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INNOVATIVE OXIDATIVE TREATMENT AND GEOPOLYMER. ENCAPSULATION OF SPENT MIXED BED ION EXCHANGE RESINS

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Several nuclear industrial applications are currently using ion-exchange resins (IERs). Organic cationic and anionic resins are mainly employed for chemical control of water and radioactivity removal during power plant operations, but also for decontamination of liquid waste streams during decommissioning stages. Upon used, IERs are usually replaced to reduce the amount of generated radioactive liquid waste. However, this approach is involving the production of large volumes of exhausted organic resins. To safely dispose of this low or intermediate level waste, processes more reliable than direct encapsulation of spent IERs in Ordinary Portland Cement (OPC) are being developed. They point to overwhelm the challenging nature of the waste due to swelling, flammability, dispersivity, and potential radionuclides leachability, and to minimize volumes of the final waste package, processing costs and environmental footprint.

The focus of this work is on the development of a Fenton-like wet oxidation process that consists of an exothermic reaction of a catalyst and an oxidant by the production of reactive radicals that decompose organic matter. It is being considered more attractive due to low oxidation temperature (< 100 °C), non-toxic catalyst and green oxidant. The appropriate tuning of catalysts ($FeSO_4 \cdot 7H_2O$, $CuSO_4 \cdot 5H_2O$) and oxidant (H_2O_2) amounts allowed the treatment of a mixed resin bed system. The successful decomposition of about 100 g of a surrogate waste loaded with Cs, Co, Sr, Ni, Cl, and I as representatives of activation and fission products contamination, has led to a scaleup of the process (about 200 g of resins). The temperature and colour shift of the solution have been helpful to monitor the oxidation evolution. The moist and brownish residue downstream of the evaporation process underwent a geopolymeric encapsulation. The sustainable formulation involves the activation with sodium hydroxide of highly zeolitized tuff and recycled industrial by-products, to provide high pozzolanic reactivity, high durability, chemical and thermal stability in compliance with the Waste Acceptance Criteria. The process showed promising weight reduction rates and organic matter decomposition as proved by Chemical Oxygen Demand measurements. Besides, inorganic compounds have been identified in the final residues by X-Ray Diffraction, Fourier Transform Infrared, and Raman analyses, while a satisfactory retention of the contaminants was demonstrated by ICP-MS. In the future, a new process scale-up will be pursued to manage 1 kg of spent resins.

Acknowledgement