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Experimental and CFD development of the OceanGlide air lubrication system

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INTRODUCTION

This presentation outlines the development capabilities of the Alfa Laval OceanGlide system on the context of fluid dynamics. Firstly, experimental results from a flat-plate fixture towed at an industrial facility are presented, demonstrating the ability to test various fluidic oscillators and discussing key parameters of their operation. Next, these experimental findings are compared with CFD simulations. The presentation also highlights challenges encountered during both model-scale testing and CFD analysis and examines how these relate to full-scale performance.

EXPERIMENTAL PART

The frictional drag reduction by air lubrication on a 7 m-long and 1.1 m-wide flat plate was investigated in a towing tank at four towing velocities (3 m/s–8.23 m/s). Air was injected through fluidic oscillators installed on the underside of the plate with air flow rates ranging from 0 L/s to 80 L/s, producing air-layer thicknesses of 0 mm to 16 mm. Videos of the air topology revealed an initial air layer film immediately downstream of the air injector at low velocities, which transitions to a dispersed bubble layer.

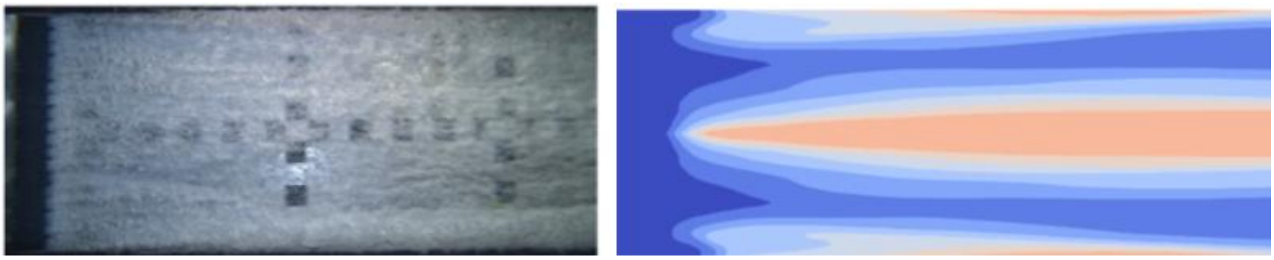

Figure 1: Topology of the ALS at a given speed and air flow rate during the towing tank test (left) and void fraction contour (right) obtained during the CFD validation process.

CFD PART

The morphology-adaptive multiphase model MultiMorph is used for the CFD validation of three-dimensional air lubrication model tests. This model can simultaneously capture the BDR and ALDR regimes, and their transition, by combining a two-fluid Eulerian model with a volume-of-fluid approach, while limiting the requirement for grid refinement. The model shows good agreement with drag prediction in wetted conditions (errors are within 6.5% of the experimental data) and is able to capture drag reduction trends with slight overprediction in continuous-phase–dominated flows (ALDR) and underprediction in disperse phase–dominated flows (BDR). Apart from drag comparisons, the flow topology is validated with graphs similar to Figure 1.