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Editorial

Special Issue on Energy Saving Device in Ship

Moon-Chan Kim

Department of Naval Architecture & Ocean Engineering, Pusan National University, Busan 46241, Korea; kmcprop@pusan.ac.kr; Tel.: +82-51-510-1424

1. Introduction

In recent years, interest in fossil energy depletion and global warming has increased. The International Maritime Organization (IMO) has applied the Energy Efficiency Design Index (EEDI) to ships built after 2013. However, as the EEDI does not effectively assess realistic improvement measures to enhance the ship operating energy efficiency, the Energy Efficiency eXisting ship Index (EEXI) will be implemented in 2023 [1]. The EEXI indicates the energy efficiency of ships during the operational phase [2]. Energy-saving devices (ESDs) effectively satisfy the EEXI requirements as they can be easily applied to existing ships.

Several solutions, such as fuel change, renewable energy use, and change in the principal dimensions of a ship, can help reduce the EEDI and EEXI. ESDs can effectively help decrease the EEDI and EEXI because energy saving is simultaneously achieved without significantly changing ship dimensions or incurring additional costs.

Although energy saving is important, addressing liabilities, such as mechanical failure and cavitation problems (noise, fluctuating force, erosion, and others), is also important, considering the long lifespan of ships. The current Special Issue, comprising eight papers, deals with the aforementioned problems.

2. Remarks on the Special Issue

The current Special Issue includes eight valuable papers that demonstrate recent activities on energy-saving technology with regard to the propulsor, rudder, hull form, and cavity. The twisted rudder [3,4] has been widely used to improve propulsion efficiency and prevent cavity risk. To improve performance and address the side effect of cavity formation, a new type of twisted rudder has been proposed. In recent times, post-devices have been widely studied because the performance improvement of pre-devices, such as the pre-swirl stator and duct, is almost saturated. Moreover, the combination of pre- and post-devices has been studied to maximize performance [5,6]. The post-device of an efficient rudder has been emphasized in the current AS Special issue, where two papers deal with the unconventional twisted rudder [3,4]. Furthermore, reliability based on increasing rudder force and attenuating cavity problems is important, although the energy-saving issue is one of the top priorities. Shin et al. (2021) proposed a new type of wavy rudder that may ensure reliability and efficiency.

The two papers [7,8] that studied hull form optimization deal with a recent advanced hull form optimization technology. Although hull form optimization is almost saturated, there is scope for improvement, which seems to be fundamentally important and cost effective.

Although the cavitation issue is not directly related to energy saving, it is closely related to the energy saving caused by decreasing skin friction or tip vortex. Two papers [9,10] in the Special Issue relate to the aforementioned cases. Super-cavitation has been applied to torpedoes for decreasing hull friction. Kim et al. [9] conducted a parametric study with experiments on the optimum super-cavitator, aiming for the efficient and stable performance of torpedoes. Another paper deals with the wing tip vortex and its cavitation, which is an

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important phenomenon for cavity inception and energy loss. Numerical investigation has been conducted to determine the scaling of cavity inception.

As the number of issues regarding energy saving is increasing, the reliability of full-scale extrapolation from the model test becomes an important subject. Although numerical simulation for full-scale performance has improved, full-scale validation is still essential for accurate prediction. In addition, full-scale measurement [11] is considered important to address the EEXI issue. Information regarding the measurement technique seems practically useful as feedback for the actual design. In particular, information regarding thrust measurement is valuable because thrust is rarely measured during a sea trial.

In the final study (the last paper), the Coanda effect was successfully applied to the propeller to significantly improve efficiency (+8.7%) [12]. Multi-design point ships, e.g., naval vessels, would be a proper target for application.

3. Prospect of ESDs

Regarding the future of ESDs, two important issues require consideration: full-scale numerical simulation with high accuracy and the application of a composite material (mostly flexible material). Full-scale simulation with high accuracy (more accurate than that conducted during a sea trial) is urgently required due to extrapolation difficulties of the model test results. The composite material would significantly help save energy and solve the cavitation problem with regard to inception. Such topics are expected to be discussed in a future Special Issue on ESDs.

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