DYNSUB: an application of the SP3 solution of the Boltzmann equation

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Abstract

One of the main subjects related with the use of nuclear energy is Nuclear Safety. Nowadays safety analyses are commonly carried out based on a Best-Estimate (BE) approach, trying to simulate the physical phenomena taking place in the core, the coolant loops and the balance of plant as accurately as possible. In order to achieve the most realistic description of the neutron flux distribution and its coupling to the thermal-hydraulic phenomena within the core, advanced multidimensional reactor dynamics codes have been developed and validated in the last decades. These state-of-the-art codes are able to predict, for instance, non-symmetrical core power perturbations and they can calculate safety margins more accurately than the former developments (based in point kinetics), by using 3D core models with a spatial resolution at fuel assembly level for a wide range of operational transients and postulated accidents. Such a level of approximation is acceptable to predict most safety-relevant variables, but there are also some important variables for safety, which must be evaluated based on local pin-level conditions, e.g. maximal cladding and fuel centreline temperatures.

The high fidelity code DYNSUB resulted from the development of a novel two-way pin-based coupling of the simplified transport (SP_3) version of DYN3D with the subchannel code SUBCHANFLOW. The new coupled code system allows for a more realistic description of the core behaviour under steady state and transients conditions. The SP_3 method overcomes the limitations of the diffusion theory taking into account the angular dependence of the neutron flux. Such consideration provides a more accurate estimation of the local safety parameters than the one of current solvers based in diffusion theory.

The comparison of the results predicted by DYNSUB with the ones of coarser coupled solutions have shown important deviations in the local safety parameters demonstrating the novel capabilities of the developed coupled system DYNSUB.