PAUL SCHERRER INSTITUT

LSM-Seminar

Friday, February 9th, 2024, 14:00 – 15:00 OHSA/E13

Zoom: https://psich.zoom.us/j/64099771897?pwd=Z2dSQXh2K3EwL0JXTGxMWUI2UDRZQT09
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Development of JUPITER code at Japan Atomic Energy Agency

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The research group for Reactor Physics and Thermal Hydraulics (RPTH) in Japan Atomic Energy Agency (JAEA) has developed a number of simulation codes of reactor physics and thermal hydraulics involved in the nuclear engineering. One of them is a CFD code named JUPITER, developed for the mechanistic prediction of the relocation behavior of molten core materials in the case of severe accidents of nuclear power plants. JUPITER is based on the coupled level set-volume of fluid (CLSVOF) method for capturing a multi-component molten material with free surface. The VOF advection term is discretized in space using the scheme of tangent of hyperbola for interface capturing (THINC) or THINC/weighted line interface calculation (THINC/WLIC), as appropriate. The Navier-Stokes equation is discretized using the fractional step method in time, in which the surface tension term is modeled as volume force on the interface on the basis of the continuum surface force (CSF) model. The complicated surface geometry of the solid structure is considered utilizing the immersed boundary model. Moreover, the energy conservation law is implicitly solved in time with the consideration of radiation heat transfer, solid-liquid phase change, material oxidation and the eutectic reaction. In order to solve the pressure Poisson equation for the large- scale simulation, the OpenMP-MPI hybrid conjugate gradient (CG) method with block Jacobi preconditioning is employed. Having been validated against numbers of analytical or experimental tests, JUPITER has been applied to versatile engineering issues concerning the molten material relocation, an example of which is shown in the figure above. Further developments are underway for JUPITER to predict gas-liquid two-phase flow involved in water cooled reactors with the consideration of boiling and condensation.

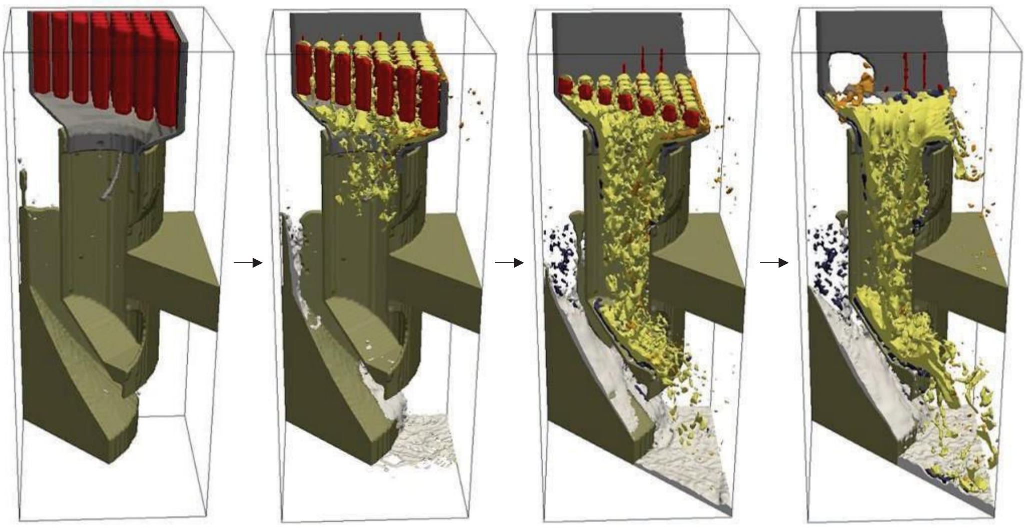

Figure: Simulation of molten material relocation behavior around core supporting structure [1].

[1] Yamashita, S., Tokushima, K., Kurata, M and Yoshida, H., Development of numerical simulation method for melt relocation behavior in nuclear reactors: validation and applicability for actual core structures, Mechanical Engineering Journal, vol.4, 2017