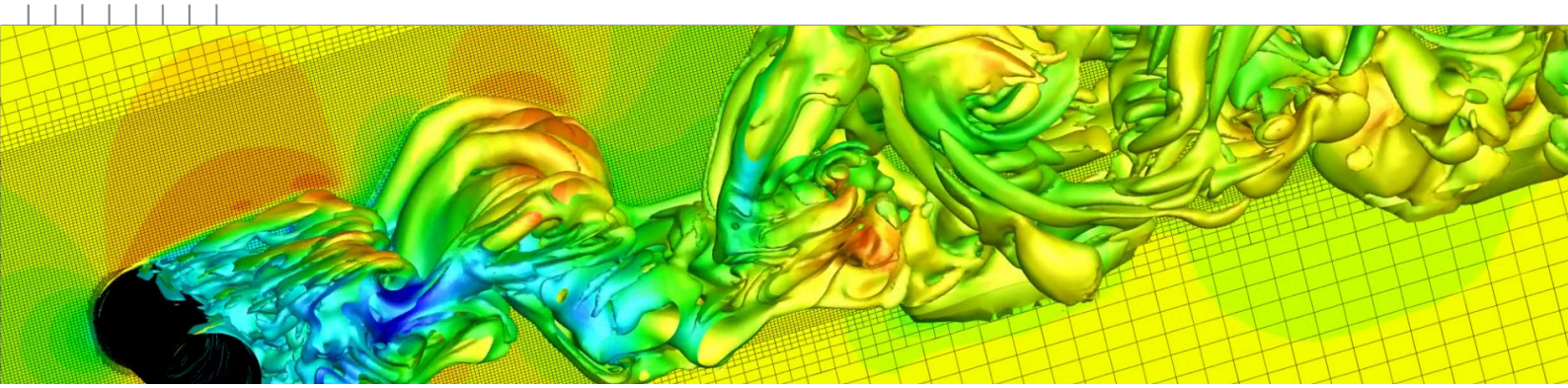
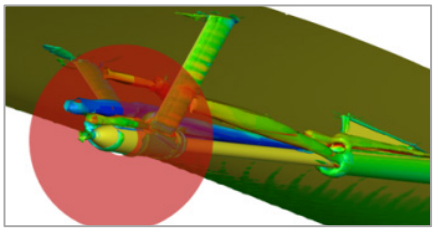


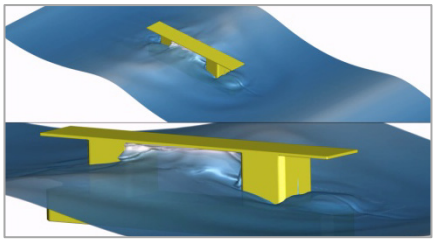
ReFRESCO

A community-based open-usage and open-source CFD code for the Maritime World

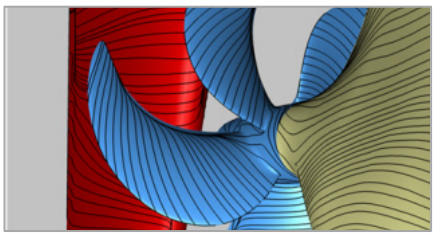
The CFD code ReFRESCO has been under development since 2005. It is based on state-of-the-art numerical algorithms and software features, and on the long-standing experience of MARIN in CFD. ReFRESCO stands for Reliable&Fast Rans Equations (code for) Ships (and) Constructions Offshore. In several respects it resembles a general-purpose CFD commercial code, although it has been verified, validated and optimised specifically for numerous maritime industry applications.



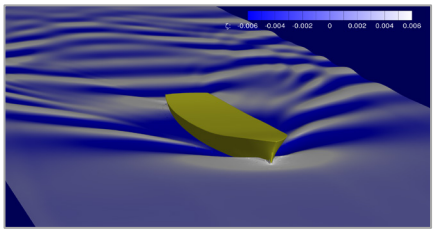
Fully-appended ships



Impacts



Cavitation



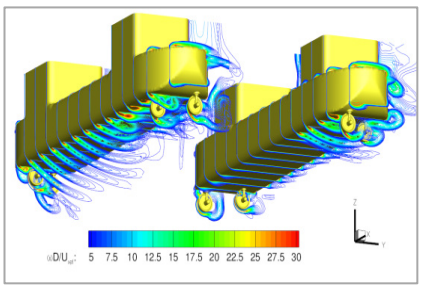
Free surface & waves

Computational method

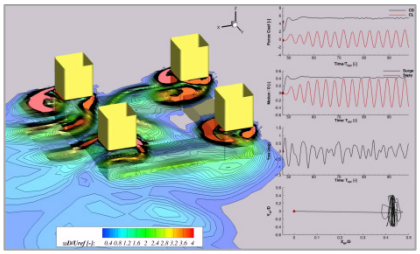
ReFRESCO is a viscous-flow CFD code that solves multiphase (unsteady) flows using the incompressible Navier-Stokes equations, complemented with turbulence and cavitation models [1]. The equations are discretised using a finite-volume approach and in strong-conservation form. A pressure-correction equation based on the SIMPLE algorithm is used to ensure mass conservation [2]. At each implicit time step, the non-linear system for velocity and pressure is linearised using Picard's method. A segregated or coupled approach may be used. The code is parallelised using MPI and runs in Linux workstations and HPC clusters.

