Experimental Investigation On Rising Bubbles With/Without Liquid Crossflow

Yang Xu[1]†, Hangbin Wang[1], Jinjun Wang

[1]Fluid Mechanics Key Laboratory of Education Ministry, Beihang University, Beijing, 100191, Chian

†Email address for correspondence: xuyang@buaa.edu.cn

Abstract

Bubble flow has attracted significant attention from both industry and academia. In this talk, we will present some experimental studies on rising bubbles both with and without liquid crossflow. In the experiments without crossflow, we used both planar PIV and Tomographic PIV to quantitatively acquire the bubble morphology and induced flow fields. Both the effects of gas flow rate (GFR) and orifice spacing on rising bubbles have been investigated and discussed, with special attention paid on the mechanism of path instability of rising bubble. It was found that the bubble-induced wake shedding plays a key role in triggering the path instability. In addition, the bubble deflection direction caused by the path instability is closely related to the sequence of wake vortices shedding: bubbles turn left with a clockwise vortex shedding first and right with a counterclockwise one. The study on bubble pairs inducated that the way bubbles interact with the flow depends on whether bubble pairs are coupled. When coupled, the primary influence on the flow is from bubble-to-bubble interactions, whereas when the bubbles move independently, the primary influence comes from bubble deformation. In experiments with crossflow, we found that an increase in GFR results in a larger bubble diameter and faster rising speed. Conversely, an increase in crossflow velocity causes bubbles to detach earlier from the orifice, leading to a reduced bubble diameter and slower rising speed. A theoretical model based on dynamic force equilibrium had been developed to explain these experimental observation. It is believed that our findings could provide some foundational references for modeling two-phase flows and also provide some guidance for the practical application of bubbles.

Keywords: Bubble/bubbly flow; 3D flow measurements; PIV/Tomo-PIV; Crossflow

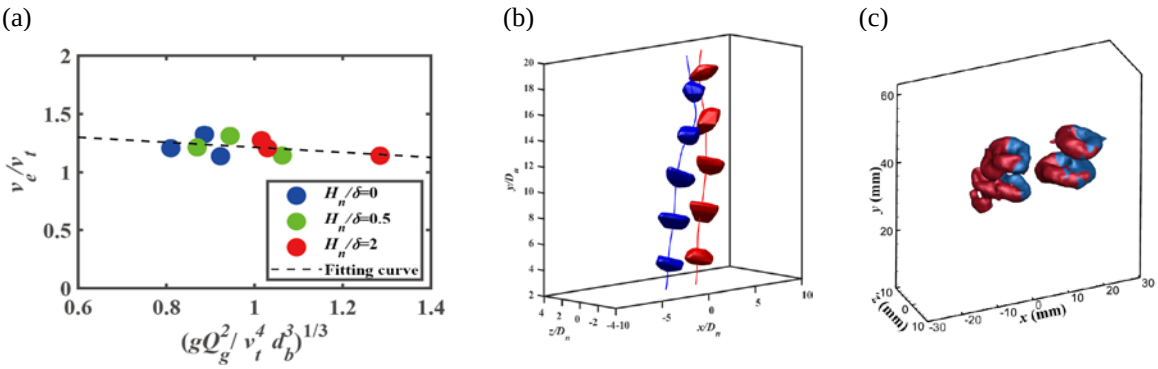

Figure 1. (a) Bubble terminal velocity model considering the bubble wake correction; (b) bubble pairs rising trajectory and (c) induced vortical structures.

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