UNIVERSITI TEKNOLOGI MARA

CHARACTERISTIC OF HEAT TRANSFER USING SYNTHETIC JET COOLING IN A CLOSED LOOP SYSTEM

AHMAD FAIZ BIN AHMAD KAMIL

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ABSTRACT

The size and complexity of modern electronic devices have made it increasingly challenging to address heat dissipation problems. Existing temperature management methods are not effective in dealing with the overheating issues of small electronic components and compact high-power devices. Previous research has overlooked the relationship between vortex formation and heat transfer coefficient (HTC) values. Therefore, this study investigates the use of synthetic jets, which involve a periodically moving diaphragm and cavity with a nozzle, to address this issue. The expelled air from the nozzle generates a vortex that progresses through different phases. Fluid characteristics are simulated using ANSYS FLUENT software, and the simulation data is validated through temperature measurement experiments. After optimizing the parameters using the Taguchi method, a temperature response prediction equation is derived. The diameter of the nozzle has the most significant impact on the maximal response, followed by the depth of the cavity and the distance between the nozzle and the heated surface. Smaller volumes and cavities are preferred because they enhance convection between the forced air and the heated surface. A distance of 30 mm is found to be sufficient for maintaining the intensity and coherence of the vortex formation. The radius of the vortex formation has no significant role when there is a considerable distance between the formation and the heated plate. In conclusion, to maximize heat transmission, the vortex formation should be as close to the heater surface as possible, and the developed equation can predict the temperature response within the parameter range studied.

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1.1.1 Background of Study

The rapid advancement of technology necessitates the dissipation of a significant quantity of heat, owing to the faster operation of each transistor and the increasing density of transistors on integrated circuits. When it comes to electronic components, thermal overstressing is one of the most common reasons of failure. This underlines the importance of effective thermal management, which is possibly the most critical aspect of the design of an electrical system (Mohammadpour et al., 2021). As technology get smaller and more compact, heat dissipation concerns become increasingly difficult to address. If heat generation and temperature rise are not properly managed, they can lead to performance deterioration, essential component failure, and even user interface discomfort. It is thought that the overheating of the working electronic component is due to a combination of three factors: heat absorption from surrounding components during operation. Temperature-related issues account for almost ninety percent of all electronic failures(Embury et al., 2020).

The currently available temperature management options, which include heat sinks, heat sinks with fans, and other conventional cooling methods, have been shown to be insufficient in tackling the thermal issues that are faced by a major amount of microelectronics. The limitations of these old approaches to cooling have become increasingly evident, and as a consequence, the demand for thermal management strategies that are more efficient and advanced in electronic equipment has become an absolute necessity. As a consequence of this, there is a growing demand for improved technologies that can effectively control temperatures and manage the dissipation of heat in electronic equipment (Ariffin & Ahmad, 2020).

A micro fan is the most common way for cooling any electronic gadget. After some time, this "active" method of cooling beats "passive" methods in terms of performance. The key obstacle is the difficulty of developing fans small enough to prevent a substantial increase in energy consumption. For instance, forced convection