Paper ID: 17665
oral
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SPACE PROPULSION SYMPOSIUM (C4)
Poster Session (P)

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MULTISCALE SIMULATIONS OF PRIMARY ATOMIZATION FOR TWO IMPINGING JETS

Abstract

Currently there is no model-free direct numerical simulation for primary atomization, since the interactions between different phases still need to be modeled. And simplified models, such as wave breakup model, Taylor analogy breakup model and their derivative or coupling models, are often used to roughly evaluate the primary atomization in engineering. However these simplified approaches sometimes give unphysical results. Therefore, more accurate methods will receive a warm welcome for primary atomization. In fact, a liquid jet upon atomization breaks up droplets that are orders of magnitude smaller than its diameter. Then multiscale simulations are good ideas to use different models at different scales. A new multiscale simulation method is proposed in this paper. The liquid blobs larger than the grid size are captured by Volume-of-Fluid (VOF) method, while the droplets equivalent to the grid size are tracked by a two-way coupling Lagrangian Particle Tracking (LPT) model. If the LPT droplets impact the liquid blobs, they will turn back to VOF field properly, avoiding the liquid droplets moving in the liquid blobs. A new LPT algorithm on virtual grids is presented to satisfy the requirement that the particle volume must be less than 10% of the Lagrangian cell volume. To describe vortex structure for primary atomization, Large Eddy Simulation (LES) with one equation subgrid scale turbulent energy transport model proposed by Yoshizawa etc. is used. A new code is developed and validated. And some characteristic parameters, such as transfer limits between VOF field and Lagrangian particles, momentum allocating coefficients, and so on, are investigated in detail. Finally, the impinging injectors with different structures and operating parameters are simulated, emphasizing on the impinging angle and momentum ratio of the two jets. The instantaneous and average characteristics of the two jets agree well with experimental results.