

A shape optimization problem for stationary Navier-Stokes flows in three-dimensional tubes

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Abstract

In order to optimize the shape design of air ducts in combustion engines, we consider a shape optimization problem subject to the stationary Navier-Stokes equations in three dimensions with mixed boundary conditions on domains of polyhedral type. An inflow profile is given at the inlet, a no-slip boundary condition is imposed on the wall, and a no-friction boundary condition on the outlet. To find optimal shapes, we choose a cost functional to achieve a uniform outflow and to minimize the total pressure loss. The associated numerical solution requires an efficient computation and yet accurate approximation of an adjoint-based shape gradient in a shape-gradient-related descent method. We present a numerical example illustrating the method.

Keywords: Shape optimization, Navier-Stokes equations, adjoint-based method.