Optimal Design of Longitudinal-Fin Heat Sinks Accounting For Simultaneously Developing Flow and Conjugate Effects

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Abstract

The thermal resistance per unit width of a fully-shrouded longitudinal-fin heat sink (LFHS) with an isothermal base is expressed in dimensionless form as a function of the conjugate mean Nusselt number, and an optimization algorithm is developed to determine the optimal fin spacing, thickness, and length that minimize the thermal resistance of the LFHS under conditions of simultaneously developing laminar flow requiring minimal algebraic computations. Prescribed quantities are the density, viscosity, thermal conductivity, and specific heat capacity of the fluid, the thermal conductivity and height of the fins, and the pressure drop across the LFHS. The present study is distinct from previous work because we do not assume a uniform heat transfer coefficient, but fully capture the velocity and temperature fields by numerically solving the conjugate heat transfer problem in dimensionless form to compute the conjugate mean Nusselt number. The results are relevant to, e.g., electronics cooling applications where heat spreaders or vapor chambers are utilized to make the base of heat sinks essentially isothermal.