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Experimental Characterization of Dense Gas-Liquid Flow in a Bubble Column using Voidage Probes

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Abstract

Gas-liquid flow in bubble columns under dilute flow condition has been investigated widely. In the present work, we have characterized gas-liquid flow in a pseudo 2D bubble column for a wide range of superficial gas velocities (U_G = 1 - 30 $cm.s^{-1}$) that cover dilute to dense flow conditions. In-house developed voidage probes were used to measure the local gas volume fraction fluctuations, which in turn were used to characterize dynamics of column-scale re-circulatory flow and bubble-scale flow processes, under dilute-to-dense conditions. Importantly, the spatial distribution of internal composition of gas volume fraction distribution, i.e. gas volume fraction contained in different bubble size groups, was measured. Further, the spatial distribution of chord length and bubble size distribution was measured for a wide range of U_G. With increase in U_G, the low frequency oscillations caused by meandering bubble plume at lower U_G were found to diminish and the fluctuations caused bubble swarms were found to dominate under dense flow conditions. Using the time spent by the probe in each bubble, the bubble population was classified in different size groups and the gas volume fraction for each size group was measured. Under dense flow conditions, small bubbles were seen to accumulate near column walls, as exhibited by wall peaking in gas volume fraction profiles and that large bubbles were found to flow through the column centre. The results presented in this work are important to improve the understanding of dense gas-liquid flow and also for rigorous validation of CFD models.

Keywords: `Bubble column, Gas-liquid flow, Gas volume fraction, Dynamics, Voidage probes, Bubble size distribution`

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