Evaluation of hydrodynamic performance of ESD for fouled ship

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ABSTRACT

The major concern for ship owners and operators today is related to the increase in the ship energy efficiency which contributes to lowering the cost of increasingly expensive fuel and the fulfilment of increasingly strict environmental regulations [1]. To increase the ship energy efficiency, several technical and operational measures are proposed [2], and one possible measure is to equip the ship with an Energy Saving Device (ESD) to either reduce ship resistance or to increase the propulsion efficiency [3]. Even though various ESD are proposed only the cost-effective, simple structured and user-friendly ones have been installed. Thus, pre-swirl ducts are employed as one of the main ESDs for removing the mean tangential flow of the propeller slipstream which reduces the rotational and wake losses [4]. In the literature, there are many studies dealing with the design procedures for ESD, as well as the evaluation of the hydrodynamic performance of various ESD. These studies demonstrate the potential savings related to the implementation of ESD and are carried out for smooth ship and propeller. During the lifetime of a ship, the surface condition of the ship hull and propeller is significantly altered due to biofouling, corrosion, and other unwanted damages, and because of that the roughness of the ship hull and propeller increases. The presence of biofouling significantly affects the flow around the hull and the ship hydrodynamic performance, including propeller load and wake fraction [5]. Therefore, the evaluation of the hydrodynamic performance of ESD should be carried out for fouled ship hull as well, with an aim to investigate whether the claimed energy savings for the smooth hull are valid for the fouled hull. In this paper, the evaluation of the hydrodynamic performance of the stern duct which is installed on a capesize bulk carrier is carried out both for smooth and fouling condition. For that purpose, the numerical simulations of resistance, open water and self-propulsion tests are carried out within the commercial software package STAR-CCM+ for a ship with and without ESD. The impact of biofouling is taken into account with the modified wall function approach and appropriate roughness length scale. The obtained results demonstrate the importance of considering the various surface conditions during the evaluation of the hydrodynamic performance of a certain ESD and the determination of potential energy savings with the employment of ESD.

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