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Numerical Simulations of Electronic Cooling with In-Line and Staggered Pin Fin Heat Sinks

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Abstract : Three-dimensional incompressible turbulent fluid flow and heat transfer of pin fin heat sinks using air as a cooling fluid are numerically studied in this study. Two different kinds of pin fins are compared in the thermal performance, including circular and square cross sections, both are in-line and staggered arrangements. The turbulent governing equations are solved using a control-volume- based finite-difference method. Subsequently, numerical computations are performed with the realizable k - ε turbulence for the parameters studied, the fin height H, fin diameter D, and Reynolds number (Re) in the range of 7 ≤ H ≤ 10, 0.75 ≤ D ≤ 2, 2000 ≤ Re ≤ 126000 respectively. The numerical results are validated with available experimental data in the literature and good agreement has been found. It indicates that circular pin fins are streamlined in comparing with the square pin fins, the pressure drop is small than that of square pin fins, and heat transfer is not as good as the square pin fins. The thermal performance of the staggered pin fins is better than that of in-line pin fins because the staggered arrangements produce large disturbance. Both in-line and staggered arrangements show the same behavior for thermal resistance, pressure drop, and the entropy generation.

Keywords : pin-fin, heat sinks, simulations, turbulent flow
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