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Numerical Simulation of Cavitation Bubble Dynamics in a Rankine Vortex PRANAV MOHAN, SADEGH DABIRI, Purdue University — High circulation velocity in a vortex can suppress the pressure at the core causing any nucleation site to cavitate. This cavitation bubble grows in a cylindrical shape and collapses very violently. Compressible Navier-Stokes equations are numerically solved in three dimensions to capture the cylindrical gas bubble dynamics in a Rankine vortex in water and the re-entrant jets formed during the final stage of the collapse. The bubble dynamics and the vortex flow fields are strongly coupled. The effects of nucleation sites, Reynolds number, vortex core size and cavitation number are thoroughly examined. We found that the size of the nucleation site does not play a role in growth dynamics. A combination of other initial conditions lead to an elongation of a single bubble into multiple inter-connected cylindrical bubbles aligned along the vortex core, as observed in experiments. Some turbulent structures can also be found inside the bubble. At the final stage, the bubbles collapse towards the center to generate re-entrant jets with velocity magnitude of several thousand meters per second. Such a strong collapse fragments the bubble and causes severe damage to the materials in the vicinity of the vortex or the bubble.

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