Numerical Simulation of Aerosol Deposition in Rising Bubbles

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Abstract

Pool scrubbing has an important role in aerosol removal under severe accidents of LWR, such as in the suppression chamber of BWR, steam generator tube rupture in PWR, wet-type filtered containment venting system (FCVS). A number of experiments and simulations have been addressed. In conventional codes, since the shape of bubbles is assumed, in a situation involving a complex interface shape change such as jet injection, the reproducibility is reduced. Therefore, a simulation method that does not depend on the complexity of the interface shape is required. On the other hand, it is common sense to utilize CFD in design due to improvement of computing capacity of computer. However, there are few cases where CFD is applied to predicting the performance of pool scrubbing, i.e. predicting DF proved by detailed motion of particles, and discussion on methods for that is insufficient.
Therefore, in this study, we proposed a numerical method for gas, liquid and particle coexisting system combining free-surface tracking method for gas-liquid two phase flow and Eulerian aerosol transporting model. Volume of fluid (VOF) method was used as a model of gas-liquid free-surface, and Navier-Stokes equation of the continuous phase is solved as one-fluid. A model of aerosol particle based on general dynamic equation (GDE) on Eulerian grid was applied to calculate advection diffusion and deposition of aerosol. The particle size distribution function and particle velocity are solved using sectional discretization in particle size. We assumed the surface as a perfect absorber of aerosol and predicted the removal process of aerosol contained in bubbles and total DF. The nozzle was single and vertical, and gas jet injection at low speed (~5m/s) to high speed (~150m/s) was investigated.
Finally, we compared the experimental data already known and the prediction using the above model and extracted some problems about the mathematical model.

Keywords: pool scrubbing, aerosol, two-phase flow, severe accident, decontamination factor