UNIVERSITI TEKNOLOGI MARA

EMPIRICAL RELATIONSHIP ON VORTEX FORMATION AND HEAT TRANSFER COEFFICIENT (HTC) USING SYNTHETIC JET COOLING

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ABSTRACT

The size and complexity of modern electronic gadgets have increased, making heat dissipation problems more challenging to resolve. The management of temperature currently in place is inefficient. Due to their small size and ineffective heat transfer, compact electronic gadgets with high power requirements and miniature electronic components are prone to overheating. The relationship between vortex formation and the heat transfer coefficient (HTC) value has not received much attention from previous researchers. Synthetic jet (SJ) consists of a periodically moving diaphragm and cavity with a nozzle has been used in this research. During the ejection phase, the cavity fluid is discharged from the opening forming vortex that move from cycle 1, cycle 2 and cycle 3. The CFD software used for simulation is ANSYS FLUENT to simulate the fluid characteristic. The numerical simulations approximate the air flow as three-dimensional, unsteady, turbulent and incompressible. The solver used is Semi-Implicit Method for Pressure-Linked Equations (S.I.M.P.L.E) algorithm meanwhile the turbulence model that has been used was K-ω SST. Experiment has been carried out to obtain temperature in order to validate the simulation data. Optimization using Taguchi method has been carried out and an equation has been generated to predict the temperature response. Nozzle diameter is the most significant parameter that contribute to the highest response followed by nozzle to heated surface distance and cavity depth. Small volume and small cavity are better because they resulted to higher velocity output thus increasing the convection process between the force air and the heated surface. Distance range of 50 mm is adequate for the vortex to have strength and coherence without been affecting by the reverse suction flow. The ability of the vortex formation to reach the heated surface is important to maximize the HTC value and the radius of vortex formation does not play huge role if the distance between the vortex formation and the heated plate is high. It can be concluded that in order to maximize the heat transfer process, the vortex formation needs to reach out as close as possible to the heater surface and the equation developed able to predict the temperature response within the range parameter used in this research.

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CHAPTER ONE
INTRODUCTION

1.1 Project Background

1.1.1 History

The rapid growth of electronic and communication technologies, particularly for 5G Wireless Communication Technologies, has resulted in the widespread use of small and compact electronic devices. Because of its integrative and intelligent features, portable electronic systems that combine numerous intelligent functional units in a restricted space have gotten a lot of attention. (Li et al., 2020) However, as devices become more compact and miniaturize, heat dissipation issues become more difficult to solve. Heat generation and temperature rise, if not properly managed, can lead to performance degradation, essential component failure, and even user-device interface discomfort. Overheating of the running electronic component is thought to be produced by a combination of three factors: heat absorption from the environment, heat creation by the component itself during operation, and heat absorption from nearby components during operation. High temperatures are responsible for over 90% of electronic failures (Jacob et al., 2020).

Numerous compact devices now utilize ineffective heat management methods. Heat sinks, heat sinks with fans, and other conventional cooling techniques are no longer effective. As a result, more powerful heat transfer improvement methods or cooling techniques are needed to keep the temperature of electronic equipment within a safe range(Jacob et al., 2020). The micro fan is the most common way to cool any mobile device. This "active" form of cooling is eventually better to the other "passive" modes of cooling. The major issue is the difficulty in making fans tiny enough so that power consumption isn't drastically raised. Forced convection cooling via a fan, for example, necessitates large, heavy equipment. Furthermore, due to noise, maintenance, and added power consumption, fans are insufficient for usage with portable and compact devices. In addition, the cooling components will incur additional costs. The undesired temperature buildup may result in electronic performance degradation, thermal discomfort, and even skin harm. Furthermore, if 5G technology is integrated