Effect of the Atomizer Geometry on the Structure of a Dry-Ice Spray

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Abstract

Mold cooling dominates the cycle time in plastic injection molding, and dry-ice sprays produced by the isenthalpic expansion of liquid CO2 offer a promising route to shorten it. Using laser light-sheet visualization with a high-speed camera, this work characterizes how a two-component atomizer, made of an expansion nozzle and a conical diffuser, shapes the resulting spray. The expansion nozzle, with inner diameters from 1 to 2.5 mm, controls the mass flow rate and the width of the hemispheric microparticle cloud, while the conical diffuser governs particle agglomeration, which only emerges for H/D ratios greater than 2 within the range tested from 1.5 to 4.

Highlights

1. The expansion nozzle inner diameter sets both the mass flow rate and the width of the hemispheric microparticle cloud.
2. Two CO2 particle populations form: microparticles from the isenthalpic expansion and agglomerates produced inside the diffuser.
3. Agglomeration occurs only in conical diffusers with H/D greater than 2.
4. At the same H/D, a smaller diffuser volume yields denser agglomerate clouds.
5. Pulse duration leaves the spray morphology unchanged and only delays the onset of turbulent structures.