Effect of superhydrophobic coatings on the ventilation of free surface piercing bodies

B. Barabé[(1)], A. Clément[(1)], C. Gabillet[(1)]
[(1)]Institut de recherche de l'Ecole Navale, Ecole Navale, Brest

Ventilation of free surface piercing bodies immersed into high speed flows [4] is an ever growing concern due to the general boat speed increase. The empirical tuning of the surface state of these partially immersed bodies is considered as a tool to limit their ventilation, however a fundamental understanding of the relationship between ventilation and surface state is lacking. In the specific case of surface wettability, its influence on ventilation has been scarcely studied and considered neglectible for bluff bodies [6, 5]. When considering another type of two-phase flow, cavitation [4], hydrophilic surfaces were reported to shift the incipient cavitation number toward higher values for lifting bodies [3, 1].
Superhydrophobic surfaces display outstanding drag reduction properties for intermediate Reynolds ranges due to the existence of an air plastron between the solid surface and the fluid [2], but their influence on biphasic flow remains to be investigated.

We therefore report an experimental study of the influence of superhydrophobic coatings on the initiation and geometrical characteristics of ventilation and cavitation sheets.

Ventilation sheets were generated in a home-made Taylor-Couette device, at the suction side of riblets attached to the rotating inner cylinder. The gap between the two concentric cylinders is partially filled with water at different heights, and ventilation sheets are observed above a critical Reynolds value. We compared the ventilation sheet's initiation and geometrical characteristics for two inner cylinders with contrasted wettability : hydrophilic and superhydrophobic.
In the case of steady state flow conditions, we report a decrease of the Reynolds number at which ventilation is initiated when the surface is superhydrophobic. Wettability, however, does not impact the transition between partial and fully ventilated flows with respect to the Reynolds and Froude numbers. After the tests, we observe a local degradation of the superhydrophobic coating, which is a limitation to potential practical use in ventilating flows. In order to put in perspective our results with the impact of superhydrophibic surface in another two-phase flow, cavitation tests on hydrophilic and superhydrophobic model foil were also performed in a hydrodynamic facility. Preliminary results show that cavitation is favoured for superhydrophobic surfaces.

Références

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