Institute of Chemical Engineering

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Identification of the regime boundaries in bubble columns based on the degree of randomness in the signals

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A new parameter (degree of randomness (DR)) was defined for the identification of the main transition velocities, U trans. The new method reconstructs the time series into multiple state vectors, thus generating non-overlapping vector pairs and then compares the distance between them with a pre-selected cut-off length. The DR values were extracted from gauge and differential pressure fluctuations as well as x-ray tomographic scans. At every U trans value, the DR index exhibited a well-pronounced local minimum. Three cylindrical bubble columns (BCs) with various diameters (0.1, 0.14, and 0.45 m in ID) and one rectangular BC (width = 0.2 m, depth = 0.04 m) were used. They were aerated by means of different perforated plate gas distributors. It was found that in the cylindrical BCs the disintegration of the bubbly flow regime took place always at U trans = 0.04 m/s. In the case of the rectangular BC the first critical velocity appeared at U trans = 0.012 m/s. The lower boundary of the churn-turbulent regime was identified at U trans = 0.11 m/s in the smallest cylindrical BC and at about U trans = 0.095 m/s in the other two cylindrical BCs. In the case of the rectangular BC, the second critical velocity was identified at U trans = 0.039 m/s. The low U trans in the rectangular BC imply that the hydrodynamic regimes are less stable in this particular column due to higher degree of liquid turbulence. The calculated DR values from the gauge pressure fluctuations successfully distinguished the upper boundary of the gas maldistribution and the first transition sub-regime.

Metryczka

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