

Ball JS, M.E.Sc., "Comprehensive Studies of the Solids Flux in Riser and Downer Circulating Fluidized Beds", The University of Western Ontario, May 1999.

Abstract

A comprehensive study into the solids flux was carried out in various circulating fluidized bed apparatus. Tests were conducted using a non-isokinetic suction probe in a 76 mm i.d. and 10 m long riser, a 100 mm i.d. and 15.1 m long riser and a 100 mm i.d. and 9.3 m long downer. The tests were completed using FCC particles.

The effects of gas velocity, solids circulation rate, axial and radial positions on the local solids flux were investigated in the three different columns. This allowed comparisons to be made between the various columns.

In the downer, the radial profiles of solids flux are highly dependent on the axial location within the column. The local solids flux is dependent on the overall solids circulation rate but not so much dependent on the gas velocity. The solids flux profiles in the downer is quite different from those reported in the riser.

In the two risers of different diameter, the operating conditions (U_g and G_s) were found to affect the solids flux in each reactor in the same general fashion. Significant amount of solids may flow downwards near the wall depending on the operating conditions. Increasing solids circulation rate or decreasing gas velocity increase the tendency for solids to flow down near the wall, and therefore leading to steeper radial profiles of solids flux. There appears to be little scale-up effect for the 76 mm i.d. to 100 mm i.d. risers.

In the riser two types of radial distributions of radial solids flux were observed: A parabolic shape and a flat core shape with a slight decrease at the wall. The effective solids saturation carrying capacity, defined as the solids circulation rate under a given gas velocity where significant solids downflow starts at the wall, can be used to demarcate the two operation regions corresponding to the two radial profiles. At higher solids circulation rates than the effective solids saturation carrying capacity, the parabolic shape is likely to be observed; while the flat core shape often exists at solids circulation rates lower than the effective carrying capacity.

A direct comparison on solids flux was enabled by measurements obtained in a pair of riser and downer circulating fluidized bed reactors, of the same diameter. The operating conditions and the axial position were found to affect the solids flux in each reactor in a different manner. The solids flux in the riser were affected to a large degree by the gas velocity, in contrast with the downer where no significant effect was detected from changes in the gas velocity. The axial position has an effect on the shape of the solids flux profiles in the downer, but only small effects were observed in the riser. On the other hand, increases in overall solids flux leads to the increase of local solids flux in both the downer and the riser.

It was determined that the solids flux varies throughout the various circulating fluidized bed columns. These variations must be taken into account to ensure the successful design of

circulating fluidized bed reactors.