thermal treatment for radioactive waste minimisation and hazard reduction

theramin

Introduction

The THERAMIN project was carried out by a consortium of 12 partners representing a European-wide community of experts on thermal treatment technologies and radioactive waste management and disposal. The project included an advisory group of group of European nuclear operators, waste management organisations and the Idaho National Laboratory from USA.

Benefits of thermal treatment:

- **Significant volume reduction**
- **Waste passivation**
- **Destruction of organic materials**

These benefits reduce risks during waste storage and supports development of safety cases for geological disposal.

The Project Structure

THERAMIN aimed to identify which wastes could benefit from thermal treatment, which treatment technologies were under development in participating countries, and how these could be combined to deliver a wide range of benefits.

The project was divided into five work packages (as shown in Figure 1), which also shows how information flows between WPs.

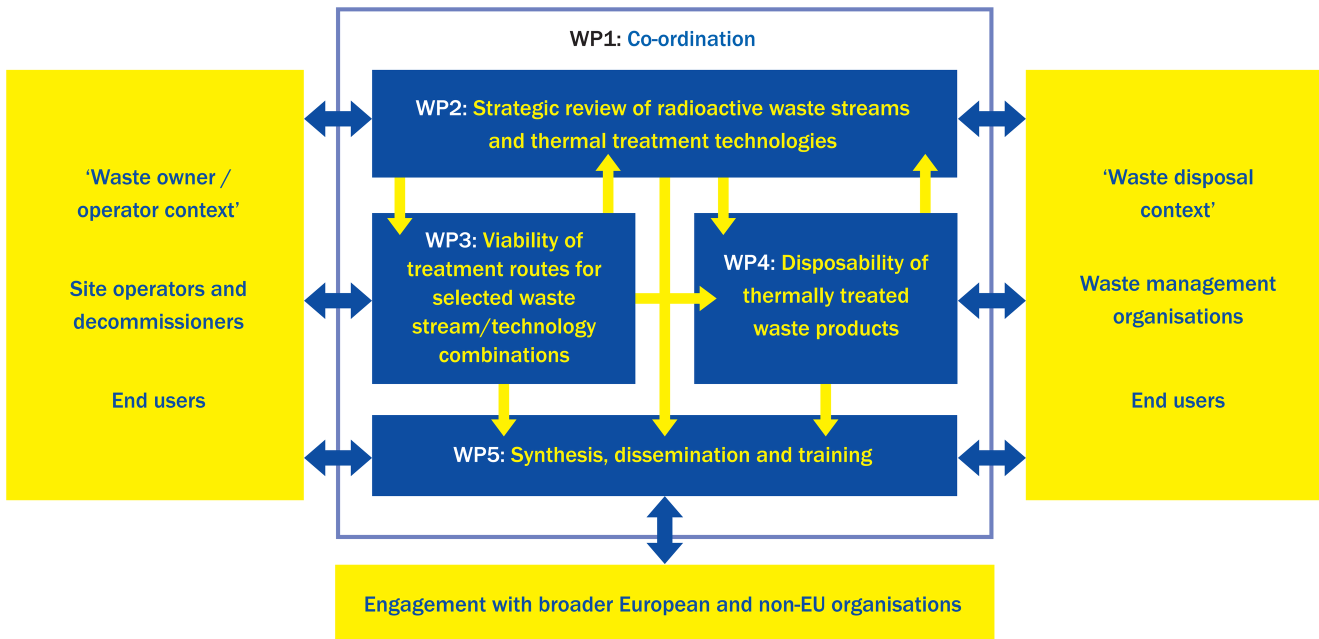


Figure 1: Structure of and interactions between the work packages within the THERAMIN project.

Over 80 researchers and industrialists from 10 countries gathered in Manchester for the EC THERAMIN Project Conference at the Mechanics' Institute on 4th and 5th February 2020.

WP2: Strategic Review of the Potential for Thermal Treatment of European Radioactive Wastes

A wide range of waste types that could benefit from thermal treatment was identified during work within WP2. Thermal treatment technologies available in Europe were also documented. Using this information, waste groups were matched with suitable technologies, to identify the potential waste group/thermal treatment combinations which could be implemented across Europe. Through this analysis, the treatment technology/waste group combinations were selected for demonstration in the THERAMIN project were selected; these combinations are shown in Table 1.

WP3: Demonstration of Thermal Treatment Technologies

The THERAMIN project successfully demonstrated that thermal techniques can be used to treat the waste groups shown in Table 1; information on each of the demonstrations listed can be found below.

Demonstrator	Waste group	Partner
SHIVA	Organic ion exchange material	CEA/ORANO
IN CAN	Sludges	
Geomelt	Cement-conditioned waste	NNL
	Heterogeneous sludges	
Thermal gasification	Organic ion exchange material	VTT
Vitrification	Chrompik	VUJE
HIP	Uranium-containing feeds	USFD
	Uranium surrogate-containing feed	NNL

Table 1: Treatment technology/material group combinations studied during the THERAMIN project.

