CFD Analysis of a Duct?s Effectiveness for Model Scale and Full Scale

Rising fuel prices and stricter regulations on emissions drive a quest for more fuel efficient ships that is reminiscent of the 1970s, when after the first oil shock a plethora of fuel saving devices was investigated. Examples are Schneekluth ducts (wake equalizing ducts), Grim vane wheel, Grothues spoilers,or asymmetric aftbodies, Schneekluth and Bertram (1998). Many of the ?propulsion improving devices?of the 1970s are now again under debate. More than a generation later, we start basically again from scratch. The original reports on efficiency gains are often incomplete and invariably based on model tests. We know that model tests violate scaling laws in the aftbody, changing boundary layers and propeller rpm and/or loading. Model tests with ?empirical scaling? were the only option in the 1970s. The progress in CFD allows today much better insight into full-scale flows involving propulsion improving devices, allowing better scaling from model to full scale conditions, hence better quantitative predictions of the efficiency gains, but also into the physical mechanism allowing better insight into why gains are achieved or not. Ok (2004,2005) presented CFD studies for a Schneekluth nozzle for a public-domain tanker geometry, the E3 tanker. Contrary to common belief, he found that the nozzle did not improve the flow at full scale but was actually harmful. His work triggered a controversial debate. However, there is large consensus that the effectiveness of propulsion improving devices depends on the individual flow conditions, thus the hull and propeller designs. Showing the ineffectiveness of a device for one ship allows only the conclusion that the device is not always effective. For other devices or other ships, case by case analyses are recommended. Intrigued by Ok?s work, and stimulated by the rising interest in these devices, we decided to conduct our own study. In particular, the study was performed to shed some light on the following issues:
- Check whether an upstream nozzle improves the wake field of a bulker in model and full scale; assess the importance of scaling effects
- Assess improvement (if any) for the propulsion case (with propeller) for model scale and full scale
- Assess the appropriate level of the model for hull optimization purposes; in particular, assess whether the wake field (?resistance test?) suffices or whether the propeller needs to be taken into account (?propulsion test?). A numerical resistance test is much faster than a numerical propulsion test.

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Industries:
Marine [1]
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Conference Location:
Duisburg/Germany
Pages:
150-153
Conference Date:
Sunday, October 10, 2010
Conference Name:
13th Numerical Towing Tank Symposium
