Vibrational Excitation and Analysis of Fluids to Predict Atomization Characteristics

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Abstract

In industrial spraying and coating, fluids to be atomized are often complex solutions, mixtures, emulsions and suspensions of multiple constituents. While prediction of and insight into the resulting droplet size and spray dynamics is challenging enough for Newtonian, simple fluids, such as fuels, it is even more poorly developed for these complex fluids. A particular case is agricultural spraying where "tank mixes" of many (apprx. 6 – 8) formulations of crop production agents are often prepared and sprayed. These mixes are commonly observed to behave very differently from simple test fluids used to develop atomization and spray transport models. As a precursor to developing a field-deployable system for testing fluids prior to or during atomization, the feasibility of vibration measurements as an indictor of fluid atomization properties was investigated. A number of fluid mixtures, including agrochemicals and spray adjuvants such as surfactants, polymers and herbicides were sprayed using typical agricultural flat fan and hollow cone hydraulic nozzles. During spraying, the characteristic vibration of the liquid sheet exiting the nozzle orifice was measured and the droplet size spectra were determined. The composition of the fluid was found to affect both the vibration and the droplet size. Decreased droplet size was correlated with higher vibration, particularly in the 7 to 9 kHz range. Alteration of the fluid mixture through additions of surfactants or polymers was easily detected through vibrational analysis.

Key words: fluid properties, vibration, agriculture, diagnostics, monitoring

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