HYDRODYNAMIC SERVICES

SHIP & PROPULSION PERFORMANCE SIMULATIONS

- Hull resistance and nominal wake
- Propulsion in a seaway
- Propeller or thruster open water
- Self-propulsion and speed prognosis
- Propulsion and hull integration
- Optimization of propulsion systems
- Analysis of power consumption
- Cavitation and pressure pulse predictions
- Waterjet propulsion

KONGSBERG ENGINEERING SERVICES

Ship & Propulsion performance simulations

CFD simulations is an important part of the hydrodynamic capabilities at KONGSBERG supporting both internal and external customers.
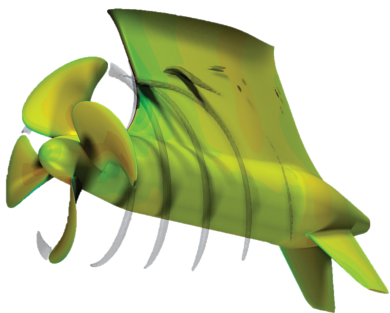
KONGSBERG's High-Performance Computer Clusters (HPCC's) allow simulations of propulsion systems and ships to be conducted in a short time frame. Simulations are performed using methods in model- and full-scale built on research and validations. The unique capability of KONGSBERG to combine in-house experimental testing and numerical simulations build confidence in CFD models used for design and optimization.

CFD simulations for analysis and optimizations are today part of the design tools available to designers at KONGSBERG.

Simulations in an iterative design process helps to minimize hull resistance and improve system performance of the vessel.
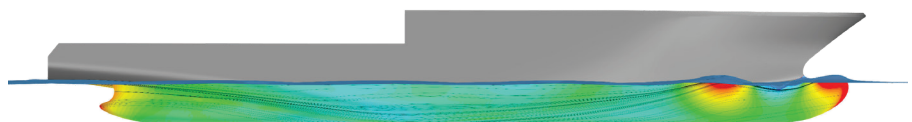
Integration of propulsion and hull is key to improve interaction effects and obtaining low fuel consumption and high comfort level. The design process strives for finding the optimal balance between propulsive efficiency and cavitation nuisance, noise and vibration levels.

These simulation capabilities are available also for our customers, as a hydrodynamic service, to support design and optimization.

Hull resistance and nominal wake

Bare hull simulation with the hull (and appendage) geometry but without propeller(s). Prediction of hull resistance (P_E) at certain ship speeds and drafts for hull lines optimisation as well as the nominal wake field for optimisation of propeller inflow and input to propeller design.

The method calculates the free water surface and wave resistance using 2-phase flow, steady state RANS and SST-kΩ turbulence model.
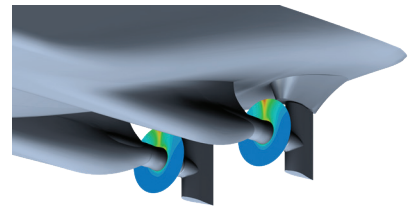

Hull resistance and nominal wake

Propulsion in a Seaway

The ocean environment tends to reduce the speed and increase the propulsion power on a ship. Kongsberg Maritime are researching the effect of added hull resistance and propulsive effects from waves and other environmental forces based on model tests, full scale measurements and computational modelling.

Prediction tools are continuously developed and improved to take the influence of waves on power-speed predictions into account and when estimating the corresponding propulsion related energy consumption.
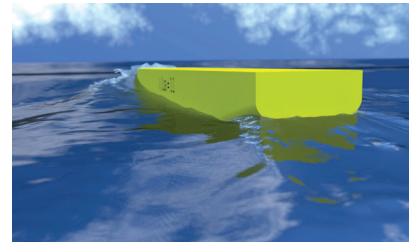

Propulsion in a Seaway

Propeller or thruster unit open water

Simulation of propeller or thruster unit performance in undisturbed inflow over a range of advance velocities (J) and shaft speed combinations, at one or several pitch (P/D) settings.

Prediction of propeller open water characteristics (K_T, K_Q, η_0) for propeller design performance prediction and optimisation.

Fully viscous RANS method using SST-kΩ turbulence model and a hybrid mesh technology with wall function. Y+ values at full-scale of 30-60 and at model-scale of approx. 1 to ensure adequate near wall treatment.
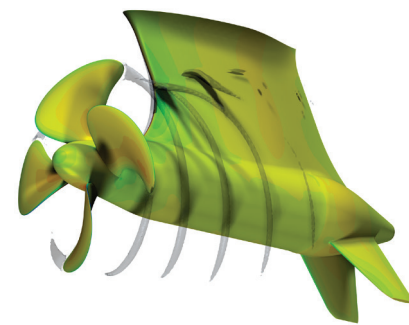
Propeller or thruster unit open water
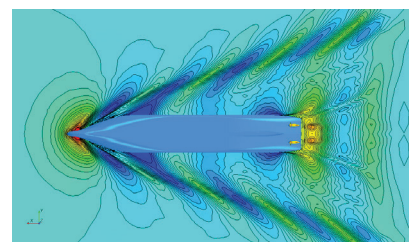
Self-propulsion simulations

Self-propulsion simulations using virtual propeller model or sliding mesh technique with the real propeller geometry represented. Iterative rpm adjustment to balance propeller thrust and hull resistance.

