International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Investigation of CPU Life Spanin Desktop by Recovering the Heatusing Heat Pipe Technology with R32 as Working Fluid

M. Shanmugam[1], Dr. S. Sundararaj[2], VR. Shiva[3], V. Sowndarraj[4], G. Vishnu prakash[5]

[1]Associate Professor Department of Mechanical Engineering, Nandha Engineering College Erode.
[2]Professor Department of Mechanical Engineering, Sri Krishna College of Technology, Coimbatore.
[3,4,5] UG Students, Department of Mechanical Engineering, Nandha Engineering College Erode.

ABSTRACT

There is a growing demand in the computer industry for efficient cooling techniques to accommodate their upgrade of associated heat from newly designed and developed computer processors. Such a requirement requires researchers to explore efficient approaches to central processing unit (CPU) cooling. In the reflection of compactness and easy installation purpose in the Desktop or Electronic gadgets, the Flat Heat Pipe (FHP) was select for the analysis. The analysis is made to find the better performance of heat transfer rate. In this research, following factors have been reviewed such as wall material and wick structure. Design and analysis are done in Ansys Work bench with R32 as working fluid. As a result, heat pipes can be a viable and promising solution to this challenge.

Keywords: *Heat pipe, Wick or capillary structure, working fluid, node and element*

1. INTRODUCTION

Effective cooling of electronic components is an important issue for the successful operation and high reliability of electronic devices. The rapid development of microprocessors requires advanced processing power to ensure faster operations. Electronic devices have highly integrated circuits that generate high heat flux, which leads to an increase in the operating temperature of the devices, which in turn causes compression of life time of the electronic devices. As a result, the need for cooling techniques to dissipate the associated heat is quiet. Therefore, heat pipes have been identified and proven to be one of the viable and reliable options to achieve this goal ahead of its simple structure, flexibility and high efficiency. Heat pipes use phase changes of the working fluid inside to facilitate heat transfer. Heat pipes are the best choice for cooling electronic devices because, depending on the length, the effective thermal conductivity of the heat pipes can be several thousand times. Higher than a copper rod.

1.1 HEAT PIPE

A heat-transfer device consisting of a sealed metal tube with an inner lining of wick like capillary material and a small amount of fluid in a partial vacuum; heat is absorbed at one end by vaporization of the fluid and is released at the other end by condensation of the vapor shown in Fig 1.1.

The heat pipe is a system with a very high thermal conductivity, which facilitates the transport of heat while maintaining an almost identical temperature with the heated and refrigerated areas. In general, heat pipes are passive heat transfer devices that can carry large amounts of heat over relatively long distances, without moving parts, using phase conversion processes and vapour diffusion.

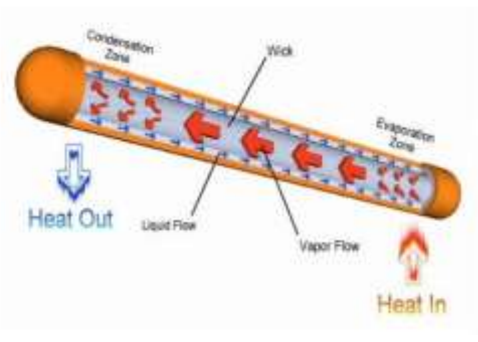


Fig 1.1 heat pipe

The main structure of the heat pipe consists of an exhaust pipe which is partially filled with working fluid in liquid and vapour stages.

1.1.1 ADVANTAGES OF HEAT PIPE

The heat pipe has many advantages for cooling electronic devices as follows:

- It can transport large quantity of heat with very small temperature difference between evaporator and condenser sections.
- Heat pipe is calm, noise-free, maintenance- free, and highly dependable.
- It is small in size and weight

1.1.2 DISADVANTAGES OF HEAT PIPE

- Heat pipes are also not ideal for situations that use high power .The system would need multiplepipes to solve the thermal challenge, thus resulting in more costs and restricted design options.
- Heat pipes is are not suitable for design situations characterized by limited and cramped spaces, such as in the case of laptops and mobile devices.

