Abstract

The design and optimization of tree-like or branching fins for heat dissipation in electronic cooling applications is numerically investigated under laminar natural convection conditions. To begin with, a simple tree-like fin having a stem of certain height which divides into two symmetrical and dichotomous branches is considered. Optimum branching angle of the fin is determined for different fin sizes. Arranging the optimized fins on a hot base plate, the optimum inter-fin spacing for maximum heat dissipation and the associated flow patterns are investigated for different fin sizes and base temperatures in different orientations of the heat sink. Vortex motion between the adjacent fins, geometry induced acceleration are some flow features that are observed which are specific to the geometrical structure of the branching fins. The dependence of Nusselt number on fin height, length, inter-fin spacing besides Rayleigh number are determined in different orientations. In the next study, the effect of perforations on the thermal performance of branching fin is investigated. Circular perforations of various diameters at different pitch sizes are tested to design an optimized perforated branching fin. The questions of 'why a particular pore size results in highest heat transfer' and 'do perforations always enhance heat dissipation' are explained by studying the flow and thermal fields besides showing the dependency between heat dissipation and pore size and pore distribution. The heat dissipation characteristics of heat sinks with the optimized perforated fins are also studied in different orientations. And the last objective is to investigate on multi-branching fins i.e., fins having more than two branches, and find out if multi-branching fins dissipate more heat than fins having only two branches. The branches are inclined about fin-stem with different offset angles. Symmetric and asymmetric arrangements of the branches are considered in different orientations. Except for one of the orientations, multi-branching fins do not better the simple tree-like branching fins having only two branches. However, the next best configurations are determined. It is found that asymmetric designs are superior to symmetric designs for some arrangements in one of the orientations.

Keywords: natural convection; branching-fin; perforation; multi-branching; Nusselt number