Institute of Chemical Engineering

Unified Approach for Prediction of the Volumetric Mass Transfer Coefficients in a Homogeneous and Heterogeneous Bubble Column Based on the Non-Corrected Penetration Theory: Case Studies

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Authors:	Stoyan Nedeltchev
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A critical review on the improvement of penetration theory is presented in this work. The volumetric liquid-phase mass transfer coefficients kLa in seven different liquids (1-butanol, 2-propanol, anilin, decalin, nitrobenzene, tetralin, and ethylene glycol) aerated with air in a small bubble column (BC) (inner diameter: 0.095 m) were measured at ambient conditions and further analyzed. It was found that the kLa values can be predicted satisfactorily on the basis of the classical Higbie's penetration model. The gas–liquid contact time was defined as the ratio of the Sauter-mean bubble diameter to bubble rise velocity. Moreover, the experimental kLa values were well predicted, not only in the homogeneous regime, but also in the transition and heterogeneous regimes. This is a new finding, since to date, it was considered that the penetration theory needs a correction factor for a successful application to any liquid, even in the homogeneous regime. The predictions of the mass transfer coefficients kLa in the above-mentioned seven liquids imply that the mean bubble diameters are always ellipsoidal or spherical, which is the key condition for the applicability (without a correction) of penetration theory. In the presented (in this work) model-based kLa predictions, the Sauter-mean bubble diameters were estimated by means of the reliable correlation of Wilkinson et al., which always predicts a gradually decreasing bubble size at higher gas velocities.

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