

121e Novel Technique to Optimum Catalyst Size Selection for Slurry Bubble Column Reactors

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Major oil companies are gearing up to build slurry bubble column reactors to utilize natural gas located in remote areas of the world and to convert it to paraffin wax, which will be upgraded to gasoline and diesel fuels (Chem. Engr. Prog., 2005, May, 6). In slurry bubble column reactors (SBCRs), the fine powdered catalyst are suspended in the fluid and the gas bubbles provide the energy to keep the catalyst mixed. SBCRs have excellent heat and mass transfer characteristics for removal of the heat given off by exothermic reactions and the ability to replace catalysts easily.

The design and scale-up of SBCRS require, among other things, precise knowledge of kinetics, hydrodynamics, and mass transfer characteristics over a wide range of operating conditions. Computational fluid dynamics (CFD) is a recently developed tool that can help in the scale-up. However, most modeling studies did not address the effect of the catalyst size on the performance of the reactor. Catalyst particles used in most fluidized-bed processes are small enough for external mass-transfer and internal diffusion resistance to be negligible. However, small particles are entrained in the product gas stream and are known to cause liquid product filtration problems. Small particles also cause the formation of the clusters, which give large effective particle sizes and, hence, poor mass transfer.

An issue of interest to the energy industries throughout the world is the size of catalyst that they should make for SBCRs. In this paper, we have applied the mathematical model for gas-liquid-solid flows to determine the optimum particle size, which is the size that has the maximum granular temperature, similar to the experiments for gas-solid systems done at Exxon. For this particle size, the heat- and mass-transfer coefficients have the highest values. We have related the mass transfer coefficient to the granular temperature computed by the hydrodynamic model.