JÓVENES EN LA CIENCIA
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ANALYSIS OF THE STATE OF THE ART OF HIGH ENERGY FLUX DISSIPATERS IN ELECTRONIC DEVICES

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Abstract

The importance of heat sinks in electronic devices will be analyzed in this project, the different types, and the factors that affect the performance of a heat sink, like the geometry, size and number of fins, the speed of the flux, the material the heat sink is made of, the diameter and positions of the channels. To understand the difference between a het sink with a fan and one with microchannels a comparision is made in this project.

Palabras Clave

Heat sinks, pressure drop, fins, microchannels, dissipation.

INTRODUCCION

Every day we use electronic devices to bring comfort to our lifes. A serious problem which we present is that these devices are usually heated after long use. Reducing the temperature is necessary to prolong the life of the component. That's why it´s important to know the operation of a heat sink because it will allow you to choose the appropriate heat sink. With the great evolution, the new computers have smaller processors with more capacity, more capacity generates a higher heat flux.

HEAT TRANSFER

Is the exchange of heat between one or more bodies that have a difference of temperature.

Heat transfer may be three modes:

* Conduction: When there is a temperature gradient in a solid and an energy transfer is made in the form of heat from the region of high temperature to low temperature.

* Convection: Energy is transferred in the form of heat through liquids and gasses. Energy can be transferred between two or more fluids or between a fluid and a solid object.

* Radiation: When there is a heat transfer in form of heat in objects that are not in contact. [13]

TYPES OF HEAT DISSIPATION IN COMPUTERS:

a) Fan: A fan is used to move the hot air out from the heat sink that is in contact with the component that is going to be cooled.

b) Water: Tubes send the liquid through the components that are going to be cooled. A tube is set from a bomb to the heat sink, then to a radiator and finally to a reservoir.

c) Vapor: A refrigerant passes through the CPU and becomes gas, the gas is moved to a compressor and then to a condenser, where it will be transformed back to liquid. This cooling system can be very useful but is very expensive. [13]

HEAT SINKS IN ELECTRONIC DEVICES

Devices used to avoid the overheating of electronic devices which may affect their performance. The average temperature for a good performance of a heat sink is between 50 and 85°C. The problem is generating devices with small dimensions that can dissipate that amount of heat. [4]

FIGURE 1 AND 2 show the different kind of heat sinks that we will analyze.

The most common haeat sinks in Mexico are the CoolerMaster and Alpha cool devices. Their cost depend on the size and type of heat sink, both of these companies have heat sinks that work with fans and liquids.

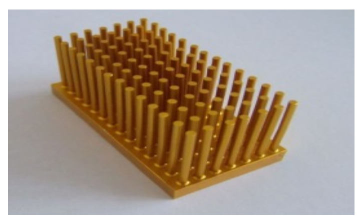

Figure 1. Heat sink with fins.[11]

Figure 2. Michrochannel heat sink.[12]

HEAT SINKS WITH FINS:

The pressure dorp is an important feature that needs to be contemplated to measure the performance of a heat sink. This will depend on the configurations of the fins and the flux pattern in the dissipator. [3]

It was known a lot of circular fins, but it was until Dogruoz et. al started to work on squared fins. [3]

Behnia *et al*. presented a study comparing fins to reduce the thermal resistance using different air speeds. [7]

Khan et al. studied squared, circular, elliptical and rectangular fins. They used the EGM (entropy generation minimization) technique that allows them to analiyze the combined effect of the thermal resistance and the pressure drop, this was very useful to evaluate the result of the interaction with the heat sink. [1]

Kai Shing Yang, Wei-Hsin Chu, Chen Ing-Yong and Wang Chuan Chi-finned realized experiments in different ways. What they got was that the better overall thermal performance for applications at low speed (v <8 m / s) is a circular fin type. [1]

Billen and S. K. Yapici conducted an experiment to see heat transfer differences of a hot plate with rectangular blocks at different angles. As a result, they obtained that apart of the variation of the angle, also affects the separation between the blocks. When the angle was 45 ° the greater heat transfer is obtained. Later experiments showed that the thermal limit for each block was accompanied by large heat transfers. [5]

Luviano-Ortiz analyzed heat transfer and fluid's movements in an horizontal channel formed by 2 parallel plates with heated blocks which are inserted periodically and with the use of curved deflectors to conduct the flow. The results show that heat transfer is greater if the deflectors were not used, however be noted that the pressure drop in the channel increases. [5]

HEAT SINKS WITH MICROCHANNELS:

A good flow distribution is need in all flow devices,that is the case in heat sinks. Flow maldistribution can create local temperatures that will affect the performance of the heat sink, that´s why it´s very important to have a good flow distribution in these devices. [10]

Tuckerman submitted a proposal to dissipate high heat fluxes. He made several experiments and found that water passing through channels with diameters of micrometer order could obtain a great dissipation. [8]

