Bubble interfacial area in a swirling contactor: Experiments and CFD simulations

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Abstract

The bubble size, gas holdup, and interfacial area in a swirling contactor were investigated through experiments and simulations. The interfacial area was obtained for liquids and gases with Reynolds numbers $Re_l$ and $Re_g$, respectively. The contactor was divided into 12 subregions. When $Re_g=23.8$ and $Re_l=20075.4$, regions near the side wall and center of the swirl contactor exhibited small bubbles with diameters of 0.33–0.40 and 0.38–0.45 mm, respectively. $Re_l$ was negatively related to bubble size, gas holdup, and interfacial area, whereas $Re_g$ was positively related. The maximum bubble interfacial area among the 12 subregions was 530 m$^{-1}$, and for the entire swirling contactor was 196.3 m$^{-1}$ with a gas–liquid ratio of 0.022. Euler-Euler simulations using the population balance model accurately predicted this area. Larger areas were obtained at lower $Re_l$ values. Increasing the liquid velocity is not necessary to achieve larger areas, which indicates a contactor with lower energy consumption.

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The diagram illustrates the interfacial area and area-weighted average interfacial area of simulation for different Re values. The interfacial area, denoted by $\sigma$, is shown for $Re_g = 6.8, 13.7, 23.8, 34.0, 44.2$. The area-weighted average interfacial area, denoted by $\sigma_{\text{simulation}}$, is also presented for the same Re values. The color scale indicates the range of values from 0.000 to 900.0 m$^2$. The diagrams show how the interfacial area and area-weighted average interfacial area change with increasing Re.