RANS modelling of a turbulent cavitating flow around a cylindrical bluff body

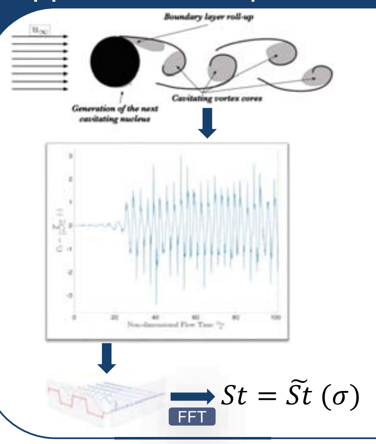
Introduction

The present work tackles the modelling of a turbulent cavitating flow around a cylinder at supercritical Reynolds conditions. Vortices filled with vapour cavities are shed off the body and their frequency computed and validated against experimental observations. A modification to the definition of the turbulent viscosity has been applied to take into account of the presence of the two phases, liquid water and water vapour.

Scope of the work

Investigations of cavitating flows commonly focus about streamlined bodies. Aim of this work is to propose a valid RANS methodology to analyse the cavity dynamics around a bluff geometry. The necessity of 3D simulations and the dependence of the solution on the grid are investigated.

Approach to the problem

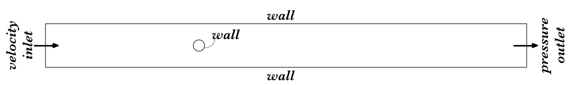


$St = \widetilde{St}\,(\sigma)$

Models:	Multiphase	Cavitation	Turbulence*
	Mixture (HEM)	Zwart-Gerber-Belrami	$k-\omega\ SST$ *Modified μ_t:

$$\mu_t = f(\rho) C_\mu \frac{k}{\omega} \qquad f(\rho) = \rho_v + \left(\frac{\rho_m - \rho_v}{\rho_l - \rho_v}\right)^n (\rho_l - \rho_v)$$

Numerical Methods:	Mom., k, ω, α eq.s	Temporal discretisation	Δt
Coupled solver	Q.U.I.C.K.	2nd order	$2 \cdot 10^{-4}$ s

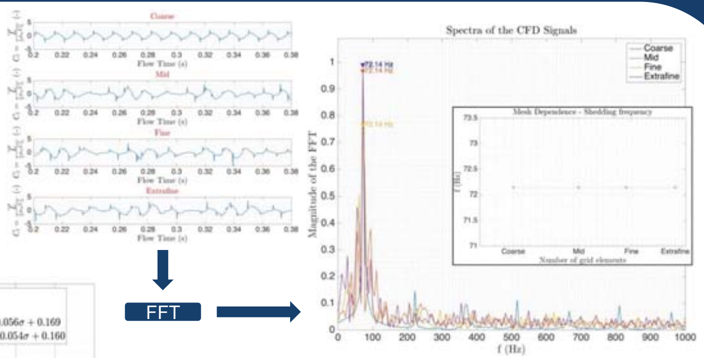


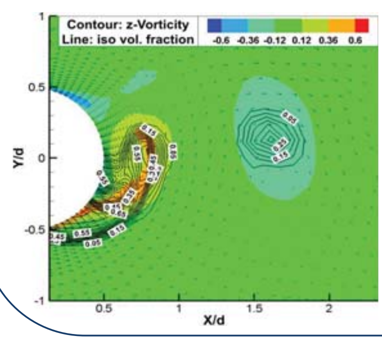
Grid:	#Cells $\cdot 10^3$	Av. Orth. Qual.
2D	40-157	0.99
3D	1,745	0.88

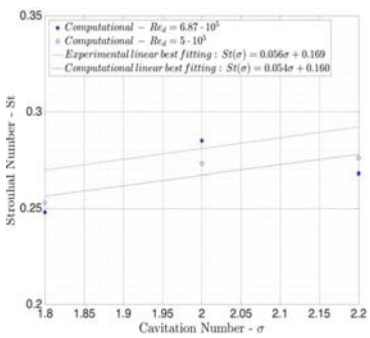
Conclusions

1. The 2D analysis shows that the shedding frequency is mesh independent: the cheapest and fastest approach can be used.

2. The periodic shedding of vapour cavities is accurately predicted with the proposed methodology.







3. Vorticity appears to be necessary to sustain the vapour cavities: *vortex cavitation.*

4. 3D geometry is necessary to capture the correct cavity dynamics.

Pre-processing: Ansys DM, Meshing.
Solver: Ansys Fluent.
Post-processing: Tecplot, Matlab environment.

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