GEN IV International Forum℠
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Cement Matrix for Nuclear Waste

Summary / Objectives:

This webinar discusses the formulation of an alternative cement matrix for solidification/stabilization of nuclear waste. The presentation provides an overview of the multiple complexities of waste management, and the many challenges that arise from it. Topics include a presentation of the French nuclear waste management methods, specific examples on solidification/stabilization of nuclear waste, the physico-chemical aspects of the interactions between the containment matrix and the waste, and the miniaturization of samples for the development of new matrices allowing human radiation protection. The webinar also highlights current experimental research focused on Portland cement and a magnesium potassium phosphate cement matrix. The latter is a promising cement for the stabilization/solidification of heavy metals. Other potential cementitious matrices will also be discussed.

Meet the Presenter:

Mr. Matthieu De Campos is a second year PhD student at the University of Lille, more specifically within the Solid Chemistry axis of the UCCS laboratory (Catalysis and Solid Chemistry Unit). He is a member of the research team CIMEND («ChImie, Matériaux Et procédés pour un Nucléaire Durable» i.e. «Chemistry, Materials and Processes for Sustainable Nuclear Activities"). This research team is involved in a joint laboratory between the University of Lille and Orano, the Laboratoire de Recherche Commun Cycle du Combustible et Chimie de l'Uranium (LR4CU) (for Joint Research Laboratory on Fuel and Uranium Chemistry). The LR4CU is focused on generating added value to fuel cycle by-products and optimizing nuclear processes. The aim is to increase the TRL levels for futures industrial applications. His PhD research aims at adding value to low-radioactive metallic materials, by considering them as reagents for the synthesis of cementitious matrix. His research activities, funded by Orano, are based on a multidisciplinary approach combining Civil Engineering and Solid State Chemistry. In 2017, he graduated from Artois University with a Masters' Degree in Materials Chemistry for Energy and the Environment.

1. French Classification of Nuclear Waste:

Separation of nuclear waste into 6 categories based on its radioactivity level and life span.

Dismantling generates many different type of wastes.

The chemical nature of this waste is the main difficulty in managing it during dismantling.

This is why the development of new adapted cementitious matrices is important to ensure safe handling & protect humans from their toxicity.

Category	Very short-lived waste	Short-lived waste	Long-lived waste
Very low-level waste (VLLW)	VSLW Management through radioactive decay	VLLW Surface disposal (Industrial facility for grouping, storage and disposal)	
Low-level waste (LLW)		LILW-SL Surface disposal (Aube and Manche disposal facilities)	LLW-LL Near-surface disposal under development
Intermediate-level waste (ILW)			ILW-LL Deep geological repository at the project phase
High-level waste (HLW)	Not applicable		HLW

ANDRA. *National Inventory of Radioactive Materials and Waste*. 2018.

2. The Conditioning Routes for Radioactive Waste:

The common point of these conditioning routes is storage.

Vitrification of fission elements

Stabilization by solidification of nuclear waste

Packing

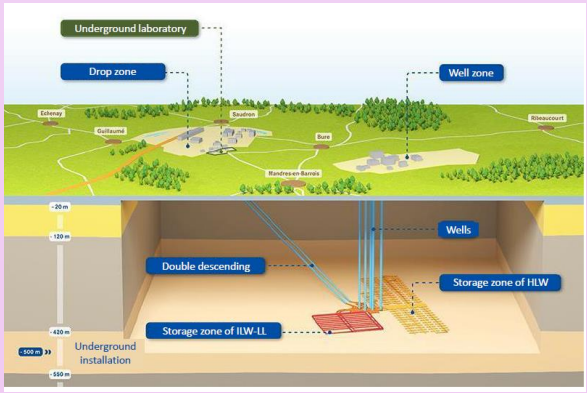
3. Types of Storage:

The French National Radioactive Materials and Waste Management Plan (PNGMDR) describes the prescribed management solutions for the different categories of radioactive waste.

Surface Storage: VLLW Disposal

Surface Storage: LILW Disposal

Deep Storage



4. Stabilization/solidification (S/S):

OPC(Ordinary Portland Cement)-based S/S of soluble Pb

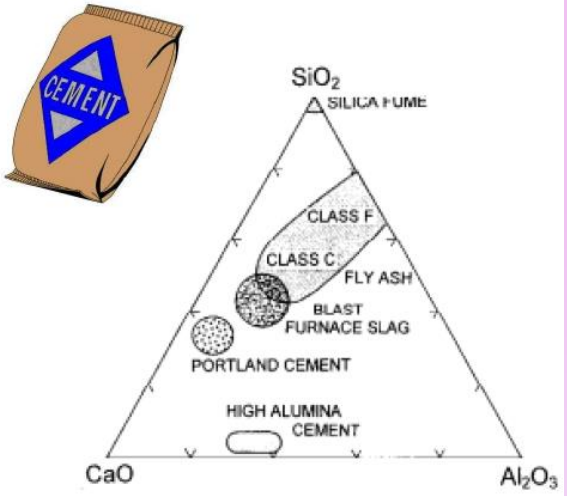
→ Physical encapsulation by calcium-silicate-hydrate (C-S-H) gels (present in Portland cement)

