Contribution ID: **697** Type: **Poster Presentation**

C2Po1F-03 [33]: Effect of Solid Surface in Vicinity of Multi-bubble Array in Cryogenic Environment

Tuesday, 23 July 2019 09:00 (2 hours)

Multiple bubble interaction in initially quiescent liquid, under certain conditions, is accompanied by the generation of jets, shockwaves, and light. At cryogenic temperature (< 123 K) when certain materials become brittle, such afore-mentioned physical effects can be effective in disintegrating them to smaller fragments under controlled erosion. The spatial and temporal-scales of such bubble-interaction being very small, it is very difficult to examine the flow-physics experimentally. But, CFD techniques based on Direct numerical simulations can help to precisely understand this phenomenon that may benefit nanotechnology-based industries and industries working with air-gun arrays.

In this paper, multiple bubble-pairs are simulated in a co-centric manner such that high-speed jets are triggered from each such pair towards a central location. A solid target (5 mm radius) is also modeled at that location and its effect on the impact velocity and pressure shockwaves are recorded in cryogenic fluid combination. VOF method is used for the numerical simulations in a compressible domain by neglecting the effect of phase change and gravity. The stand-off distance between the solid target and bubble-pairs are varied systematically as well as the number of bubble-pairs to an extent.

The numerical results are validated against suitable literature and the erosive effects are identified from the temporal development of the bubble interaction. This includes shockwave due to initial bubble expansion, impulsive hammering by high-speed jet followed immediately by pronounced lateral shear. Initial calculations suggest that jet speed gets effectively enhanced by placing a solid surface in the vicinity of multi-bubble array compared to the case where the target is absent.

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Session Classification: C2Po1F - Heat Transfer