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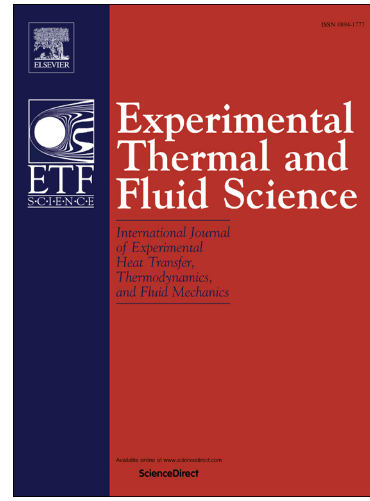

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Abstract. The development and collapse of cloud cavitation and its link to surface erosion within a transparent test single-orifice nozzle operating with a closed Diesel fuel hydraulic circuit, has been characterized using high-speed imaging. Data have been obtained for a range of cavitation and Reynolds numbers under fixed lift positions. Post processing of a large number of images acquired with short exposure time (1μs) allowed the elucidation of the distinct flow phenomena associated with the highly transient two-phase flow. At the inlet of the flow orifice, the vapour cloud was found to occupy the largest part of the nozzle hole cross-section. Coherent vortical structures of a hairpin shape have been detected to onset at the closure region of this vapour cloud and shed downstream in a fully transient manner. The effect of the operating parameters on the temporal and spatial characteristics with regards to the emergence and collapse of the hairpin vortices has been quantified. It has been established that the cavitation-vortex shedding was taking place in a periodical manner, characterized by a Strouhal number.

Keywords: cloud cavitation, injector flow, high-speed imaging, vapour collapse, erosion

1. INTRODUCTION

Cavitation occurs in a wide range of engineering applications such as marine propellers and rudders, bearings, fuel injectors, pumps and turbines; it is often associated with undesired consequences such as vibration, increased hydrodynamic drag, noise and erosion of solid surfaces. Cavitating flows are unsteady in nature with their distinct flow features exhibiting highly varying spatial topology and short time scales.

Under certain flow conditions, cavitation is possible to exhibit a periodic behavior characterized by the shedding of coherent vortical structures. Vortex shedding has been extensively investigated in non-cavitating flows (see selectively the work of Griffin [1]), as it could lead to flow-induced alterations in the thermal and structural behavior of devices, e.g. heat transfer enhancement, oscillations etc. The influence of the presence of vapour bubbles on the mechanism that induces shedding of coherent vortices has been investigated by a number of researchers [2–4]. Cavitation vortex shedding has been primarily investigated until now in numerous studies relevant to hydrofoil configurations (e.g. propellers, hydrofoils or turbomachinery blades); see selectively the work of Arndt [5] among many other.

A significant number of both experimental-visualization and numerical studies, employing either RANS simulations or LES [2,3,6–15], focus on the interaction of the attached cavitation pocket developing at the leading edge of various hydrofoil shapes (for example twisted [14], elliptical [15] etc) with vortex motion, for different values of the angle of attack and the cavitation index. Huang et al. [12] characterized the prevailing mechanism and described the various phases of cloud cavitation development and vortex shedding taking place at the trailing edge of a benchmark hydrofoil. The coherent vortices that emerge at the