MKPC(Magnesium Potassium Phosphate Cement)-based S/S process

→ Chemical stabilization with residual phosphate and physical fixation by K-struvite cement.

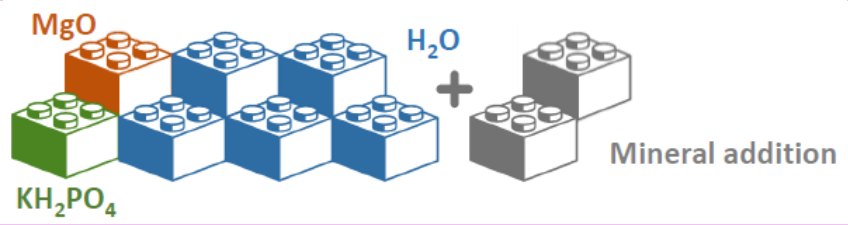
MKP is a more efficient and chemically stable inorganic binder for the Pb S/S process (compared to Portland cement)

Portland Cement



Formation of MKP cement:

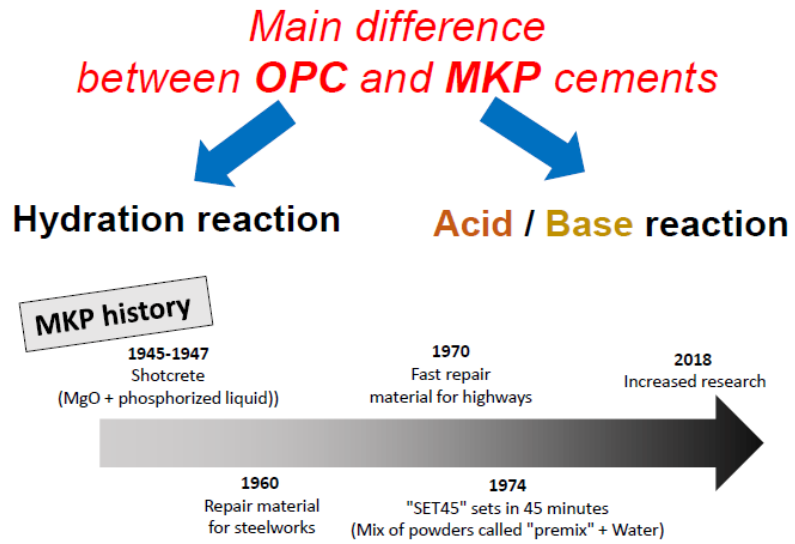
« $KH_2PO_4 + MgO + 5\,H_2O \rightarrow MgKPO_4 \cdot 6H_2O$ »

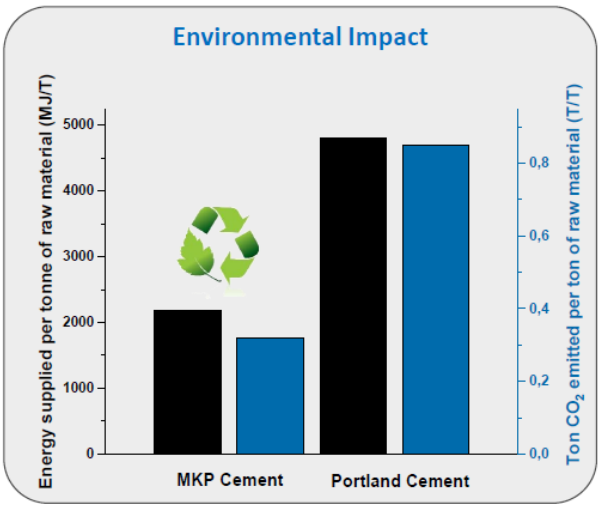


5. Difference Between MKP & OPC:

The formulation of innovative matrices requires:

- Implementation of specifications according to the intended use
- Use of a cementitious matrix appropriate to the waste
- Formulation tests
- Performance optimization(physical, leaching…)
- Understand the physico-chemical phenomena involved





6. Physical Integration of Nuclear Waste:

To Demonstrate feasibility to enable to scale-up while unlocking the technological locks