CFD simulation of hydrodynamics of rectangular external loop airlift reactor

[1]Šimčík M., [1]Ruzicka M., [1]Havlica J., [1]Drahoš J., [2]Teixeira J.
[1]Institute of Chemical Process Fundamentals, Czech Academy of Science, Rozvojová 135, Prague 6, 165 02, Czech Republic
[2]Centro de Engenharia Biológica-IBQF, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal

This contribution is aimed at CFD simulation of hydrodynamics of gas-liquid external loop rectangular airlift reactor using Euler-Euler model. Commercial code Fluent 6.3 is used to solve model equations [1]. The goal of the work was to compare simulation results with experimental data available in literature. Simulated horizontal profiles of liquid and bubble velocity and gas holdup were compared with data of Becker et al. [2].

In Euler-Euler model both liquid and gas phase are treated as interpenetrating continua. There is continuity and momentum equation for each particular phase (see e.g. [1]). These equations are coupled together through pressure, phase volume fractions (which sum to unity) and interphase force terms like drag, lift, added mass and turbulent dispersion force. Closure relations for the interphase forces are needed to solve the equations. These closures are difficult to obtain and their correct form may be unknown especially for higher phase holdup. Related problem is modelling of bubble size distribution since the interphase forces depend on bubble size. Also the turbulent contribution to the stress tensor needs to be modelled. This is usually done with single phase turbulence models such as k-ε extended for multiphase flows.

Grid and time step independence was tested in our simulations. Drag and turbulent dispersion force have been accounted for in the model. Closures based on single bubble case were used. Bubble coalescence and break-up were not accounted for in the model, dispersed particles were considered to be all of the same size. Simulations were done either in 2D or 3D coordinates. Also both steady and unsteady simulations were done. Turbulence was modelled using k-ε model.

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References

[1] Fluent 6.3 User's Guide, Fluent Inc.
[2] Becker et al. (1994). Gas-liquid flow in bubble columns and loop reactors: Part II. Comparison of detailed experiments and flow simulations. *Chemical Engineering Science* 49: 5747-5762.