Computational Fluid Dynamics Modeling of Pulse Jet Mixer Vessels at the Waste Treatment Plant

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Abstract

This presentation will status the progress of using computational fluid dynamics (CFD) to model solid-liquid mixing in vessels equipped with pulse jet mixers at the waste treatment plant at the Hanford site in Washington State. The Hanford Tank Waste Treatment and Immobilization Plant (WTP), under construction by Bechtel National, Inc. and teaming subcontractor Washington Group International for the U.S. Department of Energy, Office of River Protection, will treat nearly 53 million gallons of radioactive waste over a time period of nearly 40 years. Because of the necessary duration of operation, mixing systems in this environment require low maintenance. Pulse jet mixers satisfy this requirement since there are no moving parts. These mixers work by using compressed air to empty and fill cylindrical vessels with nozzled jets that have various arrangements within the mixing vessel. The size of these mixing vessels range from 9 to 47 feet in diameter, and the number of pulse jet mixers within the vessel range from 1 to 12. Because of the difficulty in testing at such large scales, the reliance on computational fluid dynamics to understand mixing in these designs has increased.

This emphasis on computational fluid dynamics requires embarking on a robust, focused experimental validation program. To expand on our many years of work modeling multiphase mixing in these systems, CFD will be compared to several tests and experimental and theoretical applications from literature, incorporating suggestions from several peer reviews. First, we compare CFD results to single-phase impinging jet correlations from literature (Poreh, 1967) for wall shear and velocity decay. Next, we will present single-phase experimental velocity measurements made with prototypical pulse jet operation of a full-scale vessel (13 ft diameter vessel with 4 PJMs). Finally, we will show early results from testing at a ~1/5 scale in a solid-liquid mixing environment comparing zone of influence and concentration measurements with the CFD data (4ft diameter vessel with 8 PJMs).

keywords: Computational Fluid Dynamics, solid-liquid mixing, experimental validation

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Do you anticipate submitting a full paper to the special Mixing issue of the Canadian Journal of Chemical Engineering? Maybe