The Navier-Stokes equations in two different formulations with moderate and high Reynolds numbers.

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ABSTRACT

The goal of this work is to present results for 2D viscous incompressible flows governed by the Navier-Stokes equations. Two different formulations will be used: The velocity-vorticity formulation and the stream function-vorticity formulation. We are going to report results for the well known un-regularized driven cavity problem, with Reynolds numbers in the range of $5000 \leq Re \leq 25000$.

Results, in both formulations, are obtained using a simple numerical scheme based on a fixed point iterative process, Nicolás (1991), applied to a nonlinear elliptic system resulting after time discretization. The scheme has shown to be robust enough to handle such Reynolds numbers, from moderate to high, which is not an easy task to deal with.

As the Reynolds number increases the mesh has to be refined and a smaller time step has to be used, numerically, by stability matters and physically, to capture the fast dynamics of the flow, as pointed out in Nicolás-Carrizosa A., Bermúdez-Juárez B (2011), although, with the velocity-vorticity formulation (see Nicolas A., and Bermúdez B., (2007)), a finer mesh and a smaller time step has to be used. So, because of this, computing time is in general very large with this numerical scheme and for both formulations, so we seek to reduce this time by, instead of working only with the matrix A, resulting from the discretization of the laplacian term, using both matrixes A and B, the second one resulting from the discretization of the advective term. For the stream-function-vorticity formulation and moderate Reynolds numbers, this second scheme has been faster than the fixed point iterative method (see Bermúdez B., Juárez L. (2014), Bermúdez B., Posadas R., (2014)).

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