Andra Call for Projects
with the support of the
Investments for the Future Programme

MILOR
Mineralisation of radioactive organic liquids using plasma

Project supported by Andra under the "Investments for the Future Programme" ("Investissement d'Avenir") - Selected under the Andra Call for Projects: "Optimisation of post-dismantling radioactive waste management", organised in cooperation with the French National Research Agency (ANR).

Duration: 48 months

Project launch: 09/2017

Total project cost: €4.6 million

Sum covered under the Investments for the Future Programme: €2.3 million

Type of financial support: Subsidy with ROI guarantees for the State

Locations: Bagnols-sur-Cèze, Saclay, Donzère

Coordinating body: CEA - Nuclear Energy Directorate (DEN)

Partners:
- CEA - Nuclear Energy Directorate (DEN)
- CEA - Fundamental Research Division (DRF)
- A3I

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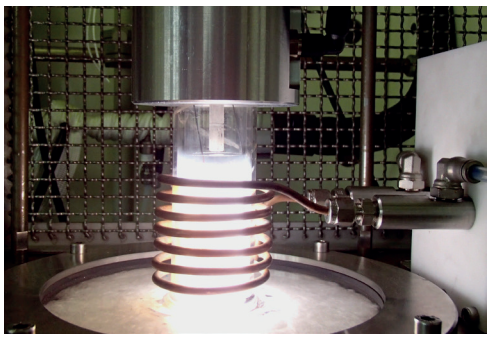
BACKGROUND

The nuclear industry, and also hospitals and universities, may produce radioactive organic liquid waste as a result of their activities (scintillating fluids for medical imaging, molecules labelled for medical research, etc.) This waste must be solidified prior to disposal. These liquids are generally incinerated at the Socodei Centraco facility in Marcoule, and the resulting ashes can then be cemented. However, the radiological (e.g. overly high concentration of carbon 14) or physical/chemical characteristics (high concentration of halogens, production of corrosive gases, etc.) of some radioactive organic liquid waste prevent it from being processed in this incinerator. This is especially true for radioactive organic liquid waste from older activities.

The development of alternative methods to process this waste for disposal has therefore been identified by the French government as a priority action under the National Radioactive Materials and Waste Management Plan.

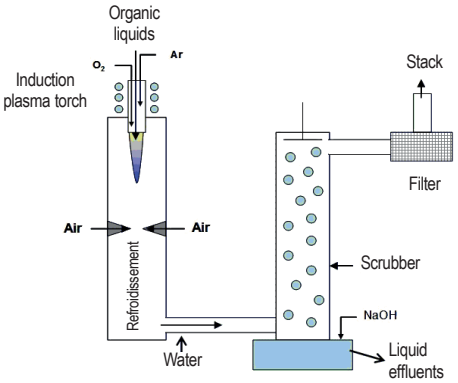
OBJECTIVES

The MILOR industrial research project aims to develop two complementary processes at the same time for the incineration of radioactive organic liquid waste using plasma:



▶ IDOHL process

- the first process, IDOHL (Liquid Organic Halogen Destruction Facility) processes organic liquid waste with a low mineral concentration (<1%) using low-power (5 electrical kW) airborne plasma (inductively coupled plasma). This mature system is in the pre-production phase and offers a service life of several thousand hours with limited maintenance. However, the flows are limited (around 100 mL/h) due to the relatively low plasma power (approx. 5 kW). A pilot facility will be installed for the project at the CEA Saclay Centre to process real radioactive organic liquid waste;
- the second process, ELIPSE (elimination of liquids using submerged plasma) uses a higher-powered (45 electrical kW) plasma immersed in an aqueous solution (submerged sprayed plasma arc). It can process liquid waste at higher rates (up to 3 L/h) and can handle waste with a high mineral fraction while also significantly simplifying the management of gases generated during processing. This process requires significant technological developments before commercial operation.



▶ Schematic diagram of the IDOHL process in operation

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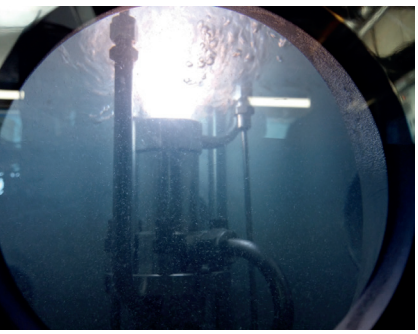
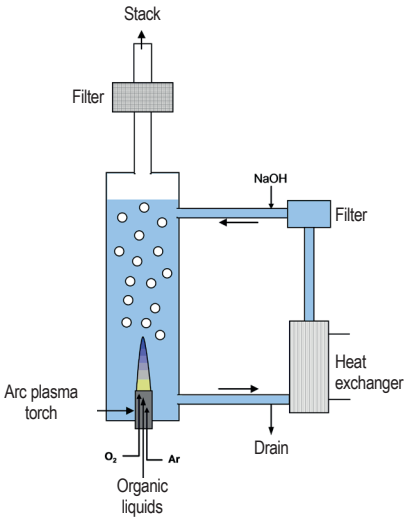


▶ ELIPSE process



▶ Schematic diagram of the ELIPSE process in operation

PROJECT SEQUENCE

The project will last four years and involve three complementary partners:

- CEA DEN (Nuclear Energy Directorate) via the Enrichment Decommissioning Waste Research Department (DE2D), with its expertise in thermal waste treatment processes;
- CEA DRF (Fundamental Research Division) via the Molecular Labeling and Bio-Organic Chemistry Unit (SCBM), which is in possession of radioactive organic liquids produced through older molecular labelling activities using tritium and carbon 14 for medical applications, but has no waste management solution;
- SME A3I, a subsidiary of the INOVERTIS group, witch has extensive engineering experience.

The project seeks to develop the IDOHL and ELIPSE processes, while also more generally studying the various steps in managing radioactive organic liquid waste with no elimination solution, from waste characterisation to conditioning for disposal:

- A first step will therefore seek to specify the composition of these organic liquids, thus providing essential data for their incineration.
- Major work is also planned to ensure that the aqueous effluents and solid halogen-rich residues (chlorides and fluorides) from the incineration of radioactive organic liquid waste are compatible with existing disposal solutions (liquid effluent treatment plants and Andra's disposal facilities).
- Several tests will be carried out throughout the project, first on simulated non-radioactive waste. For the IDOHL process, which is in a more advanced stage, a prototype will be installed to conduct tests on simulated radioactive liquids at the end of the project, and then on real waste from CEA DRF.

EXPECTED RESULTS

Innovation

Both technologies developed under the MILOR project aim to provide flexible options for the various types of radioactive organic liquid waste to process, while controlling costs. This final point applies particularly to the IDOHL process that will be commissioned for real waste under the project. The ELIPSE process will develop an original technology, with the implementation of submerged plasma to simplify the management of gases created during processing, and at higher rates. New conditioning matrices will also be developed for generated residues.

Economic impact

The MILOR project will develop two relatively complex plasma processing technologies for limited volumes of waste (a few hundred m^3). Special efforts will therefore be made throughout the project to analyse the economic impact, through two main actions:

- achievement of a technical and economic study from the facility design phase in order to control costs associated with radioactive organic liquid waste management. The project will develop an economically competitive facility that can adapt to processing requirements: a compact, potentially mobile facility with small but adjustable capacity;
- identification of markets similar to that in France for radioactive organic liquid waste with no management solution, looking not only at international radioactive organic liquid waste deposits, but also organic liquids from other industries.

Impact on radioactive waste management

The MILOR project will have a major impact on future management of radioactive organic liquid waste with no elimination solution. In the short run, the IDOHL prototype installed by CEA DRF will solve the problem of certain types of radioactive organic liquid waste from the nuclear power industry and certain older radioactivity-contaminated sites. In the long run, the ELIPSE process will simplify this type of waste treatment.

Application and commercialisation

In addition to the benefits to radioactive waste management, application of the technologies developed under the MILOR project could be extended beyond the nuclear field, particularly to the chemical and pharmaceutical industries. These industries also face problems regarding the treatment of toxic and/or aggressive organic effluents CMR, active cytotoxic pharmaceutical ingredients, etc. which are incompatible with currently available industrial technologies (incineration, wet oxidation, hydrothermal oxidation, etc.).