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▶ **To cite this version:**

J. Serp, E. Mendes, M. Bertrand. Actinides chlorides electrowinning. Global 2015, Sep 2015, Paris, France. cea-02506813

HAL Id: cea-02506813
https://cea.hal.science/cea-02506813

Submitted on 12 Mar 2020

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Global 2015

Actinides chlorides electrowinning

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ABSTRACT

In the frame of the European SACSESS program (Safety of ACtinides SEparation proceSSes), electrowinning of actinides chlorides was studied in LiCl-KCl (450°C) onto aluminium and tungsten cathodes in order to evaluate a salt cleaning process for spent electrorefining salts. In the electrowinning cell, chlorine gas is produced at a glassy carbon anode while actinides are recovered on the cathode leaving lanthanides (Ln) fission product in the salt phase by an appropriate control of the cathode potential. This salt cleaning procedure is developed in SACSESS to assess its potentiality and drawbacks in terms of Actinide/Lanthanide separation efficiency and residual actinide (or lanthanide) concentration in the salt after the electrolytic step.

Inactive cerium and neodymium electrowinning tests onto reactive aluminium and inert tungsten cathodes were carried out to optimize the electrochemical set-up. Results show that 95% of the Ln can be removed easily from the salt. The final Ln concentration in the salt at the end of the electrolysis is approximately 500 ppm. A good agreement is reached between the amount of metal withdrawn from the solution and the one measured on the Al electrodes. The faradic yield is higher when the chlorine gas produced at the anode is correctly extracted from the electrolytic cell.

In the first active experiments, the spent salt was simulated by a LiCl-KCl solution in which uranium, plutonium (U, Pu) and lanthanides are dissolved under the trichloride form. The initial actinide and lanthanides contents in the salt are in the range of 0.5-1 wt% and 5 wt% respectively. Electrodeposition tests were carried out on two set-ups to evaluate the Cl_2 and U^{3+} oxidation into U^{4+} impacts on the recovery yield at the cathode. In the first one, the anode is surrounded by an open-end tube. In the second set-up, the anode is placed in a close tube with a 0.5 mm hole at the bottom (diaphragm). Electrolysis experiments were carried out by applying a constant current between the anode and the cathode at 450°C. A special attention will be paid to the An/Ln separation and the residual actinide concentration in the salt.