1.1.3 APPLICATION OF HEAT PIPE

- Space
- Electronic equipments: Laptop, Computer
- Medical equipments
- Aircraft

1.1.4 TYPES OF HEAT PIPE

- Standard heat pipe
- Flat heat pipe
- Pulsating heat pipe
- Loop heat pipe

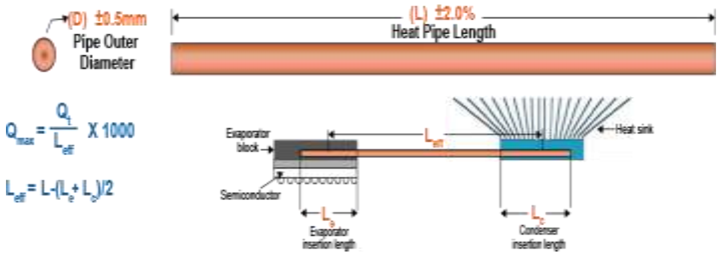


Fig 1.2 Flat heat pipe

1.2 WICK OR CAPILLARY STUCTURE

The wick system is the most important component of the heat pipe. Even against the direction of gravity, it is responsible for the return of fluid from the capacitor section to the evaporator area by the capillary characteristic. Thus, the heat pipes operate in all orientations because of the wick.. The grooved wick, sintered wick, and screen mesh wick are the most important types of wick studied abundantly is shown in fig1.3. These types of wick are widely used in the electronics Industry.

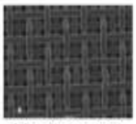
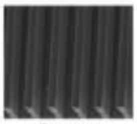
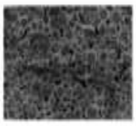
Wick structure	Capillary force	Permeability	Thermal conductivity
 Mesh screen	High	Low-average	Low
 Groove	Low	Average-high	High
 Sintered particle	High	Low-average	Average-high

Fig 1.3 Wick or Capillary Structure

1.2 WORKING FLUID

The heat pipe working fluid chosen depends on the operating temperature range of the application. Working fluids range from liquid helium for extremely low temperature applications (-271°C) to silver (>2,000°C) for extremely high temperatures. The most common heat pipe working fluid is water for an operating temperature range from 1°C to 325°C. Low temperature heat pipes use fluids such as ammonia and nitrogen. In the consideration of the low grade heat energy in the electronic device the refrigerant R32 will be considered for this investigation.

R32 REFRIGERANT

R32 coolant is also known as difluoromethane and it belongs to the HFC family of refrigerant. This gas is ready to be converted to other gases such as R-410A and R-407C due to its low global warming potential. The properties of refrigerant are shown in table1.4

Table 1.4 R32 properties

R32 PROPERTIES	
Boiling temperature	-62ºF(-52ºC)
Critical temperature	172.6ºF(78.1ºC)
Critical pressure	838.6PSI(57.8 bar)
Latent heat	195.66KJ
Global warming potential	675
Ozone warming potential	0
Ashrae safety group	A2L

1.4 APPLICATION OF OUR PROJECT

In our project heat pipe technology is used to recover heat from the CPU to increase the life span of desktop because CPU plays a important role in computers. so our aim is to increase the life span of CPU and to save electricity

