

# A shape optimization problem for 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 Navier-Stokes equations in three dimensions with mixed boundary conditions in the duct geometry. An inflow profile is given at the inlet, a no-slip boundary condition is imposed on the wall, and a do-nothing boundary condition on the outlet. To find optimal shapes, we choose a cost functional to achieve the flow uniformity at the outlet and minimize the dissipated power. 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 to illustrate the method proposed.

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

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