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Comprehensive Analysis of the Overall Gas Holdup Profiles in Various Air-Water Bubble Columns

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Authors:	Stoyan Nedeltchev, et al.
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Bubble columns (BCs) are widely used gas-liquid contactors in the chemical industry. Their hydrodynamic and mass transfer performance depends on the prevailing flow regime (FR) and the gas sparger (GS) type (particularly in the homogeneous FR). In this work, numerous gas holdup profiles measured by means of different techniques in various air-water BCs (with inner diameters between 0.1 and 0.33 m) have been carefully analyzed. A comparative analysis of the power-law dependence of gas holdup on the superficial gas velocity UG has been performed. Eight different GS types have been used. The dependence of the constant C and the exponent n (in the power-law fit) on the GS type in both main FRs has been investigated. The effect of the operating pressure P on these parameters has been studied in a BC equipped with a perforated plate GS with an open area (OA) of 2.25%. The previous knowledge about the exponent n was corrected based on our database of gas holdups. It was shown that in some cases the n value could exceed the limit of 1.2 in the homogeneous FR. On the other hand, in the case of gas maldistribution, the n value could be lower than 1. It was also found that the n value increases with P, which implies that the n value is associated with the behavior of the small bubbles, which predominate at elevated P values. It turn out that in the heterogeneous FR the n value at ambient P was as low as 0.17 and then gradually it increased to 0.44 at P = 3.0 MPa. In the case of heterogeneous BCs equipped with the other GS types and operated at ambient P, the n values varied between 0.11 and 0.73. Such a low n value has not been reported hitherto.

Metryczka

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