Air Cooling Enhancement in Entrance Region with Delta Winglet Vortex Generators Set at the First Row of In-Line Array of Electronic Module

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ABSTRACT

The objective of this study was to experimentally investigate the heat transfer enhancement by delta winglet vortex generators for air cooling in entrance region of in-line array of electronic modules. The study had been carried out when the winglet pairs were placed in front of the first row of the array. Each module had a dimension of 1.8 cm x 5.8 cm x 0.6 cm and each one generated heat at 5 W. The adiabatic heat transfer coefficients and the thermal wake for the modules with and without the generators were considered at different values of Reynolds number. It was evident that the vortex generators could enhance the adiabatic heat transfer coefficients, reduce the thermal wake function and the module temperature, especially for the first row. Moreover, the correlations to predict the heat transfer data had been developed when the vortex generators were integrated and the predicted module temperatures agreed very well with those of the experiments.

Key words: Electronic cooling, Vortex generator, Heat transfer enhancement

INTRODUCTION

There are many techniques for the thermal management but the convective air cooling is still the most common for electronic cooling because of its low maintenance and low investment cost. However, the common forced-air cooling is not sufficient in case of high power dissipation, especially, for the complex electronic components.

Heat transfer enhancement of air cooling by vortex generator is one passive method that generates streamwise vortices which creates high turbulence in fluid flow over heat transfer surfaces. Delta winglet vortex generator is one of the promising techniques to integrate in compact heat exchangers and shows a very good heat transfer performance. There was a report (Wrobleski and Eibeck, 1991) which showed that the longitudinal vortices imbedded into turbulent boudary layers could enhance the heat transfer. Some researchers (Fiebig et al., 1986, 1993; Fiebig, 1998) had studied the influences of different types of vortex generators on heat transfer performance such as delta wing, rectangular winglet and delta winglet and the best performance was found in the delta winglet type.

Vortex generators have also been applied to enhance heat transfer in electronic modules. There was a report (Garimella and Eibeck, 1991) which investigated heat transfer enhancement by installing a row of half-delta wing vortex generators upstream of a heated copper chip array. The study used water as a coolant and two heights of the vortex generators (one and two times of the chip's height).

Thermal wake and pressure drop characteristics in a set of electronic modules when there were different shapes and sizes of ribs fixed to the array board had also been studied (Jubran and Al-Saleymeh, 1999). The thermal wake function of the chips downstream could