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Boundary Control of Optimal Mixing in Stokes and Navier-Stokes Flows. Preliminary report.

We discuss the problem of optimal mixing of an inhomogeneous distribution of a scalar field via an active control of the flow velocity, governed by Stokes or Navier-Stokes equations, in a two dimensional open bounded and connected domain. The problem is motivated by mixing the fluids within a cavity or vessel by moving the walls or stirring at the boundaries. It is natural to consider the velocity field that is induced by a control input tangentially acting on the boundary of the domain through the Navier slip boundary conditions. Our main objective is to design an optimal Navier slip boundary control that optimizes mixing at a given final time. This essentially leads to a finite time optimal control problem of a bilinear system. A rigorous proof of the existence of an optimal controller and the first-order necessary conditions for optimality are presented. (Received September 12, 2017)