Rubio et al. Realized studies about microdevices acting as heat sinks. They demostrated that microchannels heat sinks with triangular and trapezoidal shapes, using water as the cooling fluid, are not able to dissipate heat flux higher than 100 W/cm2.[8]

Lim et al. presented a study to explain the reason for the decreasing of the friction coefficient in the channel. They blamed the water viscosity reduction in tubes with diameters smaller than 300 μm.[8]

Rubio et. al. realized an analysis conducted in microchannel heat sinks. The experiments performed were based on movements of the nature, the water passes through the microchannels just as a leaf. [9]

Anderson and Moffat used curved vanes to improve the cooling of electronic components through increased thermal mixing in the coolant flow. To reduce air temperatures, they installed the curved vanes near electronic components in the regions of high temperature and low velovity. [2]

Peterson, GP, Ortega, A., Yang, and Zhang WJ, N. L found that the way to dissipate high heat fluxes is placing the sink as close as possible to the source of generation. [6]

Comparision between heat sinks (with fan and microchannels)

Experiments were realized between these 2 types of heat sinks to see which one is better. One of the heat sinks used was an INTEL device, the other one was a CoolerMaster device. The power used for both devices was 30 watts.

FIGURE 3 AND 4 show the heat sinks used for this comparision, one working with air and the other one with liquid.

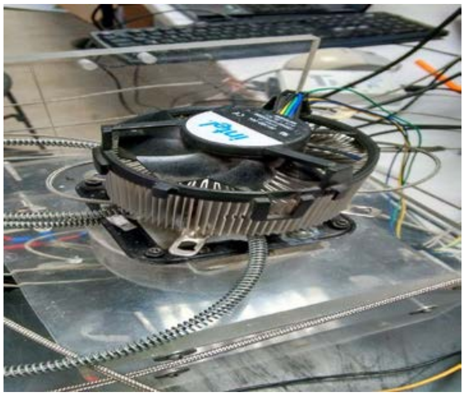

Figure 3. Intel heat sink.

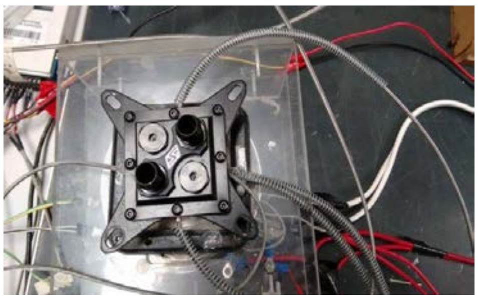

Figure 4. CoolerMaster heat sink.

The results were very usefull to see which one has the best performance.

FIGURE 5 AND 6 show the results obtained. With the Intel heat sink the temperature obtained to stabilize the heat sink and the processor was 58.6 and with the CoolerMaster was 46.9.

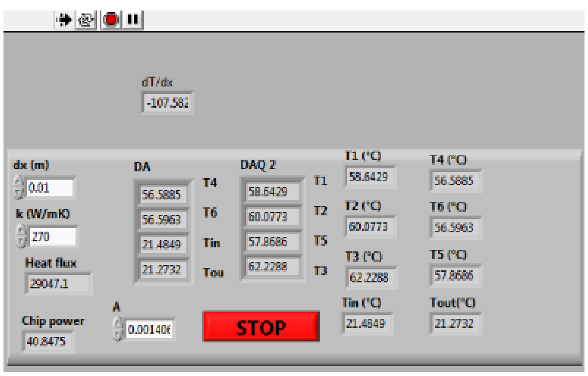

Figure 5. Intel results.

HEAT SINK	TYPE OF COOLING	TRANSITORY STATE TEMPERATURE (°C)
Intel	Air	58.6 °C
Cooler Master	Liquid	46.9°C

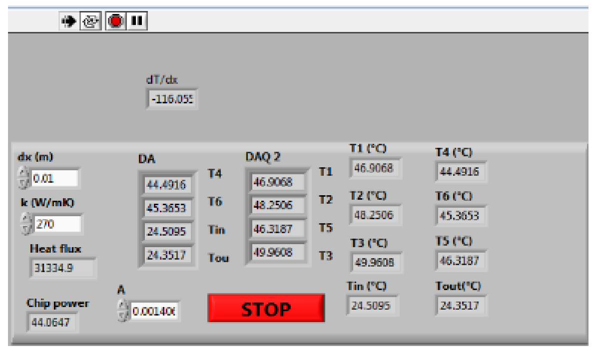

Figure 6. CoolerMaster results.

CONCLUSIONS

It was rather interesting to work on this topic. I had the opportunity to have a hands-on laboratory experience and was able to compare a heat sink suited with a fan (conventional mechanism used in current computers) and a state-of-the-art heat sink with microchannels. The results demonstrated that the difference of temperature at which the processor which is cooling and the heat sink stabilize is quite high, almost 12°C. Clearly the foreseeable future for the cooling of high-level electronic equipment lies on the use of the the novel systems developed by Dr. Hernandez's research group.

This project was very helpful to learn how to do research and write properly. I hope to be able in the future to become a researcher on this area.

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