FISA EURADWASTE 2025

SNETP Forum

Innovation in radioactive solid organic waste treatment and conditioning in the framework of the PREDIS project on predisposal waste management

Mennecart Thierry

SCK CEN, Belgian Research Center, Boeretang 200, MOL, BELGIUM

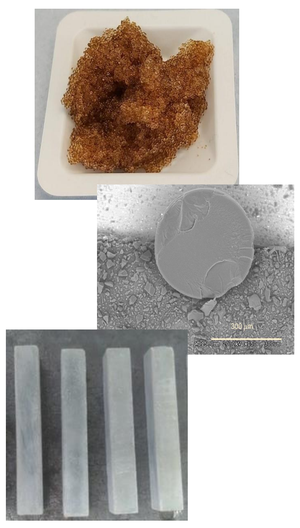
PREDIS

Pre-disposal management of radioactive waste

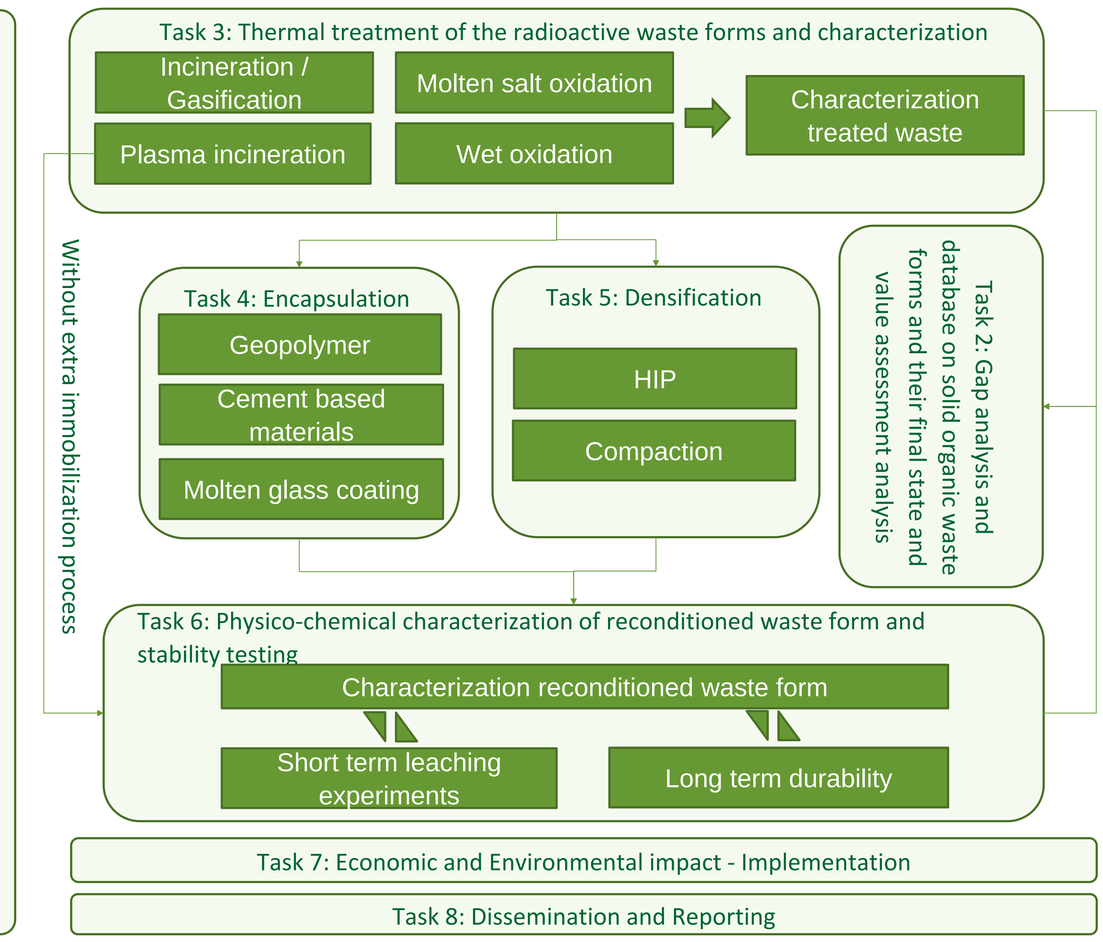
Among the various areas covered by the PREDIS project (Pre-Disposal Management of Radioactive Waste), the treatment and the conditioning of the Radioactive Solid Organic Waste (RSOW) was addressed in the Work package 6. The objective was to propose innovations and solutions for the management of Low- and Intermediate-Level Waste (LILW) forms whose safe long-term storage and disposal is difficult to achieve because they are considered not sufficiently stable and / or too highly reactive in the conditions expected to prevail in many final repositories.

Context

The gap analysis performed during the first year of the project confirmed that operational wastes (resins, mixed of plastics and cellulosic wastes) already conditioned wastes (cemented or bituminized wastes) are the most challenging waste streams to manage for the radioactive wastes management organization.



