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Drag Reduction for Flow Past a Perfectly Hydrophobic Surface¹ GLEN MCHALE, Northumbria University, UK, MICHAEL I. NEWTON, Nottingham Trent University, UK, MORRIS R. FLYNN, University of Alberta, Canada, BRIAN R.K. GRUNCELL, NEIL D. SANDHAM, University of Southampton, UK, ANGELA BUSSE, Glasgow University, Scotland — We consider drag reduction for flow past a perfectly hydrophobic sphere (i.e. a vanishing Cassie solid surface fraction or with a Leidenfrost layer). At small Re number an exact analytical model for drag can be constructed for a sphere encapsulated in a layer of a gas (a "plastron") [McHale, G. et al, Soft Matter 7 art. 10100, (2011)]. This predicts an optimum thickness for the gas layer for maximum drag reduction due to a competition between increased lubrication of the flow and increased cross-section for drag by the compound object (the solid plus its surface-retained layer of gas). Using numerical simulations for a perfectly hydrophobic solid sphere in water we show that the maximum drag reduction increases from 19% to 50% as the Re number increases to 100; this is due to suppression of flow separation and a narrower wake [Gruncell, B.R.K. et al, Phys. Fluids 25 art 043601, (2012). Introducing roughness into the simulations to model a superhydrophobic surface with a finite Cassie fraction results in less drag reduction because the vortex regime is no longer fully suppressed. Finally, we describe an analytical model of flow resistance through tubes or channels using similar boundary conditions to the flow past a gas-encapsulated sphere Busse, A. et al, J. Fluid Mech. 727 488, (2013)].

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