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Accurate numerical solution for the incompressible flow equations

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The conservation of mass of incompressible flows poses a major difficulty in their numerical solutions. That difficulty arises from the lack of pressure term in the conservation of mass equation. Several methods have been developed to introduce the pressure into the continuity equation directly or indirectly such as the Artificial Compressibility method and the Pressure Poisson equation method respectively. Unlike compressible flows, the incompressible flow dependent variables are the velocity and the pressure derivatives. Therefore, deriving a pressure equation, for incompressible flows, imposes additional constrains such as compatibility condition and Neumann boundary conditions for the pressure. In this study, we modified the continuity equation to calculate the pressure derivatives leading to Dirichlet boundary conditions which enhances the convergence of the numerical solution. The pressure is then calculated to within an arbitrary constant from the computed pressure derivatives. The present method is consistent with physics of incompressible flows, accurate, robust and efficient. Numerical solutions are obtained for the driven cavity problem for validation.

Biography

Shaaban Abdallah, a Professor of Aerospace Engineering, has been at the University of Cincinnati since 1989. He obtained his PhD in Aerospace Engineering at the University of Cincinnati in 1980. He joined Penn State University from 1981 to 1988. His research interests include Computational Fluid Dynamics, nano fluids, Turbo-machines, Unmanned Aerial Vehicles and Medical devices. He has two US patents on centrifugal compressors and three disclosures with university of Cincinnati on medical devices.

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