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COOLING OF DESKTOP COMPUTER USING HEAT PIPES

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ABSTRACT

The present experimental work investigates the heat transfer performance of parallel heat pipe in a desktop computer, which consists of four single tube heat pipe connected by two copper blocks at the top & bottom ends. For this purpose, the copper tube of 4.75 mm ID is used with acetone as working fluid. One copper block is placed above the heat source (on the processor) & another copper block is placed above the heat sink to dissipate the heat to the outer finned surface (natural convection). Heat transfer characteristics are determined experimentally, based on the principle of phase change. The experimental results show that, the steady state temperature of the processor has been reduced substantially when using heat pipes compared to the cooling fan. Cooling fan in the condenser section can also give promising result as well as natural convection by finned surface, which have also been studied in this project.

Keywords: Heat Pipe, Desktop Computer, Heat Transfer Performance,, Cooling Fan.

1. INTRODUCTION

Much effort has been made in recent years to minimize noise generated by CPU cooling fans, a fact that has been demonstrated by the popularity of variable and low speed fans coupled with efficient CPU heat sink designs. Even with the adjustable fans generating lower noise at lower speeds, the main noise sources in a computer system are fans and hard drive. Therefore, the best way to eliminate the noise is to remove these sources. As it is impractical to get rid of the hard drives, it seems like a good idea to cool the CPU without a fan. After looking at products based on heat pipe technology, such as Zalman's graphics card coolers, we felt it would be a good idea to try passive CPU cooling utilizing heat pipes [1] [2] [3].

Heat pipes are capable of transferring a large amount of heat per a given volume of working fluid due to the phase change that takes place. Inside of a heat pipe is a liquid under low pressure (or vacuum) that boils into vapor when it absorbs heat. This vapor then condenses back into liquid at the cooler surfaces of the heat pipe and releases the heat. So the concept here is to draw the heat from the CPU into one end of the heat pipe, while putting the other end of the heat pipe in contact with a larger heat sink to expel the heat into the air.

The purposes of this study are:

- To study the performance of the heat pipes with respect to the normal fanned CPU unit.
- To lower the steady state temperature of the microprocessor by increasing the heat transfer rate using heat pipes.
- To observe the effect of cooling fan in the condenser section along with the large heat sink.

2. COMPONENTS

In this project following main components have been used

A desktop computer
An evaporator
Heat pipes
Heat sink
Aluminum support
Cooling apparatus
Extended Al-fins
Cooling fan
Measuring apparatus
Temperature display
Thermocouple wire
Selector switch
Working fluid (acetone)

3. EXPERIMENTAL PROCEDURE

Steps of experimental procedure are as follows:

1. First of all the Cu-blocks is made very precisely to mate with the heat pipes. Grooves are cut inside the Cu-block pair. This is one of the most important parts of this work. Because if the blocks are not in precise dimension and surface finishing the contact resistance will be more & the heat transfer will be reduced.

Two pairs of Cu-blocks are used in this arrangement. The evaporator & the condenser sections are placed in

Table 1: Experimental parameters & their ranges

Parameters	Condition
Diameter of pipe (mm)	OD:6
	ID:4.75
Length of total Heat Pipe (mm)	310
Length of evaporator (mm)	50
Length of adiabatic section (mm)	210
Length of condenser (mm)	50
Dimension of Cu-block (mm)	67×51×8
Kinds of working fluid	Acetone
Charge ratio	0.90
Wick(SS)	200 mesh

A desktop computer
Configurations of the computer used in this project are follows

Table 2: Detail configuration of the Computer

Components	Specification
Processor	Ali M1542A1 100 MHz
Fan	DC voltage- 12V Power- 0.75 Watt
Ram	16 MB
Hard disk	Seagate Model ST34321A 10GB
Power box	115/230 VAC 15 A/ 10 A

between the two Cu-blocks. Heat is generated in the processor & then conducted in the Cu-blocks from where the heat pipes gain the heat. Similarly in the condenser section the heat which is carried by the acetone is rejected to the Al-fin through Cu-blocks & Al-sheet. Precise control of dimension of the cu-blocks is a very important factor. The surface finish of the blocks needs to be very smooth. These reduce the contact resistance of heat flow.