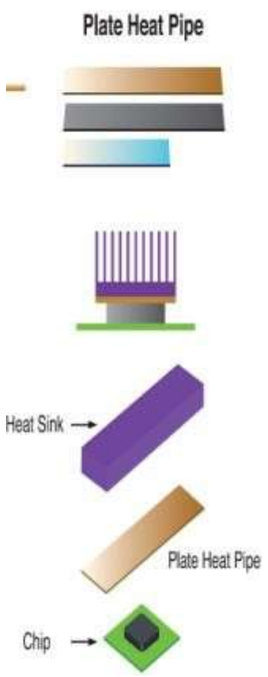


Fig 1.5 Classical heatpip

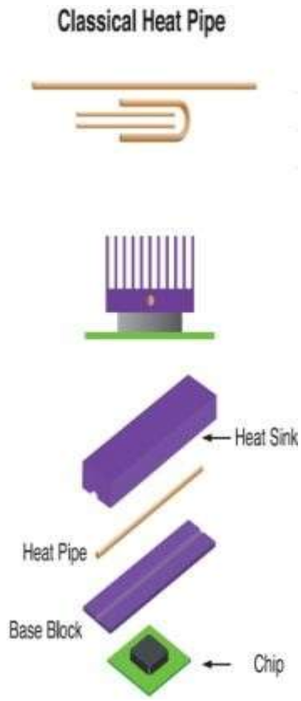


Fig 1.6Flate heatpipe

By comparing the fig 1.5 (classical heat pipe) and fig1.6 (plate or flat heat pipe). Plate or flat heat pipe is the better solution to recover the heat from CPU shown in Fig. 1,2

CHAPER 2

2.1 NODE AND ELEMENT

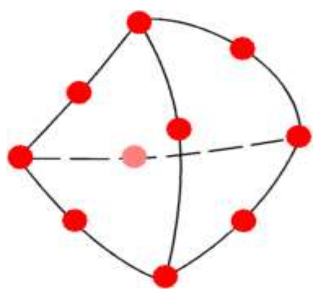


Fig2.1Node and Element

- Red dots represent the element's nodes.
- Elements can have straight or curved edges.
- Each node has three unknowns, namely, the translations in the three global directions.The process of subdividing the part into small pieces (elements) is called meshing. In general, smaller elements give more accurate results but require more computer resources and time.
- Ansys suggests a global element size and tolerance for meshing. The size is only an average value, actual element sizes may vary from one location to another depending on geometry.
- It is recommended to use the default settings of meshing for the initial run. For a more accurate solution, use a smaller element size.

2.2 MESH MODEL

The below mentioned image is the mesh model of heat pipe using ansys workbench software

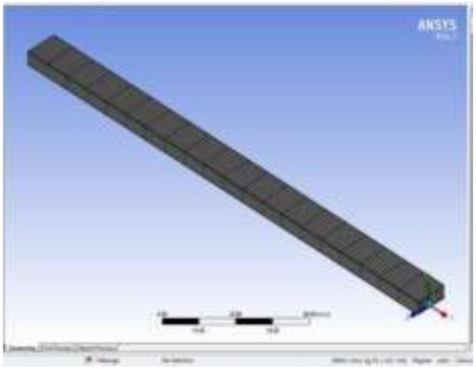


Fig 2.2 Mesh Model

Table 3.2 No. of Nodes and elements

No. of Nodes	2750
No. of Elements	1700

3. PROBLEM IDENTIFICATION

The below mentioned points are the problem statements of our project:

- In CPU heat is removed by fan-cooled aluminium heat sink for this it need more space and also produce noise. consumption of electricity is more for this setup.
- When electricity passes through the CPU, it gets turned in heat energy, the average heat produced from CPU is (40o-65oC). Due to overheat, the life span will decrease.
- To increase the performance of CPU the heat has to be recovered

3.1 OBJECTIVES

Below mentioned points are the objectives of our projects:

- To design flat heat pipe with light weight
- To fix optimum position of heat pipe to absorb heat from CPU
- To increase the performance of CPU by recovering heat using heat pipe technology

4. RESULT

Here we have analaysed three model of heat pipe for cooling the CPU using ansys workbench software

- Copper with R32 refrigrant model
- Aluminium with R32 refrigrant model
- Copper and Aluminium with R32 refrigrant model

4.1 3D MODEL

The below mentioned image is the 3D model of heat pipe using ansys workbench software

