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# Two-Dimensional Analysis and Numerical Simulation of the Navier-Stokes Equations for Principles of Turbulence around Isothermal Bodies Immersed in Incompressible Newtonian Fluids

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**Abstract :** In this present paper, the thermos-fluid dynamics considering the mixed convection (natural and forced convections) and the principles of turbulence flow around complex geometries have been studied. In these applications, it was necessary to analyze the influence between the flow field and the heated immersed body with constant temperature on its surface. This paper presents a study about the Newtonian incompressible two-dimensional fluid around isothermal geometry using the immersed boundary method (IBM) with the virtual physical model (VPM). The numerical code proposed for all simulations satisfy the calculation of temperature considering Dirichlet boundary conditions. Important dimensionless numbers such as Strouhal number is calculated using the Fast Fourier Transform (FFT), Nusselt number, drag and lift coefficients, velocity and pressure. Streamlines and isothermal lines are presented for each simulation showing the flow dynamics and patterns. The Navier-Stokes and energy equations for mixed convection were discretized using the finite difference method for space and a second order Adams-Bashforth and Runge-Kuta 4th order methods for time considering the fractional step method to couple the calculation of pressure, velocity, and temperature. This work used for simulation of turbulence, the Smagorinsky, and Spalart-Allmaras models. The first model is based on the local equilibrium hypothesis for small scales and hypothesis of Boussinesq, such that the energy is injected into spectrum of the turbulence, being equal to the energy dissipated by the convective effects. The Spalart-Allmaras model, use only one transport equation for turbulent viscosity. The results were compared with numerical data, validating the effect of heat-transfer together with turbulence models. The IBM/VPM is a powerful tool to simulate flow around complex geometries. The results showed a good numerical convergence in relation the references adopted.

**Keywords :** immersed boundary method, mixed convection, turbulence methods, virtual physical model
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