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Simulating circulating-fuel fast reactors with the coupled TRACE-PARCS code

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Fast reactors that circulate liquid fuel exhibit a strong coupling between neutronics and thermal-hydraulics that necessitates the use of coupled multi-physics codes to study dynamic behaviour. Presently, most such tools employ computational fluid dynamics (CFD) to resolve thermal-hydraulics. This paper concerns an alternative approach in which the system code TRACE is used to compute two-dimensional flow patterns and temperature distributions of liquid-fuel fast reactors using coarse-meshes and a simplified set of equations. As such, computational requirements are greatly reduced compared to CFD-based solvers. In the coupled tool, the thermal-hydraulic variables are sent to the spatial neutronics solver PARCS that calculates power using cross-sections from the Serpent Monte Carlo code. We report the application of TRACE-PARCS to the primary and secondary circuits of the Molten Salt Fast Reactor, and compare the results with alternative multi-physics tools. Reasonable agreement is found, which paves the way for whole-plant simulations including tertiary turbine circuits.

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