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Current status and progression of GERMINAL fuel performance code for SFR oxide fuel pins

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A fuel performance code for SFR oxide fuel pins, GERMINAL, is developed by CEA within the PLEIADES simulation framework. The present main goal of GERMINAL is to meet the needs of the design studies of ASTRID, the future Advanced Sodium Technological Reactor for Industrial Demonstration in France.

Recent works have been conducted to improve the modelling of different physical mechanisms having a strong influence on the design criteria evaluation. Thus, the formulation of the fuel pellet fragments relocation model has been revisited, by introducing a dependence to the thermal gradient inside the pellet. The description of this mechanism represents a key point to evaluate the pellet-to-cladding gap closure and the margin to melting at beginning of life. Another evolution concerns the pellet-clad mechanical interaction. The ability to simulate a stronger interaction for fuel pins with a higher filling fraction has been acquired with a focused work on fuel mechanical behavior. A stronger mechanical interaction may also happen with lower power operating conditions and a cladding material remaining stable under irradiation. Moreover, the description of the thermochemistry of oxide fuel is currently being improved by coupling GERMINAL with the OpenCalphad thermodynamic calculation software. In doing this, the goal is to obtain a better prediction of the amount of volatile fission products being transported outside the fuel pellet, and then contributing to the "Joint Oxyde-Gaine"formation. With refined estimations of JOG volume and composition, we expect further to improve the evaluation of heat transfer through pellet-to-cladding gap at high burn-up, and also a more mechanistic description of cladding corrosion due to released fission products.

These works are based on a systematic comparison of calculation results to post-irradiation measures, by integrating progressively additional objects to our validation base. This process leads to a wider validity range targeting ASTRID design, and brings out new working perspectives.

Country/Int. Organization

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