Methods of Advanced Waste Conditioning by Microwave Internal Gelation: Set Up Development and Modeling

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Abstract

Based on closed packed microspheres produced by gelation, the Sphere-pac is a promising concept for transmutation of minor actinides in fast reactors [1]. In the case of internal gelation, the chemical reaction is triggered by a temperature increase within aqueous droplets. Since microwaves provide a fast and volumetric heating, a set up is developed in PSI where the microspheres undergo gelation as they cross the electromagnetic field generated inside a cavity [2].

In this work the current set up of the particle production unit is presented. The components were selected and mounted in such a way that the production can be remotely operated. An automation program is being developed in order to optimize the critical parameters during operation. This will allow a safe and easy control of the equipment when the cavity is placed in a glovebox with radioactive materials.

The described unit has been used to heat water and cerium solution droplets, the latter element being considered as a surrogate for active materials. The obtained results are reported and discussed here. To support the experimental data, a modelling of the electromagnetic field generated in the cavity has been developed. The perturbation of the field caused by the presence of a droplet and the amount of absorbed energy can be simulated. These experimental and theoretical studies enable the optimization of the microwave cavity design and the determination of the needed power for the production of fuel microspheres.

[1] M. A. Pouchon, G. Ledergerber, F. Ingold, and K. Bakker. Sphere-Pac and VIPAC Fuel, volume 3. Comprehensive Nuclear Materials, Elsevier, Amsterdam, 2012.

[2] Maria Cabanes-Sempere, Cedric Cozzo, Sebastien Vaucher, Jose M. Catala-Civera, and Manuel A. Pouchon. Innovative production of nuclear fuel by microwave internal gelation - heat transfer model of falling droplets. Prog. Nucl. Energ., 57:111–116, 2012.