Estimating the degradation ratio caused by attached cavitation on NACA0009 hydrofoil

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Abstract. This paper focuses on the development of such a procedure to estimate the cavitation degradation. The first step in the development of this procedure includes the numerical simulation. The determination of the attached cavity length in a two-phase cavitating flow over a NACA0009 hydrofoil for α= 2.5° and σ=0.892, 0.81, 0.723 using two cavitation models (Zwart–Gerber–Belamri and Schnerr–Sauer models) is performed. Sensitivity analysis of cavitation models and turbulence quantities selected as inflow boundary conditions are conducted to determine the influence on cavity length. The second step in the development of this procedure estimates the risk degradation corresponding to the attached cavitation for each case relative to a reference one defined by Gülich. The length of the cavity and the mechanical properties of the material are input data for the Gülich model. The degradation ratio associated with attached cavitation over NACA0009 hydrofoil at α=2.5° for three cavitation numbers and two materials (e.g., carbon steel, stainless steel) are estimated.

1. Introduction

Cavitation and its effects on the hydraulic machinery is still a major concern for both designing and operation. Both the hydrodynamic phenomena associated with cavitation and its effects are challenging issues in the design, operation and maintenance of hydraulic machines even today. Several research has been dedicated both hydrodynamic phenomena and cavitation degradation aspects [1-4].

The aim of the study is to develop a methodology to estimate the cavitation degradation generated by attached cavitating flow over a truncated NACA 0009 hydrofoil. In this case, the cavitation degradation is quantified by the pit length estimated based on a degradation model (e.g. Gülich's model [5]). This methodology includes two parts: (1) two-phase flow numerical simulation to predict the length of the cavity attached to the hydrofoil and (2) estimation of the cavitation degradation ratio generated by the attached cavity using Gülich's model.

This methodology is applied to predict the cavitation degradation ratio induced by the attached cavity over a truncated NACA0009 hydrofoil. Both numerical setup (computational domain, boundary conditions, cavitation models and so on) and numerical results obtained using two-phase flow numerical simulations over a NACA009 hydrofoil are given in Section 2. A sensitivity study of the cavitation models (e.g. Zwart – Gerber - Belamri model (ZGB) [6] and Schnerr-Sauer model (SS) [7]) and the turbulent quantities (e.g. turbulent intensity and turbulent length) on the attached cavity length are