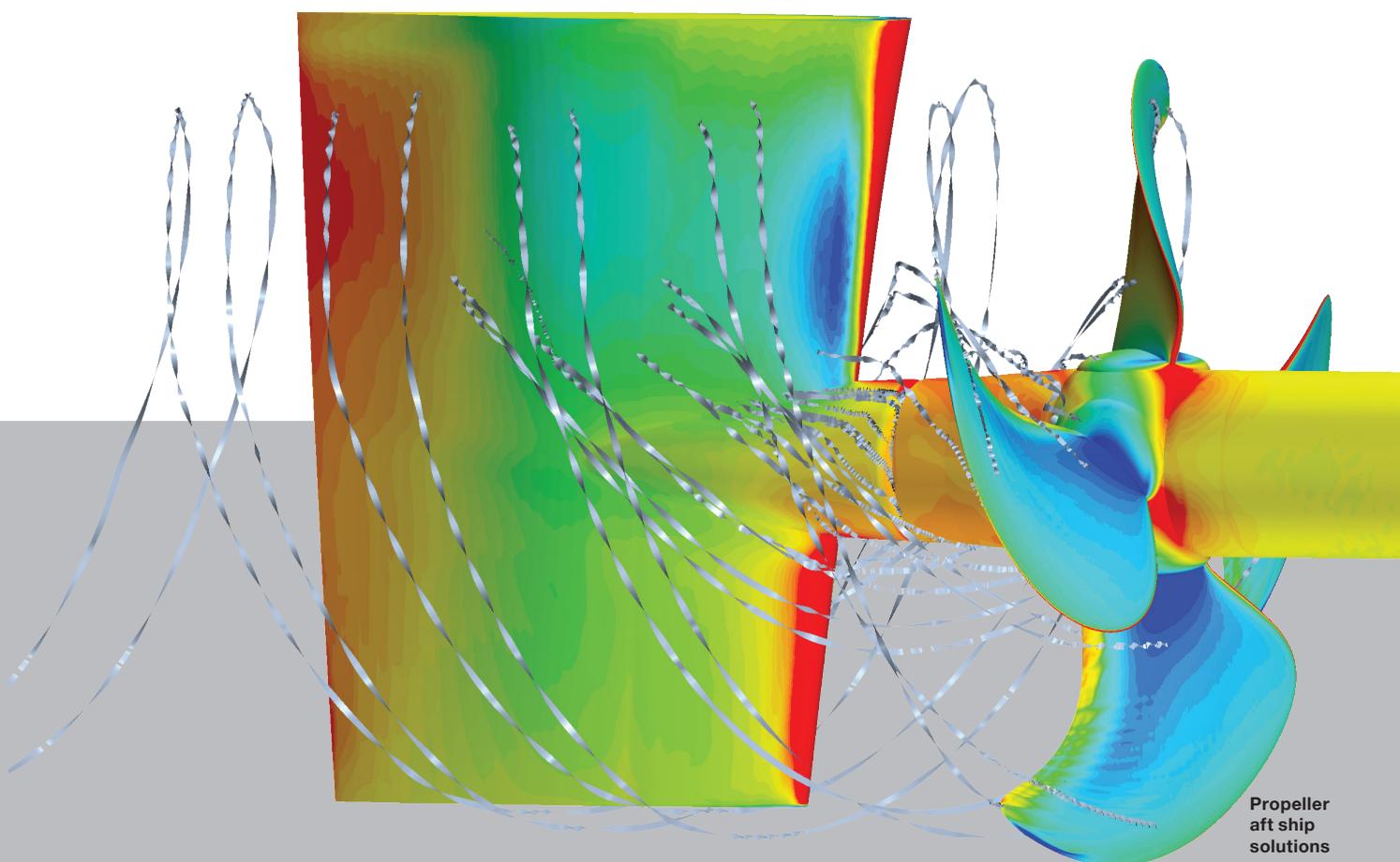


MAN Alpha EcoBulbs

MAN Energy Solutions are always pursuing the most efficient propulsion system offerings – including propeller and aft ship solutions – optimized for the individual vessel design and its operational pattern. Our customized EcoBulbs (rudder bulbs) are core elements in the complex hydro-dynamic entity – embracing hull, propeller, and rudder designs.