WP4: Characterisation of Thermally Treated Products

In order to be disposed of, radioactive waste must comply with the Waste Acceptance Criteria (WAC) for a disposal facility – this identifies the characteristics required in a waste product in order to ensure that the waste can not have a significant detrimental impact on the long-term safety provided by the disposal facility. Based on the generic WAC identified during the project for thermal treatment products and the characterisation of these products, an evaluation of the impact of thermal treatment on the disposability of the waste is underway.

WP5: Synthesis, dissemination and training

The outcomes of the project, and knowledge and experience gained from the THERAMIN project, have been disseminated within the technical community and more widely via the following activities:

- Training placements held during the WP3 demonstration trials, hosted by the University of Sheffield, VTT and the CEA in 2018 and 2019.
- A technical training school, attended by 20 people and hosted by the CEA in Marcoule in June 2019.
- The THERAMIN project conference, attended by over 80 researchers and industrialists from 10 countries, in Manchester in February 2020.
- The project synthesis report (May 2020).

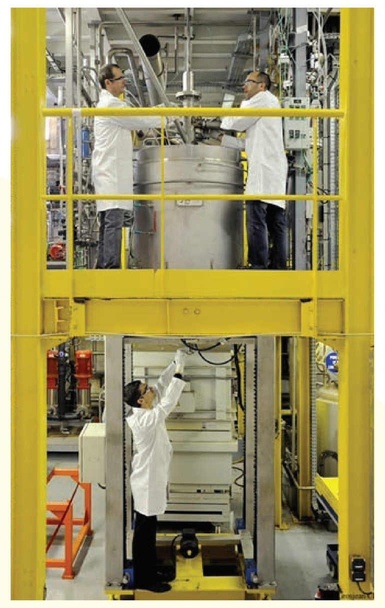
SHIVA Demonstration

Treatment: CEA has incinerated waste by plasma burner and vitrification of the resulting ashes in a cold-wall direct glass induction melting system. It is well suited to treating organic and mineral waste with high alpha contamination.
Product: Homogeneous vitrified product.

Waste glass sample from the SHIVA trial.

In-Can Melting Demonstration

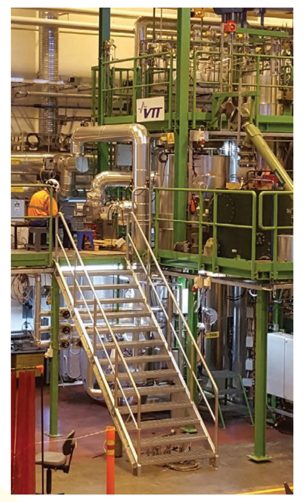
Treatment: CEA has vitrified inactive ash (by-products of incineration of organic waste) using the In-Can Melter technology, in which a metallic crucible heated in a refractory furnace using electrical resistors, allowing in-container vitrification.
Product: Crystallised glass.



In-can melting pilot plant.

Gasification Demonstration

Treatment: VTT has developed a thermal gasification treatment method to reduce the volume of radioactive waste containing a high proportion of organic matter. The method was designed for organic ion exchange resins, but can also be used for low-level operational waste containing organic matter, if crushed before treatment.



Product: Fine dust (collected on a filter) and bottom ash, which consists mainly of bed material (e.g. aluminium oxide). **Disposability implications:** These products have to be immobilised (e.g. by encapsulation in geopolymers) before final disposal.

VTT's pilot scale thermal gasification test facility.

Geomelt® Demonstration

Treatment: NNL has used the GeoMelt In-Container Vitrification (ICV) system in the NNL Central Laboratory at Sellafield to demonstrate treatment of two active waste streams. Both experiments have provided successful demonstrations of co-processing.
Product: Vitrified waste product

Geomelt® rig (NNL).

Hot Isostatic Pressing (HIP) Demonstration

Treatment: NNL and the University of Sheffield have used HIP to demonstrate treatment of surrogates for Magnox sludge and clinoptilolite, demonstrating the use of an active furnace isolation chamber that allows processing of radioactive waste simulants without risk of contamination to the processing equipment.
Product: HIP containers

Examples of the HIP containers produced during the NNL trials.

Vitrification Process Demonstration

Treatment: Vitrification of inorganic liquid waste by heating with glass frit in an inductively heated melting crucible. Following the evaporation of water and continued heating for 6 hours, the resulting vitrified product is poured into a storage container. Off-gas from the process is decontaminated via a sorption column.
Product: Vitrified product within a storage container.

Model of the vitrification facility.

Summary

The EC THERAMIN Project has successfully demonstrated the thermal treatment of eight waste types (using either active of surrogate waste materials). The products of these demonstration trials have been characterised, and now consideration of the impact of thermal treatment technologies on the disposability of the thermal products is underway.

This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 755480.

European Commission

www.theramin-h2020.eu