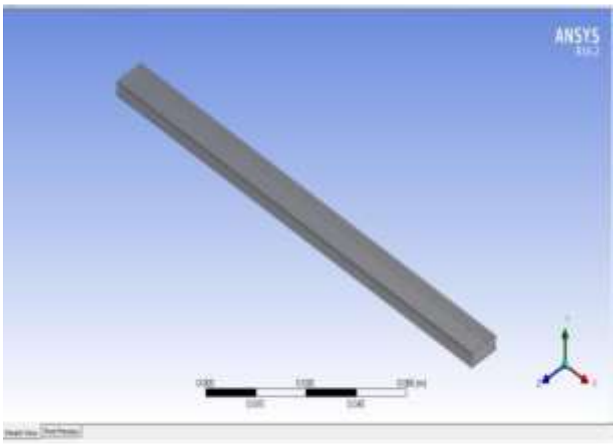


Fig 4.1 3D Model of flate heat pipe

4.2 GRAPH

- **Copper with R32 refrigrant mode**

In Fig 4.2 there are 10 itration. Each itration there are some changes in graph.

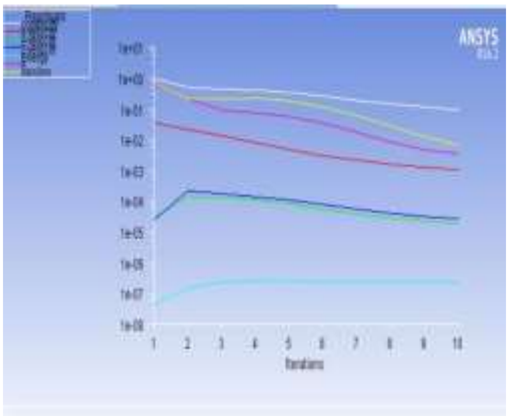


Fig4.2Iteration graph

In Fig 4.2.1 (X-direction)pressure increases and(Y-direction) velocity is constant

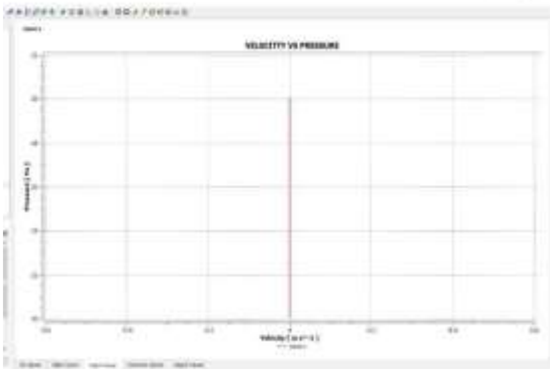


Fig 4.2.1Pressure and Velocity graph

- **Aluminium with R32 refrigrant model**

In Fig 4.3 there are 10 itration. Each itration there are some changes in graph.

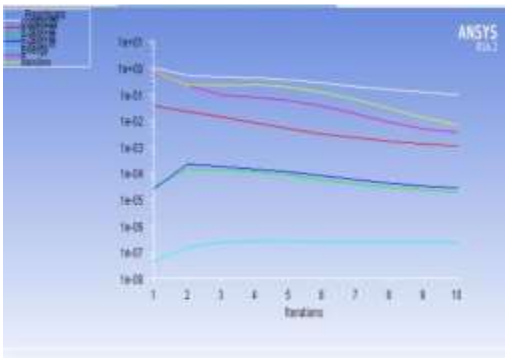


Fig 4.3 Iteration graph

In Fig 4.3.1 (X-direction)pressure increases and(Y-direction) velocity is constant

