Considerations in Phase-Doppler Measurements of Spray/Wall Interaction

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1. Introduction

The interest in a reliable modeling of spray/wall interaction is widespread, focusing on the prediction of the deposited mass fraction and the characteristics of the secondary spray. Important applications include fuel injection and spray cooling. For formulation and verification of suitable models, experiments under well-controlled conditions are essential. Inevitably the phase Doppler technique is used to characterize both the impacting and the secondary spray in terms of number flux, size distribution and velocities of the drops. The present work provides experimental results indicating influence of the measurement volume height above the rigid wall, influence of the input laser power on the characteristics of the impinging and secondary spray and considerations for Spatial location of the detected impinging and secondary spray.

2. Results and Discussion

The integration of experimental data into numerical predictions in the form of empirical models requires closer examination for several reasons. The most obvious difficulty is to specify the height above the surface at which the phase Doppler data is valid. This is illustrated in Fig.1 in which the dependence of velocity before the impact and velocity after the impact are illustrated as a function of measurement height above the wall. This data has been taken in a reasonably sparse spray impacting onto a flat target with a relatively thin film. It illustrates that both the in-coming spray and the secondary spray can exhibit strong gradients in the wall normal direction. Although numerical simulations of the spray and the gas flow can capture such gradients, the synchronization between experiment and simulations, either for model calibration or for verification of predictions, must take these gradients into account.

Results presented in Fig.1a indicate that mean impact velocity increases significantly with the measurement height above the wall. Also these results indicate that the mean impact velocity decrease with the input laser power. Other results presented in Fig.1b indicate that the average velocity after the impact increases with the measurement volume height up to 2mm and stray relatively constant. The influence of the laser power on the average after impact velocity is not significant, as presented in Fig. 1b. Extensive discussions about the influence of the measurement volume height and laser power are presented in the full paper.

3. Conclusions

An experimental study of spray impact onto a horizontal flat and rigid surface is performed to specify the measurement volume height above the surface at which the phase Doppler data is valid. Based on the results obtained in this study, the average after impact velocity and drop size doesn't change significantly with measurement volume height in the range 1 mm to 1.5 mm. However, total secondary-to-incident mass and number ratios decrease significantly with measurement volume height in this region, whereas influence of the laser power is not significant. The measurement volume height less than 1 mm is not recommended based on the results obtained in this study, since the characteristics of the secondary spray, e.g. average drop size and velocity, change significantly in this region. The laser power has its strongest influence on the average drop size before the impact.

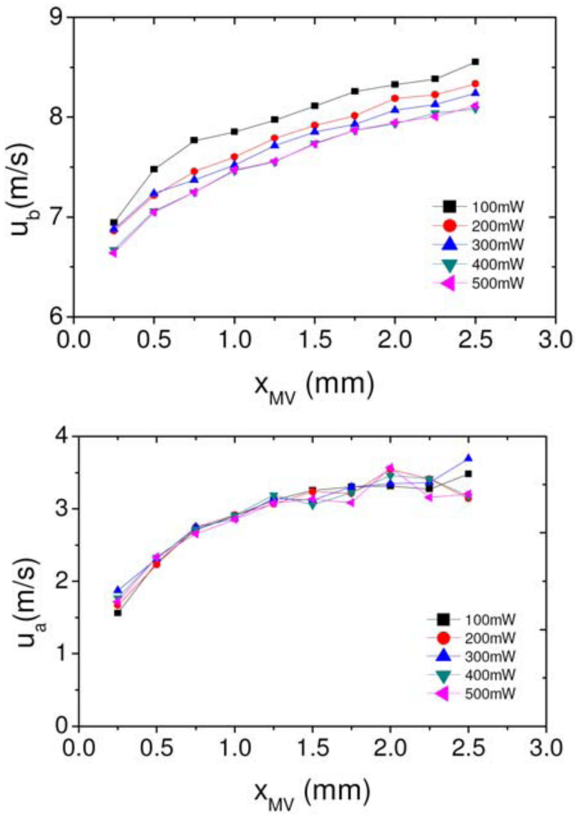

Fig. 1 Before impact velocity (a) and after impact velocity (b) as a function of measurement volume height above the rigid wall. The different lines represent different laser power.