

Liquid Cooling System for Li-Ion Battery

Team Name: LICH system

Members: Ryan "Jack" Gonzalez, Donald Funk, Jesus Barrera, Tarrin Funderburg
Special thanks to: Sam Weiss., Max Johnson, Bill Magnie and Dr. Matthew Swenson

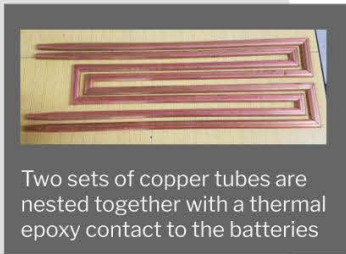


Objective

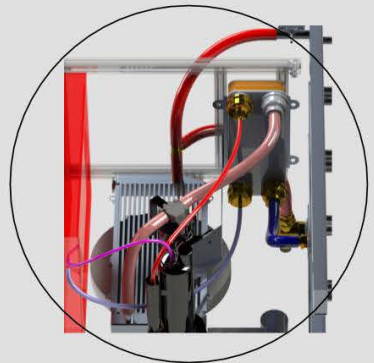
Develop a heavy duty modular liquid cooling system for a large Li-ion battery to be used on forklifts.

Background

The client for this project is Hyster-Yale Group which designs, engineers, manufacturers, sells and services a comprehensive line of lift trucks and aftermarket parts.



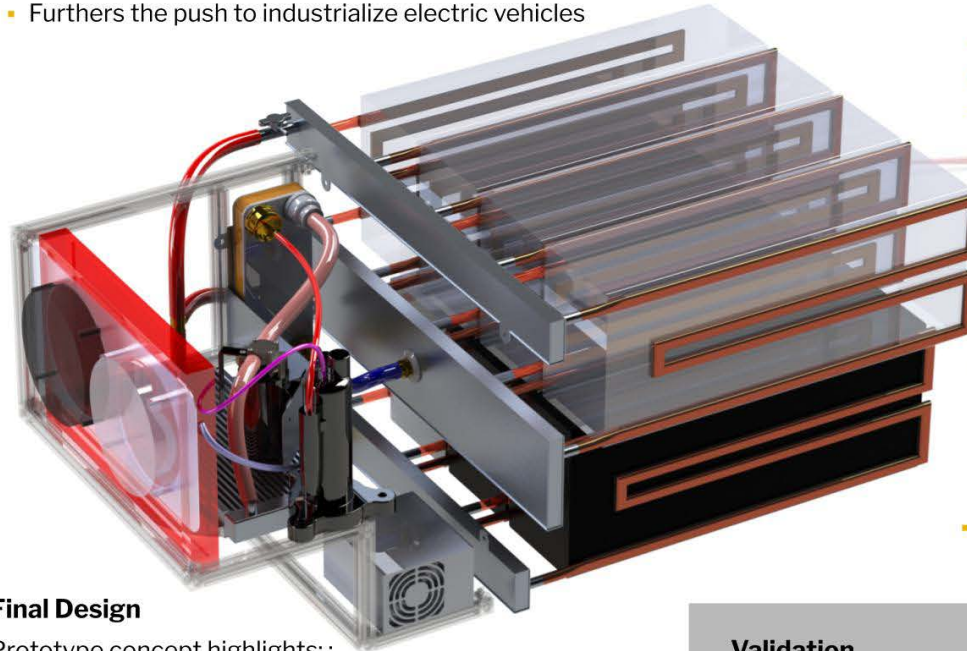
Two sets of copper tubes are nested together with a thermal epoxy contact to the batteries



- A repackaged vapor compression refrigeration system from a conventional window A/C

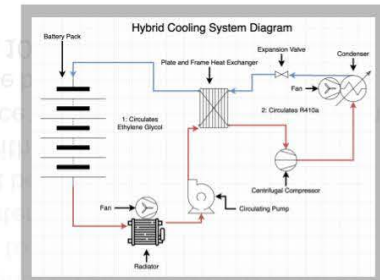
Value Proposition

- Solves problem of batteries overheating due to high ambient temperatures and while charging
- Limits carbon emissions of forklifts without sacrificing performance
- Minimizes charging downtime
- Furthers the push to industrialize electric vehicles



Requirements

- Keep battery temperatures below 45°C
- Minimize battery temperature gradient
- Will shut off cooling system at 40°C
- Able to be disassembled for maintenance
- Must be as efficient as possible
- Fit within engine bay of forklift
- Device for liquid travel route must fit in space between batteries - maximum gap : 10 mm

