Development of Novel Sensors for Measuring Electrostatic Charges on Particulate Materials and Hydrodynamics in Gas-Solid Fluidized Beds

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Abstract:

Fluidization occurs when solid particles are transformed into a fluid-like state by being suspended in a gas. The fluid flows upwards through the solids at such a velocity that the gravitational force on the solids is counter-balanced and the particles are supported by the upward flowing fluid. Electrostatic charges in fluidized systems can interfere with the hydrodynamics of the bed, causing particles to adhere to the reactor wall to form "sheets". Significant reactor wall sheeting in polyolefin reactors often causes plugging of the reactor product discharge system or loss of fluidization. Moreover, accumulation of electrostatic charges can cause hazardous electrical discharges leading to sparks, fires or even explosions. To understand the electrostatic phenomena in fluidized bed and provide countermeasures toward above drawbacks, suitable instrumentation for online monitoring charge density level in the fluidized bed is needed. In this work, several custom-made electrostatic probes, which tips composed of two different materials (Nickel and Titanium Nitride), were developed to measure the electrostatic charging behavior on particles in 2D and 3D fluidized beds in both single bubble injection and freely bubbling modes. There existed differences in the electrostatic signals from the two materials of the probe and the signals were strongly influenced by both the hydrodynamics and charge density inside the beds. Decoupling methods and signal processing procedure were developed for analyzing the probe signals. Charge densities and bubble rise velocities determined by the probe were found to be similar to those obtained directly from the Faraday cup measurement and by analyzing video images.

References:

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