

RISER HYDRODYNAMICS AND CLUSTER CHARACTERIZATION BY PARTICLE IMAGE VELOCIMETRY (PIV) AND DIGITAL IMAGE ANALYSIS (DIA) COUPLING

A.C.Varas*, Eindhoven University of Technology, Eindhoven, THE NETHERLANDS
A.E.Carlos.Varas@tue.nl

E.A.J.F.Peters, N.G.Deen, and J.A.M. Kuipers, Eindhoven University of Technology, Eindhoven, THE NETHERLANDS

We present a recently developed DIA technique that can provide full-field hydrodynamic measurements of a pseudo-2D lab scale riser reactor. The main strength of this DIA technique is the full-field measurement of solids volume fraction under riser flow conditions. It provides high quality data to perform cluster detection and characterization. In depth knowledge of the behavior of clusters is important because these heterogeneities have a large influence on mass transfer phenomena.

Riser hydrodynamics have been widely investigated in the last decades. Several experimental techniques have been employed to obtain hydrodynamic data of heterogeneity due to cluster formation in a riser flow. However, cluster-related phenomena are difficult to quantify by most of these techniques that only provide local information or/and are limited by the high number of sensors needed to describe the full flow field of the system. Full-field DIA techniques were previously applied on lab scale units under bubbling fluidization regime, where a calibration with a known solids weight was needed (1). However, under riser flow conditions, this is inherently changing and it lacks a robust methodology to quantify solids concentration for these systems. The conventional full-field DIA techniques also had severe difficulties to filter image imperfections that arise, e.g., due to inhomogeneous lighting.

This second shortcoming was tackled by employing a temporal histogramming technique for normalizing the measured image intensities. Next, a calibration with synthetic images, obtained from CFD-DEM simulation, provides a quantitative correlation between image intensity and solids volume fraction data. In this way, the combination of PIV/DIA technique enables full-field measurements solids volume fraction, solids mass flux and cluster-related properties under riser flow conditions.

The novel DIA method, extends the applicability of PIV/DIA to full-field pseudo-2D riser reactors. In our contribution full-field data and measured cluster properties will be presented. These datasets provide a generous amount of experimental references for CFD models validation of a pseudo-2D riser reactor.

REFERENCES

1. M.S. Van Buijtenen, M. Börner, N.G. Deen, S. Heinrich, S. Antonyuk and J.A.M. Kuipers. An Experimental Study of the Effect of Collision Properties on Spout Fluidized Bed Dynamics. Powder Technology. 206 (1-2):139–48, 2011.

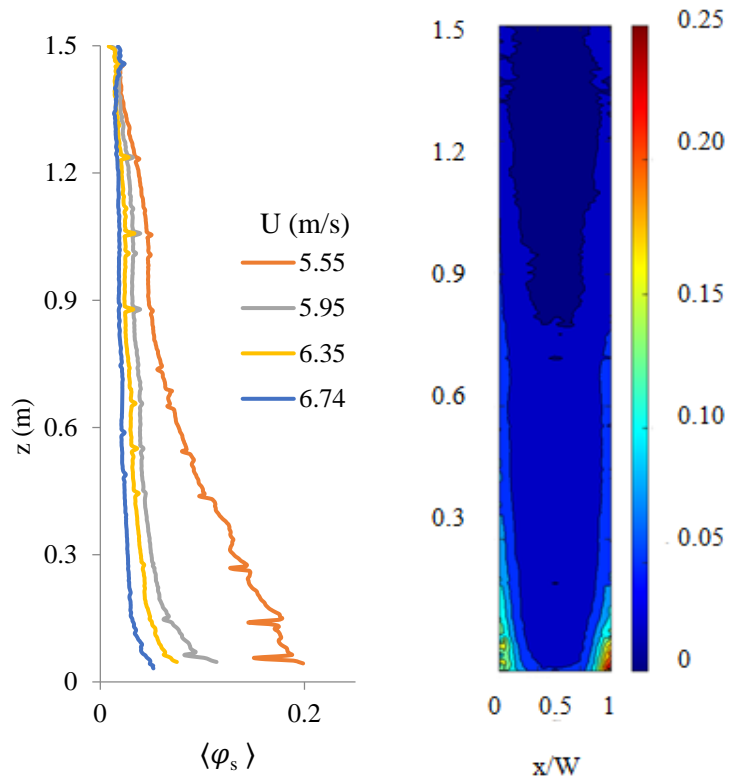


Figure 1 Left: Axial profiles of time-averaged solids volume fraction at changing superficial gas velocity U . Right: Time- averaged solids volume fraction over full flow field at $U = 5.95$ m/s and solids flux $G_s = 31$ kg/m²s of 0.8 mm glass beads.

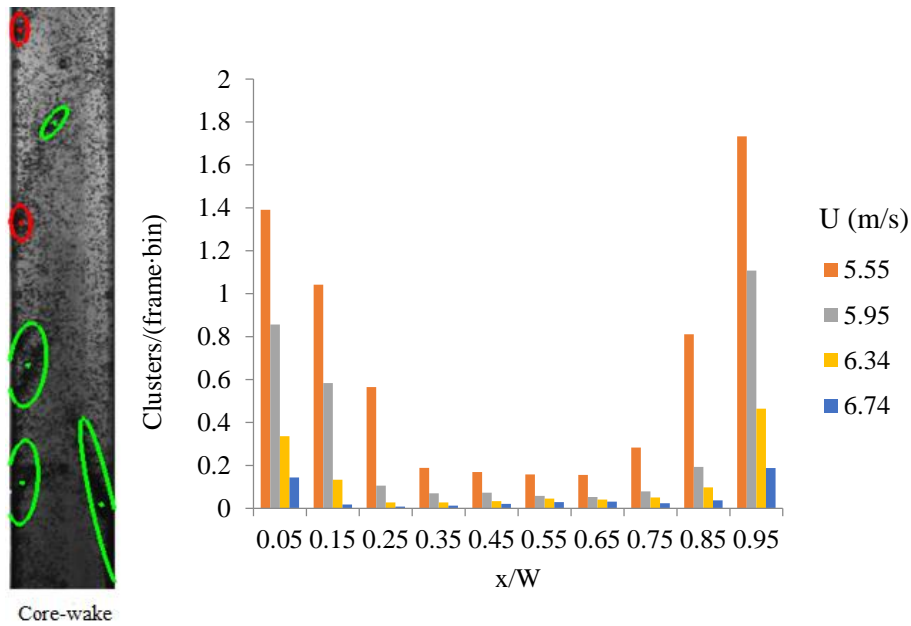


Figure 2 Left: Clusters detected in the flow field. Right: Full-field cluster frequency measurements at different U values and $G_s = 31$ kg/m²s.