Mixed Fourier Galerkin-Finite volume pressure correction method to solve the fluid dynamic equations in cylindrical coordinates

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ABSTRACT

In this contribution, we first present a numerical method to solve the governing equations for incompressible flows in cylindrical coordinates. The hybrid formulation is based on a Fourier expansion in the azimuthal direction (similar to that described in Peyret [1], see also Mercader[2]) and on a finite volume discretization for the radial and axial directions (Verzico [3]). The Fourier method guarantees full periodicity of the solution and spectral accuracy in the azimuthal direction, while the finite volume is a method that handles adequately discontinuities in the boundary conditions along the radial or axial directions. In order to decouple the pressure-coupled equations we use a strategy similar to that of the SIMPLE algorithm [4] but applied to each of the Fourier modes. In principle, the code can be easily parallelized using domain decomposition techniques.

The advantages of the proposed integration strategy, are illustrated by analyzing the stability of the natural convection flow in a vertical cylinder heated from below and cooled from above and with partial heating on the lateral wall. The results indicate that for appropriate parameters, the flow in the lower part of the cylinder, where heat is being supplied through the lateral wall is axisymmetric, while near the top, the convective pattern displays a modal distribution.

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