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Introduction

CATHARE is a 2-fluid thermal-hydraulic system code, capable of simulating thermal and mechanical phenomena occurring in the primary and secondary circuits of a Pressurized Water Reactor under a wide variety of accidental situations. One of the objectives of CATHARE-3 is the 3D modeling of a PWR core at the assembly scale to simulate various accidental situations such as the loss of coolant accident (LOCA) or the steam line break accident. This requires that the one-phase and two-phase mixing models are adapted to the assembly scale and that every closure law is validated in a separate effect way.

Data analysis and model validation

In the CATHARE code, the mass, momentum and energy conservation equations are written for each phase in a 3D porous medium approach as a result of a double time and space averaging which re-quires a modelling of all the effects of the solid structures (fuel rod, mixing grid…). Three mixing terms appear in the equations which are modeled in the CATHARE code: 1) the momentum turbulent diffusion and dispersion; 2) the energy turbulent diffusion and dispersion, 3) the dispersion of void fraction, which is an interfacial force in the momentum balance equations [1]. Weiss et al. [2] per-formed experimental tests in a two-assembly test section, consisting of two 14x14 square lattice rod bundles with non-heated rods. Unbalanced velocities at the inlet assemblies create cross-flows. The axial velocity and pressure were measured at different levels and positions, allowing us to validate the expressions of friction terms and the momentum turbulent diffusion and dispersion terms. The validation of the energy diffusion-dispersion model is performed against the PNNL 2×6 Rod Bundle Flow test [3]. In this test, the 6 left rods and the 6 right rods have different power profiles. Tests are carried out at low velocities, involving natural convection and forced mixing convection. The power dis-symmetry causes transverse velocities due to the buoyancy effect, which can be used to validate the code models by comparing predicted and measured velocities and temperature radial profiles at different elevations of the test section. The two tests series were simulated firstly at sub-channel scale, then at assembly scale with and without the diffusion and dispersion terms. The different results were compared together with experimental data.

Conclusion

The results obtained at sub-channel scale showed a reasonable agreement with the experimental data for both the Weiss test and the PNNL test. Results at assembly scale predict the general trends with the current models established at the sub-channel scale. More attention should be paid to justify or to adapt the diffusion-dispersion terms at assembly scale. These terms should be developed from sub-channel scale models with the help of an upscaling method.

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