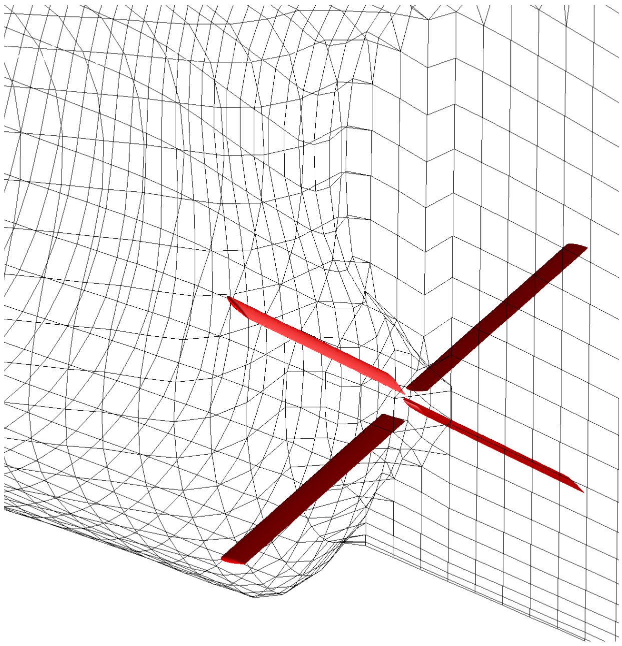
SHIPFLOW Design Package

Pre-Swirl Stator optimization

For an ordinary single screw vessel there are substantial rotational energy losses in the propeller slip stream. The pre-swirl stator is one of the most attractive devices to recover that energy since it is based on well proven energy saving mechanisms and it is simple, robust and cost effective. The pre-swirl concept consists of stator blades mounted on the stern boss in front of the propeller so that the flow is re-directed before it enters the propeller disc. The stator does not on its own save energy or create a forward thrust; in fact it adds resistance; but its interaction with the propeller blade improves the propulsive efficiency and results in a power reduction. Due to its complex nature, the pre-swirl stator has been both successful and unsuccessful, depending on the application. Therefore, the application of pre-swirl has to be integrated with hull design to find an optimum stator configuration. The present leaflet shows a first attempt to find an optimum blade angle setting by accurately evaluating propeller wake flow qualities behind the stators.

Case description

The well known and publicly available KVLCC2 hull was used for the present investigation. This hull is characterized by a moderately strong vortex structure created in the aft bilge area that enters the propeller plane and creates a "hook" like shaped wake. The hull was appended with a pair of stators on each side just in front of the propeller that should alter the wake by minimizing the velocity gradients and thereby creating a better working condition for the propeller. The picture below shows the configuration of the stators (red blades) and the surface grid on the hull. The angles of the stator wings were varied to find an optimal solution.



Computations

The calculations were carried out at model scale with a Reynolds number of 4.6x106. The background grid was created with XGRID from an offset file while the stator wings were generated using a parametric model integrated in XCHAP. In order to decrease the computational time for the optimization a rather coarse grid with around 400 000 cells was used. The calculations started with a basic solution that was iterated for 3500 iterations until the flow field was converged, and thereafter the optimizer started to vary the angles of the stator wings. Each new case was restarted from the basic one and iterated for 350 iterations. To further reduce the computational time the solver was run in parallel using 8 CPUs. An Ensamble Investigation was performed by varying the pitch of the wings in the range -15 to 15 degrees to find an optimum configuration. The maximum difference in the wake circumferential distribution was selected as the objective. The next picture illustrates the distribution of the design variables and also the computed results.

