11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Another way of solving the Taylor Vortex and the Driven Cavity problem in the Stream Function-vorticity Formulation.

Blanca Bermúdez[1] and René Posadas[2]

[1] F.C.C. BUAP bbj@cs.buap.mx
[2] F.C.F.M. BUAP reneposada16@gmail.com

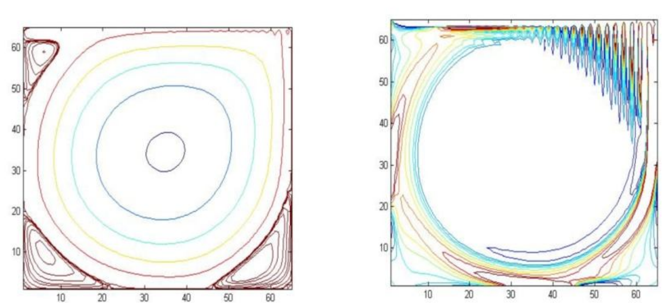
Key Words: *Taylor Vortex problem, Driven Cavity problem, Navier-Stokes equations, Stream function-vorticity formulation.*

In this work, two problems will be presented: The Taylor Vortex problem and the driven cavity problem. Both problems are solved using the Stream function-vorticity formulation of the Navier-Stokes equations in 2D. Results are obtained using two methods: A fixed point iterative method, Nicolás (1991), and another one working with matrixes A and B resulting from the discretization of the laplacian and the advective term respectively, Bermúdez (2014) (to be published).

The iterative method has already been used for solving the Navier-Stokes and Boussinesq equations in different formulations, Bermúdez et al (1997), Bermúdez et al (2010).

For the driven cavity problem, results agree very well with those reported in the literature. For the Taylor Vortex problem, since the exact solution is known, we are able to calculate the relative error, and the results were very good with both methods, but with the second method, we reduced processing time.

With the fixed point iterative method used in Nicolas (1991), the idea was to work with a symmetric positive definite matrix. This scheme worked very well, but the processing time, was in general, very large. With the second method we are working with a matrix which is not symmetric, but it can be proved that it is strictly diagonally dominant for Δt sufficiently small. The processing time was more or less 40% smaller when using this method.



. a) b)

Figure 1. Re=5000. Streamlines (a) and vorticity contours (b) with h=1/64 and Δt=.001

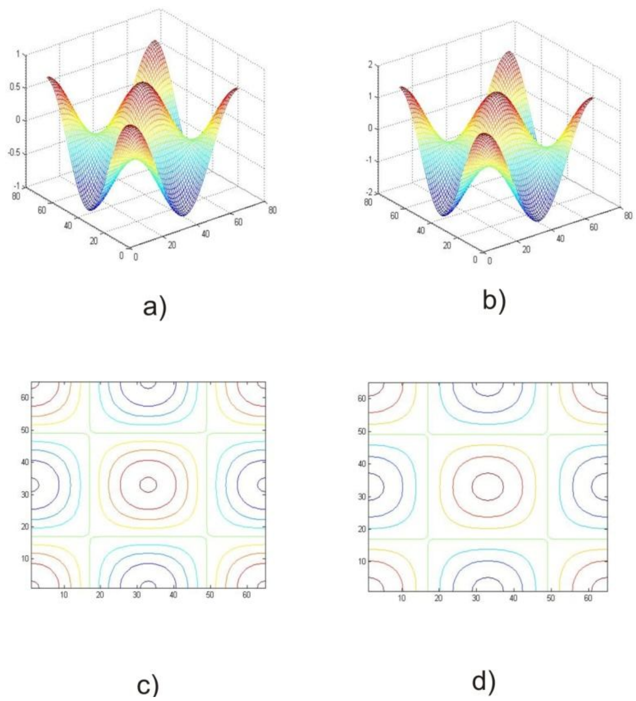


Figure 2. Stream function (a), vorticity (b), streamlines (c) and vorticity contours (d) for Re=100, T=10, h=1/64 and Δt=0.001

REFERENCES

[1] Nicolás A., A finite element approach to the Kuramoto-Sivashinski equation, Advances in Numerical Equations and Optimization, SIAM (1991).

[2] Bermúdez B., Nicolás A., Sánchez F. J., Buendía E., Operator Splitting and upwinding for the Navier-Stokes equations, Computational Mechanics, 20 (5) pp. 474-477, 1997.

[3] Bermúdez B. y Nicolás A., Isothermal/Thermal Incompressible Viscous Fluid Flows with the Velocity-Vorticity Formulation, Información Tecnológica 21 (3) pp. 39-49, 2010.

[4] Bermúdez B. y Juárez L., Numerical solution of an advection-diffusion equation, To be published in Información Tecnológica 25(1), 2014.