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"Cooling system for electronics in computer system- an overview"

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Abstract: During the power management, the inevitable power losses induce heat generation in the power electronics. In this, effective design for the cooling system is essential in terms of safety, reliability, and durability. A liquid cooling system for the power electronics is applied to chill the electrical components below the thermal specifications. Nonetheless, the layout of cooling components is usually designed after the completion of the chassis and power electronics in the automotive applications, thus, only a little freedom is allowed to change the layout. Thus, it is significant and urgent to investigate the cooling performance before finalizing the layout design.
In this work, one dimensional and computerized fluid dynamics code is employed to simulate the performance of the cooling system at the early stage of conceptual design. Three different layouts of cooling systems are chosen to compare the ensuing systematic cooling performances. The liquid flow rates, pressure drops, and maximum temperatures are computed by the numerical simulations of the cooling system which comprises the cold plates, liquid pump and heating electronic device.
Index Terms: High performance CPUs, heat transfer enhancement, liquid impingement, heat transfer

1. INTRODUCTION

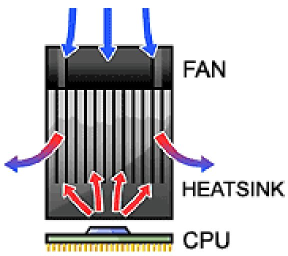
As transistor sizes continue to decrease, chip manufacturers pack even more on to the processor. In 1992, a 486/DX2 66Mhz CPU consumed about 7W of power (with 1.2 million transistors). It didn't even require a cooling fan. Today, processors can range from 50-200W depending upon the core type and load.

Most high-end video cards now exceed the total power consumption of today's processors. Other components have also followed this tendency toward higher heat outputs with each consecutive generation.

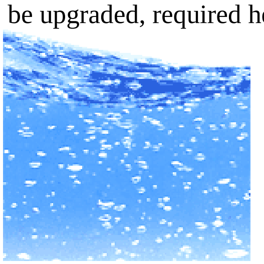
Koolance has long believed liquid to be the next evolutionary phase in computer cooling systems. Major processor and video card manufacturers have been devising water-based concepts for years, anticipating the point when air cooling would simply reach its limit.

Why Liquid?

Heat Flow in a Typical Fan & Heat Sink



Heat-producing devices in a typical computer are cooled by air. Generally, this involves mounting a heat sink and fan to each component. Heat generated from your CPU is transferred into a metal heat sink, where a fan blows air across its wider surface area.While altering a heat sink's size and makeup can improve the effectiveness, it is still limited because air absorbs and transfers heat very slowly. To help counteract this, the fan can be run at a higher speed, but most people know what that means: high performance has become equated with high noise. As systems continued to be upgraded, required heat sinks got larger and louder.



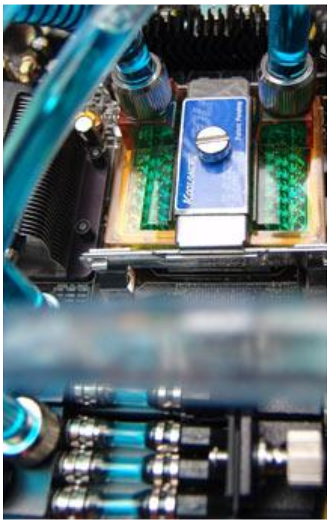
Of liquids, water (after mercury) conducts heat the fastest. Its thermal conductivity is about 30 times greater than that of air. And not only that, it holds a lot more heat. It takes over 4 times as much heat to raise the temperature of water as it does air.These basic physical attributes give liquid cooling a considerable advantage in cooling, but the benefits don't end there.

2. Research Elaborations

Cooling System Design

At first glance, liquid cooling looks simple. Liquid is pumped through a cooler, it absorbs heat, and it's cooled back down with a radiator. But because you're working with liquid, the design principles become more complicated.

1) Water Conducts Electricity



Obviously, you don't want the system to leak. This is a more common concern to those new to liquid cooling. In actuality, it's a rare occurance.mHose clamps used internally are a precaution in Koolance systems. Each device is designed to fit snugly with the next, and although not recommended, systems generally run fine without being clamped. Anyone who has installed a Koolance system quickly realizes the amount of sheer physical stress a typical hose connection can withstand.Koolance components are also pressure-tested at many times their operating rate during the manufacturing process. For example, air is injected into the radiator at 70 times (7kg/cm^2, 100psi) the normal running pressure to certify it from leakage.

