Parinya Khongprom 2011: Modeling and Simulation of Hydrodynamics, and Heat and Mass Transfer in a Down-Flow Circulating Fluidized Bed Reactor. Doctor of Engineering (Chemical Engineering), Major Field: Chemical Engineering, Department of Chemical Engineering. Thesis Advisor: Associate Professor Sunun Limtrakul, D.Sc. 254 pages.

The hydrodynamics and heat and mass transfer behavior in a down-flow circulating fluidized bed (downer reactor) were studied using the two-fluid model and the discrete element method (DEM) model. In studies of hydrodynamics and mixing behavior in a downer reactor by the two-fluid model, it was found that both gas and solids flows approximate an ideal plug flow behavior. The gas phase flow behavior reaches higher levels of attainment to ideal plug flow patterns than that of the solids phase. The correlations of the axial gas and solids Peclet numbers as a function of the operating conditions and the physical properties of gas and solids particles in the system were proposed. In addition, the two-fluid model was used for predicting the performance of CO_2 removal in a circulating fluidized bed. It was found that the CO_2 concentration in the downer reactor is much more uniform than that in the riser reactor. However, the conversion in the downer is lower than that in the riser because of lower solids fraction in the downer. Finally, DEM was developed to investigate the heat and mass transfer in a catalytic cracking downer reactor. The simulation of the catalytic cracking downer reactor exhibits the almost uniform temperature and concentration distributions in the lateral direction. In addition, the gasoline mass fraction, which is the desired product, increases with increasing cracking temperature, solids circulation rate and decreasing of superficial gas velocity. However, the gasoline product undergoes further cracking to yield more gaseous products at very high inlet temperature.

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