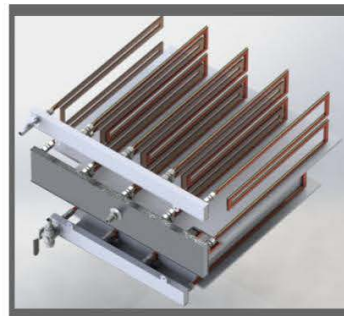


- Two fluid system: R410a refrigerant and ethylene glycol for thermal transfer

Final Design

Prototype concept highlights :

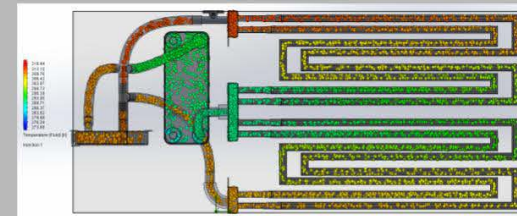
- Two modes of cooling: 1. Ethylene glycol circulation through the radiator only 2. Refrigeration system turns on for further cooling



- Nested copper tube design circulating ethylene glycol that allows for a high surface area for heat transfer

- Custom manifolds to allow for equal flow rate in all tubes

Validation



The flow simulation above shows the colder fluid in the center getting warmer as it moves through the tubes and back to the heat exchanger where it cools down again.



