CFD Analysis of Scale Effects on Conventional and Tip-Modified Propellers

Full-scale propeller performance is traditionally predicted by scaling model-scale test results, but the traditional scaling methods do not take into account hydrodynamic distinctions of tip-modified propellers in full-scale performance. An open-water CFD analysis is made on scale effects of tip-modified and conventional propellers, which are designed for the same operating condition with identical propeller diameter and expanded area ratio. While model-scale computations are made with a transition model, a fully turbulent flow is modeled in the full-scale computations. The investigation on the effect of the transition model shows that laminar and transitional flow modeling is crucial in model-scale computations. Grid-independent solutions at model and full scale are achieved by grid verification studies.

The CFD analysis of scale effects shows that the efficiency gain of the tip-modified propeller is increased at full scale. The difference of scale effects between the tip-modified and conventional propellers is related to alterations of tip vortex and sectional pressuredistributions by the bent tip and the higher spanwise loading at the tip region of the tip-modified propeller.