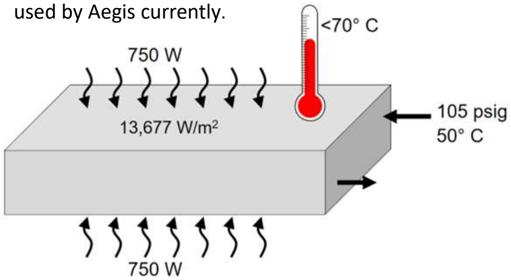
Liquid Cooled Heatsink

Aegis Power Systems

Western Carolina University

Problem Summary

Electronics cooling is a necessity, including in the military and battlefield applications pursued by Aegis Power Systems. To advance heatsink design, Aegis engaged our team to explore new water-cooled heatsink designs that depart from the more traditional air-cooled devices used by Aegis currently.

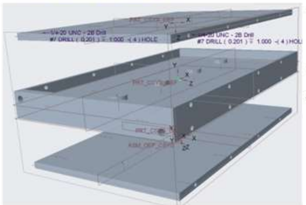


Requirements

Req #	Requirement Description	Motivation	User/Customer
1	The system must contain 105 psi of liquid coolant pressure.	The system may be subjected to up to 105 psi of pressure and cannot be allowed to leak.	End User
2	The system must be able to dissipate up to 750 Watts of heat on either side.	The largest power supply this system will be used for will require it to dissipate 750 Watts.	Aegis
3	The system must keep the electronics temperatures ≤ 70°C.	Temperatures exceeding 70°C are dangerous for many computer components.	End User
4	The system must be dual sided.	The system will be called upon to keep two individual components cooled and must be able to do so simultaneously.	End User
5	The system must have a footprint of 17 inches by 10 inches.	Drop-in replacement for Aegis Designs.	Aegis
6	The system must have a maximum thickness of 2.45 inches with under 1 inch preferred.	Aegis would prefer for the heatsink to be as thin as possible to save space without performance sacrifices.	Aegis
7	Leak testing with an experimental rig.	Water and electricity mix poorly (IP67).	End User
8	Performance vetting with an experimental rig.	Prove concept safety and reliability.	End User

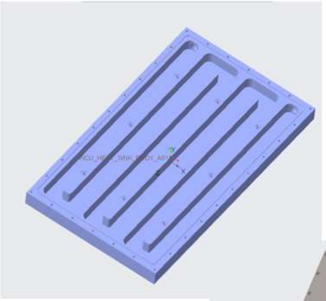
Early Concepts

"Pancake" Design

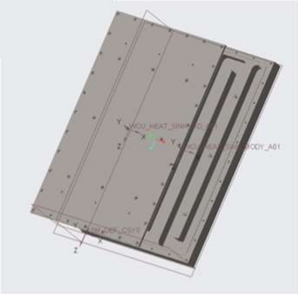


- Hardpoints bridge plate fasteners to combat pressure forces.
- Minimal hotspots.
- O-ring sealed.

Final Design



- Final design is more conventional
- The design uses six water channels to cool attached electronics

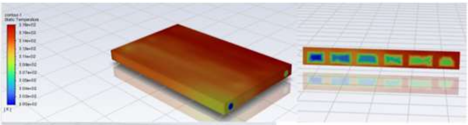


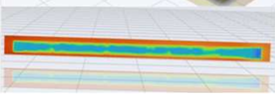
- A lid and O-ring seals water from attached electronics

Design Validation

Before fabrication, computational fluid dynamics vetted the design to assure likely cooling success. Temperatures and flows were consistent with Aegis Power Systems requirements:

ANSYS Results for 1.1gpm



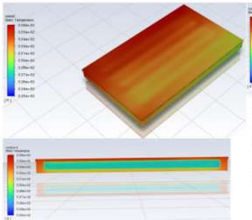


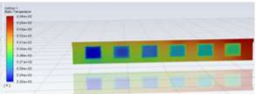
Max temperature: 318K=44.85C

Flow rate: 6.939e-5m^3/s = 1.1 gpm

Pressure difference: 322.1PA = 0.04672PSI

ANSYS Results for 0.7gpm





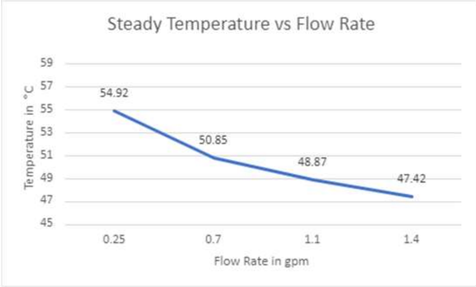
Max temperature: 336k= 62.85C

Flow rate: 4.331e-5m^3/s = 0.7 gpm

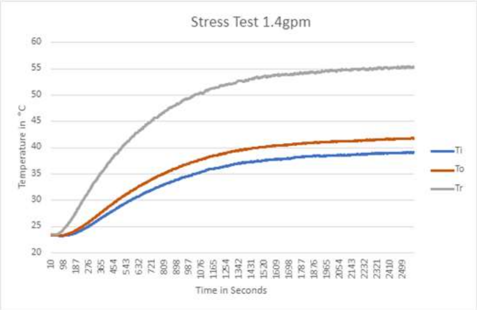
Pressure difference: 225.7Pa= 0.0327PSI

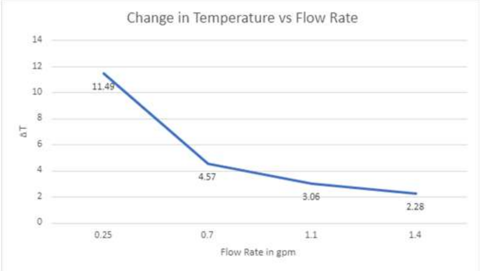
Results

After fabrication, experiments showed that the heatsink maintained temperatures below requirements (<70° C), even at low flows (0.25 gal/min). No discernable pressure loss was evident at this flow. However, only 864 Watts was achievable on the rig, versus the customer requirement of 1500 Watts.



To further explore performance the rig was "stress tested" from no-load (0 Watts) and room temperature to the maximal achievable load (864 W). No heat shock was evident, and temperatures remained moderate.





Summary and Conclusions

Ultimately, the team has concluded that a water cooled heatsink could be an effective alternative to current air-cooled design heatsink designs. The team was able to achieve the necessary form factor for the design to work, and the testing data appears very promising. Although our testing results are not exhaustive, the design seems to warrant further consideration

Future Work

In the future, direct comparisons to air-cooled heatsinks in military applications are advisable. The current heatsink could be further stressed with added heaters to achieve Aegis's 1500 W specification (versus the 864 W achieved herein). More granular pressure instrumentation is needed to examine hydraulic flow effects, especially if fouling or contaminated water degrades heatsink performance.

Team and Acknowledgments

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- Josiah Webster: B.S.E
- Faculty Mentor: Dr. Scott Rowe

AEGIS Power Systems, Inc.