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A SEPARATE-PHASE VOF METHOD AND ITS APPLICATION IN LRE INJECTOR INTERNAL FLOWFIELD SIMULATION

Abstract

The understanding and predictions of internal flowfield characteristics are essential to the design of LRE injectors because the characteristics of internal flowfield have a profound effect on injector performance. The main difficulty in the numerical studies on the flow phenomena in injectors is the accurate tracking of the interface between the two phases (gas/liquid). To overcome this difficulty and to provide a simple and practical method for capturing the interface in the injector internal flowfield, a separate-phase VOF method, which is an extension of the VOF philosophy, was developed. The present methodology represents a refinement over the original VOF method in that the flows of the two phases are solved separately by using two sets of governing equations for each phase. The governing equations of the two phases are only coupled through boundary conditions at the interface. It can unambiguously define the location and geometry of the gas/liquid interface within a cell without numerical diffusion across the interface, which results in an improvement of the accuracy of simulations. The method is outlined in this paper and examples of numerical simulations of internal flowfield (cold flow) for simplex swirl injector and swirl coaxial gas/liquid injector are presented to demonstrate the capability and validity of the proposed method in two-phase flow applications within the LRE injectors.

Keywords: separate-phase VOF method, gas/liquid interface capturing, injector, internal flowfield simulation, Liquid Rocket Engine