Benefits at a glance

- Efficiency improvements of up to approx. 5-6% (proven in model tests)
- Corresponding power reductions lowering fuel consumption and exhaust gas emission
- Efficiency improvements even at higher rudder deflections
- Reduced levels of noise and vibration



MAN Alpha EcoBulbs

**Rudder bulb solutions customized
for highest propulsive efficiencies,
fuel savings and short payback times
– often less than 0.5-1 year**

Hydrodynamic gains

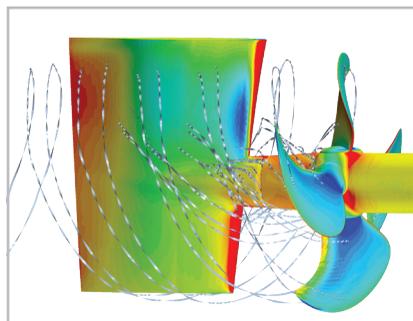
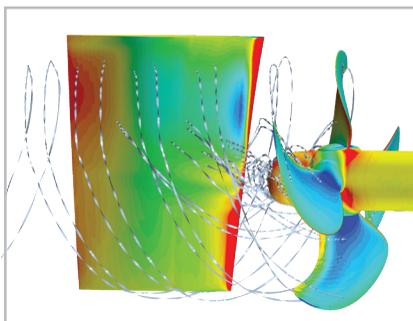
- EcoBulb efficiency gains of up to approx. 5-6% are valid for newbuilding installations
- Retrofitting of existing vessels without bulb, keeping existing propeller blades will typically gain up to approx. 2-4%
- The EcoBulb eliminates the propeller hub vortex and flow separation behind the hub
- With the EcoBulb no hub vortex cavitation will occur on rudder.

Optimization processes

- EcoBulbs are designed and customized as a result of iterative CFD calculations and modelling processes
- For optimized fine-tuning, a large number of designs are calculated prior to model testing verification
- We cooperate with a number of the leading rudder manufacturers
- To verify our results, we cooperate with the world's leading test tanks and research institutes.

Tailored customization

- Our 'Constrained Heuristic Optimization' software based on CFD masters the holistic approach to complex multi-factor systems and maximizes the EcoBulb gain
- EcoBulb solutions are efficiently integrated with various rudder designs - like spade and fishtail types, high-lift flap designs and rudders with twisted leading edge
- Additionally, we combine propeller nozzle, rudder and bulb where free sailing performance is prioritized together with pulling power ability.



Flow separation between rudder and propeller hub creates drag. With EcoBulb installed, uniform flow without separation creates improved thrust ahead. Less power required.

EcoBulb application range

- CPPs and FPPs
- Single screw and twin screw
- Open and ducted propellers
- Low speed and high speed
- No Ice and Ice Class
- Newbuilding and retrofit upgrade.



General EcoBulb characteristics

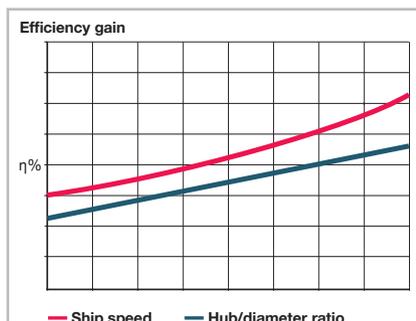
- Higher efficiency is gained at larger propeller hub diameters – meaning the CPP hub size penalty becomes smaller when compared to a FPP
- Higher efficiency is gained at higher ship speeds
- The EcoBulb geometry is by the rudder manufacturer physically integrated with the rudder construction.

Efficiency – at rudder deflections

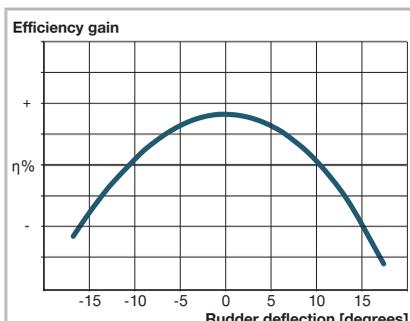
- Highest efficiency and lowest rudder/EcoBulb resistance are obtained at straight forward steaming with no rudder deflection to compensate for drift, current, waves and wind
- Flap type rudders requiring only small deflections for course keeping ensure high efficiency
- EcoBulb can contribute at rudder angles of up to ± 10 degrees.

Twin screw – toe-in/toe-out

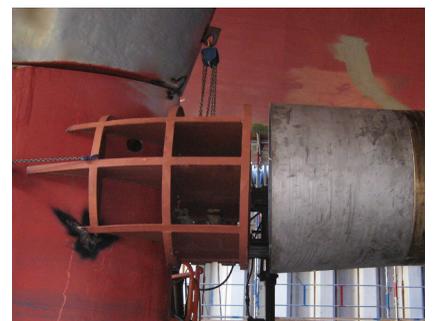
- For optimal efficiency the rudders may be positioned with a toe-in or toe-out alignment in relation to the propeller centerlines
- As a result, asymmetrically designed EcoBulbs can be optimized and design-integrated with toe-in/toe-out location on rudders.



EcoBulb efficiencies increase with higher ship speeds and larger hub/diam. ratios.



EcoBulb efficiency gain at various degrees of rudder deflections.



Easy retrofitting of the EcoBulb – a tailor-made welding-on kit supplied to shipyard.

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