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LAMINAR, TRANSITIONAL, AND TURBULENT NATURAL CONVECTIVE HEAT TRANSFER FROM A HORIZONTAL RECTANGULAR ISOTHERMAL ELEMENT IMBEDDED IN A FLAT ADIABATIC SURROUNDING SURFACE

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ABSTRACT Natural convective heat transfer from a horizontal isothermal plane rectangular heated element imbedded in a large plane adiabatic surface has been numerically studied, the surface of the heated element being in the same plane as the surface of the surrounding adiabatic material. The temperature of the heated element is higher than that of the surrounding fluid. The cases where the heated element and the surrounding adiabatic surface are facing upward and where they are facing downward have been considered. Rectangular elements with aspect ratios, i.e., ratios of element length to element width, of between 1 and 6 have been considered. The flow has been assumed to be steady and the Boussinesq approach for determining the buoyancy forces has been adopted. The solution has been obtained by numerically solving the governing equations subject to the boundary conditions using the commercial CFD solver ANSYS FLUENT©, the *k*-epsilon turbulence model, with full account being taken of buoyancy force effects, being used. The heat transfer rate from the heated element expressed in terms of the Nusselt number is dependent on the Rayleigh number, the aspect ratio, the element orientation, and the Prandtl number. Results have been obtained for a Prandtl number of 0.74, i.e., effectively the value for air. The range of Rayleigh numbers considered is such that laminar, transitional, and turbulent flow conditions can exist. The variation of the Nusselt number with Rayleigh number and element aspect ratio has been studied in detail for both the upward facing and the downward facing cases.