Free convection heat transfer from semi-circular cylinder inside a square enclosure: Orientation effects

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Abstract

Free convection heat transfer from a heated semi-circular cylinder at three orientation angles (i.e., 0 , 45 and 90) to stagnant power-law fluids inside a square enclosure has been studied numerically. The coupled governing equations (continuity, momentum, and energy) have been solved over the given range of the relevant dimensionless parameters of Rayleigh number ($10^2 \leq Ra \leq 10^5$), Prandtl number ($10 \leq Pr\ r \leq 100$), power-law index ($0.3 \leq n \leq 1.8$) for fixed aspect ratio ($d/L = 0.25$). The present numerical results explain the velocity and temperature profiles, average and local Nusselt numberd at different orientation angles of the semi-circular cylinders. All else being equal, it is expected that the rate of heat transfer from semi-circular cylinder at 90 degrees is higher as compare to the other orientation angle. Heat transfer rate can also increases with increasing value of Ra and decreasing value of
value of Pr. In the power-law fluids, heat transfer rate is always higher in shear-thinning fluids as compare to thickening fluids. Finally, the present numerical values of the Nusselt number for different orientations have been correlated via a simple expression using a composite parameter.

Keywords: natural convection, power-law fluid, Rayleigh number, Nusselt number, Prandtl number.