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Chemical Engineering Science

www.elsevier.com/locate/ces

PII: S0009-2509(16)30479-1
DOI: http://dx.doi.org/10.1016/j.ces.2016.08.041
Reference: CES13138

To appear in: *Chemical Engineering Science*

Received date: 10 March 2016
Revised date: 25 August 2016
Accepted date: 31 August 2016

Cite this article as: P. Maximiano Raimundo, A. Cartellier, D. Beneventi, A. Forret and F. Augier, A new technique for *in-situ* measurements of bubbl characteristics in bubble columns operated in the heterogeneous regime *Chemical Engineering Science,* http://dx.doi.org/10.1016/j.ces.2016.08.041

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Highlights

- A new method is proposed to measure the Sauter mean horizontal diameter of bubbles,
- That technique exploits the spatial correlation coefficient of phase indicator functions,
- Optimum sensor design is defined depending on bubble sizes and concentration,
- Comparisons with alternate techniques are achieved in industrially relevant conditions,
- The technique proves efficient and reliable in dense heterogeneous bubbly flows.

Keywords: Bubbly flow; Optical probe; Bubble size measurement; Industrial bubble column; Heterogeneous regime; high gas holdup

Abstract:

In order to characterize bubbles in dense, heterogeneous bubbly flows such as those encountered in industrial bubble columns, a new measuring technique based on the spatial correlation of phase indicator functions is proposed. By analyzing its principle of operation, it is shown that the correlation coefficient decreases with the ratio of the distance between two optical probes to the bubble size. Hence for a known distance, the bubble size, and more precisely the Sauter mean horizontal diameter of bubbles is accessible. A dedicated sensor has been designed using conical mono-fiber optical probes. It has been compared to alternate measuring techniques in the complex bubbly flows produced in an I.D. 400mm bubble column with gas superficial velocities from 3 to 35 cm/s. The performances of the correlation sensor happen to be quite satisfactory, with typical uncertainties about 15-20%, and even less (<10%) in absence of flow reversal. Similar performances are also obtained for conical mono-fiber optical probes when measuring the Sauter mean vertical diameter of bubbles.

1. Context and objectives

Bubbly flows are widely used in industry, in particular in chemical and bio-chemical engineering,