Center for Environmental & Applied Fluid Mechanics

"Multiphase Boundary Layers in Context of Frictional Drag Reduction"

Simo A. Mäkiharju
University of California, Berkeley

Frictional drag can account for more than half of the resistance of a ship, and hence techniques to reduce it can have a significant impact in decreasing fuel consumption and emissions. Air lubrication was first proposed over a century ago. However, early on it produced mixed results due to the complex flow physics of multiphase boundary layers which we are only now beginning to understand sufficiently well to implement air lubrication on full-scale ships with confidence. Data from sea trials and from commercial ships in normal operation indicate that net fuel consumption can be reduced by 4 to 8% with Air layer Drag Reduction (ALDR). However, these realized net energy savings are only half to a quarter of the reduction in the required propulsive power, as the energy required by compressors to supply the gas is significant. On the other hand, superhydrophobic surfaces (SHS) do not require continuous gas injection, but SHS alone have not been successfully implemented at full scale due to challenges on durability, gas loss from plastrons and roughness. However, it was recently shown by FLOW lab that SHS combined with macroscopic air layers can enable maintenance of continuous gas layers with gas fluxes less than half of those required on hydrophilic surfaces. Experimental study of this multiphase flow over a complex surface, SHS-ALDR, and related phenomena are ongoing. Data are being used to derive a new model for critical gas flux, one that explains both roughness and surface contact angle dependence. It is intriguing to contemplate the potential for macroscopic air layers on superhydrophobic surfaces, if as indicated by small scale experiments the net energy savings of ALDR alone could be nearly doubled.

Fall 2022 CEAFM Seminar Series

December 9, 2022 ⌘ 3:00 PM ⌘ Gilman Hall 50

https://wse.zoom.us/j/93762992307