Salah M, M.E.Sc., "Hydrodynamics of Circulating Fluidized Bed with Internals", The University of Western Ontario, September 1995.

Abstract

Circulating fluidized bed (CFB) reactors have been utilized extensively in both catalytic and non-catalytic reactions, such as in catalytic cracking of crude oil and coal combustion. Non-uniformity in radial and axial solids hold-up is characteristic of CFB with a high concentration of solids flowing mainly downwards near the wall region and most of the gas passing through the central core region. As a result, gas-solids contact is still poor in the riser although much better than bubbling bed. In this thesis the effect of ring-type internals on the reduction of non-uniformity in a riser of 7.6 cm in diameter and 3.0 m in height was investigated. Two ring internals with opening area of 70% and 90% were installed in five axial positions along the riser. Fibre optic probe was used to measure both radial and axial solids holdup profiles of sand particles along the riser. The superficial gas velocity was 6 and 8 m/s and the solids circulation rate ranged from 53 to 233 kg/m^{2}s. Results indicate that ring internals reduce radial non-uniformity in the bed, by scraping off downward flowing particles near the wall, compared to conventional CFB. Axial voidage profile shows zigzag type pattern, indicating good contact between gas and solids and better distribution of solids throughout the riser. It has also been observed that under high gas velocity and low solids circulation rate, one can have a reversed radial distribution profile: more dilute in the wall region than in the core region. Detailed study on the radial solids distribution around the rings show the formation of dense region over the ring and dilute region below the ring. Comparing 70% and 90% opening area internals reveals that significant solids gradient exists on the top of the 70% opening internal which increases with the increase of solids circulation rate. Therefore, the 90% opening internal has a better solids hold-up distribution in the radial direction than the 70% opening internal. The optimization of the opening area of the internal is recommended to improve the solids flow structure.