Bubble Clustering and Turbulent Modulation in Upward Bubbly Channel Flow

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Abstract

The behavior of single bubbles and bubble clusters is significantly altered by the presence of small amounts of surfactant. First, surfactants suppress bubble coalescence, thereby maintaining a monodisperse bubble size distribution. It is also well-known that a bubble in an aqueous surfactant solution rises much more slowly than one in purified water. This phenomenon is attributed to the so-called Marangoni effect, which arises from a nonuniform surfactant concentration distribution along the bubble surface. More interestingly, the Marangoni effect also affects lateral migration in the presence of mean shear. These phenomena influence the multiscale characteristics of bubbly flows and lead to significant changes in large-scale bubbly flow structures[1].

In this talk, we discuss bubble clustering phenomenon in upward bubbly channel flows, with a focus on detailed descriptions of single bubble behavior and bubble-bubble interactions[2]. Direct numerical simulations and PIV measurements were performed to elucidate the spatiotemporal evolution of flow structures. The results reveal that large-scale turbulent vortical structures are suppressed by inhibiting the growth of small vortical structures near the wall, where quasi-two-dimensional bubble clusters pass through. In addition to the above-mentioned phenomena, we have also begun investigating a similar bubble clustering phenomenon that occurs near an inclined wall, which was originally studied experimentally by Ogasawara and Takahira [3]. Some of the recent results of direct numerical simulations using VOF methods for bubble clustering near the inclined wall will be also presented.

References

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