INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Investigation of Gas – Solid Circulating Fluidized bed at Two Scales Using Experimental and Numerical Techniques

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Thesis Submitted to the Department/ Center	:	Chemical Engineering
Date of completion of Thesis Viva-Voce Exam	:	11/5/2017
Key words for description of Thesis Work	:	Circulating Fluidized Bed (CFB), Radioactive particle Tracking (RPT), Scale – up, Solid flow mapping, RTD

SHORT ABSTRACT

Gas – solid Circulating fluidized bed (CFB) finds application in industrial process like cracking, combustion, gasification, drying, etc. The major reasons cited being operation flexibility, efficiency, short residence time, etc. Even though, CFB is in use for more than three decades, fundamental understanding is still insufficient. Design and scale up of CFB is still empirical and based on experience rather than science. This is mainly due to the complexity of gas – solid, solid – solid and solid-wall interactions. Multi-scale nature of these interactions, both in length and time scale, makes it more difficult to delineate the hydrodynamics. These interactions are also a function of geometry and scale, which makes scale-up of CFB more challenging. Numerical simulation is cost effective approach however, has been largely suffering from lack of experimental data. Further, most of the studies on scale effect are limited to the mean values. Very few studies are available on the fluctuations at different scales. Further no study is available on scale study using noninvasive techniques and also unbiased with scale.

In current study, solid velocity field and solid mixing are investigated using radiation based noninvasive technique, radioactive particle tracking (RPT). Studies are conducted at two different scales, laboratory and pilot plant scales. Eulerian and Lagrangain velocity field of solid is estimated for different gas inlet velocity and solid inlet flux. Further turbulent parameters like Reynolds stress, turbulent kinetic energy are estimated for all the conditions. Global mixing is studied using residence time distribution and Trajectory length distribution studies. Further, local mixing is estimated by solid diffusivity which is calculated by using the first principles. A new scaling law based on solid velocity is developed to predict the effect of operating conditions and scale. Finally, numerical simulations are conducted to augment the experiments and validated with the experimental data.