Research paper on cooling systems in computers

Technology, Innovation

Abstract

This paper adequately and sufficiently dwells into the concept and usage of cooling systems in computers. It talks about the advents which have been made in the cooling technology right from the very starting to the modern times. It discusses and elaborates on the different kinds and types of cooling systems available and their respective advantages and potential, if any, disadvantages.

Cooling Systems in Computers

According to Moore's Law the number of transistors on a chip will double approximately every two years. Since 1965 this law has stood the test of the times and consequently the performances of computers have increased while their sizes have proportionally decreased making them more compact and smaller. These increased numbers of transistors not only contribute to the decreased size and increased performance but also play a part in increasing the amount of heat produced inside the system. A computer consists of many electronic components right from central processing unit, RAM, motherboard and all these parts generate heat and hence the need for cooling systems generate.

Computer cooling plays a very vital and significant role in ensuring that the machine works well and that all the components work within their permissible operating temperature limits. Cooling ensures that there is no malfunction or failure of any of the components in computers due to excess heat generated. Though the components in computers are designed in a way to generate minimum heat but off late CPU speeds have increased dramatically, forcing more transistors in CPU in order to push up clock rates. Increased number of transistors calls for more power input; all this when combined generates heat well in excess of what is recommended for smooth functioning of a computer system.

Cooling technologies and systems have evolved over the time; according to the requirements of the systems and servers they ought to be used for. Before the invent and widespread use of transistors in computers started in 1960s, vacuum tubes were the used extensively. Since the heat generated by each tube accumulated into a large problem for the systems, large blowers and cooling fans around the tubes were used and air conditioning of the rooms was a standard (Stockill 2006). With the introduction of transistors in 1960s, the problem of heat generation reduced to a large extent but the relief was very short lived as the new solid-state technology lead to greater sophistication in designs as well as capacities. This in turn led to multiplication in the number of individual circuits and hence the problem bounced back even harder. The transistors with narrow tolerance to variations in temperature often meant malfunctioning of systems creating chaos. All this furthered the need for better cooling systems in the computers. Heat sinks were used initially as a potent solution to the problem of heating and are still used in low-end computers. Further innovation proposed sophisticated fan designs, coupled with heat sinks and air flow funnels or/ and plenums. Though these cooling systems provided momentarily relief but gradually need for better cooling originated as more and more transistors and electronic components found places in a computer system. Many more overtly sophisticated systems have been developed off late like water cooling, liquid nitrogen cooling with each of these finding specific uses and applications.

Cooling systems are broadly divided into two types namely:

Air Cooling

Liquid Cooling

While air cooling is primarily sufficient and enough for low end CPUs, Water cooling is used for systems which dissipate high amount of heat and where air cooling is simply not enough to keep the temperature under desired level.

Air Cooling is further subdivided in two broad and distinct categories:

- Active Air Cooling
- Passive Air Cooling

Active Air Cooling: Active air-cooling is the most widely used and accepted method of cooling for computers across the globe. This indeed is one of the most conventional methods of cooling and is used for systems that dissipate heat under a certain level, beyond which active air-cooling ceases to be effective and useful.

In this case, a fan blows air on a cooling plate or a heat sink placed over the electronic components that generate heat and need to cooled. This cooling plate has one flat surface and the other side consists of several small fins. The fins form an important part of the entire mechanism that lies at the heart of air-cooling. These fins contribute by increasing the surface area of the plate and this in-turn enhances the heat exchange capability of the plate. The fan blows air between these fins and make the exchange quicker and much more efficient, as it rapidly removes the heat surface of air that is produced between the fins (Lazaridis 2009).

There are different possible combinations of fans and cooling plate (heat sinks). In some active air-cooling systems, there are small cooling plates and powerful fans and other systems consist of very efficient heat sinks with slow-moving yet large fans. Both these combinations could be equally efficient but the combination of efficient heat sinks with large and slow moving fans is preferred as they produce considerably less sound when compared to the other combination.

The most important advantage that air active air-cooling offers over other options is that it is the cheapest and the simplest option available to the users. They also offer a great deal of reliability to the users.

The main drawback of the system is that it only plays its part for the components that always have their temperatures above the ambient temperature and hence could be or rather is really ineffective and impotent when the system is placed in harsh conditions or is placed near components which themselves produce heat.

Passive Air Cooling: Passive air-cooling is practically the active air-cooling sans the fan, which is used in active air-cooling. In passive air-cooling method a large metal plate, like active air-cooling method, is used as the main working component. This metal plate or metal block is attached to the central processor with one of its sides consisting of many thin fins. The combination of metal block and thin fins is popularly known as heat sink. Heat sinks draw heat away from a CPU by increasing the amount of surface area available for the heat to dissipate into the air (Artman 2012). Unlike active air-cooling there is no fan in passive system to push the hot sir towards the heat sink or the metal plate but the size of metal plate or heat sink in case of passive systems in considerably larger when compared to active systems since they solely rely on heat sink for their operation.

