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Modeling and simulation of a commercial-scale slurry bubble column rector for Fischer-Tropsch synthesis

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A user-friendly simulator based on a comprehensive computer model developed in our laboratory for Slurry Bubble Column Reactor (SBCR) was used to predict the performance of a commercial-scale (9-m ID and 50-m height) SBCR for Fischer-Tropsch (F-T) synthesis. Novel correlations for predicting the hydrodynamic and mass transfer parameters and different kinetic rate expressions from the available literature for iron and such as catalyst concentration, pressure, temperature, H_2/CO ratio, and superficial gas velocity on the SBCR performance were predicted for cobalt and iron catalysts. The predictions showed that the performance of the reactor was strongly dependent on the type of catalyst and the kinetic rate expression used. At low catalyst concentration, the reactor operated in a kinetic-controlled regime with increased syngas conversion and catalyst productivity, however, with increasing catalyst concentration, the reactor operated in a mass transfer-controlled regime with decreased syngas conversion and catalyst productivity. The transition from kinetic- to mass transfer-controlled regimes occurred at different solid concentrations depending on the catalyst and the kinetic rate expressions used. High H_2/CO ratios in the inlet feed gas to the SBCR resulted in high syngas conversion and low selectivity of valuable products, such as wax cuts. Increasing the superficial syngas velocity decreased the gas residence time which decreased the syngas conversions, yet, increased the selectivity of the diesel and wax cuts for both catalysts. Also, high operating temperature always resulted in high syngas conversion, however, increasing temperature led to a significant decrease of the selectivity of the diesel and wax cuts.

Biography

Badie I. Morsi holds BS in Petroleum Engineering and MS, Ph.D. and ScD in Chemical Engineering. His research activities include: hydrodynamics and mass transfer in multiphase reactors operating under actual industrial conditions; design, modeling, and optimization of chemical processes; and development of new physical solvents for selective capture of CO_2 from fuel gas streams in power-generating facilities. He has authored and co-authored 117 publications (70 peer-reviewed journal articles, including 3 book chapters; and 47 non-refereed papers).

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