Critical Biot Number of a Periodic Array of Rectangular Fins

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Abstract

We consider the heat transfer problem associated with a periodic array of rectangular fins subjected to convection heat transfer with a uniform heat transfer coefficient. Our analysis differs from the classical approach as (i) we consider two-dimensional (2D) heat conduction and (ii) the wall, to which the fins are attached, is included in the analysis. The problem is modeled as a 2D channel whose upper surface is flat and isothermal, while the lower surface has a periodic array of rectangular extensions/fins which are subjected to heat convection. The Biot number (Bi=h t/k) characterizing the heat transfer process is defined with respect to the thickness of the fins (t). Numerical results suggest that the fins would enhance the heat transfer rate only if the Biot number is less than a critical value which is independent of the thickness of the wall, the length of the fins, and the period; the critical Biot number is approximately equal to 1.64. The optimum fins are infinitely thin and long, and densely packed, i.e., hairlike.

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