World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:12, No:04, 2018

A Computational Analysis of Gas Jet Flow Effects on Liquid Aspiration in the Collison Nebulizer

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Abstract : Pneumatic nebulizers (as variations based on the Collison nebulizer) have been widely used for producing fine aerosol droplets from a liquid material. As qualitatively described by many authors, the basic working principle of those nebulizers involves utilization of the negative pressure associated with an expanding gas jet to syphon liquid into the jet stream, then to blow and shear into liquid sheets, filaments, and eventually droplets. But detailed quantitative analysis based on fluid mechanics theory has been lacking in the literature. The purpose of present work is to investigate the nature of negative pressure distribution associated with compressible gas jet flow in the Collison nebulizer by a computational fluid dynamics (CFD) analysis, using an OpenFOAM® compressible flow solver. The value of the negative pressure associated with a gas jet flow is examined by varying geometric parameters of the jet expansion channel adjacent to the jet orifice outlet. Such an analysis can provide valuable insights into fundamental mechanisms in liquid aspiration process, helpful for effective design of the pneumatic atomizer in the Aerosol Jet® direct-write system for micro-feature, high-aspect-ratio material deposition in additive manufacturing.

Keywords : collison nebulizer, compressible gas jet flow, liquid aspiration, pneumatic atomization
Conference Title : ICFMA 2018 : International Conference on Fluid Mechanics and Applications
Conference Location : Kyoto, Japan
Conference Dates : April 26-27, 2018