**Jetting and subsequent vortex flow induced by the second oscillation of a cavitation bubble between a rigid wall and a free surface**

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Vortex flows induced by jetting of an oscillating bubble cause high shear rates near the boundaries and have important engineering applications. Compared with that near a single rigid wall, we observe that no second jet forms during the recollapse of the bubbe and a wall vortex spreading along the wall occurs instead of a free vortex migrating upward at a smaller value of stand-off distance to the wall 𝛾𝑤. A theoretical model is developed based on the theory of image for describing the radial motion 𝑅 and translational motion ℎ of the bubble near the boundaries. The free vortex occurs at the translational velocity ℎ(𝑡𝑐) < 0 while ℎ (𝑡𝑐) > 0 for wall vortex at the time end of first collapse 𝑡𝑐. The wall vortex type A and type B are, which are characterized by a downward second jet and no jet, respectively, obtained at ℎ(𝑡𝑐) > 𝑅(𝑡𝑐) and ℎ(𝑡𝑐) < 𝑅(𝑡𝑐), respectively. A phase diagram of vortex flows is obtained by solving the theoretical model and is verified by the experimental results. As a result, the water surface expands the regime of wall vortex. By analyzing the spatio-temporal wall shear stress, the collapse of the bubble at a smaller 𝛾𝑤 can be used for surface cleaning and drug delivery.

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