Experimental and numerical investigations of scale-up effects on the hydrodynamics of slurry bubble columns

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Graphic Abstract

Fluid Dynamics and Transport Phenomena

Experimental and numerical investigations of scale-up effects on the hydrodynamics of slurry bubble columns*

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Abstract: Experiments and simulations were conducted for bubble columns with diameter of 0.2 m (180 mm i.d.), 0.5 m (476 mm i.d.) and 0.8 m (760 mm i.d.) at high superficial gas velocities (0.12-0.62 m·s^{-1}) and high solid concentrations (0-30 vol.%). Radial profiles of time-averaged gas holdup, axial liquid velocity, and turbulent kinetic energy were measured by using in-house developed conductivity probes and Pavlov tubes. Effects of column diameter, superficial gas velocity, and solid concentration were investigated in a wide range of operating conditions. Experimental results indicated that the average gas holdup remarkably increases with superficial gas velocity, and the radial profiles of investigated flow properties become steeper at high superficial gas velocities. The axial liquid velocities significantly increase with the growth of the column size, whereas the gas holdup was slightly affected. The presence of solid in bubble columns would inhibit the breakage of bubbles, which results in an increase in bubble rise velocity and a decrease in gas holdup, but time-averaged axial liquid velocities maintain almost the same as that of the hollow column. Furthermore, a 2-D axisymmetric k-ε model was used to simulate heterogeneous bubbly flow using commercial code FLUENT 6.2. The lateral lift force and the turbulent diffusion force were introduced for the determination of gas holdup profiles and the effects of solid concentration were