8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

A Numerical Analysis on the Binary Droplet Collision by using a Level Set Method

Sang Hyuk Lee[1] and *Nahmkeon Hur[2]

[1] Department of Mechanical Engineering, Sogang University
Sinsoo 1, Mapo, Seoul 121-742, Korea
sh4638@sogang.ac.kr

[2] Department of Mechanical Engineering, Sogang University
Sinsoo 1, Mapo, Seoul 121-742, Korea
nhur@sogang.ac.kr

Key Words: *Binary Droplet Collision, Two-phase Flow, Level Set Method, Head-on Collision, Off-center Collision, Droplet Identity Tracking*

ABSTRACT

It is important to predict the binary droplet collision in the formation of falling drops and the evolution of sprays. When the droplet collision occurs, the interactions of droplets are influenced by the three main parameters; the droplet velocity, impact parameter and drop-size ratio. By the effects of these parameters, the collision processes exhibit very complex phenomena. The droplet collision phenomena can be classified into four regimes such as the bouncing collision, coalescence collision, reflexive separation collision and stretching separation collision regime. The separation of the droplets after the collision may cause the satellite droplets. To study the physical phenomena of the droplet collision, experimental, analytical and numerical analyses have been performed by researchers, and as a result physics involved in these collision have been explained and the map of the collision regime in the parameter space has been successfully constructed. In the present study, the binary droplet collision was simulated numerically by using a Level Set method by modelling the surface tension force at the liquid-gas interface with the continuum surface force. The simulations on the droplet collision were analyzed for both head-on and off-center collisions. 2D axi-symmetric simulations were performed mostly on head-on collisions due to symmetric nature of the collision. On off-centre collisions, however, 3D simulations were performed for half the domain by using symmetry boundary condition. As a result, the behaviour of droplets and the formation of satellite droplets after the collision were successfully obtained and compared with available experimental and numerical data. In head-on collisions, the phenomena of the coalescence and reflexive separation of the droplets were observed. Also in off-centre collisions, the phenomena of the coalescence, reflexive separation and stretching separation were observed. These numerical results showed good agreements with the experimental and analytical results of Ashgriz and Poo, 1990. From the results, it was observed that the satellite droplets might be generated in some condition when the separation phenomenon occurred. The predicted number of satellite droplets after the collision agreed well to the analytical results of Ko and Ryou, 2005. For tracking the identity of droplets after the collision, transport equations for the species fraction of the each initial droplet were used, and the coloured results agreed well with the experimental data.