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

MATRICE

Radiation-resistant cementitious materials

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

Duration: 48 months

Project launch: 05/2016

Total project cost: €4.7 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: France: Versailles (78), Bagnols-sur-Cèze (30), L'Isle d'Abeau (38), Gif-sur-Yvette (91)

Coordinating body: Léon Grosse

Partners:
- Léon Grosse
- CEA
- Nanoscience and Innovation for materials, biomedicine and energy (NIMBE) - Mixed Research Unit CEA-CNRS
- Vicat

Certification: Nuclear Valley

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BACKGROUND

The decommissioning of nuclear facilities in the decades to come will generate various types of waste, some of which will be highly radioactive and/or contaminated by high levels of α emitters (uranium and plutonium in particular). Conditioning this specific waste via solidification in a cement matrix is a robust solution, which is already widely used to encapsulate radioactive waste. This solution corresponds to a technical economic optimum for a wide range of waste. However, for storage and/or disposal safety reasons, its use can be restricted. Water naturally present in cement matrices produces hydrogen gas (which can be explosive/flammable under some conditions) when when exposed to ionising radiations (referred to as "radiolysis"). Optimised cement matrices therefore need to be formulated to limit the release of gas to an acceptable level while optimising the conditioning of highly radioactive waste.

Results of the vibro-compaction process test.

OBJECTIVES

The primary goal of the MATRICE project is to identify and define the formulations of cementitious materials in order to minimise the quantities of hydrogen gas produced by radiolysis and to quantify the production of hydrogen gas via radiolysis for these materials.

Three possibilities will be assessed during the MATRICE project:

- minimisation of water levels in classical cements (calcium silicate-based cements) by adding specific compounds (e.g. superplasticisers/water reducers);
- use of "alternative" cements, compared to classical cements (Portland cement), such as sulphur aluminate cement, and magnesium phosphate cement. These cements have higher water demand than classical cements (therefore less residual "radiolysable" water that can produce hydrogen);
- implementation of processes, such as vibro-compaction, to facilitate the casting of concrete with little water.

ANDRA
French national radioactive waste management agency

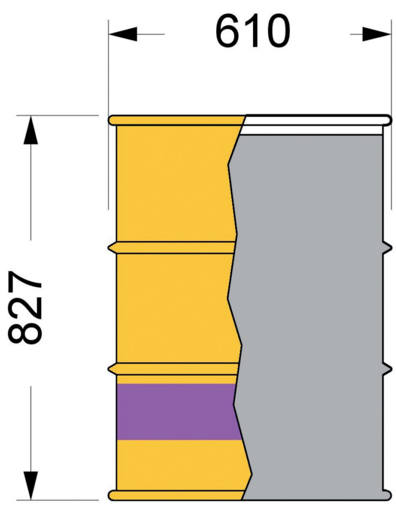

Diagram of a metal drum of cemented sludge and concentrates (in mm).

200 L metal drum used for conditioning cemented and other waste.

PROJECT SEQUENCE

The project will take place over four years and involve two CEA research laboratories and two industrial partners (Léon Grosse and Vicat). The aim is to demonstrate the robustness of the proposed solutions and their industrial feasibility.

Full-scale tests (up to a 200 L container) of the most promising cement formulations will be carried out.

Irradiation tests will be performed to assess the release of hydrogen gas from radiolysis. The final goal is to propose a model to estimate gas production based on the radiological inventory, type of waste and formulation of the cement matrix.

EXPECTED RESULTS

Innovation

The production of hydrogen by cementitious materials under the effect of ionising radiations waste conditioning activities with classical cements (such as Portland cement). The aim of the MATRICE project is to provide solutions to incorporate significantly higher activities (generally a factor of 10), while maintaining levels of radiolysis gas release that are acceptable within current limits or that decrease compared to current conditioning solutions. To do this, innovative formulations are being studied while exploring all potential avenues for optimisation (limiting the amount of water, adding products with a specific impact on radiolysis, alternative cements to calcium silicate-based cements). These cement formulations could lead to specific implementations related to their rheology during fabrication. Specific processes will be developed up to a full-scale level (200 L container) during the project. The stability of the tested admixtures under radiation will be assessed.

Economic impact

In the coming decades, the decommissioning of fuel reprocessing plants or the retrieval of old waste from these facilities will generate radioactive waste. Some could be better conditioned in the optimised cement matrices developed during the project. For radioactive waste producers, the use of these optimised matrices would generate lower conditioning costs (cheaper raw materials and processes in general), along with lower disposal costs (possibility of conditioning more waste with constant volume and gas production).

Impact on radioactive waste management

Increasing the level of waste incorporation will reduce conditioned volumes and optimise repository volume capacities while ensuring safety thanks to lower hydrogen production.

Social impact

Léon Grosse, the project leader, plans to hire three people within six years following project completion. Vicat also plans to hire two people to work on commercialisation of the project.

APPLICATION AND COMMERCIALISATION

The electronuclear industry (fuel cycle facilities in particular, whether in operation or in the decommissioning process) would potentially be interested in the solutions developed under the MATRICE project. Applications related to waste contaminated with α emitters from National Defence activities are also foreseeable.