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Electrochemical separation of actinides from molten LiCl-KCl on solid Al cathodes

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An electrorefining process in molten chloride salts using solid aluminium cathodes is being developed in the Institute for Transuranium Elements to recover all actinides from metallic spent nuclear fuel. In this process, actinides are group-selectively electrodeposited on the cathode in a form of solid actinide-aluminium alloys. Fission products are anodically co-oxidised from the fuel together with actinides to the electrolyte. Without purification of this carrier salt, the process would have to be stopped after concentration of the dissolved fission products would become too high to prevent selective deposition of actinides on the cathode. A multiple-steps procedure is considered for cleaning of the salt and a process refered as 'exhaustive electrolysis' is proposed for the first purification step. Similarly to the electrorefining process, this technique is based on the group-selective electrodeposition of actinides on solid aluminium cathodes forming actinide-aluminium alloys. On the anodic side, chlorine gas is produced by electrochemical decomposition of the carrier salt. The presented work was carried out in order to prove feasibility of the method. Two galvanostatic electrolyses were realised and the potentials of both electrodes were constantly followed. Uranium was successfully recovered from LiCl-KCl melts containing UCl3 and a mixture of UCl3-NdCl3 and its concentration decreased from 1.7 to 0.1 wt. % with no co-deposition of neodymium. Although the maximum applicable current densities were relatively low, the results are promising, showing high current efficiency and selectivity of the proposed method. A design and application of a special chlorine gas producing inert anode is also discussed.

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