Numerical stability of the fixed point iterative method to determine patterns of turbulent flow in a rectangular cavity with different aspect ratios

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ABSTRACT

2D isothermal viscous incompressible flows are presented from the Navier-Stokes equations in the Stream function-vorticity formulation and in the velocity-vorticity formulation. The simulation is made using a numerical method based on a fixed point iterative process to solve the nonlinear elliptic system that results after time discretization. The iterative process leads us to the solution of uncoupled, well-conditioned, symmetric linear elliptic problems from which efficient solvers exist regardless of the space discretization.

The experiments take place on the lid driven cavity problem for Reynolds numbers up to Re=10000 and different aspect ratios A (A=ratio of the height to the width) A=1 and A≠1, such as A=1/2, till A=3. It appears that with velocity and vorticity variables is more difficult to solve this kind of flows, at least with a numerical procedure similar to the one applied in stream function and vorticity variables to solve an analogous nonlinear elliptic system.

To obtain such flows is not an easy task, especially with the velocity-vorticity formulation. Because of this, we report here results for moderate Reynolds numbers (Re≤10000), although with them enough effectiveness is achieved to be able to vary the aspect ratio of the cavity A, which causes that the flow be more unstable.

Contribution in this work is to consider rectangular cavities of drag, which can impact on isothermal turbulent flow patterns. Another contribution is to include a wide region of the Reynolds number as well as different aspect ratios where we tested stability of the numerical method.

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