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Multl-recycling strategies of LWR SNF focusing on MOlten SAlt technology





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Orano recyling plant at La Hague (France)

Duration: June 2022/26 (4 years)

Context & objectives

Multi-recycling in LWRs is a solution for the closure of the fuel cycle, but it presents limitations related to the degradation of the Pu isotopic composition and the generation of minor actinides (MA), leading to an increase of vitrified high-level waste when compared to multi-recycling with Fast Reactors (FRs).

Improvement in converting Pu isotopes and MA into fission products (FPs) with shorter halflives can be achieved with the introduction of advanced FR systems, among which the molten salt reactor (MSR) using chloride salt is a promising option. There is no experience with chloride MSRs (Cl MSRs) in operation, but they have been studied and tested on experimental set-ups, showing great improvement in the conversion rate of actinides.

MIMOSA aims to develop an accessible, cost/risk optimised multi-recycling strategy of LWR spent fuels in the EU, based primarily on multi-recycling of Pu (and reprocessed U) in LWRs combined with the Cl MSR, using available infrastructure in the EU such as the reprocessing plant in La Hague, France.



The achievement of the MIMOSA objectives will contribute to the development of materials and technologies useful for not only MSRs but also other high temperature, high corrosion applications such as the chemical industry or energy storage, and pave the way for CLMSR deployment in Europe.

Work programme

MIMOSA focuses on the demonstration of the technical feasibility and performance of CI MSRs

- on Pu and MA conversion and on production of valuable isotopes for other applications:
- Assessment of chloride salt properties to support studies of reactor performance and safety
- Simulations of chloride salt composition evolution in the reactor
- Demonstration of key aspects of technical feasibility of chloride MSRs
- Study of salt recycling and back-end options, particularly in synergy with La Hague plant
- Evaluation of valuable isotopes for other applications, and the way to extract, separate and purify them from MSR

Highlights (2022-2025)

- SNF inventories, energy needs projections, nuclear fleet assumptions and potential evolutions in the EU have been assessed. A first simulation round of scenarios, including MSRs, has been performed.
- Several salt mixtures in NaCl-MgCl2-PuCl₃ and NaCl-ThCl₄-PuCl₃ have been selected, and synthesis of salts has been performed. Most of the salt properties measurement equipment has been set up and tested, and measurements have started.
- Three MSR configurations have been selected. Neutronic depletion simulations in these reactor configurations have started, including evolution of salt mixtures composition. The results are used to assess used salt treatment processes and valuable isotopes management processes.
- A salt irradiation experiment has been performed in the LR-0 reactor in the Czech Republic.
- The test matrix for structural materials static and dynamic corrosion tests has been completed. The testing methods, the corrosion products measurement methods and the corrosion test set ups are under development. A corrosion / irradiation test bench has been built. Tests have started on ceramic and metallic samples
- The technical study of used salt treatment in synergy with La Hague plant has been initiated: eight scenarios have been defined depending on reactor configuration and salt composition. Four of them have been assessed.
- The identification of the pyrochemical salt treatment alternative has also started, with literature review and preliminary thermodynamic calculations leading to the definition of an experimental plan which is ongoing.
- The vitrification experiments using borosilicate glass to stabilise the chlorides salt waste have been successfully performed.

MIMOSA will raise the TRL of several Cl MSR technologies, processes and materials from 1 or 2 to 3 or 4. Results are considered in scenario studies that analyse the role chloride MSRs may play in the EU's future nuclear energy systems to further the sustainable management of SNF from LWRs.

- Valuable isotopes produced in MSRs have been assessed and quantified. The applications for these isotopes and the associated market has been described.
- A device to extract by flotation the solid fission products from the molten salt has been built after preliminary tests.

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