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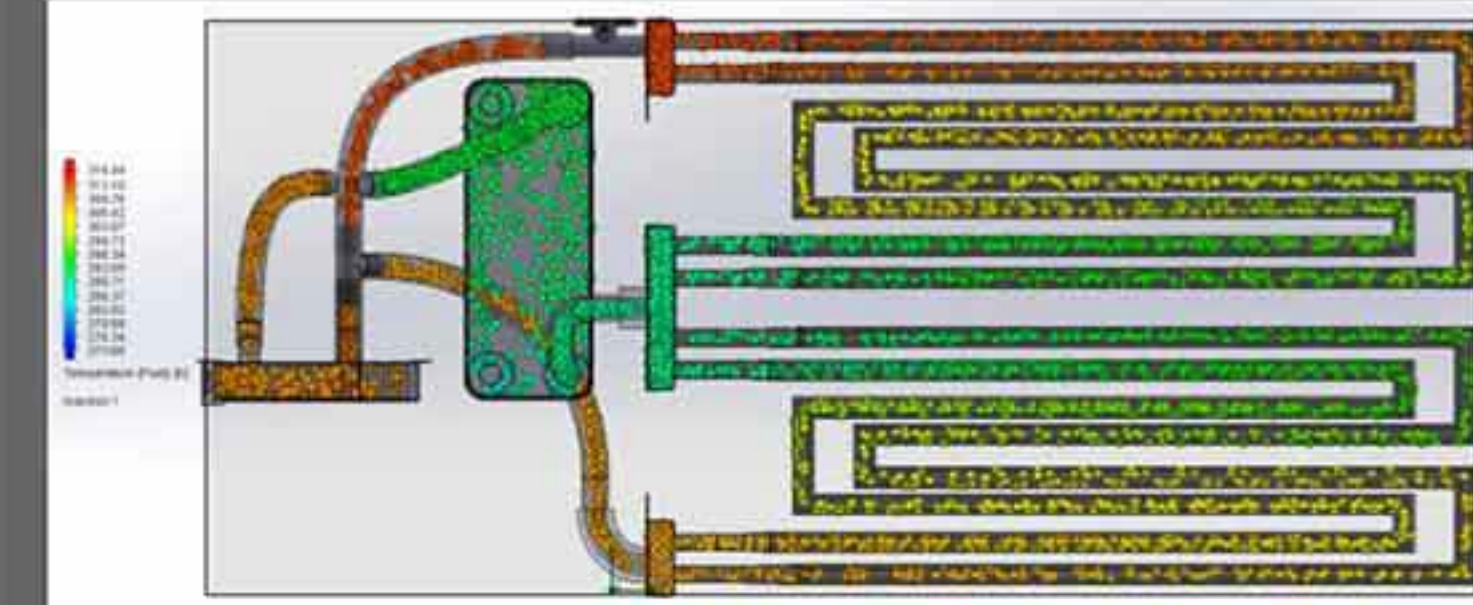
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