2. Before bending the heat pipes, wake is inserted in it. They are stainless steel wakes of 200 meshes. After inserting the wakes heat pipes are bent to the desired degree.

One end of the heat pipes is soldered & then working fluid Acetone with charge ratio 0.9 (1.2ml) in poured into the heat pipe & then the other end is sealed. Thermocouples are connected on different points along the length of the heat pipe & then insulated with glass wool.

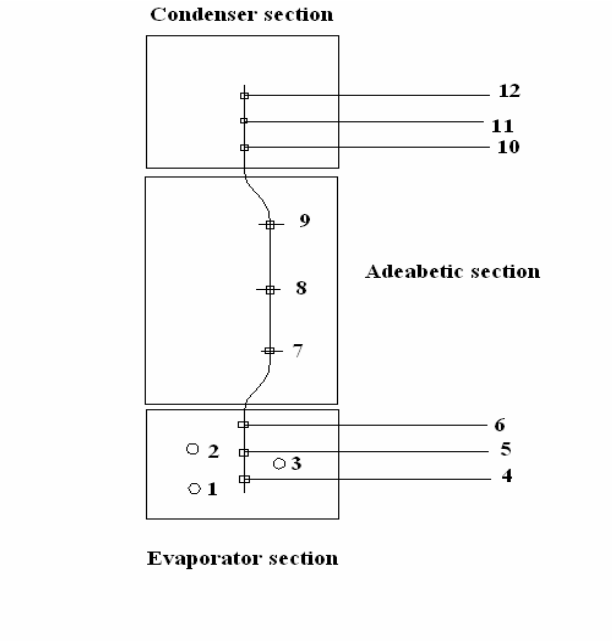

Fig 1: Position of thermocouples along the heat pipes

In this experiment four heat pipes has been used. They were used in two arrangements. At first the cooling efficiency was observed by using two heat pipes. Secondly all of the four heat pipes were used for better heat transfer purpose. The heat pipes were copper tubes consists of three sections:

One evaporator section
One adiabatic section
One condenser section

Adiabatic section is located in between the evaporator and condenser section. This section is actually kept with heat pipe to distinguish evaporator section and condenser section. Adiabatic section is thermally insulated by Glass wool.

3. The motherboard of the CPU is placed on the Al support by means of screws. The motherboard is insulated from the Al-sheet by means of a laminated sheet. Then the heat pipes, Cu-block are assembled & screwed tightly. Al support is made of mild steel sheet having dimension of 130 mm length, 40 mm width and 4 mm thickness.

4. After proper assembling, all the connections including Hard disk, Graphics card, Ram, Monitor, Power supply of the computer is connected. Then the computer is turned on. Data is taken from the temperature controllers by changing the selector switches until steady state condition is reached.

