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Electrolytic reduction of the simulated oxide spent nuclear fuel in LiCl-Li2O melt

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A pyrochemical technology for reprocessing spent nuclear fuel (SNF) and fast reactors is being implemented. One of the redistributions of pyrochemical technology is the electrochemical reduction of uranium dioxide (actinide oxides) with lithium in a LiCl - Li2O melt (1-2 wt.%) uranium dioxide and rare earth oxides at 650 ℃. To test the technological regimes of the reduction process, we used a model nuclear fuel (MNF). It was a mixture of uranium dioxide and rare earth oxides. Nickel oxide ceramics were used as the anode, and a stainless steel basket, into which MNT pellets were loaded, served as the cathode. The electrolysis process was carried out at a cathode potential more positive than the separation of the liquid phase of metallic lithium. The total amount of electricity consumed for the reduction of MNF in one cycle did not exceed 160% of the theoretical value required for the electrolytic production of lithium for the reduction of uranium dioxide.

The UO2 + 5-10 wt. % tablets (La2O3, CeO2, Nd2O3 in a ratio of 1:1:1) were used as samples for reduction. To determine the degree of reduction of the cathode product to metals, we proposed a combined approach for the determination of the metal phase in the reduced product.

The first, "bromine" method consists of dissolving the reduced product in a solution of bromine in ethyl acetate. The metal fraction of uranium goes into the liquid phase, and the remaining uranium oxides remain in the precipitate. This method is generally accepted for determining the conversion of uranium dioxide to metal. It is possible to accurately determine the amount of uranium metal and its dioxide and, consequently, the oxygen associated with uranium in the test sample.

The second method is the reduction melting of metals and oxides in a graphite crucible using a molten metal bath at a high temperature, carried out by us on a Metavak-AK device. This method allows determining the total oxygen content of the sample. The combination of these two methods and general chemical analysis for the elements of interest to us allows us to determine the amount of oxygen per atom of a rare earth element (lanthanide).

It has been shown experimentally that executing the reduction process, subject to the above conditions, makes it possible to obtain a product with the reduction to metallic uranium by 98-99%, while lanthanum, cerium, and neodymium remain in the form of oxides.

Country/Int. organization

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