Meshless methods for ‘gas - evaporating droplet’ flow modelling

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Abstract

The main ideas of simulation of two-phase flows, based on a combination of the conventional Lagrangian method or fully Lagrangian method (FLM) for the dispersed phase and the mesh-free vortex and thermal blob methods for the carrier phase, are summarised. A meshless method for modelling of 2D transient, non-isothermal, gas-droplet flows with phase transitions, based on a combination of the viscous-vortex and thermal-blob methods for the carrier phase with the Lagrangian approach for the dispersed phase, is described. The one-way coupled, two-fluid approach is used in the analysis. The method makes it possible to avoid the `remeshing' procedure (recalculation of flow parameters from Eulerian to Lagrangian grids) and reduces the problem to the solution of three systems of ordinary differential equations, describing the motion of viscous-vortex blobs, thermal blobs, and evaporating droplets. The gas velocity field is restored using the Biot-Savart integral. The numerical algorithm is verified against the analytical solution for a non-isothermal Lamb vortex. The method is applied to modelling of an impulse two-phase cold jet injected into a quiescent hot gas, taking into account droplet evaporation. Various flow patterns are obtained in the calculations, depending on the initial droplet size: (i) low-inertia droplets, evaporating at a higher rate, form ring-like structures and are accumulated only behind the vortex pair; (ii) large droplets move closer to the jet axis, with their sizes remaining almost unchanged; and (iii) intermediate-size droplets are accumulated in a curved band whose ends trail in the periphery behind the head of the cloud, with larger droplets being collected at the front of the two-phase region.