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PROCEEDINGS

Bubble Dynamics Within a Droplet: A New Mechanism for Mixing in Binary Immiscible Fluid Systems

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ABSTRACT

This study investigates the interactions between droplets and bubbles within water-in-oil (O/W) and oil-in-water (W/O) systems, a fundamental problem of bubble dynamics in binary immiscible fluid systems. Considering the density ratio between the two fluids and the bubble-to-droplet size ratio, we have refined the classical spherical bubble pulsation equation, Rayleigh collapse time, and the natural frequency. In our experimental study, we found that the Rayleigh-Taylor (RT) instability hardly develops on the surface of the droplet when the densities of the two liquids are comparable. This phenomenon is explained using the classic theory of spherical RT instability coupled with our bubble dynamic model. Therefore, the most probable mechanism of fluid mixing in this system is the impact of the bubble jet on the droplet surface. Finally, we have carried out hundreds of boundary integral simulations to reveal the dependence of the non-spherical bubble dynamics, particularly the jet characteristics, and the associated droplet evolution on governing parameters such as eccentricity/dimensionless standoff parameter, density ratio/Atwood number, bubble-to-droplet size ratio, etc.

KEYWORDS

Bubble dynamics; cavitation; multiphase flow

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