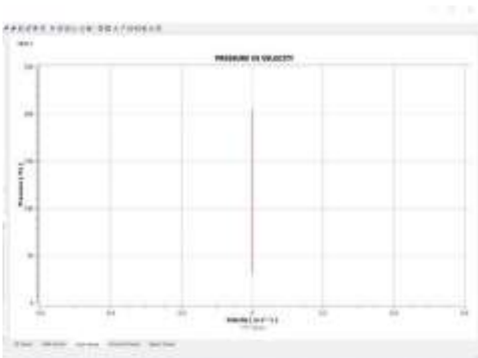


Fig 4.3.1 Pressure and Velocity graph

Copper and Aluminium with R32 refrigrant model

In Fig 4.2 there are 10 itration. Each itration there are some changes in graph

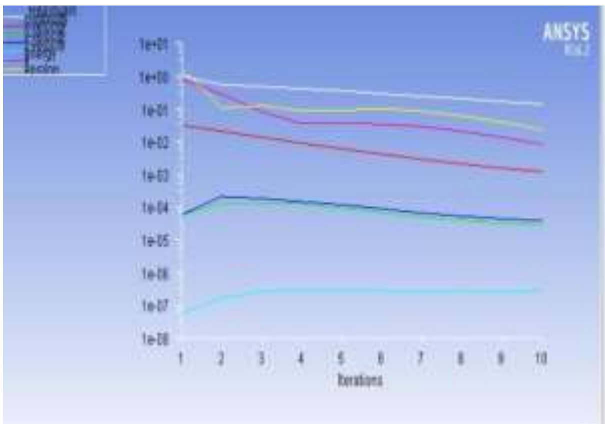


Fig 4.4 Iteration graph

In Fig 4.4.1 (X-direction)pressure decrease and (Y-direction)velocity is gradually increase

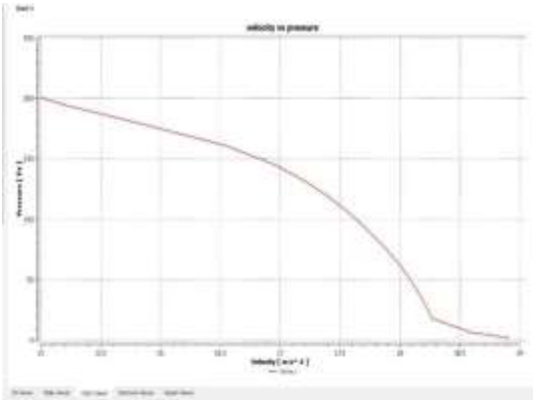


Fig 4.4.1 Pressure and Velocity graph

- Finally by analysing the three model we come to know that copper and R32 refrigerant heat pipe give better result compare to other two heat pipe.
- So copper heat pipe is the best one to reduce the heat for CPU for increasing the life span in desktop

5. CONCLUSION

In this chapter, we presented the increasing of CPU lifespan by recover the over heat in operating time. Because of sensitive devices (Circuits), the low temperature has to maintain during the system operation. In continuous study, the advanced technology was identified to recover or transfer the heat from CPU that is Heat pipe. The heat pipe can be regarded as a promising way for cooling electronic equipments. It didn't need the external energy to transfer also it is opting for transfer the low grade energy. For better performance, R32 refrigerant is selected as working fluid. We planned to Analysis the heat transfer rate using ANSYS workbench software. In this continuation the 3D model drawings, material selection and working fluids selections are completed. The analysis and results comparison has done with required dimensions in the considerations of finding the solutions for practical problems. We believe this work would definitely open ways for further research in accordance with the growing attention for the use of heat pipes in electronic devices cooling.

Reference

[1]. Ahamed MS, Mochizuki M, Mashiko K, Saito Y, Mabuchi T, Horiuchi Y. Experimental Study of Thin Flat Heat Pipe with a Special Fiber Wick Structure. 9th International Heat Pipe Symposium. 2008.

[2]. Carbajal G, Sobhan CB, "Bud" Peterson GP, Queheillalt DT, Wadley HNG. A quasi-3D analysis of the thermal performance of a flat heat pipe. International Journal of Heat and Mass Transfer. 2007; 50(21–22): 4286–4296.

