Abstract No: PO-37

Convective heat transfer through a pipe with mixed boundary conditions

W. U. Imeshan[1*] and W. P. T. Hansameenu[1]

[1]Department of Mathematics, Faculty of Science, University of Kelaniya, Sri Lanka
ujithaimeshan@gmail.com*

Convective heat transfer is crucial in various engineering applications, particularly in systems involving fluid flow through pipes. Understanding the heat transfer characteristics in such systems is essential for optimizing thermal performance and ensuring safe operation. The study of convective heat transfer through a pipe with mixed boundary conditions is significant for several reasons. It represents a more realistic representation of many industrial systems, where different pipe sections may experience diverse thermal environments. Also, accurately predicting heat transfer parameters under mixed boundary conditions is essential for designing and optimizing thermal systems, ensuring adequate heat dissipation or heat transfer efficiency. This study investigates convective heat transfer through a pipe with mixed boundary conditions: constant heat flux and variable wall temperature boundary conditions to examine the impact of temperature-dependent thermophysical properties on hydrodynamic and heat transfer characteristics. By conducting computational fluid dynamics (CFD) simulations, the velocity and temperature behaviours of the fluid are analysed under combinations of constant heat flux and variable wall temperature boundary conditions. The effects of fluid parameters are investigated to assess their influence on heat transfer performance. CFD analysis in COMSOL Multiphysics is carried out by coupling the continuity, momentum, and heat equations to determine the velocity and temperature profiles for a three-dimensional incompressible, steady, viscous laminar flow through a pipe with a diameter of $0.25m$ and length of $1m$. The mixed wall boundary conditions: linear temperature ($0.5m \leq z \leq 1m$) and constant heat flux ($z < 0.5m$) were considered. The results show that velocity reduces with increasing values of viscosity and magnifies with increasing values of density and volume expansion coefficients. Moreover, the temperature reduces with the increasing value of density.

Keywords: Convective heat transfer, CFD analysis, Laminar flow, Viscous flow, COMSOL Multiphysics