

IRE-SOLVE PROCESS: AN INVENTIVE SOLUTION TO ADDRESS THE PRE-DISPOSAL OF ION-EXCHANGE RESINS

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Nowadays, 10-50 m³/year of exhausted organic ion-exchange resins (IERs) are routinely produced from the operation of a nuclear power plant. The inventory of this waste is growing fast all over the world, and an innovative strategy is needed to address this burden. The direct conditioning of spent IERs in cement and bitumen was pursued in the past, leading to large volumes of the resulting waste forms, unfortunately affected by scarce durability because of the challenging nature of the waste. Conversely, this work provides an inventive solution consisting in the integration of the treatment of the organic waste by an advanced Fenton wet oxidation and the conditioning of the resulting inorganic residues into a tuff-based alkali-activated matrix. The resulting waste forms have shown compliance with the Waste Acceptance Criteria (WAC) of the national waste disposal.

A surrogate waste was prepared by loading nuclear-grade IERs (IRN-77/78) with representatives of fission and corrosion products and borate contaminants. The treatment of the IERs proved to be effective in degrading the organic content, resulting in a liquor containing the contamination. According to the state-of-the-art, this effluent usually undergoes a long evaporation stage to concentrate the contamination in a residue to be conditioned in the final matrix. This invention replaces the evaporation process with a selective decontamination step by using some of the materials employed in the conditioning matrix. More than 98% of the initial contamination is concentrated in a single stage. After separation, the effluent can be conventionally released, while the contaminated residue can be quickly conditioned by simply adding the remainder of the matrix recipe. Waste forms with IERs equivalent loading factors up to 30 wt.% were synthesized and tested.

The proposed integrated technology promotes sustainability and circular economy by repurposing some industrial by-products as catalysts of the treatment and precursors of the conditioning matrix, at the same time saving energy and time. Furthermore, it overcomes past issues of compatibility between the residue and the conditioning matrix, and the volumes of the resulting waste forms are more than halved.

An Italian patent application was filed for this invention (n° 102023000002082, 8th February 2023). Furthermore, the application entered the European regional phase (n° EP24156036, 6th February 2024). For a patent valorisation, the inventors are seeking a joint, collaborative research with a business partner to increase TRL and launch the technology at industrial scale.

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