CFD features

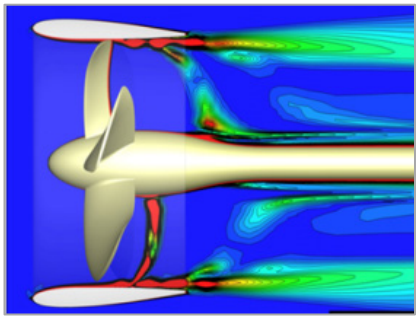
Due to specific numerical schemes, ReFRESCO can deal robustly with low up to high (full-scale) Reynolds numbers, permitting the accurate estimation of scale effects. The face-based implementation permits the handling of grids from several different grid-generation packages. State-of-the-art CFD features such as moving, sliding and deforming grids, as well automatic grid adaptation (refinement and/or coarsening) are also available. Both 6DOF rigid-body, and flexible-body (fluid-structure interaction) simulations, can be performed. For turbulence modelling, both traditional RANS and Scale-Resolving Simulations (SRS) models such as SAS/DDES/IDDES/XLES, PANS and LES can be used. Noise predictions can be made using an acoustic analogy module. Couplings with propeller models (RANS-BEM coupling), fast-time simulation tools (XMF) and wave generation potential flow codes (OceanWave3D, SWASH) are implemented.



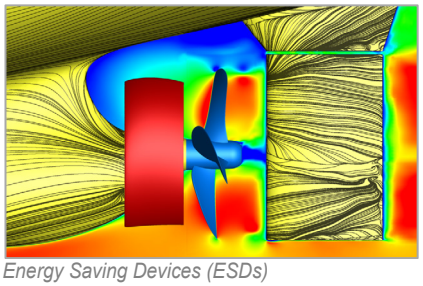
Current loads



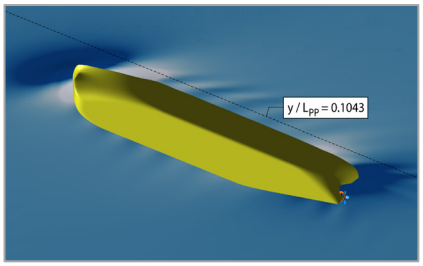
VIV & VIM



Propellers



Energy Saving Devices (ESDs)



Propulsion

For more information
please visit www.refresco.org,
the ReFRESCO YouTube channel or
contact the MARIN CFD group;
T + 31 317 49 39 11
E refresco@marin.nl

Development and Applications

ReFRESCO is currently being developed, verified and validated at MARIN in collaboration with several other worldwide non-profit organisations (universities and research institutes). Modern verification & validation (V&V) techniques and tools are used in the development and application of ReFRESCO. ReFRESCO has been applied, verified and validated for the following range of applications:

- Resistance and propulsion of fully-appended ship hull forms;
- Submarines, including manoeuvres and geometry optimisation;
- Propeller and complex propulsor flows, including cavitation;
- Energy-saving devices;
- Marine current and floating wind turbines.
- Current and wind loads on offshore structures;
- VIV and VIM of offshore structures and renewable energy devices;
- Thruster-hull and thruster-thruster interaction problems;
- Free-surface flows, wave loads and wave impacts;
- Seakeeping problems such as motions and loads of free-floating structures.

ReFRESCO-Operation and ReFRESCO-ReSearch

Two types of partnership are available to companies and institutes wishing to use ReFRESCO. The ReFRESCO-ReSearch partnership focuses on sharing the code for collaborative research, without any fees but common open development, testing, verification and validation. Tight quality control is enforced by MARIN and there is only one ReFRESCO source repository for all partners. ReFRESCO-Operation extends the ReFRESCO-ReSearch partnership by allowing commercial application of ReFRESCO (a membership fee is required). In addition, the user gains access to ReFRESCO support services, as well as MARIN's CFD best practice guidelines.

Bibliography

[1] Vaz, G., Jaouen, F. and Hoekstra, M.; "Free-Surface Viscous Flow Computations. Validation of URANS code FreSCo", OMAE2009, Hawaii, Honolulu, USA. 2009.

[2] Klaij, C. M., and Vuik, C.; "Simple-type Preconditioners for Cell-centered, Colocated Finite Volume Discretization of Incompressible Reynolds-averaged Navier-stokes Equations", International Journal for Numerical Methods in Fluids, 71(7), pp. 830–849. 2013.