Cooling High-Performance 2.5kW Processors: Experimental Data & Two-Phase Sidecar Solutions

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Introduction

As processor power densities rise, traditional air cooling is becoming insufficient. Two-phase liquid cooling provides a superior thermal management solution. This study presents experimental data on cooling a 2.5kW processor using a two-phase cold plate and explores the feasibility of sidecar cooling for full-rack efficiency.

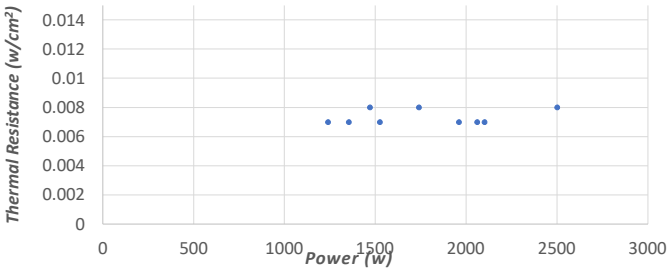
Key Findings

- **Efficient Cooling:** Two-phase pool boiling achieves high heat dissipation with minimal energy use.
- **Thermal Stability:** Maintains uniform temperature across the chip, preventing thermal throttling.
- **Scalable Cooling:** Sidecar cooling solutions offer a modular, facility-independent approach.

Experimental Results

- **Saturation and T-case measurements** confirm superior heat transfer performance.
- **Thermal resistance calculations** highlight improved efficiency over air cooling.
- **Max allowable air temperature** into the condenser ensures optimal reliability.

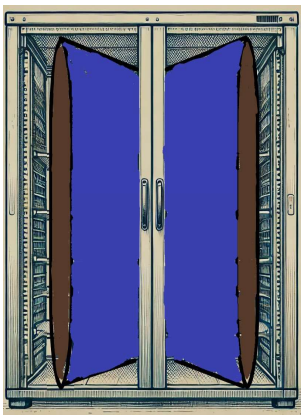
Power (W)	Saturation (°C)	T. Case (°C)
2500	42.4	63.5
2100	39	54.6
2060	44	58.3
1960	41.8	55
1740	43.8	57
1525	43.3	53.5
1470	40.7	52.4
1353	38.2	47.3
1240	37.1	45.3



Sidecar Cooling Solution

Hybrid Integration: Combines liquid cooling with existing air-cooled setups.
Modular & Scalable: Fits within standard data center layouts, supporting IT expansion.
Enhanced Reliability: Redundant and hot-swappable components ensure continuous operation.
Optimized for High-Density Racks: Enables cooling of full racks with 2.5kW processors.

Rack power calculation:
Given the current design of AI servers, we can anticipate that the servers utilizing GPUs with a power consumption of 2500W will have the following configuration within 2RU height:
8 X GPUs (2,500W), 4 X Network switches (150W), 2 X CPUs (350W), Total server power = 21,300W.
Each rack will have up to 16 servers, and the total rack power will be 340.8 kW.



Key Calculation:

*Condenser Surface Area = (Total cooling power) / [(water outlet temp – air inlet temp) * heat transfer coefficient]*

- boiling temperature=42°C
- chip case temperature < 65°C
- Expected air inlet temperature=25°C
- Load = 340.8kW

Two sidecars, each with 2 condensers in V-shape topology will be needed.

Sustainability Benefits

- **Energy Efficiency:** Uses latent heat of vaporization for better thermal management.
- **Reduced Carbon Footprint:** Lower cooling energy demand reduces environmental impact.
- **Component Longevity:** Improved cooling prevents overheating, extending hardware lifespan.

Conclusion

Two-phase sidecar cooling presents a viable, scalable, and sustainable solution for high-power processors in data centers. By leveraging advanced liquid cooling, data centers can significantly improve efficiency, reliability, and environmental impact.

Contact us for more details!