The heat sinks in passive air-cooling system can be made of different metals based on the requirements as well as the budget of the person purchasing them. Cheap and inexpensive heat sinks are most commonly made of Aluminum while the most expensive and resultantly more efficient are made from Copper. Though used almost as widely as active air-cooling systems, passive systems are not at all recommended for high-power and high-end CPUs and hence fins their use limited to low-power CPUs or processors.

Passive air-cooling systems offer number of advantages over other cooling systems including the active air-cooling ones. The reliability of these systems if top notch and even better than active air-cooling since there are no components at all which might fail. Moreover, passive systems require no power for their operations. Passive air-cooling systems are most preferably used for silent operations since they produce no noise at all.

The only major disadvantage that these systems face is their weight. Use of heavy and large heat sinks consisting of metal parts increases the overall weight of the system they are part of.

There are various kinds of liquid cooling techniques and systems that are available in the market. Broadly speaking, these are the most important types of liquid cooling systems:

- Water Cooling
- Thermoelectric Cooling
- Peltier Junction

- Extreme Cooling System

Water Cooling: This is the most common and simplest form of liquid cooling. Though originally devised and invented for monster mainframe computers, it is largely gaining popularity among the users with personal high end PC's and CPU's. It is a very effective method of reducing temperatures of the three most important i. e. processor, video card and chipset. Besides being vital and imperative for a flawless computing experience, these are the biggest contributors to the heat generated in a system. In water-cooling systems, tubes are used to send water over the components of computer that generate excess heat. The water soaks the heat off the components and finally this water is pumped out to a radiator before finally being returned to the computer. Users who configure their processors to operate and run at extraordinarily high speeds often use this method.

This method offers a number of advantages. First and foremost, unlike the air-cooling methods, water-cooling can cool multiple components of a computer simultaneously. They are much more effective and are noise free even though they serve the high-power CPUs.

The only possible disadvantage of this system is that the system is inherently risky and a leak inside the computer can damage electronic components.

Thermoelectric Cooling: Thermoelectric cooling or vapor-compression refrigeration uses the evaporator coil of a phase change system to chill the water below ambient air temperature (doityourself 2013). This method generates incredible cooling foe the components and hence keeps their overall temperatures much below the ambient temperatures. Though this system allows a user to achieve much higher clock speeds than a conventional air-cooling or water-cooling system can, there are number of flaws associated to this method and resultantly this method is not the most popular method. Apart from being extremely expensive, these systems are heavy and require loads of electricity to operate well. It even calls for steps to prevent condensation as that could lead to permanent damage to the computer system.

Peltier Junction: It puts into practice an electrical phenomenon famously known as Peltier effect and that is where it derives its name from. Peltier cooling system transfers heat from the processor using a thermoelectric element, the very backbone of this method. This thermoelectric device is installed between the components responsible for generating heat and the water block that leads to isolation of the area with sub-ambient temperature. This system could be very effective and offers some advantages over the thermoelectric cooling method, as it does not require antifreeze. Despite this, Peltier coolers are not very common since they are risky and need impeccable planning and design, without which the condensation they produce could lead to dangerous situations.

Extreme Cooling Systems: As the name suggests, these systems are essentially used in extreme cases when all other methods almost turn ineffective. In such methods liquid nitrogen is quite often used. The liquid is transferred across the surface of the CPU to be cooled which freezes it to nearly -196 degrees. These systems are used when the clock speed required is extremely high.

Liquid cooling systems offer a number of advantages over the air-cooling methods like superior heat removal, Increased Overclocking capability for the processor, Less maintenance and Quiteness and Coolness when compared to air-cooling systems. These advantages, though, do not come without their disadvantages like the high price tags, technical difficulties and requirement of more space (Anthony 2009).

Cooling systems have indeed evolved and transformed themselves over the last four decades and continuous innovation is still put in coming up with better solutions, which could help users in achieving better speed and performance with less risk. Inventions like soft cooling, which use software to enable CPU power saving technologies and Undervolting, which enables operability of components at a voltage below their specifications do signal an era of better cooling techniques and practices.

Cooling techniques off late have become as vital and important for the operation of a system as any other of its part. Their effectiveness and efficiency have been continuous rise due to the inventions in this field. In a nutshell, cooling techniques allow us to use our systems to the maximum optimal level and even beyond and hence help us realize their true potential.

References

Anthony (2009). Water can cool your PC-Benefits of Liquid Cooling. Pctechnotes. com.

Retrieved March 9, 2013,

Artman, Jason (2012). Types of CPU Cooling. Ehow. com.

Retrieved March 9, 2013,

doityourself (2013). 4 Types of Liquid Cooling Systems. Doityourself. com.

Retrieved March 9, 2013,

systems#. UTn3yRhZ8zo

Lazaridis, Giorgos (2009). PC Cooling Methods. Pcbheaven. com.

Retrieved March 9, 2013,

Stockill, Tony (2006). History of the Computer-Cooling. Ezinearticles. com.

Retrieved March 9, 2013,

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