[3]. Chang Y-W, Cheng C-H, Wang J-C, Chen S- L. Heat pipe for cooling of electronic equipment. Energy Conversion and Management. 2008; 49(11): 3398–3404.

[4]. El-Genk MS, Lianmin H. An experimental investigation of the transient response of a water heat pipe. International Journal of Heat and Mass Transfer. 1993; 36(15): 3823– 3830.

[5]. Fadhil OT, Saleh AM. Thermal performance of a heat pipe with sintered powder metalwick using ethanol and water as working fluids. Anbar Journal for Engineering Sciences. 2011; 4(1): 62–71.

[6]. G. Xiahou, J. Zhang, R. Ma, Y. Liu, Novel heat pipe radiator for vertical CPU cooling and its experimental study, Int. J. Heat Mass Transf. 130 (2019) 912–922.

[7]. Ismail MA, Abdullah MZ, Mujeebu MA. A CFD-based experimental analysis on the effect of free stream cooling on the performance of micro processor heat sinks. International Communications in Heat and Mass Transfer. 2008; 35(6): 771–778.

[8]. Liou J-H, Chang C-W, Chao C, Wong S-C. Visualization and thermal resistance measurement for the sintered mesh-wick evaporator in operating flat-plate heat pipes. International Journal of Heat and Mass Transfer. 2010; 53(7–8): 1498–1506.

[9]. Mahajan R, Chia-pin C, Chrysler G. Cooling a microprocessor chip. Proceedings of the IEEE. 2006; 94(8): 1476–1486.

[10]. Mochizuki M, Saito Y, Kiyooka F, Nguyen T. The Way We Were and Are Going on Cooling High Power Processors in the Industries. 17th International Symposium on Transport Phenomena. 2006.

[11]. P. Naphon, S. Wiriyasart, Liquid cooling in the mini-rectangular fin heat sink with and without thermoelectric for CPU, Int. Commun. Heat Mass Transf. 36 (2009) 166–171.

[12]. P. Naphon, S. Wongwises, S. Wiriyasart, Application of two-phase vapor chamber technique for hard disk drive cooling of PCs, Int. Commun. Heat Mass Transf. 40 (2013) 32–35.

[13]. P. Naphon, S. Wongwises, S. Wiriyasart, On the thermal cooling of central processing unit of the PCs with vapor chamber, Int. Commun. Heat Mass Transf. 39 (2012) 1165–1168.

[14]. Peterson GP. An Introduction to Heat Pipes: Modeling, Testing, and Applications. New York: John Wiley & Sons, Inc. 1994.

[15]. Rittidech S, Boonyaem A, P.Tipnet. CPU cooling of desktop PC by Closed-end Oscil-lating Heat-pipe (CEOHP). American Journal of Applied Sciences 2005; 2(12): 1574– 1577.

[16]. S.A. Jajja, W. Ali, H.M. Ali, Multi walled carbon nanotube nanofluids for thermal management of high heat generating computer processors, Heat Transf. Asian Res. 43 (2014) 653–666.

[17]. Saengchandr B, Afzulpurkar NV. A novel approach for cooling electronics using acombined heat pipe and thermoelectric module. American Journal of Engineering and Applied Sciences. 2009; 2(4): 603–610.

[18]. Scott D, Garner PE. Heat Pipes for Electronics Cooling Applications. Electronics Cooling Magazine, Thermacore Inc. 1996.

[19]. Suzuki M, Hirano M. Fan-less Cooling Technology for Notebook Computers. Fujitsu Scientific & Technical Journal. 1998; 34(1): 87– 95.

[20]. T. Yousefi, S.A. Mousavi, B. Farahbakhsh, M.Z. Saghir, Experimental investigation on the performance of CPU coolers: effect of heat pipe nclination angle and the use of nanofluids, Microelectron. Reliab. 53 (2013) 1954–1961.