Institute of Chemical Engineering

Reliable identification of the first transition velocity in various bubble columns based on accurate sophisticated methods

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In bubble columns (BCs), the reliable identification of the first transition velocity Utrans-1, marking the end of the homogeneous regime, is an essential prerequisite for the successful BC design since this parameter marks the onset of bubble coalescence. In this work, a new database with 13 experimental Utrans-1 values at various operating conditions is reported. They are identified precisely by different sophisticated methods, which are considered most suitable and powerful for the analysis of the specific experimental data used. The BCs have different column diameters (and bed aspect ratios) and they are equipped with different perforated plate (PP) gas distributors. For Utrans-1 identification, eight different time-dependent signals recorded in air-deionized water, air-tap water, nitrogen-tap water, nitrogen-ethanol (96%), air-therminol and air-benzonitrile systems have been analyzed. The hidden information in the time series has been quantified by reliable identification parameters such as degree of randomness of the signal, Kolmogorov, information and reconstruction entropies and degree of disorder of the signal. Their profiles as a function of superficial gas velocity have been used for flow regime identification. In the case of column diameters between 0.1 m and 0.46 m and bed aspect ratios beyond 5, a simple empirical rule-of-thumb has been established: when the open area (OA) of the PP gas distributors is ≤1.0%, the Utrans-1 value should occur at around 0.03 m/s. On the other hand, when the OA is greater than 1.0%, then the Utrans-1 value is identifiable at 0.04 m/s. It has been found that this new rule yields better predictions than the most popular empirical correlation of Reilly et al. (1994).

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