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Electrical Capacitance Tomography Imaging of Gas-Solid and Gas-Liquid-Solid Fluidized Bed Systems

Fan, L. -S.[1], W. Warsito.[1] and B. Du.[1]

1) Department of Chemical Engineering, The Ohio State University, 140 West 19th Avenue, Columbus, OH 43210-1180, U.S.A.

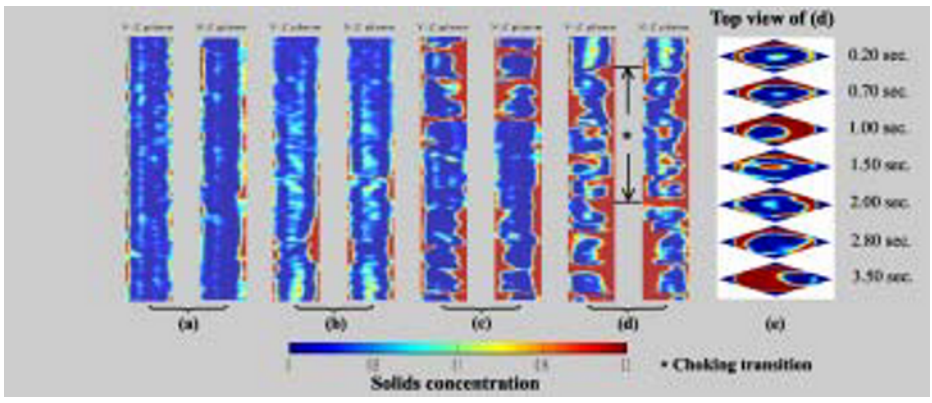

Fig. 1. Instantaneous solids concentration distributions of a circulating fluidized bed (CFB) with Group B particles at U_g = 2.4 m/s (G_s = 8.57 kg/m^{2}s (a); 11.43 kg/m^{2}s (b); 25.72 kg/m^{2}s (c); 14.86 kg/m^{2}s (d), (e))

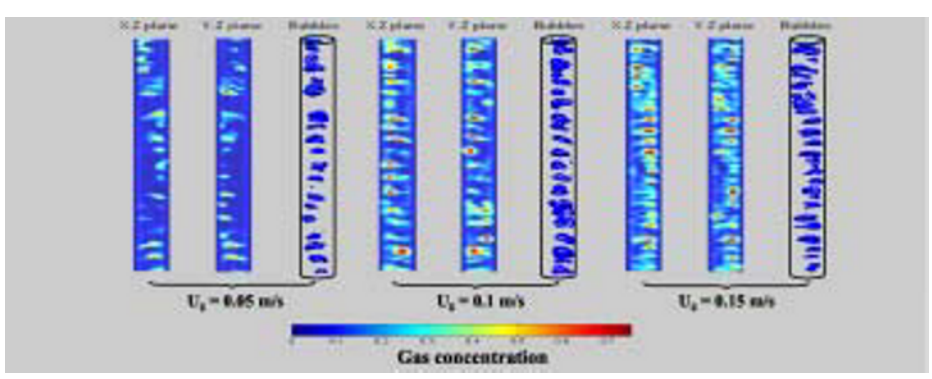

Fig. 2. Instantaneous gas concentration distributions of a gas-liquid-solid fluidized bed

The electrical capacitance tomography (ECT) based on the neural network multi-criteria optimization image reconstruction technique (NNMOIRT) developed by this research group (US Patent # 6577700 B1) is used to accurately reveal the instantaneous phase holdup distribution of complex multiphase flow systems. Figures 1 and 2 show the time series of ECT images in a given plane of the column; the images stack up to reflect the dynamic behavior of the phase holdup distribution. Specifically, Fig. 1 shows the real time solids concentration distribution variation for a 0.1-m ID and 6.32-m-high CFB riser (0.5 m above the distributor) with coarse sand particles as fluidized material (d_p = 240 μm and ρ_p = 2200 kg/m^3) for a gas velocity of 2.4 m/s. With an increase in the solids circulation rate, G_s, the CFB riser undergoes a variation from the double solids-ring flow structure (a), three-region flow structure (b), to slug flow structure (c). Figure 1 (d) and (e) illustrate the dynamic process of the choking transition. Figure 2 shows the real time gas concentration distributions at a level 0.2 m above the distributor in a gas-liquid-solid fluidized bed under different gas velocities and without liquid inlet flow. Air, Norpar 15 (ρ = 773 kg/m^3) and glass beads (d_p = 200 μm, ρ_p = 2470 kg/m^3) are used as gas, liquid and solid phases, respectively. Spiral motion of bubbles is clearly observed at a low gas velocity.