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Reprocessing of nitride and metallic spent nuclear fuel using molten salts

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In recent years, several countries, including Russia, have been developing a pyrochemical (anhydrous) method for spent nuclear fuel (SNF) reprocessing. Molten salts have several advantages, such as thermal and radiation stability, a wide electrochemical window, etc. They can be used practically at all technological stages of SNF processing.

The first stage of pyrochemical reprocessing of nitride spent nuclear fuel can imply its dissolution in the molten LiCl-KCl eutectic containing a chlorinating agent. It is proposed to use CdCl2 or PbCl2 as a chlorinating agent. We have studied in detail the interaction between UN and molten LiCl-KCl eutectic, containing cadmium chloride, depending on the temperature and CdCl2 concentration. It was found that at temperatures below 750 ℃, the interaction proceeds through several parallel reactions and, along with UCl3, a precipitate, consisting of UNCl, nonstoichiometric nitrides UN1.59, UN1.69, U4N7, and several other compounds, is forms. At 750 ℃ and above, all intermediate uranium nitrides dissolve in excess CdCl2 to form UCl3. The conditions, under which the100% conversion of UN → UCl3 is possible, are provided. The use of lead chloride as a chlorinating agent has also been studied. The chlorination proceeds according to the same mechanism, but the use of PbCl2 allows the process temperature to be reduced by 100 degrees maintaining the 100% UCl3 yield.

The interaction between metallic uranium and its alloys and noble metals with the LiCl-KCl eutectic melt, containing PbCl2, was studied. The dissolution of uranium in such melt is very intense. For samples weighing ~ 15 g, the reaction is completed in 15-20 minutes. The interaction between U-Pd and U-Ru alloys proceeds much more slowly and according to a more complex mechanism. A high temperature and a large excess of PbCl2 are required to complete the reactions. Thermodynamic modeling of the interaction reactions was carried out. The kinetics was studied and the reaction products were identified.

It is shown that pyrochemistry methods may be successfully used for reprocessing of both nitride and metallic spent nuclear fuel. Virtually all processing operations can be performed using molten salts as a process medium.

Country/Int. organization

Russian Federation

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