Ship design and propulsion systems for the future

MARINTEK seminar at NOR-Shipping 2009. Wednesday June 10th.
Ship design and propulsion systems for the future

Is there a single optimal solution with regards to:

Hull design and
Propulsion system?

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Subjects to be discussed:

- How the energy consumption is spread.
- Optimizing hull lines, or ship hull.
- Thoughts and assessments around propulsion systems

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Calm water ship resistance and propulsive losses

Average values for single screw ships (Tankers, Ro-RO, Container, Merchant)
Ship resistance

Ship Resistance, 64%

Wave resistance, 19.5%

Frictional resistance, 36.4%

Air resistance, 2.1%

Eddy making, 6.0%

Which one of these can be optimised?
Ship resistance

- **Eddies**: Mostly from transom stern vortices (Base drag)
  - Optimisation: Reduction of transom area
  
- **Frictional resistance**: Hull coating and Marine growth:
  - It has been reported that with modern hull coatings, optimum docking schedules and good workmanship during docking a fuel saving potential of the order of 5% may be expected. Nano-Technology may in the future give further reduction (15%?)

- **Wave resistance**: The potential is normally in the range of 5 – 20%. Still, on single ships improvements in power requirements of up to 30% has in fact occasionally been achieved on particularly ill conceived designs.

- **Air resistance**: 6.0%

- **Frictional resistance**: 36.4%

- **Eddies**: 19.5%

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Knowledge for future shipping
Ship resistance

Model test and CFD calculations merged. CFD calculations provide useful information about the pressure field below the water surface that creates the wave pattern along the hull. Details of bow/bulb-design are critical and can be better understood using a combination of CFD and model tests.

MARINTEK REVIEW #2 contains an article regarding this.
Ship resistance

Much focus is today on:

• Reduction of speed loss in waves.
• Alternative bow forms to achieve better seakeeping characteristics with lower speed loss in waves.

• MARINTEK has research programs on both.
Calm water ship resistance and propulsive losses

Average values for single screw ships (Tankers, Ro-RO, Container, Merchant)
High efficiency is achieved by small acceleration of a large quantity of water.

Large Propeller diameter – Low RPM
Propulsion

CHANGE OF PROPELLER:

3-bladed 2150mm propeller changed to 4-bladed 3200mm.

RPM changed from 375 to 147 RPM
Ballast: 17-18% lower PB
Full load: 27-28% lower PB
Bollard: 37-38% lower PB
Propulsion

Lots of devices can be installed to improve the efficiency:

- Propeller energy recovery devices to recover some of the abt 10% rotational loss:
  - Coaxial contra rotating propeller
  - Free rotating vane wheel
  - Ducted propeller
  - Pre-swirl devices
  - Post-swirl devices
  - Integrated propeller and rudder units
Propulsion
Conclusions

- No revolutionary new solutions.
- Good design judgments still most important.
  - Hull lines and propulsion system – integrated systems.
- Impossible to generalize:
  - Different types of ships with different level of flexibility: DP, good manoeuvrability
  - Good efficiency while steaming as well as during low load conditions.
- Very often, every ship is a prototype with its special requirements
Conclusions

- The best option for improving power consumption on new ships today is to evaluate and optimise the design systematically with regard to underwater and propulsion efficiency in calm water and in a seaway, this within the constraints set by payload and traffic requirements.
- Increasingly more advanced underwater hull coatings seem to hold great promise for the future if present day claims prove to be realised.
- Various concepts for propeller race energy recovery and after body flow smoothing may give valuable improvements in individual cases but requires systematic evaluation in each case.
- New external propulsion concepts do not presently seem to have any advantages compared to the screw propeller.
- Wind power has already proved to be of interest as an additional source for propulsive power that can be installed on almost any ship without the need to increase the manpower onboard.