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Advanced ORIENT Cycle - progress on research, with focusing on safety and engineering

A multi-functional separation process is proposed on the Adv.-ORIENT Cycle (Advanced Optimization by Recycling Instructive Elements) concept1). The tertiary pyridine-type anion-exchange resin embedded in silica beads was demonstrated for the separation process using spent fuel. In this process, hydrochloric acid (HCl), mixture of nitric acid (HNO3) and methanol (MeOH) should be used as eluents. In order to apply this process to engineering scale, two important subjects should be solved so as to prove the availability. One is environmental aspect for the use of HCl solution, because of its corrosive property to the material. The other is explication of the reactive safety between IER (ion exchange resin) and solvent (HNO3 –MeOH).
The four candidate metals of Ta, Zr, Nb, Hastelloy-B (28%Mo-Ni) and SUS316L as a reference were dedicated. The conditions of immersion and acid mist-exposure tests were conducted in 0.5~12 M pure and simulated high level liquid waste (SHLLW) HCl at room temperature for maximum 7,200 hr and at 90℃ for 72~1440 hr. In addition, corrosion potential was evaluated by electrochemistry measurement all the same conditions.
From the result of the corrosion experiment, Ta was all roundly anti-corrosive in HCl media, and Hastelloy-B seemed to be acceptable at RT, with evidence of low corrosion rate (<0.1mmpy) and general type corrosion.
Thermal analysis by DSC was performed to investigate the thermal stability of TPR itself and the mixtures of TPR/MeOH/HCl or HNO3. Moreover, the thermal stability of TPR mixtures of TPR and SHLLW-NO3 was investigated and the stability of presence or absence of coexistent elements was compared.
Sudden exothermic heat and release of fumes were observed with a mixture of TPR-NO3/MeOH/HNO3 when the temperature of the heater reached 220 ℃ regardless of the HNO3 concentration. The temperature increased slowly to 175 ℃ followed by a sudden increase in temperature. Violent reaction occurred in TPR under high temperature in the HNO3 system. The reaction occurred regardless of HNO3 concentration and presence or absence of MeOH. However, it was confirmed that the reaction did not occur when the heating temperature decreased.
In this report, outline of current progress of Adv-ORIENT research as well as detailed evaluation results of this safety and engineering study were described.
1) M. Ozawa, T. Suzuki, S. Koyama, H. Akatsuka, H. Mimura and Y. Fujii, "A new back-end cycle strategy for enhancing separation, transmutation and utilization of materials (Adv.-ORIENT cycle)", Progress in Nuclear Energy, 50, 476 (2008).

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