Prediction of delivered power to the propeller (P_D), propeller shaft speed (n) and propulsor-hull interaction coefficients (W_T, t, η_R).

The hull is free to move in trim and sinkage and the method calculates the free surface and wave resistance using 2-phase (water and air) flow, transient RANS and SST-kΩ turbulence model.

The simulation can be done with fixed trim and sinkage and without surface waves for quicker relative comparisons.

As an alternative; analysis and prediction of power consumption and propeller shaft speed can be based on bare hull resistance, empirically determined propulsive coefficients (wT, t, η_R) and open water characteristics from the large database of model tested propellers/thrusters at Kongsberg Hydrodynamic Research Centre.
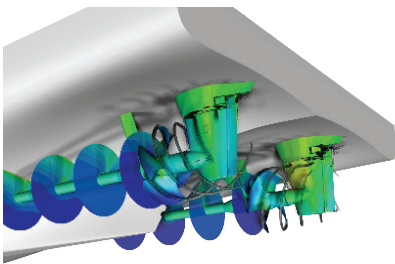

Self-propulsion simulations
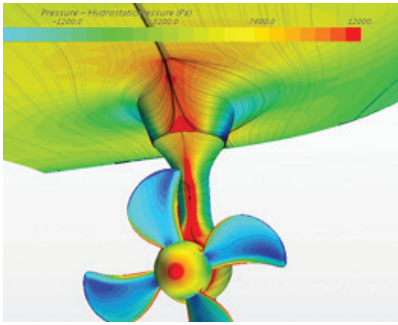
Propulsion and hull integration

Propulsion and hull integration

The integration of propulsion and hull is crucial for obtaining high efficiency, reducing pressure pulses and improving interaction effects. CFD can be used efficiently in propeller/hull integration to optimize performance. Examples of KONGSBERG capabilities are:

- Bare hull or self-propulsion simulations using virtual propeller model or sliding mesh technique to predict propeller/hull interaction effects and optimise propulsive system performance.
- Evaluation and/or optimisation of headbox and appendage designs.
- Analysis and optimisation of propeller rotational direction, neutral rudder angles (toe in/out) or thruster orientation (tilt and toe in/out).
- Thruster-thruster interaction and/or thruster-hull interaction (nozzle tilt).
- Optimize tunnel thruster installation, tunnel inlet shape, positioning of tunnel thrusters and effect of tunnel grids.
- Identify propeller slipstream interaction with appendices.
- Static/dynamical loads for structural analyses.

Optimization of propulsion systems

Optimization of propulsion systems

Self-propulsion simulations used for prediction of delivered power to the propeller (P_D), propeller shaft speed (n) and propulsor-hull interaction coefficients (W_T, t, η_R). The hull is free to move in trim and sinkage and the method calculates the free surface and wave resistance using 2-phase (water and air) flow, transient RANS and SST-kΩ turbulence model. The simulation can be done with fixed trim and sinkage and without hull waves for quicker relative comparisons.

Through an automated simulation setup, different design alternatives can quickly be relatively compared for:

- Comparison of different propulsion systems.
- Optimisation of propeller rotational direction, neutral rudder angles (toe in/out) or thruster orientation (tilt and toe out).
- Thruster-thruster interaction or thruster-hull interaction (e.g. nozzle tilt).
- Etc, etc...
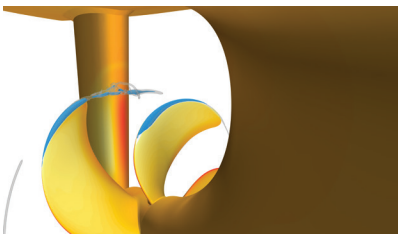
Cavitation and pressure pulse prediction

Cavitation and pressure pulse prediction

Simulation at calm water and constant ship speed using sliding mesh technique with the real propeller geometry operating behind the ship's hull. Prediction of propeller, rudder and/or appendage cavitation either by pressure distribution or with cavitation models predicting the cavitation. Prediction of non-cavitating and cavitating pressure pulse amplitudes at blade passing frequencies (1-3 BPF).
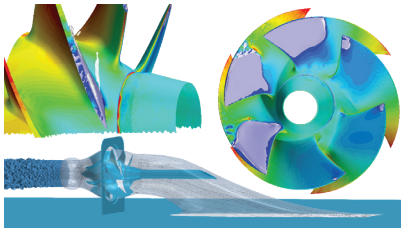
Waterjet propulsion

Waterjet propulsion

WJ Vessel Simulation
Self-propulsion simulation using body force pump model or sliding mesh technique with the real pump geometry represented. The hull is free to move in trim and sinkage and the method calculates the free surface and wave resistance using 2-phase (water and air) flow, transient RANS and SST-kΩ turbulence model. Prediction of vessel performance and WJ-hull interaction effects.

WJ System Simulation
WJ system simulations of inlet, pump unit and steering and reversing unit (SRU). Prediction of pump wake, potential cavitation in inlet and pump, steering and reversing unit forces.