Archwit Aimdilokwong 2006: Simulation of Hydrodynamics in a Downflow Fluidized Bed Reactor. Master of Engineering (Chemical Engineering), Major Field: Chemical Engineering, Department of Chemical Engineering. Thesis Advisor: Associate Professor Sunun Limtrakul, D.Sc. 123 pages.
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A downflow circulating fluidized bed (downer) is important in gas-solid reaction processes. Apart from the conventional upflow circulating fluidized bed (riser), a downer has a special flow characteristic. The flow of gas and solids in a downer resembles that of the ideal plug flow. This makes the residence time distribution in a downer narrower compared with a riser. Hence a downer gives higher selectivity for many multiple reactions and becomes an important reactor in the chemical and petroleum industries. However, there is still inadequate data regarding the hydrodynamics in a downer. In this work, a 2-D full-components downer reactor model was designed and then simulated with Fluent software to study the hydrodynamics. The model components consist of a 9.3 m high and 0.1 m wide downer column, a riser, two gas-solid separators, and two storage tanks. The gas-solid separator used in this work was compared with the simple settling tank. The gas-solid separator designed in this work shows the outstanding abilities to separate particles and deal with high flow rate. The effect of the number of solid distributing tubes was also studied. The radial profiles of solid holdup and solid velocity shows that more particle distributing tubes provide more uniform radial solid holdup profile, thus enhancing the downer reactor performance. The axial and radial profiles of solid holdup and solid velocity were used to characterize the hydrodynamics in a downer in addition to the solid holdup contour and solid velocity plot. The flow in the downer column is separated into core and annulus zones with solid holdup peak near the wall. The axial solid velocity profile in the downer is divided in 3 zones; the first acceleration zone where particles are accelerated enormously by both gas momentum and gravity until their velocities equal, the second acceleration zone where particles are accelerated slowly by only gravity, and the constant particle velocity zone. More over, the effect of solid circulation rate (G_s) was studied. The cross-sectional averaged solid holdup increases linearly with the increasing solid circulation rate (G_s). The drag-back force of the gas phase has less effect upon the particle phase at high solid circulation rate in the second acceleration zone. Therefore the particle velocity with higher G_s can increase more. The simulation results of this work were compared with the experimental results of Zhang *et al.* (1999, 2000) and Yasemin *et al.* (2003). Both simulation and experimental results agree that hydrodynamics in a downer separates into core and annulus zones with solid holdup peak near the wall but the solid holdup peak of the experimental results disappeared at the end of the downer column. The hydrodynamics results obtained by this work can be used to design a proper circulating fluidized bed downer for industrial uses.

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