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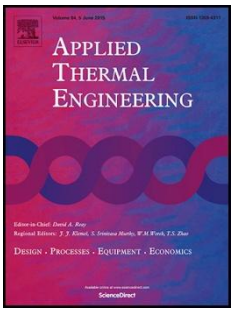

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Local heat transfer on a finite width surface with laminar boundary layer flow

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The effect of a lateral discontinuity in the thermal boundary conditions in two dimensional laminar flow on a flat plate is investigated with numerical and analytical modeling. When the thermal and momentum boundary layers start at the same location, the resulting self-similar two dimensional boundary layer equations were solved numerically. For flow with an unheated starting length, three dimensional numerical simulations were required. For both the two and three dimensional thermal simulations, the Blasius solution for a two dimensional momentum boundary layer was assumed. It is found that all the Nusselt numbers collapse to a single curve when graphed as a function of a spanwise similarity variable. Simple correlations for the local Nusselt number on a rectangular flat plate are presented for a variety of boundary conditions.

Keywords: *Laminar, forced convection, Nusselt number, finite lateral span, electronic cooling*

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1 Introduction

Cooling of electronic components is an important design consideration for digital systems. Many of these have discrete rectangular heat sources that are cooled in a channel, but modeling both the fluid flow and the conduction in the substrate can be a prohibitively expensive task. Many studies seek to simplify the modeling by presenting heat transfer coefficient correlations for the boundary conditions of the conduction problem.

Several studies have investigated the heat transfer coefficient from finite flat plates. Baker conducted one of the first studies of small heaters [1], and noted that the average heat transfer coefficient could be more than an order of magnitude more than predicted by the canonical two dimensional flat plate correlations. Other studies have reported heat transfer coefficient correlations that also take into account the conductivity of the substrate [2, 3]. Bhowmik [4] recently published a short review of the subject.