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Summary

This thesis is concerned with the development of models related to spray/wall interaction phenomena. To this end, a literature survey is first performed on droplet and spray impingement and liquid film flow processes. In this preparatory step all physical parameters relevant for the description of these phenomena are isolated and their relevance is described. Three main different droplet impingement regimes are identified and the existing regime transition criterion is theoretically justified by applying a scaling analysis. A semi-empirical spray impingement model is formulated on the basis of the experimental observations, and the mass, momentum and energy conservation constraints. Correlations are introduced which correspond to the experimental findings valid for polydispersed sprays and an attempt is made to identify their physical meaning. A hypotheses for the secondary droplet velocity and the mass distribution are introduced. The basis for these hypotheses is found in the theory related to the propagation of the kinematic discontinuity and the ejection of the liquid sheet. The model includes a random procedure to determine some of the post-impingement characteristics from pre-described probabilities.

A mathematical model for liquid films formed by spray impingement is presented and implemented into a commercial code (SWIFT - AVL LIST GmbH). The model takes into account the effects of the liquid film motion of the impingement pressure and tangential momentum imparted by the droplets, as well as the gas shear force and capillary pressure. The general transport equations of the wall liquid film flow are established by applying boundary layer assumptions and by integration through the film depth. These two-dimensional liquid film equations are solved by an efficient finite volume method, which avoids cost and complexity of three-dimensional computations.

Assessment of the impingement and film models is performed by comparing prediction to several sources of experimental data involving both normal and oblique impingement. The calculated impinging spray and wall liquid film characteristics show fair agreement with the experiments.