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Flow Regimes in Slurry Bubble Column: Effect of Column Height and Particle Concentration

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Abstract

This is an experimental study focussed on the flow regimes and gas holdup behaviour in a lab-scale slurry bubble column (vertical plexiglass cylinder, 0.14 m dia, total height 2 m). The gas distributor was a fine perforated brass plate (0.5 mm dia orifices, free plate area 0.19 %), producing both homogeneous (HoR) and heterogeneous (HeR) flow regimes, and the transition between them (TrR). The three-phase gas-liquid-solid mixture was composed of local air, tap water and fine porous silica particles (size 100 μm). The particles were characterized by several methods for their individual and collective properties (optical and electron microscopy, granulometry, porosimetry, effective density and viscosity, granular rheology and bulk properties, effects on liquid conductivity and surface tension). The gas holdup e was measured by bed expansion method, using free layer height evaluated visually or by digital image analysis. Three experimental parameters were tested: gas input q, initial slurry layer height H and concentration of solid particles c. It was found that increasing both H and c reduces gas holdup and destabilizes HoR and enhances its breakdown. At low solid load, the three flow regimes exist for all H tested. At higher solid load, only one regime is observed, the turbulent Pure HeR (PHeR). The experimental data were described with suitable models, based on simple physical concepts used for gas-liquid systems, which were successfully applied also to gas-liquid-solid systems. All four flow regimes observed (HoR, HeR, TrR, PHeR) were fitted with few easy formulas, at the price of few adjustable parameters with clear physical meaning.