

# Steady-state cavitation modeling in an open source framework

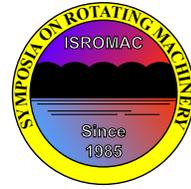
## Theory and applied cases

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**Long Abstract**

## Introduction

Besides the fact that cavitation is most often an unsteady phenomenon [1, 2] it is necessary to have a robust and reliable software able to represent the steady state flow patterns. Especially in the early design state it is mandatory to be able to predict the occurrence of cavitation without time consuming transient computations.

The authors will therefore give a short summary of the theory behind different cavitation models and their implementation into an in-house modified version of OpenFOAM®.

The main focus of the paper will then point out the integration of mixture type cavitation models into a pressure correction based steady-state solver. Different strategies have been tested and a stable formulation was found.

## 1. Methods

The used solver is an in-house, 3D, unstructured, object-oriented finite volume code. It is implemented into the framework of OpenFOAM® [3, 4] and designed to solve steady-state compressible and incompressible RANS-Equations [5]. The pressure-based solver uses a SIMPLE-C like algorithm with special treatment of the pressure correction [6] and is capable of handling multiple references of frame (MRF). Full second order upwind scheme for convection discretization has been used for all computations. An overview of the code capabilities and developments is given in [7].

The following four mixture type cavitation models have been integrated:

- Kunz et al. [8]
- Park, Ha, Merkle [9, 10]
- Yuan, Weixing, Sauer, Schnerr [11, 12]
- Zwart, Gerber and Belamri [13]

Turbulence model modifications as suggested by Schnerr [14] have been tested and compared. Results will be presented

The major challenge was the stability issues of numerical implementations found in literature. While transient solutions can be achieved, prediction of steady-state phenomena is impossible. A stable formulation of the phase change contribution to the pressure correction equation was then found by a linearization and implicit integration.

Validation against measurement data and commercial code was carried out based on the following testcases. Profound validation results will be presented.

- Dupont, Naca0009 [15, 16]
- Nurick [17]
- Rouse and McKnown [18, 16]

After the validation campaign, the code was then used in industrial applications.

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