

Design, development, and installation of hot cell instrumentation for Spent Fuel Autoclave Leaching Experiments (SF-ALE)

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Accurate determination of radionuclide release from spent nuclear fuel under geological repository conditions is a critical aspect with respect to various safety scenarios and with a significant impact on the societal acceptance of long-term fuel disposal. Understanding the kinetics of this release - in short (instant) and long-term time domains - allows us to support more accurate models and solutions for safe long term spent nuclear fuel strategies. The work on fuel dissolution kinetics was initiated at SCK•CEN in the FIRSTnuclides project (www.firstnuclides.com). While continuing on this basis, the current efforts are intended to take a step further by improving the fuel dissolution and sampling instrumentation and developing experimental in-cell capabilities, such as Raman spectroscopy.

The project SF-ALE (Spent Fuel Autoclave Leaching Experiments) was developed to prepare a complete hot cell infrastructure for performing spent fuel dissolution experiments with high precision. The project has currently two stakeholders, NIRAS-ONDRAF (Belgium) and Forschungszentrum Jülich (Germany), who both operate three independent autoclaves under specific dissolution conditions.

The poster will describe the equipment needed to perform such a dissolution experiment in a hot cell. The autoclaves were purchased and then adapted for use in hot cell. A support frame was developed to move it from a standby position towards sampling position. During the 18-months experiment several samples need to be taken. A method was developed for sampling liquid and also for the gas phase without the opening of the autoclaves to avoid as much as possible the air contamination. The hot cell was adapted for this purpose with extra feedthroughs. Liquid samples will be taken inside the hot cell 04 and they will be diluted in an adjacent hot cell before analysis. The gas phase will be sampled in a container outside the hot cell using an in-house developed valve system. This valve system is placed in a closed cabinet with in and outlet filters which are connected to the main ventilation system of the hot cells.

A new gas mass spectrometer was taken into service. The gas sampling procedure was developed in order to assure that an optimal pressure of 25 mbar is obtained for the mass spectrometry. Radiochemical analyses for the solution samples include: Alpha spectroscopy, Gamma spectroscopy, LSC + separation, TIMS+separation and HR-ICP-MS analysis. Further development is currently ongoing to commission in-cell Raman and harness hot-FIB to further investigate the link between the physical state of fuel and the nuclide release.



Figure P37: Valves system for gas sampling
Use the Caption style and label Figure

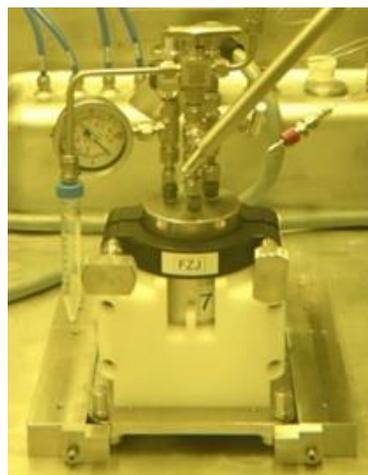


Figure P38: Autoclave in his parking spot in
hot cell 04