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Passive control of the flow around a hemisphere using porous media

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Abstract

In this work, a passive flow control study is proposed in order to regularize the flow dynamics around a hemisphere at a low and a higher Reynolds number in the wake transition regime. This passive control is realized by covering the projected curved surface of the hemisphere with a porous coating. The presence of such porous medium modifies the boundary conditions at the body-fluid interface, allowing a non-zero velocity to settle in this region. This phenomenon smoothes the global flow dynamics and leads, in particular, to a decrease of the energy dissipation and the aerodynamic force. In this paper, the flow control study is carried out for several configurations using a vortex-penalization technique which allows to easily model solid-fluid-porous media without prescribing any boundary condition.

Keywords: passive flow control, porous media, drag reduction, flow past a hemisphere, vortex methods, Brinkman penalization method.

1. Introduction

The main advantage of passive control for drag reduction, in aerodynamics, relies in the fact that it is energy free and generally easy to implement. Many devices have been proposed in the literature as for instance compliant walls like the dolphin skin [1, 2], ribelets or bumps [3, 4, 5], and wavy or rough surfaces [6, 7]. Another possibility is to introduce porous and permeable layers [8]. The main effect of a porous interface between the solid and the fluid

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