

Removal of Radiocesium from High-Level Liquid Waste using Inorganic Ion-exchangers

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The present study demonstrates the use of inorganic ion-exchanger (IX) to condition the high-level liquid waste (HLW) by selective separation of one of the major radionuclide, cesium-137 (^{137}Cs) from it. ^{137}Cs possesses a broad range of potential applications in societal and agricultural area. In addition to this, the selective separation of ^{137}Cs from HLW would drastically bring down secondary waste generation and reduce burden on the off-gas treatment in the vitrification process. Here, we have successfully demonstrated the conversion of Cs loaded IX to compact waste form.

Among the various adsorbents, Ammonium Molybdo-Phosphate (AMP) was preferred and used as IX in the present study because it shows high selectivity towards Cs^+ in the presence of various metal ions (alkali, transition, lanthanides and actinides) and is stable under highly acidic & irradiation condition. Despite these advantages, the powder form of IX is not readily adaptable and does not provide ideal flow dynamics for continuous column operations. With a view to bring it to a usable form, synthesis of composite forms of IX (20-30%) in Poly-Ether-Sulfone (PES) was carried out. By adjusting the flow rate of the polymer liquid, particles with an average size ranging from 150 to 710 μm were obtained using a dual nozzle device that allows the break-up of polymer solution by air blowing. The polymer particles of 355-600 μm in diameter were mainly used for Cs extraction studies.

The obtained beads were characterized for thermal stability using thermogravimetry (TG), phase purity by X-ray diffraction (XRD) and functional group identification by Fourier transform (FT)-infra-red (IR) spectroscopy. The thermograms of IX and IX-PES beads showed few steps of decomposition reactions, it may be due to the loss of moisture, ammonia, PES and MoO_3 from AMP-PES. To assess the efficiency of the IX-PES beads, its cesium extraction capacity and distribution coefficient were determined using actual HLW. The extraction capacity and distribution coefficient of cesium in actual HLW (3M acidic) was 4369.3 cm^3/g and 0.4 meq/g , respectively. Column studies ($L/D=3$) were also carried out with an HLW flow rate of 0.5 mL/min . The performance of the column was evaluated by plotting a breakthrough curve. Pellet formation of the inactive cesium loaded IX beads was successfully demonstrated using a manual pelletiser with a pressure of 150 kg/cm^2 .

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