

CFD-DEM Study of the Effect of Cyclone Arrangements on the Gas-solid Flow Dynamics in the Full-loop Circulating Fluidized Bed

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The multiple cyclones are adopted to improve performance and scale up fluidized beds. In this work, the effect of cyclone arrangements on the gas-solid flow dynamics in the full-loop circulating fluidized bed (CFB) is investigated by the computational fluid dynamics coupled with discrete element method (CFD-DEM). The overall gas-solid motions, pressure distribution and gas-solid non-uniform distribution in the CFB with two types of cyclone arrangements (*i.e.*, central symmetry arrangement and axial symmetry arrangement) is studied. The results show that the CFB with multiple cyclones lead to some unique characteristics, including (1) intensive solid back-mixing behavior mainly occurs close to the four corners and front and backs walls of the riser, (2) the spiral directions of the internal and external vortexes of gas flow in the cyclone are same, (3) the closed-loop pressure is obtained and the pressure drop in the standpipe and L-valve are nearly four times of that in the cyclone, (4) gas-solid flow shows non-uniform distribution in the multiple cyclones, and the middle cyclones have higher solid holdup and solid velocity than the corner cyclones, (5) the axial symmetry arrangement for the multiple cyclones is better than the central symmetry arrangement in terms of the uniform distribution of solid flux in the cyclone and solid inventory in the standpipe. The results provide meaningful understanding for the design, operation and scale-up of CFBs.

Keywords: CFD-DEM; circulating fluidized bed; cyclone arrangement; gas-solid flow dynamics; mathematical modeling.

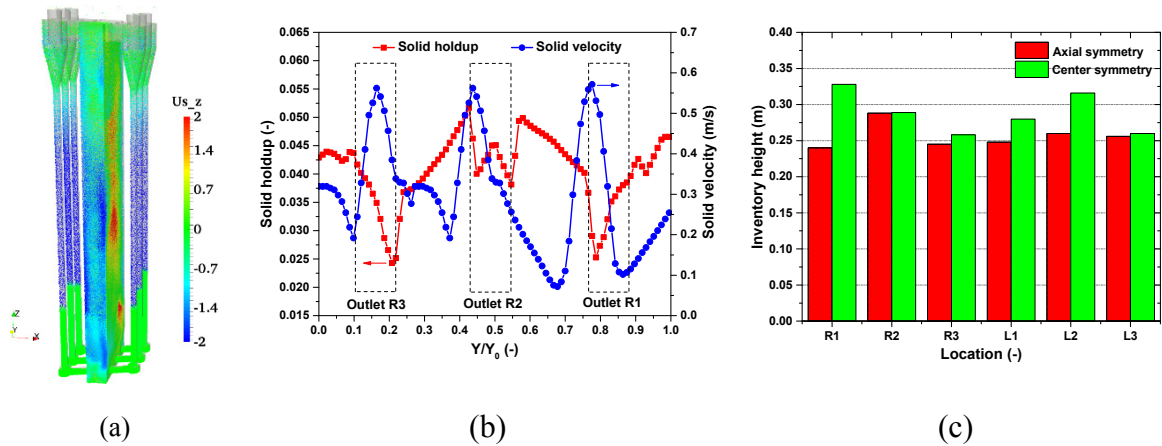


Fig. 1. (a) Snapshot of the full-loop solid motion; (b) solid holdup and velocity distributions in the region of riser outlets; (c) effects of cyclone arrangements on solid inventory height in six standpipes.