Fig 2: Grooves in Cu-blocks

Fig 3: Alluminium support

Fig 4: Arrangement of Thermocouple, Heat Pipe & Selector switch

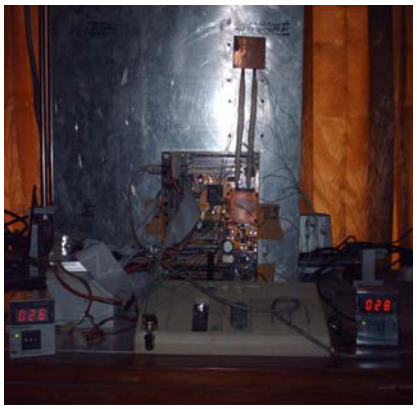

Fig 5: Experimental setup with two heat pipes

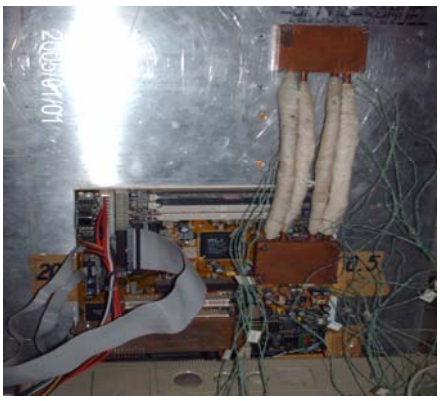

Fig 6: Experimental setup with four heat pipes

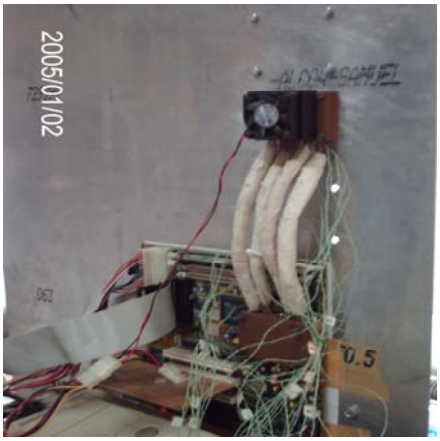

Fig 7: Experimental setup with four heat pipes & cooling fan in tyghe condenser section

4. RESULTS AND DISCUSSION

The figure 10 shows the comparative results obtained in this experiment.

- The actual steady state temperature of then processor using only cooing fan is 91ºC.
- Replacement of the cooling fan with two heat pipes gives maximum steady state temperature to 85 ºC. The maximum heat pipe wall temperature in the evaporator section is 75 ºC.
- Replacement of the cooling fan with four heat pipes is efficient as it can reduce the steady state temperature to 81 ºC -82 ºC. The maximum heat pipe wall temperature in the evaporator section is 73 ºC.
- Replacement of the cooling fan with a combination of four heat pipes and cooling fan in the condenser section give a much more efficient result as it can reduce the steady state temperature to 77 ºC-78 ºC. The maximum heat pipe wall temperature in the evaporator section is 69 ºC. The time taken to reach this steady state temperature is also short. The steady state temperature was attained about 30 minutes before than the previous set up (with four heat pipes only) .This implies that natural convection using only finned condenser is not so efficient than the combination of cooling fan and finned section in the condenser.

Figure 7 shows the steady state temperature of the processor when it is being cooled by fan only. Figure 8 &

figure 9 shows the change of temperature along the length of the heat pipes using two & four heat pipes respectively.

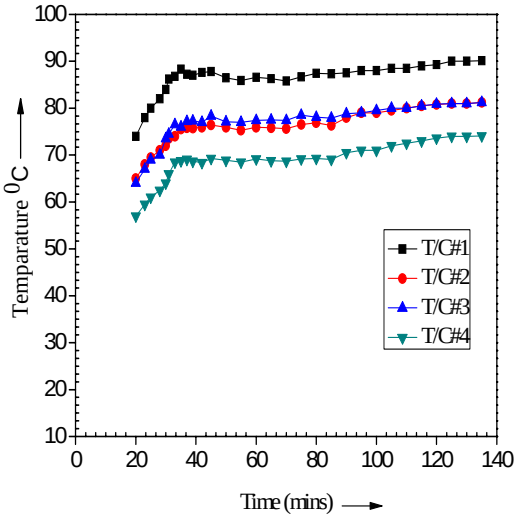

Figure7: Temparature Vs Time curves for the steady state condition using fan on the processor