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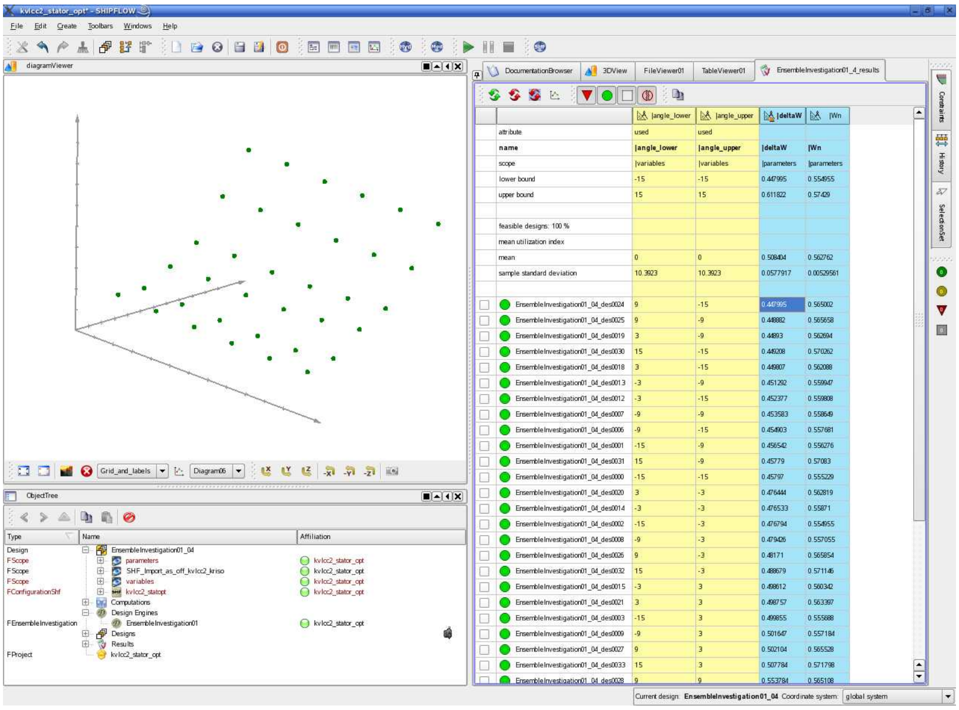
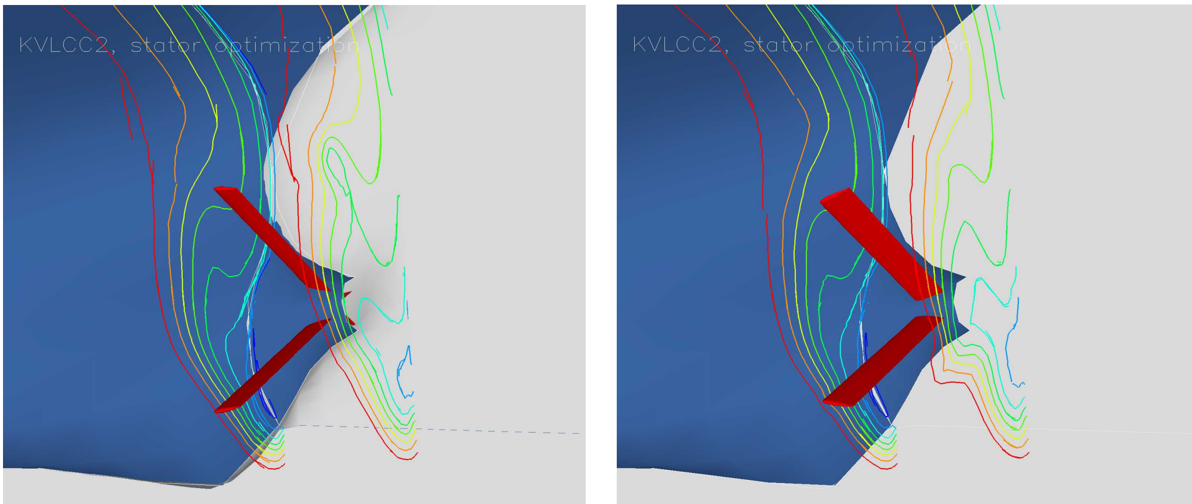


Results

The whole investigation was completed within 48 hours including case set up and post-processing. It was found that the wake can be optimized with respect to the chosen criteria. The optimum case had smaller variations for the total wake in the circumferential direction and the velocity contours in the propeller plane were more round. The picture below shows wake contours at the propeller plane for two different attitudes of the stator wings. The left side of the picture shows the case where the maximum difference was found to be the largest while the right side a case where the difference was minimized.



Concluding Remarks

The integrated design environment of SHIPFLOW Design Package allows the designers to investigate and optimize the flow around appended hulls. The robust and flexible solver featuring overlapping grids technique can be controlled from easy to use and powerful graphical interface that includes also optimization tools.

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