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CFD-population balance modeling and simulation of coupled hydrodynamics and mass transfer in liquid extraction columns. (English) Zbl 1443.76008

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Summary: A hierarchical approach for modeling and simulation of coupled hydrodynamics and mass transfer in liquid extraction columns using detailed and reduced bivariate population balance models is presented. The hierarchical concept utilizes a one-dimensional CFD model with detailed bivariate population balances. This population balance model is implemented in the PPBLAB software which is used to optimize the column hydrodynamics. The optimized droplet model parameters (droplet breakage and coalescence) are then used by a two-dimensional CFD reduced population balance model. As a reduced bivariate population balance model, OPOSPM (One Primary and One Secondary Particle Method) is implemented in the commercial FLUENT software to predict the coupled hydrodynamics and mass transfer of an RDC extraction column with 88 compartments. The simulation results show that the coupled two-dimensional-OPOSPM model produces results that are very close to that of the one-dimensional PPBLAB detailed population balance model. The advantages of PPBLAB are the ease of model setup, implementation and the reduced simulation time (order of minutes), when compared to the computational time (order of weeks) and computational resources using FLUENT software. The advantages of the two-dimensional CFD model is the direct estimation of the turbulent energy dissipation using the $k-\epsilon$ model and the local resolution of continuous phase back mixing.

MSC:

76-10 Mathematical modeling or simulation for problems pertaining to fluid mechanics
76T10 Liquid-gas two-phase flows, bubbly flows

Keywords:

liquid extraction; OPOSPM; CFD; population balance; PPBLAB; fluent

Software:

FLUENT; PPBLAB; LLECMOD

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