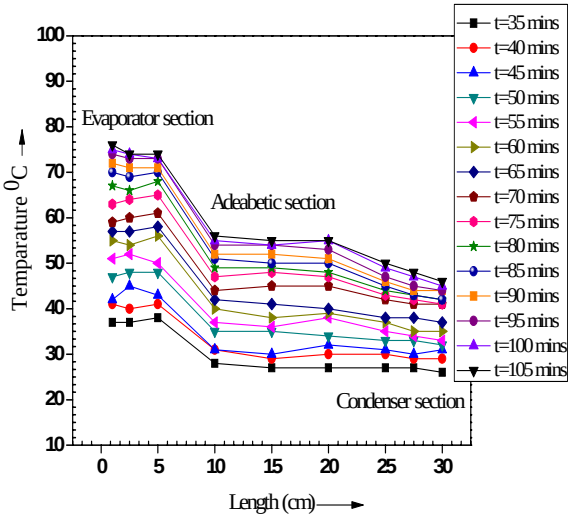

Figure 8: Temparature Vs Pipe Length curves for Pipe 2 using two heat pipes

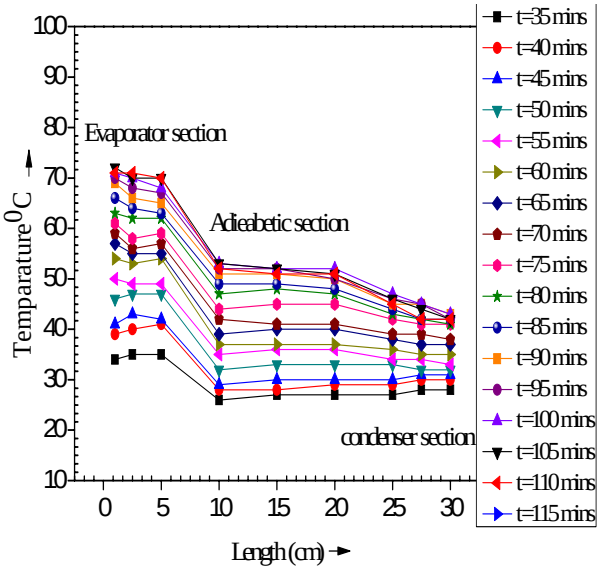

Figure 9: Temparature Vs Pipe Length Curves Using Four Heat Pipes

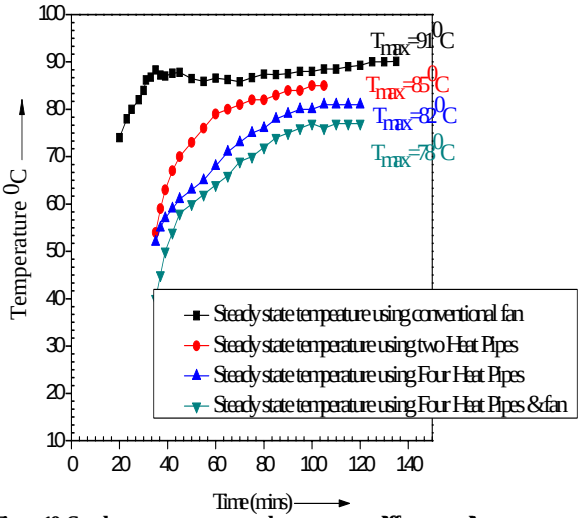

Figure 10: Steady state temperature on the processor at different conditions

5. DISCUSSION

The conventional desktop computers use only cooling fan for removing the heat generated in the high speed processor. As the speed of the processor is increasing day by day, some alternative ways should be devised for better cooling. This is why this project has been taken to cool the desktop computer with the application of heat pipes.

In doing the above objectives three sets of combination have been used. They are:

- Cooling with two heat pipes
- Cooling with four heat pipes and
- Cooling with a combination of four heat pipes and fan in the condenser section.

First the normal steady state temperature has been measured using fan only. The temperature was 91 ºC. Then only two heat pipes have been used instead of fan and measured the steady state temperature which was 85 ºC which below the previous temperature. So it is a positive result.

Now four heat pipes have been used. The steady state temperature now became 81 ºC-82 ºC. This indicates a much more efficient result. So by using four heat pipes better cooling have been obtained than using only cooling fan. The number of heat pipes used in this regard is limited by the space available in the evaporator & condenser section.

Lastly combination of the fan with four heat pipes has been introduced, which showed very good result. The steady state temperature is successfully reduced to 77 ºC-78 ºC. Consequently the maximum heat pipe wall temperature is reduced to 69 ºC .This also took less time to reach the steady state temperature. The reason is that using fan in the condenser section means forced convection. When the Acetone vaporized by taking the heat from the evaporator section it comes to the condenser section & heat is removed rapidly by dual action of forced convection of the cooling fan & finned surface compared to only natural convection by finned surface.

So from the above discussion it can be said that design with four heat pipes can perform well for normal usage and more likely even for extended gaming. As the speed of the processor of desktop computer is increasing day by day, a time will come when only fan cooling will not be sufficient to take this thermal load. At this condition the combination of four heat pipes along with cooling fan can handle this problem efficiently.

6. CONCLUSIONS

Though the incorporation of heat pipes in the desktop computers seems to be costly but it gives a better performance compared to only fan. Again, the processor speed is increasing day by day. So in the next future heat pipes will take the position of the cooling fan. There are many ways to modify the system, but the existing system function very effectively at both reducing noise & cooling the CPU in a passive manner.

7. REFERENCES

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