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NUMERICAL ANALYSIS OF LAMINAR NATURAL CONVECTION HEAT TRANSFER FROM A VERTICAL WALL WITH SEMICIRCULAR FINS FOR SUSTAINABLE THERMAL MANAGEMENT

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Abstract

The present investigation signifies the heat transfer phenomena from a vertical wall augmented with a fin and the other side with a constant boundary condition. The fins selected are semicircular with varying diameters and spacing is studied for a fixed length of vertical wall. A two-dimensional (2D) natural convection heat transfer for a laminar regime has been investigated along with the continuity, momentum, and energy equations of the semicircular fins with numerical simulation. The radius of semicircular fins varied from 10mm to 50 mm and fin spacing varied from 30 mm to 90 mm. A comprehensive study has been conducted to investigate the impact of fin geometry parameters and Rayleigh number on various aspects of heat transfer. Specifically, the study has examined the total heat transfer from the fin surface and from the heat transfer per fin, and Nusselt number based on fin radius. The study has analyzed these factors in detail to better understand their effects on the overall heat transfer process. Furthermore, the study has also determined the optimal fin spacing for a given fin radius. In addition, contour plots have been generated to visualize the change in temperature along with the velocity vectors of the area surrounded by the fin wall. A suitable correlation has been established after the numerical simulation establishing the dependence of the Nusselt number, Rayleigh number, and the few non-dimensional factors like fin radius to fin spacing ratio. This correlation serves as a predictive tool for designing efficient heat transfer systems, promoting energy savings and improved thermal management in environmentally conscious engineering applications.

Key words: constant boundary condition, continuity, momentum, numerical simulation, natural convection, semicircular fin

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