INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Hydrodynamic Study of a Sidewall Nozzle Assisted Gas-Solid Fluidized Bed

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SHORT ABSTRACT

The progress of new chemical technologies is moving faster in the design of the unconventional reactor system to upgrade the old technologies and to solve new tasks. There are several tasks that need to be addressed for enhancement of the selectivity of the product in a distributed feeding of reactants along with the reactor height. One of such reaction is, thermal denitration of ammonium di-uranate (ADU), which thermally decompose the ammonium nitrate into nitrogen and water vapor. The reaction is carried out in a fluidized bed maintained at 350 °C. In this reactor, the side streams of ADU (reactants) are injected at higher velocity through multiple pneumatic nozzles. At the surface of the hot solid ammonium nitrate decomposes into nitrogen and water vapor. It is observed that fraction of ammonium nitrate bypasses the reactor without any decomposition. This affect the performance of the reactor and overall process. The extent of bypassing depends on nozzle diameter, flowrate, nozzle configuration, solid flow field and solid distribution. Therefore, it is vital to study the effect of above mentioned parameters on the behavior of sidewall nozzle injected fluidized bed reactor.

The solid flow field parameters, characterizing the hydrodynamics of the solid phase (glass beads or Geldart B type powder), are measured via a non-invasive, radioactive particle tracking (RPT) technique. The investigation is conducted in a laboratory-scale cold flow model setup of 0.21 m diameter and 2.25 m height cylindrical column by studying: single nozzle injection with two different sizes (6 mm and 1 mm) at same planes, and multiple injections of 6 mm diameter nozzle at same planes. All RPT experiments with multiple sidewall injections has been performed in a 6 mm diameter nozzle under fixed fluidization conditions. The experimental results show that the symmetric arrangement of injection at the sidewall of the bed does not only reduce the axial mean velocity of the solid but also bring the system in a condition similar to the normal fluidization.

In the subsequent chapter of this thesis, gamma-ray densitometry measurement technique (GDT) has been used to study the solid distribution in the same experimental setup and for different configuration of nozzles. Single/multiple sidewall horizontal injection(s) through 6 mm diameter nozzle(s), operating at same plane are used at fixed fluidization condition and the solid hold up are measured using chordal scans. This work has been conducted at different nozzle flow rates. The results show that the solid hold up is lowest (~15%) at lower plane in the case of three nozzles. Similar study has been performed at same injection flowrates through two nozzles of same size (6 mm or 1 mm) operated at different plane. Thus, such result provides useful information on the effect of different configurations of nozzles for optimizing the design consideration of the reactor.

Finally, computational fluid dynamics (CFD) simulations are performed by using commercial software ANSYS 14.5 and compared with experimental findings. The outcome of this work will be important in optimization, designing and troubleshooting of sidewall nozzle assisted fluidized bed.