Zheng Y, Ph.D., "Flow Structure in a Liquid-Solids Circulating Fluidized Bed", The University of Western Ontario, September 1999.

Abstract

Flow behaviors were systematically studied in a liquid-solids circulating fluidized bed of 76 mm I.D. and 3 m in height with three different types of particles. The axial and radial distributions of local solids holdup were obtained using a fiber optic probe and the radial distribution of liquid velocity at the axial position of 0.8 m from the main liquid distributor were measured by a dual conductivity probe. The results show that the solids holdup distributes fairly uniformly along the riser for relatively light particles but a dense-bottom dilute-top axial flow structure exists in the heavy steel particle system under relatively low liquid flowrate. Radial nonuniformity in both solids holdup and liquid velocity was identified in the circulating fluidization regime, with low solids concentration/high liquid velocity in the center region and high solids concentration/low liquid velocity in the wall region. The radial profile becomes steeper with increasing solids circulation rate. The radial nonuniform distribution was also studied through the analysis of microflow structure, which further confirmed the results obtained in the macroflow study. The transition criteria from the conventional fluidization regime to the circulating fluidization regime has also been properly defined. In addition, a pressure balance analysis has been carried out to predict the stable operating conditions and explain the origin of the unstable operation phenomena of the liquid-solids circulating fluidized bed. The stable operating window is proved to be significantly affected by the particle properties, the solids inventory and the unit geometry.