EXPERIENCE ON THE IMMOBILISATION OF ION EXCHANGE RESINS IN GEOPOLYMERIC AND ALKALI-ACTIVATED MATERIALS: SPANISH EXPERIMENTAL PROGRAMME

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In Spain, typically, Spent Ion Exchange Resins (SIERs) are cemented in Ordinary Portland Cement (OPC) matrices with different additions, depending on the Nuclear Power Plant (NPP). However, conditioning of borated resins present problems such as delayed setting or microcracking generated by the swelling of the beads. In order to avoid these problems that limit the SIERs content in the waste packages, new materials are being developed for their encapsulation. In the EU-PREDIS project (2020-2024) and, in parallel, as part of the Spanish experimental program, CIEMAT-CSIC-UAM groups were working on different alternatives to conventional cementation methods, including a one-part geopolymer and two alternative Alkali-Activated Cementitious blends (Blast Furnace Slag (BFS)/Fly Ash (FA)). In PREDIS, one-part technology was chosen, as one of the initial limiting conditions imposed was the compatibility of the resulting formulation with conventional NPPs conditioning systems. One-part geopolymers present several advantages as components are solid and handling of concentrated alkaline solutions is not necessary (especially considering occupational risks in controlled areas in NPPs). Surrogate SIERs, both, thermally-treated and beads, were immobilised in a sodium-metakaolin based geopolymer and, in both cases, a 20 wt.% waste load was achieved. In parallel to PREDIS project, and as part of the Spanish national experimental programme, two alkali-activated cementitious (AAC) blends were formulated for the encapsulation of highly-borated resins. The designed AACs were based on BFS with partial FA substitution containing 100 and 85 wt.% of slag and 0 and 15 wt.% of ash, respectively. Each of them was activated with two activating solutions, sodium carbonate and sodium silicate. The maximum waste load achieved (7.5 wt.%) surpassed the current waste load (< 5 wt.%) and met the Spanish mechanical WACs with an acceptable workability. In general, the three alternative matrices exhibited an improved mechanical performance decreasing the leaching behavior for Cs and Sr, compared with currently in-use formulations. However, boron leaching slightly increased with respect to OPC reference matrices. This work will have continuation throughout EURAD-2 (2024-2029), where CIEMAT-CSIC-UAM groups will contribute to the work packages STREAM and L'OPERA, addressing two relevant aspects for implementation: scaling-up and prototyping and long-term performance under disposal conditions.

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