The Royal Institution of Naval Architects

Influence of EEDI on Ship Design & Operation

International Conference

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22-23 April 2020

RINA, HQ, London, UK

www.rina.org.uk/EEDI_2020.html

Virtual comparison of different energy savings solutions

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In this paper, we propose to compare different innovative energy saving technologies with a conventional ship propulsion system. The ship described here is an Offshore supply vessel. The comparison is made virtually using system simulation algorithm, based on different mission profiles, suppliers technologies, control strategy and model complexity. The CO2/FOC results are compared to the baseline ship and allow for rapid decision taking prior to any commissioning and see trial.

A Review of Safety and Environmental Compliance Requirements for Offshore Vessels

J. Gullaksen, JG Maritime, UK

In recent years, environmental concerns have led to a significant increase in the number and scope of compliance imperatives across all global regulatory environments. In this context the compliance with limits in Energy Efficiency Design Index (EEDI) is considered. Efficient energy use, or simply energy efficiency, is the goal to reduce the amount of energy required to provide services and/or transport capacity. For example, designing for reduced hull resistance to use less thrust power to achieve and maintain a comfortable service and transport at same time as the environmental impact is reduced. Safe operation of offshore vessels is considerably influenced and regulated by a number of organizations and their various rules and regulations set out by the International Maritime Organization (IMO), regional (EU) and national authorities and recommendations by the classification societies. Environmental compliance means conforming to environmental laws, regulations, standards and other requirements such as permission is to operate. Thus, the operability of an offshore vessel is dictated and governed by its performance in safety and environmental compliance. Considering environmental compliance, ISO 19030 standard consolidates new energy efficiency measures and IMO DCS regulations require documentation of energy efficiency measures in excess of EU MRV compliance. Safety and emerging environmental compliance requirements in the shipping industry in general, will be drivers to reduce the environmental impact related to offshore oil and gas operations and to limit their consequences. This paper considers a review of safety and environmental compliance requirements for offshore vessels.

Energy sustainability index - an alternative to EEDI based in multiobjective optimization of sustainable energy systems in ship design

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Whilst acknowledging the value of the EEDI in the current need for decarbonization in the maritime sector, the present paper outlines some relevant limitations of this design index in valuing non-conventional ship energy conversion and propulsion options. Batteries, hybrid propulsion/energy conversion, renewable energy sources, wind propulsion and energy face challenges in the current EEDI calculation framework, typically fitted for conventional power and propulsion plants. In addition, the present paper highlights limited value of energy efficiency improvements in the wider context of decarbonization and the need to adopt a more holistic approach, performance goal-based certification framework, adoptable for both new designs and existing ships, converted or in operation, and, finally, tailored to best assist the international strategy to reduce CO2 emissions from international shipping, recently adopted at IMO.

Following the above, a proposal is then made for a goal based optimization process index, for both new and existing ships, suggesting a multi objective optimization instrument for the calculation of life-cycle and tank-to-propeller CO2 equivalent emissions, together with the definition of a margin for the use of different fossil CO2 content from different fuels. Design and Operational considerations are made for the development of the multi-criteria optimization process. Making use of elements from both dimensions, a new Energy Sustainability Index (ESI) is suggested.

The application of this tool is demonstrated in the present paper, though a concept proposal for an existing 5,500TEU containership retrofit/conversion project.. ESI is calculated, supported by the definition and implementation of relevant objective functions, allowing to identify the best design option for development. Comparison with EEDI calculations for the same design options is provided. The paper defends that design and operational relevant elements should be incorporated into the same calculation, within a performance goal-based approach.

The nondominated sorting genetic multi objective algorithm, NSGA-II, is used, unconstrained, to better assess the range of possible solutions, with post-result discussion for possible constraints to implement or preference regions to be established for decision-making support.

Shaft/engine power limitation

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The introduction of a shaft/engine power limitation was discussed during the last IMO MEPC meetings. This method should allow to install a larger engine but to restrict the available power. The limited power is applied for EEDI calculation. The restricted, additional power should only be available in emergency cases. What are emergency cases that allow to use full power? How can be controlled that the additional power is not applied in other cases, e.g. to keep the schedule? Will there be a large administrative burden connected to this method? Does this method help to get better designs or is it just a calculation trick to get better EEDI values? These questions will be discussed, and it will be shown that the shaft/engine power limitation will be an appropriate method to fulfill the minimum power requirements. Larger engines offer a larger torque range for slow engine speeds which is needed in adverse weather conditions. Besides, the shaft/engine power limitation supports the introduction of innovative technologies, e.g. wind assistance propulsion. In adverse conditions the innovative technologies might not be available, so a larger engine is required in emergency cases.

How Energy Saving Technologies can reduce EEDI

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The EEDI is now a well-established measure for the transport efficiency of a ship's design. The EEDI value for a specific ship design in g.CO_2/(tonne.nm) is used by the IMO as a measure of the ship's efficiency compared to their targets set for specific ship types and for specific sizes. As the IMO targets are lowered periodically, from 1-January 2020, the target will be 20% lower than the original values issued in 2013, measures to help improve the EEDI are of interest. Using recorded ship's operational data, this paper explores how wind-based energy saving devices (i.e. such as Flettner Rotors & Turbosails), Organic Rankine Cycles (ORC) and shaft power-take-off (PTO) devices can help lower the declared EEDI in accordance with the IMO regulations. The study uses a 61,000 tonne dwt bulker as the working example to analyse the sensitivity of the EEDI to revisions to the ship‘s declared design speed and the main engine's nominal power rating as well as the effects of the wind-EST, ORC and PTO devices.

Influence of EEDI on Self-Unloader Design & Conversion

G. Sugumaran, CSL Australia, Australia

Self -Unloaders are in business for more than a century. Since the amendment of EEDI & EEOI regulations, most of the self-unloaders are following the guidelines outlined for a bulk carrier. This paper investigates the impact of EEDI on the design/conversion of gravity self-unloaders and possible solution to mitigate the constrains from future emission control standards.

Determining the EEDI “Minimum Propulsion Power”

F. C. Gerhardt and M. Kjellberg, SSPA Sweden AB, Sweden

The introduction of the EEDI, slow steaming and the wish to save fuel have resulted in a trend to install less powerful engines in ships. To avoid vessels becoming underpowered and thus unsafe, the International Maritime Organization has introduced regulations regarding the “Minimum Propulsion Power to Maintain the Manoeuvrability of Ships in Adverse Conditions”. IMO circular MEPC.1/Circ.850/Rev.2 outlines the details of how to determine this “Minimum power” and presently gives two alternative calculation methods. The first method is simple, very conservative and based on installed power of existing ships. It uses deadweight and ship type as the only input. The second method is more advanced and takes main dimensions, rudder size, and wind area into account. It requires the yard to demonstrate, that the ship will be able to maintain a minimum ship speed (in the order of 4 knots) under closely defined environmental conditions. This approach involves a speed-power prediction in wind and waves and requires detailed knowledge of the various resistance components, namely calm water, wind, and added wave resistance. In this paper we discuss the resistance and power calculation methods outlined in the IMO circular. Using the KVLCC2 tanker as an example we follow the IMO-guideline step by step and compare resistance components from different sources like CFD-calculations and model tests. The parameters and assumptions behind the guideline are also discussed in some detail. Results show, that it is particularly important to determine the added resistance in waves correctly because it dominates the power prediction.

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