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APPLICATION OF AN INTEGRAL VORTICITY BOUNDARY CONDITION TO SOLVE THE VORTICITY-STREAMFUNCTION EQUATIONS

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In this study, we present finite element solutions of incompressible Navier-Stokes equations cast in the vorticity and stream function. The transport equations for vorticity and stream function under investigation are subject to boundary conditions of integral character for non-primitive vorticity variable.

In the first part, we formulate the integral vorticity boundary conditions for the elliptic-parabolic differential system of vorticity-streamfunction equations [1, 2]. Then, we assess the formulation with the explicit vorticity boundary condition on a simple example. We quantify the convergence behavior with respect to the mesh size and evaluate the error on the velocity with respect to the solution of the Navier-Stokes equations cast in primitive variables. All computations presented and commented are realized by means of the code FreeFem++ developed by Hecht [3]. Finally, we present some numerical applications where the domain of interest $\Omega \in \mathbb{R}^2$ is a bounded multi-connected domain implying that the boundary $\partial\Omega$ has connected components which are disjoint closed curves.

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