Characteristics of liquid sheet break up for spill-return swirl atomizers with different spill-line designs

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Abstract

The spill-return atomizers with spill-return allow for various configurations of the spill line (SL) orifices. The SL shape and dimensions affect the atomizer control characteristics and spray parameters. We have experimentally investigated these factors in a previous work [1]. The differences in the spray quality were found linked with the breakup process of the liquid sheet. Therefore, in this work, advanced image analysis tools have been used to high-speed image sequence of the near-nozzle structures (the sheet and spray images) for evaluation of the breakup distance, thickness of the liquid film and the sheet velocity. The effects of varying the discharge velocity, spill-to-feed ratio (SFR) and SL design were used as control factors for the sheet breakup process.
The proper orthogonal decomposition method was used to experimentally investigate the liquid sheet characteristics (the wave length and frequency of the surface waves). The results were confronted with the theoretical estimations of the breakup characteristics. The data shown that all the above listed factors influence the breakup process and the character of the breakup process and spray steadiness depend on SFR and SL design.
Two atomizers were compared: a version with spill orifices placed close to the nozzle centreline (1) and a version with spill orifices placed in the periphery of the swirl chamber (2). Atomizer 1 generates attenuating liquid sheet, which is disintegrated through the short-wave sinusoidal asymmetric breakup mode. Atomizer 2 featured the long-wave mode with longer length of the smoother sheet until the breakup point and finer spray resulted. The space and time dependent liquid sheet features are discussed in the poster in detail.

Keywords: spill, return atomizer, liquid sheet breakup, proper orthogonal decomposition, breakup mode, spill orifice design

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