Kinematics and Load Conditions at the Voith-Schneider-Propeller

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ABSTRACT

The design and dimensioning of marine propulsion systems requires a precise knowledge of the existing operating conditions. To ensure manoeuvrability and the associated safe navigation under all conditions on the water, extremely high demands on the reliability of the propulsion systems exist. The load components to be considered also differ depending on the type of drive which is used.

To drive the vessel, the classic rigid propeller must convert the applied torque into thrust by the pitch of the propeller blades. Rudders are used to change the direction of travel. On ferries, tugs and ships in the oil and gas industry, thruster drives are also used due to their good manoeuvring characteristics. In these drives, the function of the drive and rudder is combined in one assembly. The propeller is mounted in a propulsion nacelle under the ship and this nacelle can be arbitrary rotated around the vertical axis. In addition to the torque, bending moments resulting from rudder movements and inflow conditions must also be considered in the design loads. The use of Voith-Schneider propellers provides an even faster possibility for adapting the thrust direction. The drive, consisting of individual circularly arranged rudder blades, rotates around the vertical axis and does not generate any thrust when the blade profiles are guided tangentially through the water. A lever mechanism makes it possible to cyclically adjust the pitch of the blades over the rotation of the drive and thus adjust the direction of the propulsion as required.

The presentation and the contribution to the conference provide an overview of the design of a drive for a Voith-Schneider propeller. The kinematic boundary conditions, which define the lengths and joint points of the lever mechanism and at the same time influence the efficiency of the ship's propulsion, will be presented by an example. Different approaches to finding solutions will be presented and discussed. Based on all determined design parameters, the kinematics of the entire propulsion system were modelled in a multibody system simulation model and loaded with the position- and angle-dependent water loads on the rudder blades. The simulation of different operating conditions enables the determination of the loads occurring at the blade roots and in the lever system.

The simulation of different operating conditions enables the determination of the loads occurring at the blade roots and in the lever system. The resulting time and angle-dependent force curves and the transfer of the results into the design loads for dimensioning the drive train are discussed based on selected examples. In addition, the simulation model can be used to analyse the efficiency of the drive as well as alternative adjustment mechanisms for the rudder blades. The results obtained can be compared and analysed with the aid of the simulation results for different blade pitch designs.

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