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Comparison of separation factor of Ce/U and Nd/U in fused Me (Cd)/3LiCl-2KCl and Me (Ga-20 wt.% In)/3LiCl-2KCl systems

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Actinides recycling by separation and transmutation are considered worldwide as one of the most promising strategies for more efficient use of the nuclear fuel as well as for nuclear waste minimization, thus contributing to make nuclear energy sustainable. The major steps of it include electro refining or reductive extraction for recovering actinides from lanthanides in molten chloride/liquid metal systems. A strategy named as partitioning and transmutation (P&T) is being developed in several countries. The goal of it is to realize the highest possible reduction of the radio toxicity of the nuclear waste in the back end of the fuel cycle. The effectiveness of electrochemical separation of metals during their deposition at the cathode is commonly characterized by the value of separation factor θ, which is the quotient of the ratios of the mole fraction of the separated metals M1 and M2 in the electrolyte (C1, C2) and in the alloy (x1, x2):

$$(1)\ \Theta = \frac{C_2 x_1}{C_1 x_2}$$

or by equation (2), where is an apparent standard potential of lanthanide in alloy, V; is an apparent standard potential of actinide in alloy, V;

$$(2)\ \lg \Theta = \frac{3F(E_2^{**} - E_1^{**})}{2{,}3RT}$$

The experiments were carried out by:

Electrolysis of molten 3LiCl-2KCl-UCl3-CeCl3-NdCl3 system on active Cd electrode at the temperature range 723-823 K at inert atmosphere; measuring EMF of the cell: (-) Me (alloy) | molten salt, Me (III) || molten salt | $C_{(s)}$, $Cl_{2\ (g)}$ (+) at the temperature range 723-823 K at inert atmosphere. The main experimental data are listed in Table.

Table.1: Separation factor of U/Ce и U/Nd in molten Me (Cd)/3LiCl-2KCl and Me (Ga-In)/3LiCl-2KCl systems at 773 K.

Separation factor, θ	Cd liquid cathode (calculation by exp. 1)	Cd liquid cathode (calculation by exp. 2)	(Ga-20 wt.% In) liquid cathode (calculation by exp. 2)
U/Ce	70.2	147.1	-
U/Nd	71.3	82.5	35481.0

The separation factor for uranium/cerium (neodymium) systems shows that uranium will be concentrated in the alloy phase, while cerium and neodymium will stay in the molten salt phase. The results of experiments show the preferred used of Ga-In eutectic liquid alloy in comparison with liquid Cd. Analyzing the obtained data show the perspective of use Ga-In liquid system for separation fission products in future innovation method for recovery of nuclear waste.

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