GAMMA IRRADIATION STABILITY OF NOVEL BINDERS FOR RADIOACTIVE LIQUID ORGANIC WASTE IMMOBILIZATION

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Radioactive liquid organic waste (RLOW) is generated by the nuclear industry during reactor operations and decommissioning. RLOW includes lubricants, solvents, and scintillation liquids. Although RLOW represents a small fraction of liquid radioactive waste, its management is challenging due to its organic composition and limited compatibility with conventional cementitious binders. The adoption of Geopolymers (GP) and Alkali Activated Materials (AAM) has introduced a new route for the direct conditioning of RLOW. These materials serve as inorganic binders typically composed of a two-component mixture: a reactive aluminosilicate powder and an alkaline activation solution. Generally, these binders are characterized by good durability. Furthermore, the majority of the constituent raw materials are recycled industrial by-products, which increases the matrix's environmental sustainability. Usually, these binders are less affected by organic waste and have proven effective in incorporating up to 30%v of low-viscosity oils. The study of stability under irradiation is crucial to assess how the matrix will withstand the dose from real waste. In this joint collaborative research performed within the PREDIS project, three different formulations were gamma irradiated up to 500 kGy. The samples were prepared by NNL-ECL, SCK CEN, and KIPT-CEA, using different reactive solid powders (metakaolin, blast furnace slag, and fly ash) along with various alkaline activators (potassium or sodium hydroxide and silicate solutions) while other partners focused on assessing their durability. Samples were analysed both with and without surrogate wastes, specifically industrial Nevastane oil. Irradiated samples without waste were evaluated to identify the most reliable formulations through measurements of hydrogen production and leaching tests. Meanwhile, samples containing surrogate waste were examined using micro-computed tomography to assess the interaction and distribution of the waste. After irradiation, leaching tests were performed to evaluate the amount of surrogate waste released. The results show how the different formulations yield varying structures and robustness, particularly in the formation of open and closed pore structures, depending on the raw materials used. Although the rate of hydrogen production and leaching is higher for the metakaolin-based GP, these values are still compliant with regulatory limits. The choice of raw materials also affect oil encapsulation; however, the variation between the most and least emulsified samples does not result in significant oil release during leaching. Barring additional interventions, these promising findings are helpful for demonstrating the practical applicability of RLOW direct conditioning.
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