Numerical study of cavitation on a ship propeller in regular waves of different headings

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ABSTRACT

Ships are designed mainly for calm water operations corresponding to sea trial conditions. As ship operates under sea wave conditions most of time, sea margins are added to ship resistance for considering sea states and other environmental effects [1]. When considering sea waves in the ship propeller design, it is important to take into account not only added resistance but hull wake flows as propeller inflows in predicting propulsive performance and cavitation safety.

In this work, unsteady cavitation simulations are carried out on a five-bladed propeller of KRISO container ship (KCS) in calm water and regular waves of five different headings. Bare-hull simulations are made for estimating nominal hull wake fields by URANS solver [2]. Cavitation simulations are made on the propeller and rudder by DES with a cavitation model and an Eulerian multiphase flow model. Nominal hull wake is numerically modelled in cavitation simulations as a propeller inflow instead of including a hull model [3].

The maximum cavity area on the suction side of the blade is increased by 20 – 32% in beam, stern-quartering, following waves compared to calm water mostly due to the stronger axial hull wake. As the sheet cavity is more extended, tip vortex cavitation is intensified especially in stern-quartering and following waves. The maximum cavity area is on a similar level with less than 3% differences in head and bow waves as in calm water. The CFD investigation shows that hull wake differs depending on the wave direction and it can lead to significant changes in cavitation safety.

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