Liquid Spray Morphological Information from Laser-Diffraction Measurements

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Abstract

The Laser-Diffraction Technique (LDT) based on the analysis of the light diffraction pattern forwardly scattered by droplets going through a laser optical probe, reports a drop-diameter distribution of a set of spherical drops that would scatter the same diffraction pattern as the one recorded. However, a light diffraction pattern depends on the shape of the scattering drop. Thus, a LDT measures an equivalent-diameter distribution that depends on the shape of the drops but the relationship between this equivalent-diameter and the shape of the particle is unknown. The work presented in this paper intends to shed more light on this very point. The present experimental work consists in measuring liquid spray characteristics with a LDT instrument and an Image Analyzing Technique (IAT). IAT is used to measure projected-area diameter distribution as well as the surface-based scale-distribution of the liquid sprays. Being an alternative to drop-diameter distribution, the surface-based scale-distribution is explicitly a function of the shape of the drops. All experimental precautions are taken to validate the experimental protocol. First, the results show experimental evidences of the dependence between the LDT equivalent-diameter distribution and the shape of the drops. Second, it is demonstrated that average information of the shape of the drops of the spray can be obtained from the analysis of the mean-diameter series δ_{q2} of the LDT equivalent-diameter distribution. Although this result has not been fully explained, it is believed that this LDT performance is due to the fact that LDT provides a multi-scale description of the spray droplets similar to the one performed by the scale-distribution analysis. This point is supported by the fact that scale-distribution of the LDT equivalent-diameter distribution is very similar to the one of the actual spray. This induces the idea that LDT measurement conserves the spray surface-based scale distribution: it reports the diameter distribution of the set of spherical droplets that has the same surface-based distribution as the actual spray. As noted in this paper, this diameter distribution is unique for a given scale-distribution. These results participate to a better definition of the diameter distribution provided by LDT and evidence LDT potentialities that have not been explored so far.

Key words: Measurement instrumentation and diagnostic equipment development related to sprays for drop size

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