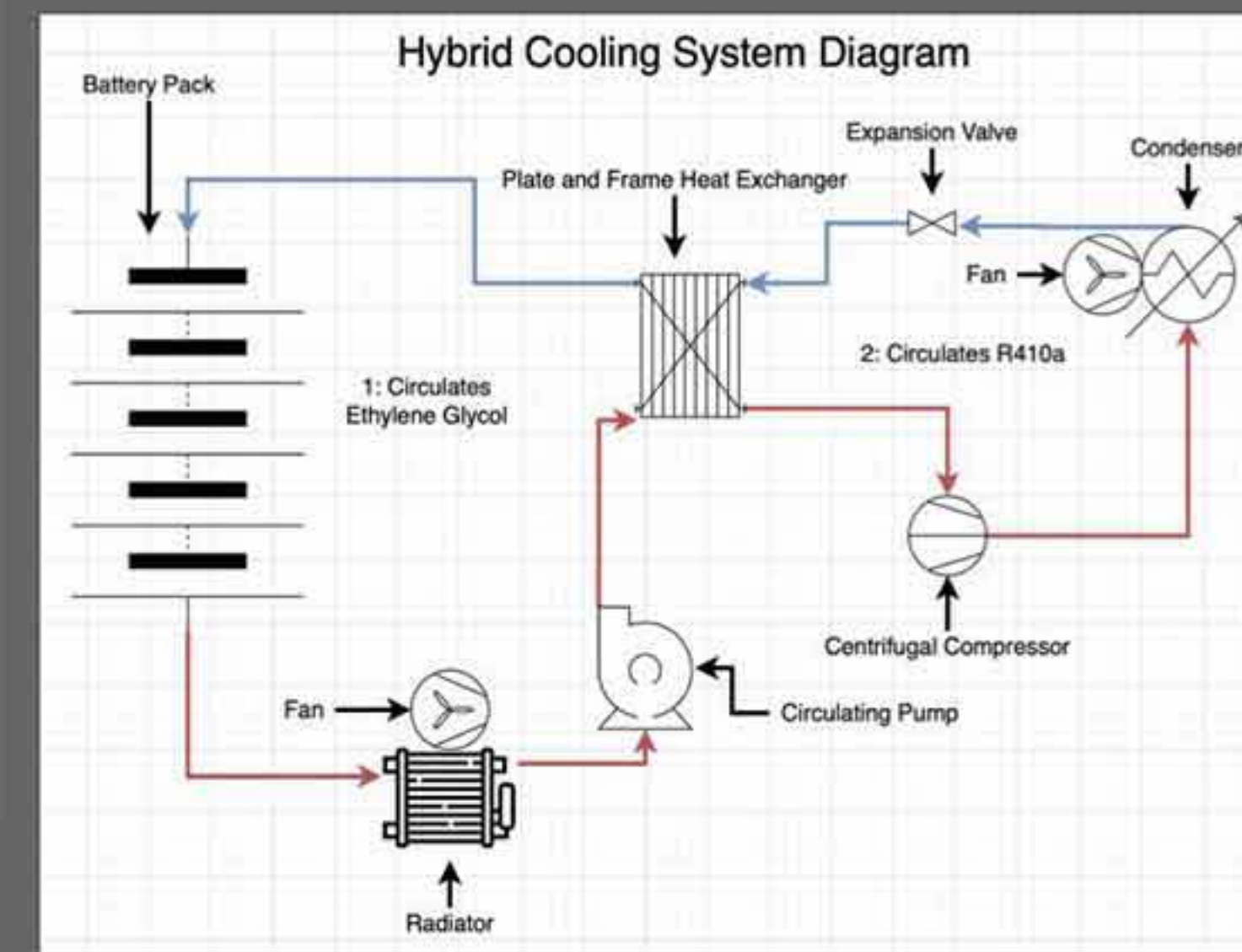
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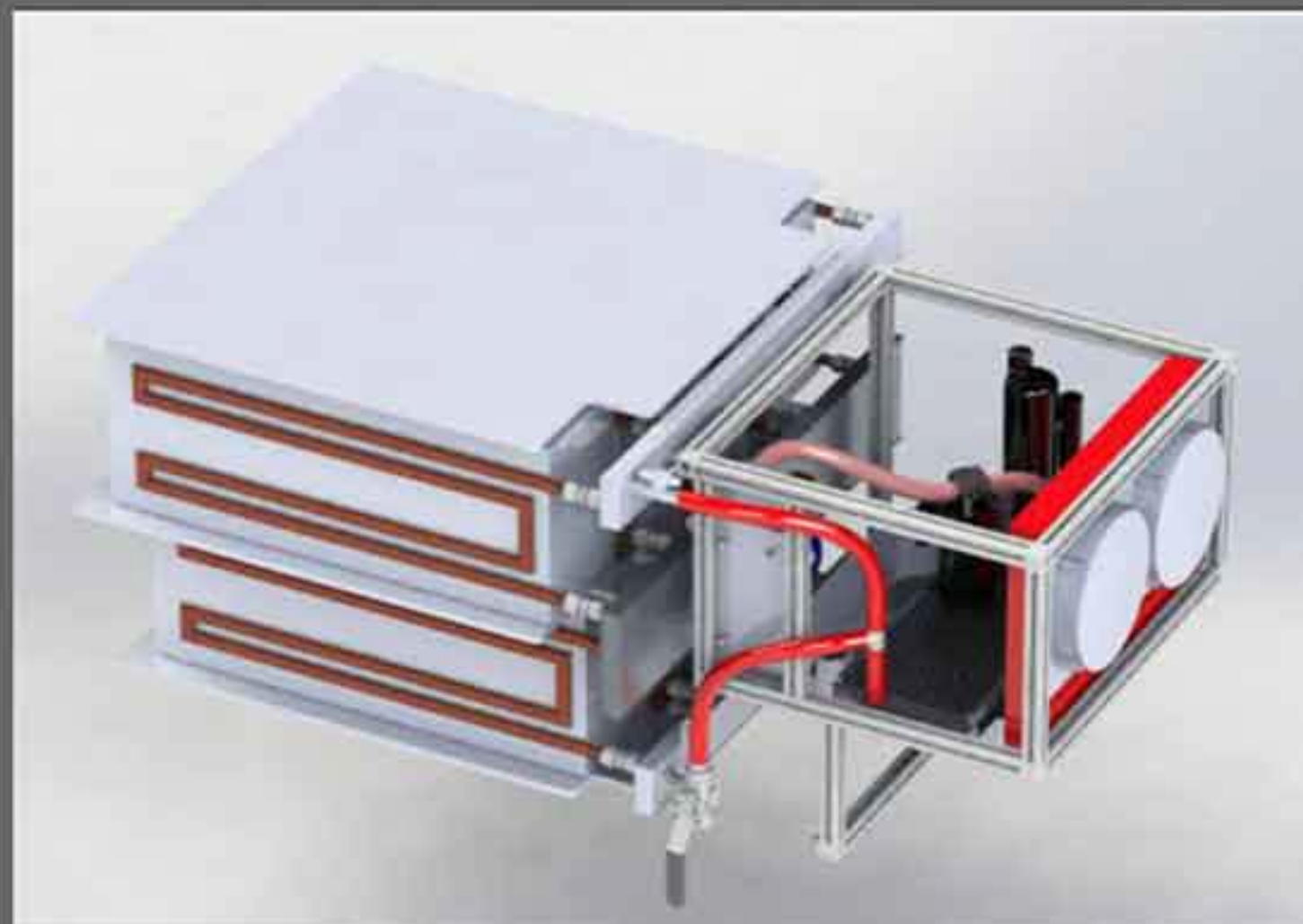
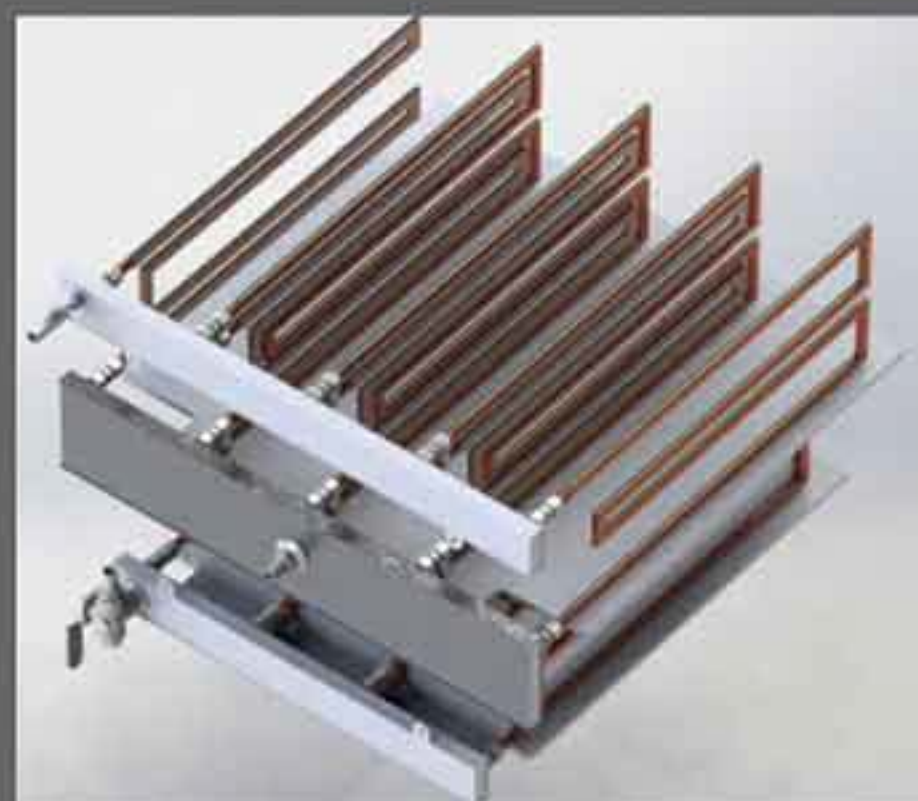


