DRBEM Formulation with Fractional Step in Time for Solving Backward-Facing Step Flow

Ayşe Sarıaydın\textsuperscript{1}, M. Tezer - Sezgin\textsuperscript{1,2}

\textsuperscript{1} Institute of Applied Mathematics, METU, Ankara, TURKEY
\textsuperscript{2} Department of Mathematics, METU, Ankara, TURKEY
saayse@metu.edu.tr
munt@metu.edu.tr

Extended Abstract

In this study, two-dimensional, transient flow of an incompressible, laminar, viscous fluid in a channel is considered. The equation of continuity, and momentum equations define backward facing step flow in terms of primitive variables (velocities and pressure). The no-slip condition for the velocity is imposed on the top and bottom walls of the channel. The height of the channel is $H$, length is $L$, and $h$ is the height of the entrance such that $H - h$ is the height of the step. We have given a parabolic velocity profile at the inlet. The dual reciprocity boundary element method (DRBEM) is employed for solving backward facing step flow equations utilizing fractional step for the time derivatives. This uncouples velocities from the pressure. Then, the predicted velocity and the pseudo-pressure equations are all solved by using DRBEM with constant elements. DRBEM transforms directly the differential equations to the boundary integral equations, and thus, only the boundary of the problem has to be discretized. This saves considerable computational work. Velocities and the pressure are obtained iteratively in the time direction with a predictor-corrector scheme. In the iterative procedure the nonlinear convective terms are approximated explicitly from the two previous steps. The present numerical procedure gives quite accurate results for small Reynolds numbers $\leq 100$. It has the advantage of treating directly the primitive unknowns and obtaining the pressure field also. Since the time derivatives are discretized at the beginning of the procedure, the solution is obtained iteratively at all transient levels and also at steady-state with considerably large time increment compared to other explicit time integration procedures. The proposed numerical scheme is also computationally cheap since DRBEM discretizes only the boundary of the region, resulting with small sized systems, compared to other domain-type numerical methods.

Keywords: DRBEM, Backward Facing Step Flow, Fractional Step Time Integration

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