Operational profile optimization and energy saving device study on a container ship

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Abstract:

Operational profile has aroused more and more attention in the past years. EEDI pressure on new ships and profit-driven motivation have pushed ship owners to take every possible measures to improve ship's performance.

Shipline Optimization is the first choice. When considering the round trip, it's very important to balance different speed and draft, to ensure the minimum oil consumption. To reach this goal, it's not enough to make use of one's own experience. Thanks to the rapid development of automatic optimization technology, computer software and hardware, it's possible to optimize the shipline within an acceptable time period, taking different speed and different draft into account.

In this paper, optimization technique, the Free-Form-Deformation (FFD)technique, and the CFD technique are incorporated to optimize the fore body of a container ship at multi-speed and different draft from potential code. The outcome from optimization shows remarkable decrease at relative lower speed and limited power increase at high speed from wave-making resistance. This is confirmed by the viscous numerical method and validated by model test.

From CFD study and model test, it's possible to reduce resistance 2-4% on the weighted basis for the container ship.

To further enhance ship's performance, energy saving devices(ESD) have been systematically studied on a container ship both with CFD and by model test. These ESDs include Rudder Bulb(RB), Propeller Cap Turbine(PCT), Rudder Thrust Fin(RTF).

For RB, Diameter and longitudinal position are investigated. The conclusion is, RB should be large enough to match propeller hub and the thickness of rudder, and the distance between hub and RB should be as close as possible.

For PCT, pitch angle and hub length are studied. Compared with hub only, PCT can increase open-water efficiency by 0.9%-1.7% at different advance ratio J=0.4-0.75. Kt increases and Kq decreases. It's also noted that at working point J=0.6, different PCT plans contribute 1.02-1.54% and different installation angle contributes 1.33-1.54%. This suggests PCT is not very sensitive to pitch angle, hub length and installation angle.

For RTF, installation angle, longitudinal position, chord length, are important parameters. From open-water efficiency, it's found that -1°>-3°>3°=5°, -1°is the best one; Longitudinal position, afterwards 40mm >20mm >original. Afterwards 40mm position is the best. Chord length change is not so sensitive to efficiency.

Model test further shows, propulsive efficiency increases by 3-4% with RB and RTF for container ship.

Work in this paper will help to reduce overall resistance and increase propulsive efficiency with suitable energy saving devices.