INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Fluidized bed technology is one of the most promising technologies to harness power due to numerous advantages such as enhanced heat and mass transfer rate, fuel flexibility, supreme gas-solid mixing and emission control ability. Because of its enormous benefits, this technology has found widespread application in many industrial sectors, including the petroleum and refining industries, combustion and gasification industries of coal and biomass, drying industries of various agricultural and pharmaceutical products, etc. Various industrial groups have well recognized the conventional straight type of riser, and studies of various characteristics are well organized in open works of literature. But, the major hindrances associated with this type of riser are elutriation of fine particles, de-fluidization of coarser particles, agglomeration, segregation in size, back mixing of particles, high bed pressure drops and long residence time, etc. Spurred by these challenges, people started conducting research on the conical riser. However, the insight physics of this type of riser is scarcely reported. Therefore, it necessitates extensive research to comprehend the fluid flow behaviour, heat transfer characteristics, drying characteristics etc., when operated under varying parameters. Present work is an attempt to investigate conical bubbling fluidized beds so as to evaluate the bed hydrodynamics, heat transfer and drying characteristics. Hydrodynamics and heat transfer characteristics in three fluidized bed risers of atmospheric bubbling fluidized bed dryers of cone angles 0°, 5° and 10° are studied with sand as inventory initially was studied. Experimental results were validated with numerical results and found to be in good agreement. Furthermore, the drying characteristics of paddy granules have also been studied in these three risers. Finally, thermodynamic analysis of the drying process is carried out in the three risers for different operating parameters such as inlet air velocity, inlet air temperature, the mass of paddy, spiral and cone angle.

As a result of the present investigation, the bed pressure drop is found to decrease by 22.23%, with an increasing cone angle from 0° to 10°, when sand particles are used as bed inventory. Similarly, the bed pressure drop is also observed to decrease by 3.54% with the increase in air velocity. But the bed pressure drop increases by 30% and 24%, respectively, when the bed height and particle size of the sand increase. The interphase heat transfer coefficient is found to be increasing (6.25%) from 288 to 306 W/m^{2}K with the increase in cone angle. The interphase heat transfer coefficient also increases (8.1%) from 296 to 320 W/m^{2}K with the increase in air velocity from 1 to 2 m/s. For all operating conditions, the time required for drying paddy grains in a conical fluidized bed dryer is almost half of the time required for drying the paddy grains in a conventional fluidized bed dryer. A conical bubbling fluidized bed dryer is found to be a better option for energy-saving than any other conventional fluidized bed dryer. The incorporation of a spiral reduces the drying time by 16.67% in a conical dryer of 10° cone angle. A 26.67% reduction in energy consumption of the blower is observed due to the higher degree of cone angle. The percentage of head rice is found to be 63% and 58% for the conical dryer with and without a spiral, respectively, while in conventional dryers, it is approximately 30 to 50% in Asian countries. The addition of a spiral increases the milling recovery by 3%. The EU and EUR are found to increase with the addition of a spiral and an increase in cone angle. The addition of a spiral improves the exergetic efficiency of drying processes in a dryer. It is also seen that there is an improvement in the exergetic efficiency with an increase in the cone angle. The maximum exergy efficiency is found to be 0.41 at an inlet air velocity of 2.1 m/s, inventory of 3 kg and inlet air temperature of 65°C with spiral and higher cone angle.