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Title: 3D Moving Mesh Technique for Diabatic Microscale Two-Phase Flows

Numerical simulation is employed to simulate diabatic two-phase flow phenomena using the continuum method for surface tension modeling. The pure Lagrangian approach moves the mesh points with respect to the flow field, thus the particle's positions in the next time step are precisely calculated. In interface flows, the moving mesh approach leads to a highly deformable grid, which quickly adversely influences the quality of the computational elements. On the other hand, fixed grid formulation allows an easier treatment of complex interface motion but the pure Eulerian description presents numerical difficulties due to the nonsymmetric character of the convection operator. To overcome these limitations, a generalized description capable of combining the best aspects of both classical descriptions is employed, namely the Arbitrary Lagrangian-Eulerian (ALE) framework. The set of equations are based on the Navier-Stokes formulation and the energy equation but with the relative mesh velocity included in the convective terms. By varying a single parameter, the formulation can be set to a fixed or a complete moving mesh technique. Another important issue in two-phase flow modeling is the definition of the interface between the fluids. In the classical Eulerian formulation, the interface is described implicitly by an equation which is convected by the fluid flow. Due to the discretization of such an equation, numerical diffusion may lead to low accuracies of the calculated surface tension term. In this work, the interface between fluids is described explicitly in a Lagrangian way by points and geometrical elements, thus a sharp and precise representation is successfully achieved. This geometrical procedure also ensures undesirable modes and spurious oscillations are damped out, thus leading to the convergence of the results. A Laplacian smoothing operator is applied to the whole grid and to the surface mesh to keep the points homogeneously distributed, thereby avoiding large concentrations of points in one specific region. Unfortunately, only using the Laplacian operator is not enough to preserve the mesh quality, thus other common geometric procedures also need to be applied. The new methodology proposed here to simulate diabatic two-phase flows provides good accuracy to describe the interfacial forces, bubble dynamics and the heat and mass transfer between phases.