HULL FORM OPTIMISATION DROVE SUPER-ECO ULTRAMAX GAINS

A hull form optimisation project using Computational Fluid Dynamics (CFD) helped a new class of Ultramax bulk carriers to achieve best in class fuel consumption

The first two LEM65 class super-eco Ultramax bulk carriers have entered service

In the spring of 2017 Cyprus-based shipowning group Lemissoler launched a project to improve the efficiency of an existing Ultramax bulk carrier design. The project involved close collaboration between Lemissoler, the Chinese shipbuilder New Times Shipbuilding, Shanghai-based naval architects SDARI and classification society ABS. The project resulted in a new class of 65,000 dwt super-eco Ultramax bulk carriers, LEM65.

The initial discussions encompassed the vessel's main particulars, including cargo intake which was agreed prior to commencing the optimisation of the vessel design, with work initially focussing around the initial hull form proposed by SDARI.

HULL FORM OPTIMISATION

The optimisation work involved the ABS Energy Efficiency team in Copenhagen and the Houston-based CFD team, which utilised a range of CFD models and a proprietary optimisation tool in the ABS Large CFD Cluster.

The optimisation of vessel hull form is a fine balance between minimising the power requirement without compromising either the cargo intake in terms of available deadweight nor the tons per centimetre (TPC) immersion for commercial reasons.

Christian Schack, who leads the ABS Energy Efficiency team, commented on the need for close dialogue between the project partners. "In order to optimise a vessel hull form and propulsion arrangement it is paramount to understand the intended operation and the intent of the owners. Thus we always seek to have as close a dialogue as possible to understand the 'pain points' for the owner, enabling us to optimise the vessel as far as possible."

The work was carried out in multiple rounds to ensure that each element of the hull form was carefully evaluated and optimised. in total more than 5,000 CFD simulations were carried out. After each round of optimisation, the results were presented to the joint team and discussed to ensure that the data were consistent and did not breach any of the pre-agreed requirements.

As a part of the optimisation process, open-water data for the specified Kappel propeller design from MAN Energy Solutions was provided in the final optimisation of the aft of the ship, to ensure the propeller had the best operating conditions with an even inflow of water to the propeller disk.

The final optimised hull form was subsequently evaluated using the same procedures as were applied for the baseline hull design in order to quantify the performance gains. It was found that the required power - averaged over the operational profile - could be reduced by 4.4% and that at the same time, the required power at the design condition was reduced by 5.6%. The power savings corresponded to a saving in fuel oil consumption of about 4.3% over the operational profile, which in this case consisted of four speed and draft combinations and of about 6.2% at the design condition.

INNOVATIVE FEATURES

In addition to the process of rigorous hull form optimisation, the vessel design encompasses a series of other innovative features to reduce energy consumption, including:

- Optimised propulsion system with well selected main engine and Kappel propeller delivered by MAN Energy Solutions to minimize fuel consumptions and eliminate vibrations;

- Propeller boss cap fin to reduce the hub swirl and improve propulsion performance;
- Fan duct to improve flow into the propeller disk and in turn reduce the power requirements;
- Optimized skeg to ensure course-keeping ability without adding additional resistance;
- Aerodynamic accommodation design to minimize air resistance;
- Super-eco electric cranes co-developed by Lemissoler and manufacturing partners;
- Wide installation of LED fixtures to reduce the lighting power consumption
- Optimized energy generation and consumption throughout the vessel.

The CFD simulations were verified by model tests performed at model basin China Ship Scientific Research Center (CSSRC) in Wuxi, China.

Several model tests were performed to evaluate the impact of multiple combinations of Energy Saving Devices (ESD), until the optimal results were obtained at the prevailing operational profile delivered by Lemissoler.

The rigorous tests confirmed that the optimisation had produced the expected results and provided a high level of confidence to the joint team about the final performance of the vessel series when built.

During the model tests the EEDI condition was also tested and this allowed the preliminary EEDI to be calculated.

The preliminary EEDI results showed that the unique design was able to meet proposed Phase 3 of the EEDI rules which define 30% lower emissions than the baseline.

PRINCIPAL PARTICULARS - *MV Lem Geranium*

Length, overall	199.90m
Breadth, moulded	32.26m
Depth, overall	18.50m
Draught, scantling	13.50m
Deadweight	64,900
Main engine	7G50ME-C9.6
Class	ABS

SEA TRIALS AND OPERATIONAL EXPERIENCE

The sea trials of the first vessel *MV Lem Geranium* in late November 2019 confirmed that the vessel's performance was in line with expectations from the hull form optimisation and model tests. The sea trials allowed the calculation of the final EEDI for the vessel, confirming the results from the model tests. All results have been further verified following the deliveries of *MV Lem Geranium* in early December 2019 and *MV Lem Marigold* in March 2020.

Lemissoler Technical Director Dimitris Solomonides said: "Our operational experience with our so far two deliveries *MV Lem Geranium* and *MV Lem Marigold* has been exceptionally good and could even say exceeded our expectations when we initially pitched the 'LEM65' concept to ABS and SDARI."

Christian Schack noted that the results of the optimisation process translated into SFOC savings of about 4.3% over the operational profile