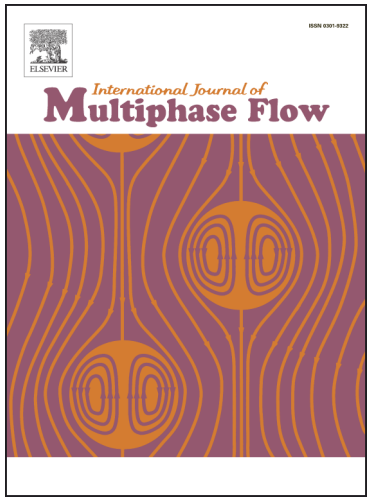

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Large Eddy Simulation and theoretical investigations of the transient cavitating vortical flow structure around a NACA66 hydrofoil

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Abstract: Compared to non-cavitating flow, cavitating flow is much complex owing to the numerical difficulties caused by cavity generation and collapse. In this paper, the cavitating flow around a NACA66 hydrofoil is studied numerically with particular emphasis on understanding the cavitation structures and the shedding dynamics. Large Eddy Simulation (LES) was coupled with a homogeneous cavitation model to calculate the pressure, velocity, vapor volume fraction and vorticity around the hydrofoil. The predicted cavitation shedding dynamics behavior, including the cavity growth, break-off and collapse downstream, agrees fairly well with experiment. Some fundamental issues such as the transition of a cavitating flow structure from 2D to 3D associated with cavitation-vortex interaction are discussed using the vorticity transport equation for variable density flow. A simplified one-dimensional model for the present configuration is adopted and calibrated against the LES results to better clarify the physical mechanism for the cavitation induced pressure fluctuations. The results verify the relationship between pressure fluctuations and the cavity shedding process (e.g. the variations of the flow rate and cavity volume) and demonstrate that the cavity volume acceleration is the main source of the pressure fluctuations around the cavitating hydrofoil. This research provides a better understanding of the mechanism driving the cavitation excited pressure pulsations, which will facilitate development of engineering designs to control these vibrations.

Keyword: Sheet/cloud cavitation, Large Eddy Simulation (LES), Vortex structures, Vorticity transport equation, One-dimensional model, Cavity volume acceleration

1 Introduction

Owing to it's importance in a wide range of fundamental studies and engineering applications, much effort has been made in the past decades to study cavitation shedding dynamics. Sheet cavitation shedding often leads to cloud cavitation, which strongly affects hydrodynamic performance and produces vibration, noise and cavitation erosion. Comprehensive reviews on this

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