11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

# A COMPARISON OF PANEL METHOD AND RANS CALCULATIONS FOR A HORIZONTAL AXIS MARINE CURRENT TURBINE

**João M. Baltazar[1*] and José A. Falcão de Campos[2]**

[1] Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1 1049-001 Lisboa, Portugal, joao.baltazar@ist.utl.pt and http://fenix.ist.utl.pt/departamentos/dem/
[2] Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1 1049-001 Lisboa, Portugal, falcao.campos@ist.utl.pt and https://fenix.ist.utl.pt/departamentos/dem/

**Key words:** *Marine Current Turbine, Panel Method, RANS.*

In this paper, a comparison between the results of a panel method and a RANS (Reynolds-Averaged Navier-Stokes) solver is made for a horizontal axis marine current turbine in straight inflow conditions.

The panel method calculations were made with the panel code PROPAN for a surface grid with 8 thousand panels, Fig.1-(right). PROPAN is a IST (Instituto Superior Técnico) in-house panel code which implements a low-order potential-based panel method for the calculation of the incompressible potential flow around marine current turbines. This method has been used in the hydrodynamic analysis of marine current turbines in steady and unsteady inflow conditions and for the prediction of sheet cavitation on the turbine blades [1].

The RANS calculations were carried out with the RANS code ReFRESCO for a grid with 19 million cells, Fig.2-(left). ReFRESCO is a MARIN (Maritime Research Institute Netherlands) in-house viscous flow CFD code [2]. It solves the multiphase unsteady incompressible RANS equations, complemented with turbulence models and volume fraction transport equations for different phases. The equations are discretised using a finite-volume approach with cell-centered collocation variables. The code is targeted and optimised for hydrodynamic applications. For the calculations presented in this paper, the flow is considered turbulent, where a $\kappa - \omega$ SST model is used. A higher-order convection scheme (QUICK) is used for the momentum equations.

The purpose of the present work is to make a comparison between results of the panel code PROPAN and results of the RANS code ReFRESCO in order to obtain a better insight on the viscous effects of a marine current turbine and on the limitations of the inviscid flow model. The comparison is carried out for a marine current turbine in uniform inflow

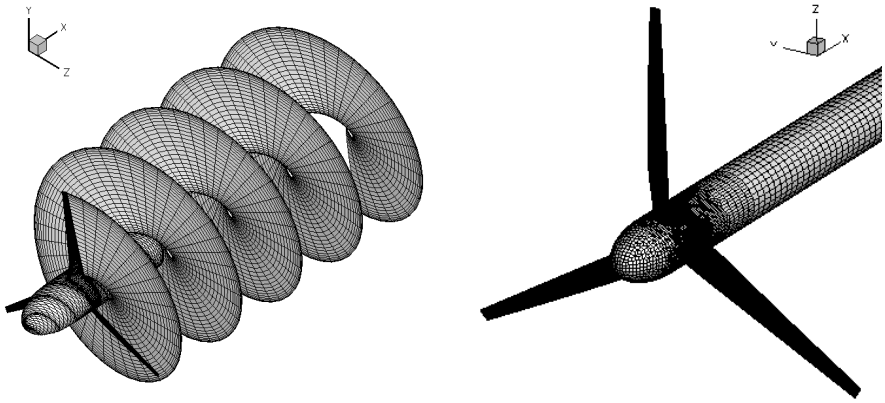

Figure 1: Overview of the surface grids used for the inviscid calculations with PROPAN (left) and RANS calculations with ReFRESCO (right).

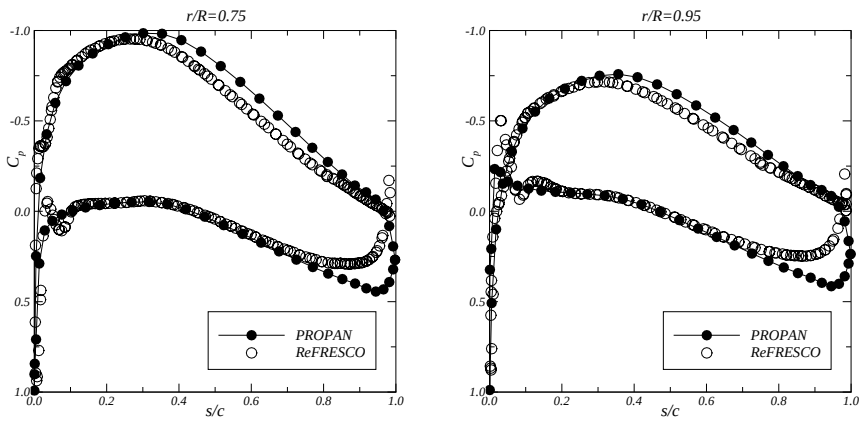


Figure 2: Blade pressure distribution at the radial sections 0.75 (left) and 0.95 (right). Comparison between PROPAN and ReFRESCO for $TSR = 5.15$.

conditions in steady flow. The RANS calculations were carried out at IST following the computations done by Otto et al., [2]. A comparison of the blade pressure distribution, blade circulation, wake geometry and axial force and power coefficients is made. Figure 2 illustrates the comparison of the pressure distribution on the blade for $TSR = 5.15$. In general a good agreement is obtained for the blade pressure distributions. The force coefficients are also compared with experimental data available from towing tank tests in a wide range of tip-speed-ratios (TSR).

## REFERENCES

[1] J. Baltazar, J.A.C. Falcão de Campos. Prediction of sheet cavitation on marine current turbines with a boundary element method. In Proceedings of the ASME 2012 31st International Conference on Ocean, Offshore and Arctic Engineering, 2012, Rio de Janeiro, Brazil.

[2] W. Otto, D. Rijpkema, G. Vaz. Viscous-flow calculations on an axial marine current turbine. In Proceedings of the ASME 2012 31st International Conference on Ocean, Offshore and Arctic Engineering, 2012, Rio de Janeiro, Brazil.