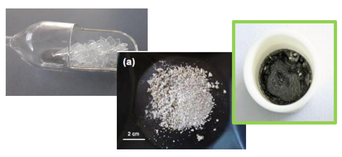
Five thermal treatment routes were considered within the WP6 leading to the production of treated wastes that required an immobilization using geopolymer or cement-based materials matrices, or to the production of glassy / ceramics materials without further treatment. Once under their final state, the stability and durability of the reconditioned wastes were evaluated under 'generic' conditions in order to provide relevant characteristics which will allow the end users to draw conclusions according the waste acceptance criteria (WAC) at their national level.



Development and optimization of the processes, among others:

- ✓ Encapsulation: determination of the most appropriate matrix formulations as a function of the treated waste properties
  - Innovation in geopolymer formulation: blast furnace slag, metakaolin, volcanic tuff, solid activators,...
  - Comparison with cement-based materials: CEM I – CEM III
  - Loading optimization (25% of MSO, 10% - 20% of ashes)

- ✓ Wet oxidation route:
  - Upscaling: from 20 g to 1kg of IER
  - Iodine and Chlorine collection

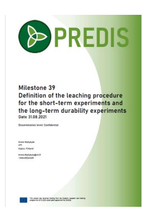


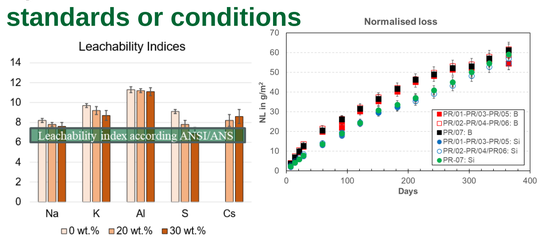
- ✓ Molten glass coating
  - Determination of the best ratio waste (ashes) / glass

- ✓ Adjustment of HIP parameters (T°, P and duration) and additive need for the formation of homogeneous glass-crystalline product

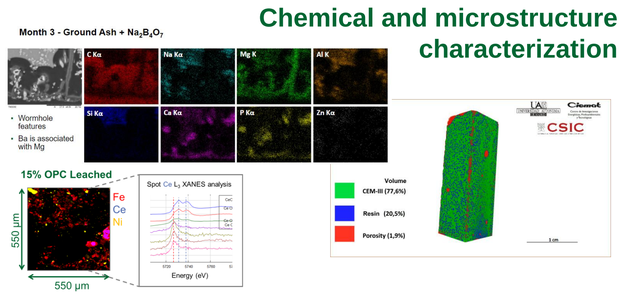
Characterization of reconditioned waste forms and stability testing

Leaching experiments: about **400 samples** were investigated using a reference leaching protocol (representative of **disposal conditions**) and under conditions in agreement with **national standards or conditions**





Chemical and microstructure characterization



Scaling-up and modelling

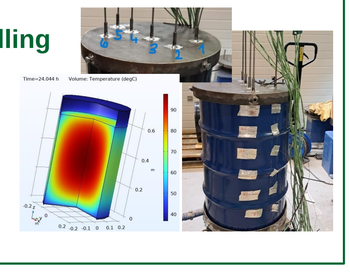


Table 1. *Level technology improvement after 4 years of project (2024)*

Technology	Ambition (TRL increase)
Molten Salt Oxidation used for the treatment of Radioactive Liquid Organic Waste	Transposition of the technology to the treatment of RSOW (IER). Trials with inactive IER and conditioning of the salt using goepolymer or cement-based materials. **TRL from 4 to 6**
Wet Oxidation Route used for the destruction of dissolved organic contaminants	Development and optimization of the process for the destruction of IER leading to the complete recovery of the ^{14}C and associated radionuclide inventory into iron sludge. The sludge will be thermal treated for a complete immobilisation (task 5). **TRL from 2 to 3 - 4**.
Goepolymer immobilisation	Determination of the best geopolymer formulation for a safe and long-term immobilisation of treated wastes after thermal treatment (e.g. ashes, salt). **TRL from 2 - 3 to 5**
Cement based materials immobilisation	Determination of the best cement-based materials formulation for a safe and long-term immobilisation of treated wastes after thermal treatment (e.g. ashes, salt). **TRL from 3 to 5**
New technique: Molten glass coating	Feasibility demonstration of the glass coating for the immobilisation of ashes after incineration of IER at the lab scale. **TRL from 1 to 4**
HIP technology	Increase the technology level using radiotracers or radioactive samples. **TRL from 2 to 4**
Compaction assisted by thermal treatment	Feasibility demonstration of densification of ashes coming from incineration process by compaction, eventually with adjuvants and temperature. **TRL from 1 to 3 - 4**

Conclusions

- **Progress was made in the management of problematic Radioactive Solid Organic Waste thanks to the thermal treatments allowing to change their chemical composition and physical properties incompatible with the current Waste Acceptance Criteria.**
- **The durability and stability of reconditioned wastes are investigated under 'generic' conditions representative of a waste repository.**
- **The Economic, Environmental and Disposability Impacts assessment shows that new treatment technologies generally offer benefits compared with current options for the management of the RSOW**

This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945098.