Time & Location: August 21, 2012 at 3:00 PM in ENG 1 288
Title: Simulation of Heat/Mass Transfer of a Three-Layer Impingement/Effusion Cooling System

Cooling techniques for high density electrical components and electronic devices have been studied heavily in recent years. The advancements in the electrical/electronic industry have required methods of high heat flux removal. Many of the current electrical components and electronic devices produce a range of heat fluxes from 20 W/cm² - 100 W/cm². While parallel flow cooling systems have been used in the past, jet impingement is now more desirable for its potential to have a heat transfer coefficient 3-5 times greater than that of parallel flow at the same flow rate. Problems do arise when the jet impingement is confined and a cross flow develops that interacts with impinging jets downstream leading to a decrease in heat transfer coefficient. For long heated surfaces, such as an aircraft generator rotor, span wise fluid management is important in keeping the temperature distribution uniform along the length of the surface. A detailed simulation of the heat/mass transfer on a three-layer impingement/effusion cooling system has been conducted. The impingement jet fluid enters from the top layer into the bottom layer to impinge on the heated surface. The spent fluid is removed from the effusion holes and exits through the middle layer. Four impingement jets were spaced around each effusion hole ranging in diameter from 0.5 - 2 mm. Temperature uniformity, heat transfer coefficients, and pressure drops were compared for each effusion diameter, jet to target spacing (H/d), and addition of heated surface ribs. A Shear Stress Transport (SST) turbulence fluid model was used within ANSYS CFX to simulate all design models. Three-layer configurations were also set in series for long, rectangular heated surfaces and compared against traditional cooling methods such as parallel internal flow and normal jet impingement with cross-flow effects. The results show that the three-layer design compared to a traditional impingement cooling scheme over an elongated heated surface can increase the average Nusselt number by 60% and reduce the temperature difference on the surface by 75%. It was also shown that the average Nusselt number increases when the H/d is small and the heated surface includes ribs. The pressure drop increases with the decrease in effusion diameter while having minimal change in heat transfer.

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Approved for distribution by Dr. Louis Chow, Committee Chair, on August 5, 2012.

The public is welcome to attend.