Theoretical and Experimental Fluid/Structure Investigation of an On Demand Induced Spray

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Abstract

We report in this paper a physically based drop size distribution of a spray. The atomization is performed by a new Spray On Demand (SOD) device which exploits ultrasonic generation via a Faraday instability. The Modified Hamilton's principle is used to describe the fluid structure/interaction with a vibrating micro-channel conveying fluid excited by a pointwise piezoactuator, a non-equilibrium thermodynamics results is used allowing determining the volume flow rate generated by the tube motion. We combine to the fluid/structure description a physically based approach for predicting the drop-size distribution within the framework of the Maximum Entropy Formalism (MEF) using conservation laws of energy and mass coupling with the three-parameter generalized Gamma distribution. The prediction and experimental validation of the drop size distribution of a new Spray On Demand print-head is performed. Deriving an analytical expression estimating Sauter Mean Diameter (D_{32}) and Volume Mean Diameter (D_{30}), a validation of this model is also performed by comparing predictions with experimental results of drop size distribution. The dynamic model is shown to be sensitive to operating conditions, design parameters and physico-chemical properties of the fluid and its prediction capability is good. The approach avoids the traditional adjustment for each operating condition and has better predictive capabilities. We also report on a model allowing the study of the evolution of drop size-distribution. This model couples physically based Maximum Entropy Formalism and the Monte Carlo method to solve the temporal drop-size distribution equation in a continuous manner.

Key words: Modified Hamilton's Principle, Jet Printing, Ultrasonic Atomization, Spray Modeling, Maximum Entropy Formalism, Monte Carlo Method

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