CFD Simulation of Charge Generation due to Single Particle Contact

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Abstract — **When a gas or liquid flows vertically through a bed of solid particles at a sufficient velocity, the solid particles start exhibiting fluid-like behavior. This is known as fluidization, and it occurs when the drag force exerted by the fluid fully supports the buoyant weight of the solid particles. Gas-solid fluidized beds are widely applied in industries including polymerization, combustion, drying, etc., which are prone to generation of electrostatic charges due to particle-particle and particle-wall interactions. Particularly in the case of polymerization fluidized bed reactors, the electrostatic charge generation can result in the accumulation of particles on the reactor wall (known as "sheeting") and consequently force a reactor shutdown for clean-up. Unlike the experimental investigations, the computational fluid dynamic (CFD) modeling of electrostatic charging in fluidized beds has received limited attention. In a previous work Rokkam et al. (1) used an Euler-Euler multi-fluid and electrostatic model to simulate laboratory-scale experiments on electrostatics. In that work, the CFD model used experimentally measured particles charge-to-mass ratio (q/m) as an input for the simulation. The q/m was assumed to be constant throughout the simulation and did not have a mechanism for generating charge based on particle interactions. Preliminary work was initiated to modify this electrostatic model to simulate charge generation due to particle interactions. The particle charge generation is calculated based on the particle-wall contact charging model proposed by Matsusaka & Masuda (2). Single particle contact experiments were conducted to obtain charge generation values and used as an input to an Euler-Lagrange model accounting for electrostatics. The ultimate objective is to obtain simulated values of electrostatic charge of particles which are comparable to measurements from laboratory-scaled fluidized bed experiments.**