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Investigations of the uranyl and neodymium(III) adsorption behavior on ion exchange resins for the weak-acid resin process

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Partitioning and transmutation (P&T) is considered as one of the promising methods to safely handle minor actinides which origin from energy production by nuclear fission. Current focus is on the production of suitable particles which can be used for future fuels.
Promising types of particle fuels are Sphere-pac and Vipac fuels [1]. The Vipac method uses randomly shaped particles, whereas the Sphere-pac process requires spherical particles. By the use of different size classes a density equal to conventional pellet fuel can be achieved. In both processes, the particles can be loaded directly into the fuel rod. One of the considered particle types consist of a homogeneous mixture of uranium and minor actinide oxides.
In framework of the ASGARD project [2], microspheres consisting of a homogeneous mixture of U and Nd have been prepared by the weak-acid resin process [3]. Neodymium acts as a surrogate for trivalent actinides, such as americium. During the process, weak-acid cation exchange resins are loaded with ions. After full loading the resin beads are thermally treated in various atmospheres to produce different microspheres, such as oxides, carbides and nitrides.
In this work, the ion exchange resins Amberlite IRC-86 and Lewatit TP-207 are loaded with UO_2^{2+} and Nd^{3+}. Various parameters have been investigated to maximize the adsorption. The adsorption kinetics of UO_2^{2+}, Nd^{3+} and a mixture of both ions have been studied. In addition, the temperature influence and the effect of the pH on the adsorption of UO_2^{2+} and Nd^{3+} have been investigated.
Neodymium ions show significantly faster adsorption kinetics compared to uranyl. With a contacting time of 18 h, adsorption of both UO_2^{2+} and Nd^{3+} reaches equilibrium. An exchange of Nd^{3+} by UO_2^{2+} is observed for mixtures of UO_2^{2+} and Nd^{3+} for contacting times longer than 18 h. The difference of adsorption at various temperatures is negligible, while the pH of the solution plays an important role. A pH lower than 3 causes a decrease of the adsorption. Acid-deficient uranyl nitrate (ADUN) solutions can be used to maximize the pH of the uranyl nitrate solution without the introduction of foreign cations.
References
[1] M. Pouchon et al., chapter 3.11 Sphere-Pac and VIPAC fuels, Comprehensive Nuclear Materials, Elsevier Ltd., 2012, p. 275 - 312
[2] http://asgardproject.eu/
[3] K. Notz et al., Radiochimica Acta, 1978, 25: p. 153-160

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