Koolanceuser manuals provide instructions on testing each cooling system prior to placing any hardware into the chassis. This allows customers to validate the work they have done on nozzles and tubing arrangement before operating the computer.

2) Pump Reliability

The pump is a liquid cooling system's "heart". In conformance with that analogy, a similar effect can happen to the system if this component were to fail. This doesn't mean it is necessary for a liquid cooling system to use a $200 pump. It only means you can not use any off-the-shelf aquarium pump and hope it continues to operate for months and years under computer cooling conditions.Different pumps are used in Koolance systems, depending on the thermal application. All models are specifically tested for long-term use, with reliability generally exceeding 30k-50k hours MTBF (3.4 to 5.7 years of continuous 24/7 operation).

3) Fail-Safes

Let's assume something does go wrong. A motherboard cooler was installed, but the tubing got folded during installation of a new video card. There is almost no liquid flow, which is similar to the effect of a dead pump. The CPU is heating up, the liquid is absorbing the additional heat, but slowly, the liquid temperature begins to increase.With a regular liquid cooling kit, this situation could result in a dead computer. Koolance systems, however, have built-in hardware safety features. Once your liquid temperature reaches a configured level (for example, 50°C/122°F), an alarm sounds. If you're not there to hear or see it, the system can shut off power to the computer automatically.

4) Corrosion

There are multiple types of chemical reactions that can be present in a cooling system that uses liquid. The most common is galvanic corrosion, caused by different metals in an electrolyte (in this situation, water). These varying electrode potentials can create a "battery" effect, damaging the anode metal.Using domestic tap water can encourage corrosion. Tap water contains numerous trace elements that can accelerate this process. This is the reason distilled water should be used (not "purified", "de-ionized", or bottled drinking water).

Koolance's liquid coolant features many additives combined with di-water: anti-corrosives, anti-biology, anti-foamer, pH balancer, and other chemicals that are commonly used in the engineering field to help avoid reactions. Koolance coolant is renowned for its extended time between replacement (2-3 years).

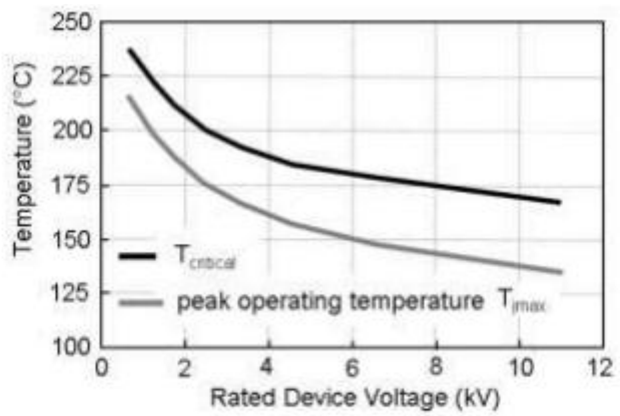


Figure 1 Critical thermal runaway temperature and estimated maximum safe operating temperature of Silicon devices [2]

Objective of the work:

1) The objective of the above work :

2) Design and Optimization liquid cooling based coolig device for cooling the high dissipation rates in the electronic devices

Methodology:
1. Design of cooling system for high heat dissipation rate
2. Design of liqid cooling system including pump, liquid channels, no. of fins, cold water flow rate
3. CFD Analysis of different combination of design paramters
4. Optimization for maximum cooling rate with less cost of the cooling device

Tools needed:
Gambit and Fluent for Design and Analysis work.

Results or Finding

ADVANTAGE;

- Of liquids, water (after mercury) conducts heat the fastest.
- . Its thermal conductivity is about 30 times greater than that of air. . And not only that, it holds a lot more heat.
- It takes over 4 times as much heat to raise the temperature of water as it does air.
- Low thermal resistance—maximum junction temperatures below 150°C while dissipating several hundred W/cm2.
- Low electrical losses—low resistance, inductance and capacitance.
- Good electrical isolation—standoff voltages as high as 15,000 V.
- Low thermal stress—coefficient of thermal expansion (CTE) of electronic component in the low ppm/°C.

DISADVANTAGE;

- There are multiple types of chemical reactions that can be present in a cooling system that uses liquid.
- Varying electrode potentials can create a "battery" effect, damaging the anode metal.
- domestic tap water can encourage corrosion.
- For cooling electronic components, the liquid has to be thermally, but not electrically conductive.
- It not possess good dielectric properties.
- If the temperature excursion prior to boiling incipience is not controlled, the temperature increase would result in failure of the electronic component.

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