Portable Environmental Chamber

Project Description

• A collapsible, portable chamber which thermally isolates the environment and has attachments for ducts and sensors. Project

Purpose of Project

- HVAC Experiment in the Thermal-Fluids Laboratory
- Electric Vehicle and Roadway (EVR) Research Facility and Test Track

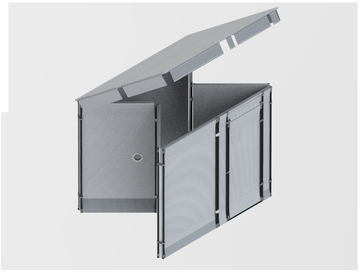
Requirements and Constraints

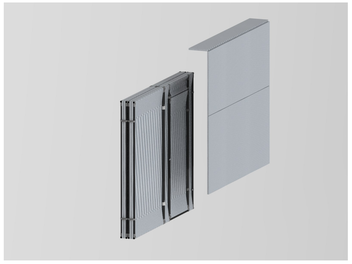
Specification	Target	Threshold
Ambient Temperature – Internal Temperature (hotter outside) [°C]	25 °C	15 °C
Internal Temperature – Ambient Temperature (colder outside) [°C]	15 °C	10 °C
Air Escaping (percentage of chamber volume) [%]	10%	15%
Chamber Size (volume) [ft³]	512 ft³	729 ft³
Collapsed Size (ratio of collapsed to full size volume) [%]	20%	35%
Total Weight [lbs]	200 lbs	300 lbs
Compartmentalized Weight [lbs]	100 lbs	120 lbs
Time Required [min]	30 min	60 min
Expected Life [years]	10+ years	5 years

MAE Thermal-Fluids Laboratory HVAC unit

USU's Innovation Campus Electric Vehicle and Roadway (EVR) Research Facility and Test Track

Design Description

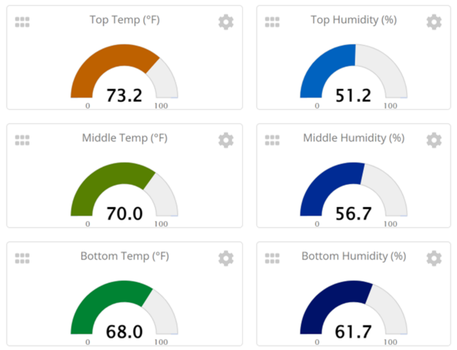




Performance Review

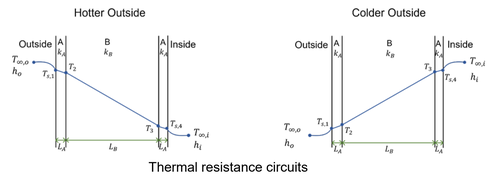
Insulation Analysis

In order to choose an insulation that would satisfy the temperature difference constraint, a thermal resistance circuit was used to calculate the total heat transfer through the chamber walls.



$$R_{cond} = \frac{L}{kA} \qquad R_{conv} = \frac{1}{hA} \qquad q = \frac{\Delta T}{R_{tot}}$$

Thermal resistance and heat transfer equations

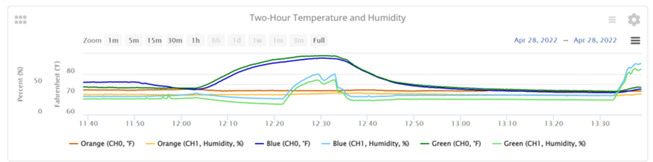


Thermal resistance circuits

Raspberry Pi Sensor Testing

For testing the actual performance of the chamber, the Raspberry Pi sensor system was used to run experiments as is done in the Thermal-Fluids HVAC lab.

The chamber was able to reach and maintain the required temperature difference between internal and external temperature.



A graph depicting experiment data collected inside the chamber while hooked up to the HVAC unit. The Raspberry Pi sensors are used to observe the affects of powering on difference HVAC components.

Conclusion

Results

The addition of the portable environmental chamber really enhances student experience during the HVAC lab. Students can feel the affects of temperature and humidity changes all throughout and beyond the thermal comfort zone. Students can observe the changes to temperature and humidity readings in real time with a convenient graphical user interface.

Assembly Time: 7 minutes with two individuals
Successfully maintains +20 degree temperature difference from ambient
The chamber successfully meets the size, weight, mobility, and temperature differential requirements

Lessons Learned

. The prototype phase of the design process is essential for confirming that materials, processes, and concepts will work as expected during the build process. Time and resources should be generously applied to this phase.

Recommended Future Work

. Improve upon fabric sleeve design so that each sleeve is identical, has all required attachment points firmly embedded, fits around the panel frame exactly, and incorporates Velcro attachment points instead of button attachments.

. Incorporate a window or lighting system to illuminate the inside of the chamber without altering the air temperature and humidity within the chamber.

. Design a support system that prevents the roof from sagging in the middle without impeding the collapsibility function of the chamber.

College of Engineering
UtahStateUniversity

Project Airflow

Wyatt Olsen - david.wyatt.olsen@gmail.com
Madilyn Webb - webbmadi98@gmail.com
Josh Burdick - joshua.burdick.r@gmail.com

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Dr. Nick Roberts
Prof. Jackson Graham