BEYOND THE STANDARD: PIE IN SUPPORT OF MECHANISTIC CODE DEVELOPMENT

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ABSTRACT

The ability to accurately calculate the behaviour of LWR fuel rods under long-term irradiation and post-irradiation storage is a major objective of fuel performance codes. In general, there are several types of such codes, i.e. codes for licensing, engineering codes and mechanistic codes. Different data are needed to build and validate those codes. Standard PIE data may completely serve the needs of licensing and engineering codes, but mechanistic codes built on the principle "from primary processes to principal/integral effects" demand more specific data for confident verification and validation of applicability. At the same time validated mechanistic codes may be a useful tool to analyse the complex behaviour of fuels beyond the range where supporting experimental data exist.

During the last three years a mechanistic code MACROS has been under development and verification at SCK-CEN. The main objective of the code is to predict in-pile behaviour of homogeneous and heterogeneous fuels of interest for LWR fuel cycles. Technically the code makes three levels of simulations as follows:

It predicts integral rod characteristics (such as fission gas release, fuel/clad elongation, corrosion) which can be measured during standard PIE

It also predicts radial distributions (of porosity, minor actinides and fission products) where EPMA and SIMS data are in a great use

And it makes predictions of microscopic phenomena and properties (e.g., changes in lattice parameter, high burn-up structure formation and polygonization of as-fabricated polycrystalline fuel matrixes) where special techniques are needed to provide verification database

This paper will discuss two specific topics – integral and radial gas balance and local porosity balance. It is to say that scenario of development of RIA type accidents and to some degree LOCA strongly depends on fraction of fission gases (Xe and Kr) accumulated in intergranular pores and in vicinity of grain boundaries. Unfortunately limited PIE data exist on this item. Thus, there is objectively motivated need for developing advanced PIE methods and means to address the issues of experimentally sound determining integral and local gas balance in connection to corresponding porosity balance.

KEYWORDS   EPMA, SIMS, MOX, UO_2, POROSITY, FISSION GAS RELEASE, FISSION PRODUCTS

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