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Evaluation of fuel injector atomization process by detailed numerical analysis of two-phase flow

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In the present study, a detailed numerical analysis of gas-liquid two-phase flow is conducted for the atomization of injected fuel from a straight nozzle. The inject velocity is changed, and three cases with different Weber numbers (440, 740, 1470) are analyzed. The total computational cell numbers are 770 million and 7.7 billion. Figure 1 and 2 shows the liquid-gas interface distribution of the lowest and highest Weber number case (Case1 and Case3). The tip of the fuel liquid jet has a mushroom shape, and the ligaments are generated from the edge of the mushroom shape. The higher Weber number case shows smaller droplets due to small surface tension effect compared with the inertia. The atomized droplets are classified with the geometrical parameters, slenderness and sphericity. Figure 3 and 4 shows the relations of slenderness and sphericity of the lowest and highest Weber number case. In these figures, each element (droplets and ligaments) are classified. The large plots indicate the elements which be resolved by enough grid resolution, and the small plots indicate the others. The green plots indicate the elements close to the droplets, the blue plots indicate the elements close to the ligament, and the red plots indicate the others. In terms of the computational accuracy, the elements shown by the small red plot have a large issue because the grid resolution is not enough and no valid model exists. The present analysis pointed out that the geometry parameters have the potential to evaluate the possibility of the secondary breakup, which is difficult by the conventional evaluation by the droplet diameter, and the uncertainty of accuracy for the detailed analysis result.

Fig.1 Distributions of gas-liquid interface (Case1).

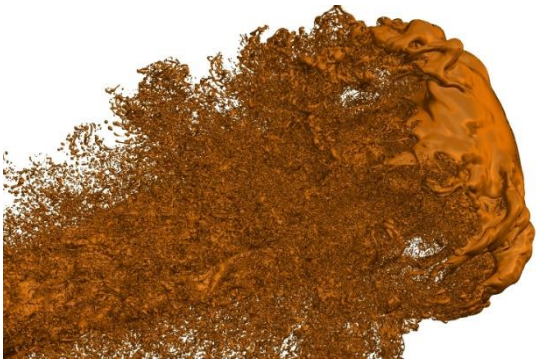

Fig.1 Distributions of gas-liquid interface (Case3).

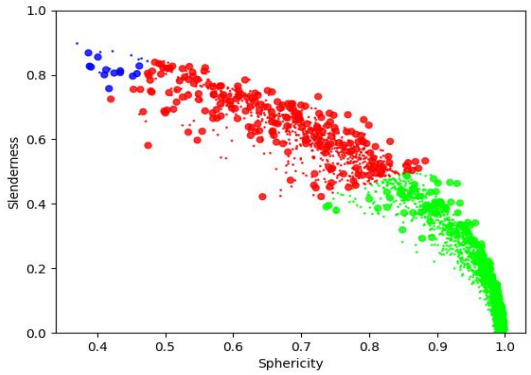

Fig.3 Relation of slenderness and sphericity (Case1).

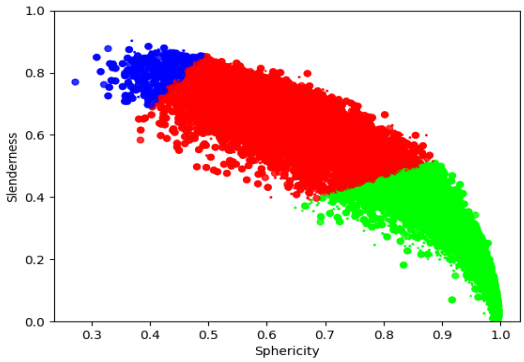

Fig.4 Relation of slenderness and sphericity (Case3).