EFFECT OF VOLUME CAVITY AT VARIOUS DISTANCES FOR THERMAL COOLING PUMPING JET DEVICE

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ABSTRACT

Space is a major constraint in electronic cooling to dissipate heat that can cause overheating to the device. Synthetic jet is an air based cooling system that developed without the use of fans to its flow. Due to the intake and eject for high velocity working fluid from a single opening makes synthetic jets are zero-net-mass-flux.This research was focused on the effect of volume cavity at various distance between the nozzle to heated surface and effect of volume cavity at various frequency. Three experiments have been conducted during the study which were experiment of heater characteristic, external and internal temperature and fluid air velocity for the fabricated synthetic jet.. The experiment using heater of 24 V; 100 W. The power input were used to determine the consistent heater surface temperature at 343.15 K.Five different volume have been used in this research. Each volume were tested from 300 Hz to700 Hz driving frequency at 50 mm distance nozzle to heated surface. Result show that, high temperature reduction for model 1 at 500 Hz (431.75 K) compare to other driving frequency. It given that 500 Hz is the resonance frequency that has maximum amplitude. Maximum temperature reduction was obtained at 50 mm distance. Maximum air velocity for all model of synthetic jet were located at distance of 10 mm while minimum air velocity located at 70 mm Model 1 of synthetic jet were given the highest air velocity and lowest air velocity which is 1.29 m/s and 0.08 m/s respectively

CHAPTER ONE

INTRODUCTION

1.1 Background Study

Nowadays, electronic devices are really important in our daily life. For example, television, mobile phone, computer, laptop and so on. For every electronic device there, will be a maximum allowable operating temperature that is provided by the electronic device manufacturer. If the electronic device is operated beyond its maximum allowable operating temperature its performance and expected life time will not be guarantee (Shabany, 2010). Therefore, it is important to cool electronic device so that their operating temperature remains below the maximum allowable value.

For every electronic device, there will be a failure due to high temperature or overheating process. If the heat is not dissipated from the device efficiently, it will cause the device burn or caught on fire (Shabany, 2010).If the temperature continuously rises even it will not enough to cause fire or burn to device, failure may still cause due to the high temperature. Figure 1.1 shows a CPU before and after failing due to overheating.

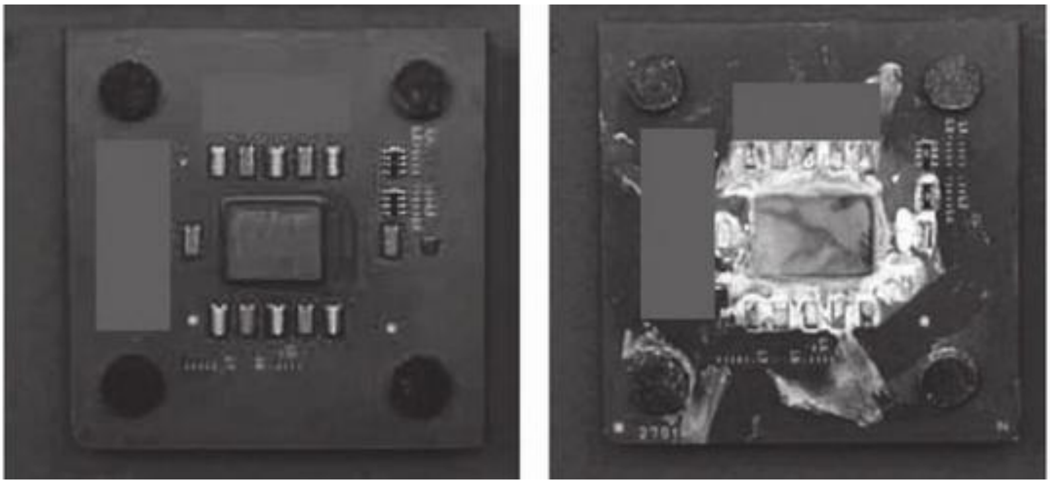

Figure 1.1 Before and After Overheating Temperature Toward CPU (Shabany, 2010)

Meanwhile, the temperature dependence of microelectronic device failures are often classified as mechanical, corrosion and electrical failure (Shabany, 2010).For mechanical failure it related to any kind of excessive deformation, yield, crack and fracture in a material or the separation of the joint between two pieces (Shabany, 2010). When the force applied to a material create stress (force per unit area),which is higher than a yield stress of material ,the joint between two pieces cannot tolerate the shear or tensile stress applied to it, or the repetitive application of a small force creates fatigue failure . Figure 1.2 demonstrate the deformation of bar due to temperature changes.

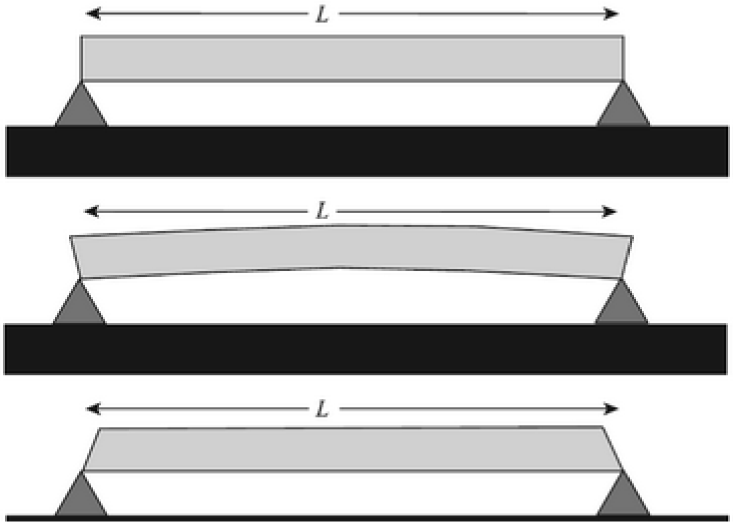

Figure 1.2 A Metal Bar Mounted on Rigid Joint(Top),Deform when Temperature Increases (Middle), and goes Under Tensile Stress (Bottom),when Temperature Decrease (Shabany, 2010)

Equation 1.0 define the rate of expansion or contraction of a unit length of a material per unit change in its temperature known as coefficient of thermal expansion (CTE).

$$\alpha = \frac{1}{L}\left(\frac{\partial L}{\partial T}\right)\mathrm{P} \qquad \text{(Eq 1.0)}$$

The index P indicates that pressure is kept constant during the measurement of α, such that the change in length is due to the change in the temperature only. The CTE is measured in ppm/°C where ppm stands for part per million.

Thus, for mechanical failure in electronic device can determine from a difference in CTE of bonded material, large time-dependent temperature changes, and large spatial temperature gradient (Shabany, 2010).

Failure in electronic device is refer to failure that will affect the performance of the device. Common electrical failure such as thermal runaway, electrical overstress, ionic contamination and electro-migration (Shabany,2010).For example,