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Numerical Study of Cavitation Bubble Collapse under Various Conditions

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Extended Abstract

Cavitation bubble plays an important role in applications in diverse fields of science and technology such as naval structure engineering, biosciences, and biomedical technology. The cavitation bubble collapses violently, and in different conditions, the collapse of the cavitation bubble produces high-speed jets of liquid bubbles moving in different directions [1, 2]. This in turn generates high local energy and high-pressure waves and high temperature [3, 4]. Multiple events of cavitation bubble collapse that produce high pressure over time can cause detrimental effects on the mechanical components. This in turn generates high local energy and impacts the surface with high-pressure waves that can erode the metals [5]. Conversely, this energy was observed as useful for the hydrodynamic cavitation process in cleaning technology or in industrial applications such as wastewater treatment and biofuel production [6]. Bubble collapse leads to the re-entrant jet formation, concentrated pressures, shear, and lift forces on the dirt particle or biomass, and high impulsive loads on a layer of materials. In the other approaches, cavitation bubbles can be intentionally generated by using acoustic waves or laser technologies to take advantage of local high-energy and microjets for application to biosciences, and biomedical technology such as needle-free injection devices, tissue engineering, and lithotripsy [7].

In this study, we numerically simulate the cavity bubble expansion and its spherical and non-spherical collapse under various conditions. We shall compare different numerical models for this problem with the advantages and disadvantages of each model. We shall discuss the bubble dynamics as well as the high-speed jet, the presence of a shock wave, drastically varying pressure, and temperature fields which are induced during the bubble expansion and collapse of the bubble in different conditions such as near a wall and/or free surface, and under shear flows.

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