APCOM & ISCM
11-14th December, 2013, Singapore

Improvement of bubble/droplet measurement accuracy in optical fiber probing based on 3D ray-tracing numerical simulation

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Optical fiber probing is a useful and reliable technique for bubble/droplet measurement (diameter, velocity and number density). In the present study, optical signals from the optical fiber probe (OFP) were numerically analyzed in order to improve its measurement accuracy using a new 3D-ray-tracing simulator of the OFP; the simulator can trace enormous ray-segment trajectories in an optical fiber and render complicated optical-boundary-conditions. Moreover, evaluation of the complex signals was achieved by computing the polarization and energy of every ray. Based on the signal analysis, we clarified characteristic of the pre-signal involved in the signal; when the OFP touched a bubble central region, the pre-signal clearly peaked. Determining a position touched by the OFP on a bubble surface was the most difficult issue in practical measurement. We applied the pre-signal to bubble measurement in a bubbly flow. The difference between measured results via the OFP and the visualization was improved from 42 to 20%.

Keywords: Gas-liquid two-phase flow, Optical fiber probe, Ray tracing method, Bubble, Droplet