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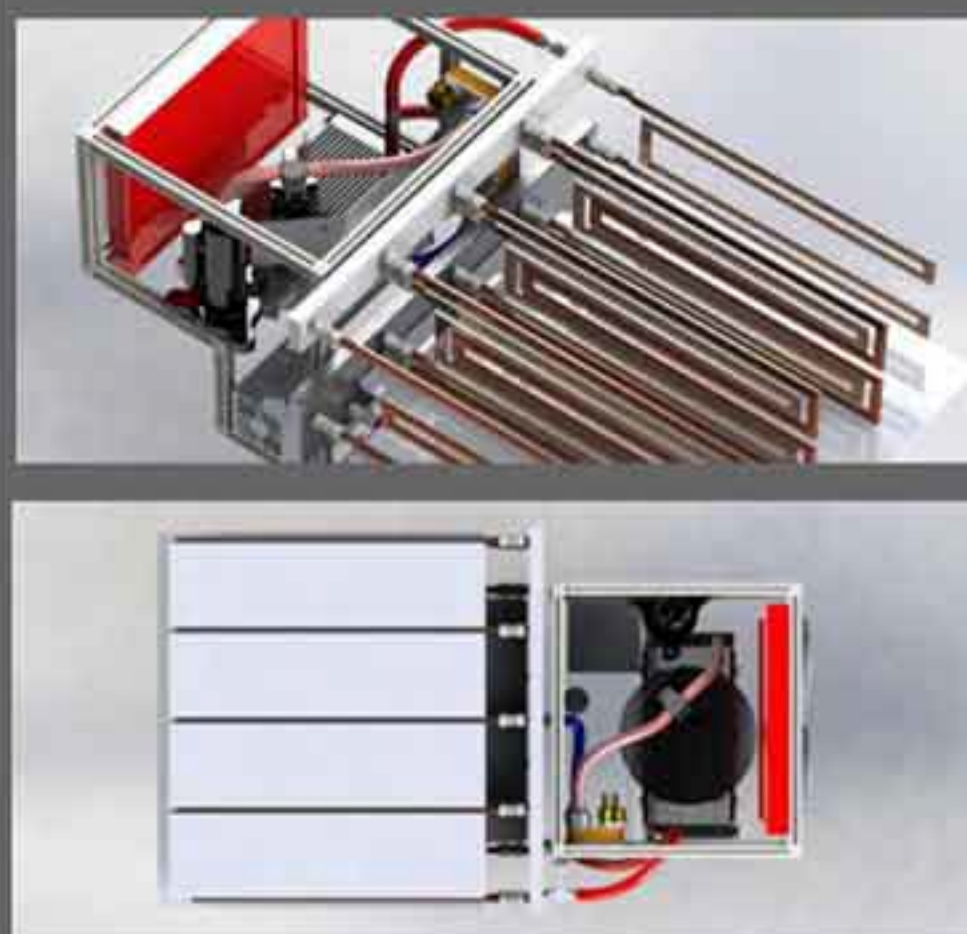


Final prototype concept render

Two sets of copper tubes are nested together with a thermal epoxy contact to the batteries



Cooling system fits between batteries



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