Gas-Liquid Mass Transfer in Taylor-Couette Flow: Experiments and Simulation

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Bubbly gas-liquid Taylor-Couette vortex flow has gathered increasing interest because of its potential applications to a variety of chemical and biochemical processing problems. In order to quantitatively describe the hydrodynamics and mass transport during two phase Taylor-Couette flow, a rigorous two-fluid CFD model was developed for the simulation of bubbly turbulent Taylor-Couette flow and compared with previously published experimental data. This model includes a complete description of the constitutive closure for inter-phase forces and the comparison of turbulence models. In addition, the mechanism by which the dispersed fluid obtains a non-uniform radial and axial distribution is analyzed and the relative importance of various interphase forces is discussed. The model was then used to predict mass transfer coefficients for semi-batch bubbly Taylor-Couette flow, and these predictions were compared with data obtained from oxygen transport experiments using an air-water Taylor vortex flow system. The simulations accurately predict mass transfer coefficients, phase velocity, velocity fluctuation, gas distribution, and these in turn can provide important guidance for reactor design and scale-up.