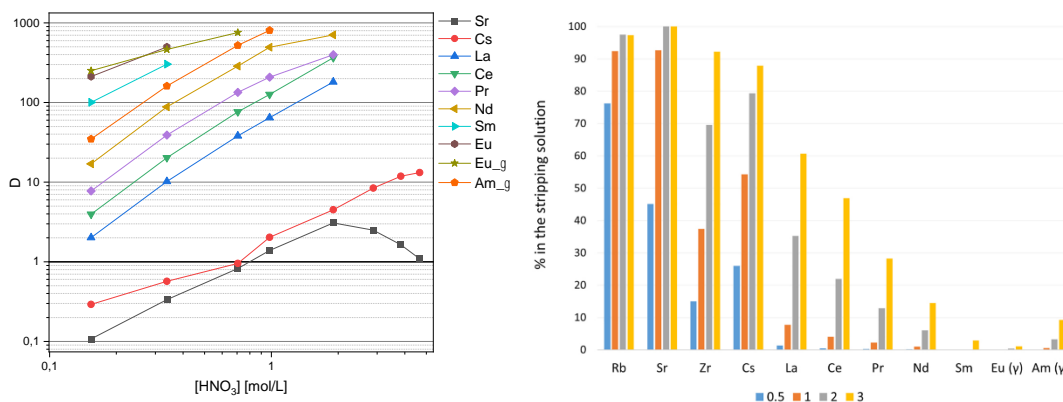


Figure 1: Left) Extraction of Cs(I), Sr(II), Y(III), Ln(III) and Am(III) by the CHON UNEX organic phase and right) mass % of each element in the stripping solution (1 mM HNO<sub>3</sub>) at different A/O ratios [1]

As shown in Figure 1, this solvent is able to co-extract all targeted elements (Am(III), Ln(III), Cs(I), Sr(I)), while diluted nitric acid is sufficient for the selective stripping of Cs and Sr, provided that A/O > 1. Among all competing cations, only Zr(IV) was largely co-extracted ( $D_{\text{Zr}} > 8$ ) and an improved scrubbing step will be necessary.

The selective recovery of Am from both Ln and Cm will then necessitate the use of a complexing agent in the aqueous phase. A few compounds can be found in the literature (e.g. SO<sub>3</sub>-Ph-BTP, Phen-2DIC4OH, BTrzPhen, etc.) but they present low  $SF_{\text{Am/Cm}}$  and research is still on-going.

[1] M. Simonnet *et al.*, « First investigations on a CHON UNEX process », *Radiochim. Acta*, vol. 111, n° 8, p. 597- 600, août 2023, doi: 10.1515/ract-2023-0151.