Parallel Simulation of Thermal Conduction in Coal Gasification Vessel Considering Cooling Pipes

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Abstract: Research and development with regard to advanced coal-fired power plants to reduce CO2 emission have been conducted. Coal gasification is one of the key technologies. In reactor for the coal gasification, coal is crushed into fine particulate matter and then partially burned into gas in a high-pressure environment in the reactor. Our research group has carried out a project to tackle a coupled problem of thermo-fluid-structure interaction for quantification of its efficiency, environmental load, and structural integrity. As one of key components of the project, we present a large-scale parallel simulation of three-dimensional (3D) thermal conduction in a gasification vessel. As a parallel solver for thermal conduction, we adopt ADVENTURE_Thermal, which is based on the hierarchical domain decomposition method and the balancing domain decomposition preconditioner. To simulate effect of cooling pipes in the vessel, we model heat transfer in the pipe as a one-dimensional (1D) convection-diffusion equation, and develop a discontinuous Galerkin-based solver. These 3D and 1D solvers are coupled by a staggered coupling scheme with a subcycling technique to deal with different time increments in the 3D and 1D analyses. We perform a validation test for our proposed system for the coupled analysis and discuss parallel efficiency.

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