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Krunal M. Gangawane, B. Manikandan

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Laminar natural convection characteristics in an enclosure with heated hexagonal block for non-Newtonian power law fluids

Krunal M Gangawane*, B. Manikandan,

Department of Chemical Engineering, College of Engineering Studies, University of Petroleum and Energy Studies, Dehradun-248007, Uttarakhand, India

ABSTARCT

This work illustrates the steady state, two dimensional natural convective flow and heat transfer features in square enclosure containing heated hexagonal block maintained either at constant wall temperature (CWT) or uniform heat flux (UHF) thermal conditions. Governing equations (mass, momentum and energy) are solved by using finite volume method (FVM) with 3rd order accurate QUICK discretization scheme and SIMPLE algorithm for range of field pertinent parameters such as, Grashof number ($10^3 \leq Gr \leq 10^6$), Prandtl number ($1 \leq Pr \leq 100$) and power law index ($0.5 \leq n \leq 1.5$). The analysis of momentum and heat transfer characteristics are delineated by evolution of streamlines, isotherms, variation of average Nusselt number value and Colburn factor for natural convection (j_{nH}). A remarkable change is observed on fluid flow and thermal distribution pattern in cavity for both thermal conditions. Nusselt number shows linear variation with Grashof and Prandtl numbers; while rate of heat transfer by convection decreases for power law index value. Higher heat transfer rate can be achieved by using uniform heat flux condition. A Nusselt number correlation is developed for possible utilization in engineering/scientific design purpose.

Keywords: Square cavity; Heated block; Grashof number; Natural convection; Power law index

*Author to whom correspondence may be addressed: Tel.: +91 9760522280,

Email address: krunalgangawane@gmail.com; kmgangawane@ddn.upes.ac.in (Krunal M. Gangawane)

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