Unified formulation for thermo-coupled FSI problems using the PFEM. Application to phase change problems

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ABSTRACT

We present a unified Lagrangian formulation for solving the thermo-coupled mechanics of a general domain that may include compressible or quasi-incompressible solids, and fluids. The coupled thermal problem is solved using a staggered scheme [1]. First the mechanical problem is analyzed considering isothermal conditions and then the thermal problem is solved in the updated configuration. The solution of the Fluid-Structure Interaction (FSI) problem is obtained using the Unified formulation proposed in [2]. According to this strategy, fluids and solids are computed monolithically using the same Velocity-Pressure solver. For the solution of incompressible materials the formulation is stabilized with the Finite Calculus (FIC) technique presented and validated in [3]. The fluid is modeled using the Particle Finite Element Method (PFEM) and a quasi-incompressible model [3]. On the other hand, the solid is solved with the classical Finite Element Method (FEM) and using a hypoelasto-plastic constitutive law [4]. The Unified PFEM-based formulation is particularly useful for solving thermal problems involving phase change of materials. For the simulation of melted metals, the flow approach [5] has been used. The numerical solution of various FSI problems, including an industrial application, is presented for showing the validity of the proposed formulation.

References

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