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Electrochemical decontamination of radioactive solutions from PHADEC-based processes enhanced by addition of co-precipitation agents

An advanced Phosphoric Acid Decontamination (PHADEC)-based process is being developed to manage the large amount of contaminated metallic materials coming from dismantling activities in nuclear decommissioning. Volume savings of the final waste, lower environmental footprint and reduction of secondary waste by declassifying scrap metals and reusing decontaminated phosphoric solution are the main goals of the process. This PHADEC-like method relies on the following steps: i) dissolution of the superficial contaminated layer of scrap metals by phosphoric acid, ii) oxidation of the pickling solution, iii) electrochemical precipitation of iron and contaminants phosphates, and iv) conditioning of the dried precipitate by vitrification.
From commercial steel pickling and oxidations steps, a simplified surrogate metal liquor was prepared by adding 500 Bq each of Co-60, Sr-85, Cs-137 and Ni-63 radiotracers, as representatives of activation and fission products contamination. The electrochemical process conducted at laboratory scale (120 mL) showed a precipitation yield of about 35% for Co-60 and Ni-63, 25% for Sr-85 and 50% for Cs-137. To reuse the phosphoric acid solution in a pilot plant, the electrochemical decontamination needs to be improved. The concentrations of the radionuclides in the dissolved metal liquor might be much too low to reach the product solubility constants of the contaminants phosphates. Research efforts are being focused on the potential role of co-precipitation agents in the electrochemical precipitation step. Notably, precipitation tests have been performed in the same configuration cell by adding stable Co, Cs, Sr and Ni ions and introducing $BaSO_4$, $Ca_2P_2O_7$ and $Ca_3(PO_4)_2$ compounds in the concentration range 0.1-0.3 M. $BaSO_4$ and $Ca_2P_2O_7$ at a concentration of 0.3 M showed a slightly improved abatement of contaminants into the precipitate (both around 50% against about 30% without adding co-precipitation agents). More promising results have been found after using 0.2 M $Ca_3(PO_4)_2$, that promoted an abatement of about 70-75% of initial contamination.
Focused improvement of the decontamination yields is carried out by tuning the concentration of the co-precipitation agents and investigating new experimental setups by varying the solution volume or managing more electrochemical precipitation stages. The best experimental conditions will be adopted in performing electrochemical decontamination tests, by adding the most promising co-precipitation compounds to surrogate metal liquors spiked with radioactive solutions. The outcomes of this research will encourage a large-scale implementation of the process.

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Do you wish to participate as a Young Professional?

Yes

Do you wish to be considered for a Young Professional grant?

Yes

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