Characterization of aerosol emitted by impact of millimetric droplets onto a liquid film

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A liquid droplet impinging onto a liquid film is of both fundamental interest and practical importance to determine the potential sources of contamination in the case of scenarios of liquid falls such as dripping. During the impaction of droplets, three phenomena can occur: deposition, rebound or splash. The key parameters of these phenomena are the characteristics of the droplets (diameter d_i, velocity V_i, density ρ, viscosity μ and surface tension σ of the liquid) and the thickness h_{film} of the liquid film. Cossali et al. (1997) and Vander Wal et al. (2006) have determined qualitatively the deposition/splash threshold for the impact of millimetric droplets as function of dimensionless numbers (Reynolds, Weber, Ohnesorge) and the film parameter S_f. These phenomena are detailed by Motzkus et al. (2006). We measure the mass and the size distribution of the dry residues produced during the impact of droplets onto a liquid film, whose thickness is maintained constant, with a drip frequency of 0.4 droplet/s during 60 min, in a ventilated closed vessel. The size distribution of dry residues is measured with an Aerodynamic Particle Sizer. When the splash is observed, we prove the presence of the dry residues stemming from the impact of droplets onto a liquid film. Cossali et al. (1997) that describes correctly the threshold for small Ohnesorge numbers (< 3 10^{-3}) in contrary to the one of Cossali et al. (1997) that describes correctly the threshold for high Ohnesorge numbers (> 3 10^{-3}).

Moreover, by comparing our visualizations with threshold relations, we note that the one of Vander Wal et al. (2006) describes correctly the threshold for small Ohnesorge numbers (< 3 10^{-3}) in contrary to the one of Cossali et al. (1997) that describes correctly the threshold for high Ohnesorge numbers (> 3 10^{-3}).

The diameters of emitted droplets are calculated from the residues diameters by using the concentration of the tracer (10 g/l). We study the influence of different parameters V_i (2.2, 3.1 and 3.7 m.s^{-1}), d_i (2 and 4 mm), S_f (0.3, 0.6 and 1) and σ (66 mN.m^{-1}) on the emission of droplets. We take into account the losses of particles by sedimentation to calculate the number of droplets produced by impact. Figure 2 represents the count distributions of droplets produced by impact of a 4 mm-diameter droplet with different parameter of V_i and S_f. These results show that the increase of V_i or the decrease of S_f involve an augmentation of the number of droplets emitted by impact in the range 2-50 μm.

Figure 2. Count distributions of emitted droplets

Figure 1. Count distribution of emitted dry residues