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I-CReST 2025:123-087 – Vortex Formation and Heat Transfer Coefficient Relationship Through Synthetic Jet Cooling Application on Electronic Devices

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ABSTRACT

With the decreasing size and the increasing complexity of modern electronic gadgets, heat dissipation problems on these gadgets have become increasingly challenging to resolve thus causing inefficient in thermal management. Compact electronic gadgets with high power requirements and miniature electronic components are usually more susceptible to overheating due to their size which hinders efficient heat transfer. This paper discusses the application of synthetic jet cooling on these devices through the relationship between vortex formation and heat transfer coefficients. Synthetic jet is a device capable of discharging fluid to dissipate heat on given devices. It consists of a periodically moving diaphragm and cavity with a nozzle. Vortices were formed when fluid is being discharged through the synthetic jet. Through ANSYS FLUENT, fluid characteristics of these vortices were simulated, and the air flow is approximated to be of three-dimensional, unsteady, turbulent, and incompressible. Experimental data are also being discussed in this paper to validate the simulated data. Taguchi method was chosen as the method for optimizing the data hence generated an equation to predict the temperature response to the synthetic jet application. It was observed that nozzle diameter became the prominent parameter that contributed to the temperature response. Nozzle to heated surface distance and cavity depth came in second and third respectively as contributors. Based on these contributing factors, heat transfer process can be most effective when the vortex formed through synthetic jet is as close as possible to the heater surface. The generated equation was able to predict the temperature response as accurately as possible.

Keywords: Synthetic jet; Thermal management; Vortices; Optimization