



Molten Salt Processing and Phase Relations for Radioactive Waste Immobilisation

Luke Cooper¹, Alex Scrimshire¹, Anthony M.T. Bell¹, Paul A. Bingham¹

¹Sheffield Hallam University, Howard Street, Sheffield, S1 1WB, UK

Lead Presenter - Luke Cooper

Pyroprocessing is an advanced nuclear fuel recycling technique that uses molten salts to separate valuable actinides, like uranium and plutonium, from spent nuclear fuel ¹. Unlike the PUREX method (Plutonium-Uranium Redox Extraction)², pyroprocessing operates at high temperatures and does not involve aqueous solutions, offering greater proliferation resistance and compact processing systems. However, it generates molten salt waste contaminated with lanthanides and other fission products, requiring purification for effective reuse and safe disposal.

This project focuses on the LiCl-KCl eutectic salt, a critical medium in pyroprocessing¹. Over time, lanthanide chlorides accumulate, diminishing the salt's effectiveness and posing challenges for waste minimisation. Zone refinement, a method relying on controlled melting and solidification, is applied here to purify the salt by isolating contaminants based on their solubility and distribution behaviour during the process.

Experimental studies are combining zone refinement with advanced analytical techniques, such as XRD, SEM-EDX, and ICP, to evaluate the efficiency of lanthanide chloride removal. Vitrification of the remaining salt waste that cannot be reprocessed is being explored as a method of immobilisation. The outcomes aim to enhance the sustainability of nuclear fuel cycles and reduce long-term environmental impacts of nuclear waste disposal.

1. K. Nagarajan *et al.*, 'Development of Pyrochemical Reprocessing for Spent Metal Fuels', *Energy Procedia*, vol. 7, pp. 431–436, Jan. 2011
2. L. Rodríguez-Penalonga and B. Y. Moratilla Soria, 'A Review of the Nuclear Fuel Cycle Strategies and the Spent Nuclear Fuel Management Technologies', *Energies*, vol. 10, no. 8, Art. no. 8, Aug. 2017