Zeolites as sorption sink in concrete based radioactive waste disposal facilities

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NIRAS/ONDRAF, the Belgian Agency for Radioactive Waste and Enriched Fissile Materials, is currently preparing the construction and operation of a surface disposal facility for short-lived, low- and intermediate-level radioactive waste (category A waste) in the municipality of Dessel (the cAt project). In 2011, the safety report, illustrating that surface disposal of such type of waste was feasible and safe, was peer reviewed under the auspices of the OECD Nuclear Energy Agency (NEA) prior to the submission of the license application to the Belgian safety authority FANC, the Federal Agency for Nuclear Control.

During peer review of the safety case, the international review team recommended that ONDRAF/NIRAS continues to look into the possibility of backfilling inspection rooms with alternative materials to add a further defence-in-depth layer to the reference design.

As one of the potential options to satisfy the reference design, ONDRAF/NIRAS is considering to fill inspection rooms within the disposal concept with a zeolite-based material with optimised sorption properties for radionuclides within the inventory who limit and prevent detrimental radiological impact of the disposal system on the environment.

Preliminary confirmed results identified clinoptilolite and chabasite as those zeolites exhibiting superior performance as Cs^+ selective sorption sinks in hyperalkaline porewater, which is associated with fairly to moderately fresh concrete. In addition, and unexpectedly, Cs^+ sorption isotherms demonstrated a dramatic increase of Cs^+ in pH 13 solutions compared to conditions at pH 8. Combining these results with the observed stability trends in ultra-alkaline zeolite transformations, indicated chabasite as highly promising sorption sink for Cs^+ in ultra-alkaline conditions encountered in concrete porewater. This stimulated research activities assessing the long-term stability of chabasite in concrete porewater and understanding the important CEC increase in pH 13 solutions compared to pH 8 solutions.