Pulse Jet Mixers – The Known and Unknown About Solids Suspension

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Abstract

Pulse Jet Mixers (PJMs) are unique for large-vessel mixing equipment because they have no moving parts. PJMs are controlled and operated entirely by air-driven fluidic devices. Besides having unique mechanical features, PJMs also have a unique cyclical operation, alternating between a power jet period and a suction recovery period. This on and off operation creates unique results for solids suspension. The actual suspension occurs almost entirely in a start-up mode as rapidly-settling solids are lifted from the vessel bottom during the power jet period of the cycle. During the suction recovery period, the same rapidly settling particles may return to the bottom of the vessel, awaiting resuspension during the next power pulse. In large-scale vessels, the power jet period could be roughly a minute, while the suction recovery period could last for two to four minutes.

Extensive testing in scale-model systems has provided interesting data about how pulsed suspension of solids both works and fails. During the power pulse, a range of particle sizes and densities have been studied to decide the pulse requirements for successful suspension. Simultaneously, the lengthy suction recovery period virtually assures that a "uniform" suspension can never be achieved. While more than two-thousand test results have looked at scale-up and operating effects in three vessel sizes, 0.367 m, 0.860 m, and 1.778 m in diameter, uncertainties about some effects remain. Additional geometrically-similar prototypic tests have been conducted in a 1.10 m diameter vessel.

The literature on mechanical mixing contains only limited information about the effects of variables like liquid level, bottom shape, solids concentration, vertical distribution of solids, initial and resuspension of settled solids, bimodal and broad particle size distributions, but especially the scale-up of these aspects of solids suspension. Dynamic operation for solids suspension with PJMs provides some insights into the operational and mechanistic characteristics of all types of solids suspension, including many opportunities for further investigation.