



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS**

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Thesis Title: EXPERIMENTAL INVESTIGATION OF SOLID FLOW PATTERN IN GAS-SOLID CIRCULATING FLUIDIZED BED RISER

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**SHORT ABSTRACT**

Circulating fluidized bed (CFB) technology finds extensive applications across various industries, including petrochemical, chemical, fine chemical, metallurgical, and power generation. Its widespread use can be attributed to its exceptional heat and mass transfer capabilities, higher throughput rates, and operational versatility. CFBs are employed in various applications, each tailored to handle different levels of solid fluxes. Low-solid-flux CFBs are instrumental in processes such as drying, alumina calcination, and iron ore reduction. On the other hand, high-solid-flux CFBs are mostly used for fluid catalytic cracking (FCC), making maleic anhydride, burning gasifying coal and biomass, and chemical looping combustion, among other things. Although CFB has been in use for many decades, there is still a lack of fundamental knowledge. CFB is still designed empirically and scaled up based on experience rather than science. The complexity of gas-particle, particle-particle, and particle-wall interactions is primarily to blame for this. Geometry and scale have an impact on these interactions. There is a scarcity of detailed velocity flow field data especially in the case of Geldart Group B particles.

In the current work, radioactive particle tracking techniques and single particle residence time distribution are used to investigate the solid phase velocity field and solid mixing. Experiments are conducted at the bottom and middle sections of the risers, as well as at the laboratory and pilot-scale CFB setups. Lagrangian and Eulerian velocity flow field data are presented at the bottom and middle sections of the riser. Mean velocity, root mean square (RMS) velocities, granular temperature, stress and turbulence intensity are estimated for all conditions at both the bottom and the middle sections of the riser. It is found that solid motion is predominantly in the axial direction and mean radial motion is negligible. Though mean axial velocity is higher at the center irrespective of the operating conditions, mean velocity profiles are comparatively flat in the case of laboratory scale w.r.t. pilot scale riser. Instantaneous velocity PDF plot shows that solid back mixing decreases with increasing gas velocity. However, in pilot scale riser, solid back mixing is comparatively higher under similar operating conditions. At the pilot scale riser, significant amount of particle downward motion is observed at a gas velocity of 7.6 m/s. However, in the case of the laboratory

scale riser, solids' downward motion is not visible even at a gas velocity of 7 m/s; at below 7 m/s, the downward motion of solids is visible even though the mean motion is always in the upward direction.

Solid mixing is analyzed using residence time distribution study at different heights. It is observed that the solid mixing at the bottom section dominates the overall solid mixing. Increasing the solid flux at a constant gas velocity results in greater solid mixing, while decreasing the gas velocity at a constant solid flux also enhances mixing. However, solid flux has a lesser impact on solid mixing compared to gas velocity. A simplified scaling correlation is developed based on operating conditions to predict the solid phase mean velocity for Geldart Group B particles.

