Improvement of the grid dependency of the momentum coupling and the droplet collision modeling in the Arbitrary Lagrangian-Eulerian method for spray simulations

Sayop Kim, and Chang Sik Lee*
Department of Mechanical Engineering, Hanyang University
17 Haengdang-dong, Sungdong-gu, Seoul 133-791, Korea

Abstract

In the simulation of liquid spray penetrating into gaseous phase, the conventional computational fluid dynamic (CFD) code adopts the Arbitrary Lagran-gian-Eulerian (ALE) method. In this approach, the continuous gaseous phase is calculated in the Eulerian view point by solving the conservation equation of mass, momentum and energy, and the dispersed liquid particles are tracked in the Lagrangian view point. This algorithm has been proved to be very useful for IC engine spray simulations. However the ALE method has inherent grid dependency problem causing serious numerical errors. The grid dependency is generally induced when calculating the momentum coupling between gaseous and liquid phases, and applying the droplet collision algorithm. Thus, this study investigates the strategies for reducing the grid sensitivity involved in the momentum coupling and the droplet collision modeling. In order to achieve the goals, the gas-jet model was implemented in the KIVA code, and the calculated results were compared to the appropriate experimental results. Then the feasibility of the models for the spray simulations was discussed. In addition, the advanced algorithm of the droplet collision modeling which can overcome the grid de-pendency problem was applied to the KIVA code. By simultaneously considering the momentum coupling and the collision modeling, successful reduction of the grid sensitivity could be accomplished in the prediction of spray pene-tration and Sauter Mean Diameter (SMD)

Key words: Grid dependency, Momentum exchange, Droplet collision, Spray simulation, KIVA code: