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#06-49 MERARG Experimental Loop: A new deconvolution Method for FGR analysis

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MERARG experimental loop hosted at the LECA-STAR Hot Laboratory (CEA Cadarache) allows characterizing nuclear fuels with respect to the behavior of fission gases during thermal transients representative of accident conditions such as for example loss of coolant accident (LOCA). MERARG loop consists of three main parts: 1- an induction furnace 2- a gamma spectrometry detector 3- a glove box containing a micro gas chromatograph (μ-GC). The furnace is located in a high activity cell while gamma detector and μ-GC are both located in the back zone of the hot cell. The fuel pellet to be characterized (generally with its cladding) is introduced into a metal crucible. The sealed enclosure of the furnace is swept by the circulation of a carrier gas (argon or dry air) with a low flow rate (about 60 cm3 /min). As the temperature rises, the released gases are driven to the back zone to the gamma spectrometry station measuring their activities on-line. After passing in front of this on-line gamma station, the gases are then driven to a glove box where they are analyzed by μ-GC and then collected in storage capacities. In order to simulate the thermal characteristics of a loss of coolant accident, the annealing test consists in a first stage of thermalization at 300℃ followed by an increase in temperature up to 1200℃ (according to a ramp of 0.2℃/s or 20℃/s).

Consequently, fission gas release measurement is carried out at a distance of several meters from the sample where the release actually occurs, in a dedicated counting chamber located outside the hot cell itself (i.e. at the so-called back zone). It is therefore necessary to deconvolve the acquired experimental data in order to "rebuild"the release rate data at the sample position. This requires taking into account fission gas flow out of the furnace to the counting chamber and its dilution in the carrier gas. Up to now, a previous deconvolution procedure ran well for the major part of the experiments performed but showed, in very few cases, some drawbacks such as "negative release"or "unappropriate noise"yielding in unusable-reconstructed spectra.
This paper aims to expose a new mathematical deconvolution method for re-processing the experimental data obtained using Laplace transformation. This new method is based on a simulation of the measurement made during the heating of a glass capsule containing 85Kr that opened abruptly during a heat treatment. The release of the 85 Kr during capsule opening was considered as a Dirac function, which allows the fitting of the 85Kr measured at the gamma counter position by an analytically calculated transfer function. The obtained numerical transfer function is used to build elementary functions whose combination allows to describe the experimental release in a satisfactory manner while overcoming numerical instability issues. This deconvolution method provides an accurate modelling of the measured release and allows the analysis of the annealing test data making it possible to describe physical phenomena directly related to the gas release of the samples such as the release of Kr85 by bursts at different temperature levels.

Primary authors: LOSFELD, Jimmy (CEA, DES, IRESNE, DEC/SA3E); Mr DESGRANGES , Lionel (CEA, DES, IRESNE, DEC/SA3E); Mr CLEMENT, Sidonie (CEA, DES, IRESNE, DEC/SA3E); Mr PONTILLON, Yves (CEA, DES, IRESNE, DEC/SA3E)

Presenter: LOSFELD, Jimmy (CEA, DES, IRESNE, DEC/SA3E)

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