D12

APPLICATION OF IMPROVED NUMERICAL SCHEMES

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There have been a variety of methods used to solve the Navier-Stokes equations. Most schemes which solve the steady state form of these equations employ the SIMPLE (Semi-Implicit Method for Pressure-Linked Equations) method developed by Patankar and Spalding in 1972 (ref.1). Although this scheme has proven to be quite effective, its convergence rate can be improved. This investigation focuses on two approaches which accelerate the solution of the steady state Navier-Stokes equations.

The SIMPLER algorithm (ref. 2), a revised version of SIMPLE, provides a more accurate pressure field for each iteration through the momentum equations,thereby speeding convergence. PISO (Pressure Implicit Split Operator, ref.3) performs a secondary correction of the velocity and pressure fields (after the typical pressure correction) which enhances convergence. Both schemes account for terms neglected in the SIMPLE approach, but do so in slightly different ways.

A series of calculations of two-dimensional driven cavity flow and flow over a step were made to examine the effect of geometry on the performance of these schemes. Computations were carried out on a series of progressively finer grids. The effect of relaxation number on convergence rate was analyzed, using results from SIMPLE as criteria for performance correlation.

Preliminary results indicate the following:
1. The improved schemes promoted convergence by up to sixty percent for the driven cavity and forty percent for flow over a step.
2. For the driven cavity problem, the efficiency of PISO and SIMPLER increased as the number of nodes increased.
3. To ensure faster convergence, higher relaxation numbers must be applied.

References

1. Patankar,S.V. and Spalding, D.B.(1972). A Calculation Procedure for Heat, Mass and Momentum Transfer in Three Dimensional Parabolic Flows, Int. J. Heat Mass Transfer, vol. 15, p.1787.

2. Patankar, S.V. (1979). A Calculation Procedure for Two Dimensional Elliptic Situations, Num. Heat Transfer, vol. 2.

3. Issa, R.I. (1982). Solution of Implicitly Discretised Fluid Flow Equations by Operator-Splitting, Int. Rep. Dept. Mineral Resources Eng., Imperial College, London.