Preface

Operations in the nuclear power industry produce a wide variety of radioactive wastes. The predisposal waste management is to produce waste packages suitable for storage, transportation and final disposal. Cementation is a widely applied technique for the conditioning of low- and intermediate-level radioactive wastes. Compared with other solidification techniques, the cementation process is relatively simple and inexpensive. Moreover, calcium silicate cements show many advantages, such as easy supply, compatibility with aqueous wastes, good self-shielding and high alkalinity, which allow to precipitate and thus confine many radionuclides. However, specific issues have still to be addressed, such as the limitation of adverse cement–waste interactions which may affect the quality of the resulting solidified waste form, or the understanding and prediction of long-term properties of the waste packages and cement barriers. There is also a need for safe processes minimizing the production of secondary wastes.

Facing these major challenges, the objective of the 1st International Symposium on Cement-Based Materials for Nuclear Wastes (NUWCEM), that was held in Palais des Papes, Avignon and Marcoule Research Center on 11–14 October, 2011, was to promote the exchange of advanced information on the ongoing research and development activities dealing with cementation of nuclear wastes, from elaboration of waste packages to their final disposal and long-term behaviour.

This book contains some of the contributions to the NUWCEM Symposium. The invited speakers and the contributions from the participants covered the full range of theoretical, computational, experimental and technological approaches. In addition to the present contribution, there were numerous other excellent contributions to the meeting, but because of the shortage of space, not all of these presentations could be included in this book.

The chapters included in this book have been grouped as follows: methods of production of cement–waste forms, physico-chemical processes occurring in cement–waste forms at early age, influence of external and internal factors on long-term properties of cement–waste package and cement barriers and emerging and alternative cementitious systems.

In the first group of contributions, concerning methods of production of cement–waste forms, Drace and Ojovan summarize IAEA research project on cementitious materials for radwaste management; Sukhanov et al. discuss the main results of cementation technology for immobilization of hydroxide pulps and Cardinal et al. evaluate the performance of high energy mixer for the cementation of ILW surrogate slurry.

The works on physico-chemical processes occurring in cement–waste forms at early age compose the second group of contributions. Lothenbach investigates the blending of Portland cement with silica-rich materials that leads to changes in composition of the hydrated cement and of its pore solution; Gibsy et al. describe the application of a sub-lattice model for C-S-H gel, allowing substitution of alumina, sulphate or heavy metals into the structure, while Aimoz et al. develop a thermodynamic model for the AFm-(I_2, SO_4) solid solution with the purpose of predicting the fate of ^{129}I in the complex cement matrix.

In the third part, contributions concerning the influence of external and internal factors on long-term properties of cement–waste package and cement barriers are regrouped. Torrenti et al. examine the coupling between calcium leaching and mechanical behaviour of concrete, while Bary et al. develop a chemo-transport-mechanical model for the simulation of external sulphate attack in cementitious materials. Concerning radionuclides sorption and transport, Wieland et al. present a study on U(VI) and Np(V, VI) binding in hardened cement paste by micro-X-ray fluorescence and micro-X-ray absorption spectroscopy (μ-XRF/XAS); Wang et al. summarize a significant database of selected sorption values on cement for 25 elements; Mercado et al. propose an experimental way to obtain the diffusion coefficient of ions based on the determination of the electrical conductivity of the specimen; Pang et al. review the multiphase modelling of moisture transport process in pore structure of cement-based materials, while Boher et al. focus on the hydrogen diffusion through partially water saturated materials. Finally concerning the concrete cells of nuclear repositories, Albrecht et al. review the current status of microbiological catalysis of redox reactions in concrete and Depierre et al. study the leaching of nuclear glasses in cement pore waters.

The final part will consider the emerging and alternative cementitious systems for radwaste solidification and stabilization. After an exhaustive review of such binders, proposed by Cau, a focus will be made on several matrices. Calcium sulfo-aluminate cements are used as $ZnCl_2$ stabilization matrix by Berger et al. and as highly concentrated borate solutions conditioning material by Champenois et al. On the other systems, Swift et al. evaluate the effects of supplementary pulverised fuel ash on phosphate-modified calcium aluminate cement, while Poulesquen et al. present the rheological behaviour of geopolymers. Finally on low-pH cement, Bach et al. propose an original approach to predict their long-term chemical evolution and Alonso et al. summarize the results of the international project Round Robin test, which aims to propose methodologies for pH determination in low-pH cement systems used in the context of nuclear waste repositories.

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