

An investigation into the design and integration of a chilled thermoelectric compartment into an aircraft cabin.



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Introduction

This project involved investigating and producing a concept of an air cooled compartment that can be integrated into an aircraft suite, which has the potential to be the first to market. An air-cooled solution was chosen due to refrigerants being banned on aircraft, due to being very explosive when subjected to rapid decompression. The project target was to help improve the passengers experience while flying in a business or first class suite.

Aims and Objectives

- To run at 30W with a max of 55W from a 28V power supply
- Achieve a 5°C – 8°C internal compartment temperature
- Ensure the system doesn't exceed 61dBA
- Design a solution using a thermoelectric device and fans
- Design the full system to fit in a small confined space
- Carry out tests while changing variables such as fluid containers, insulation foam thickness and ambient temperatures
- Test in a representative aircraft environment and suite
- Build prototypes to be able to test different solutions

References

- [1] - Dongliang Zhao, G. T., (2014) A review of thermoelectric cooling: Materials, modeling and applications. *Applied Thermal Engineering*, 66(1-2), pp. 15-24.
- [2] - By Ken Brazier - Own work - <https://commons.wikimedia.org/w/index.php?curid=3372983>
- [3] - Digikey, 2024. Thermoelectric, Peltier Modules - <https://www.digikey.co.uk/en/products/detail/laird-thermal-systems-inc/387005696/14113446>

Thermoelectric Device

Thermoelectric devices are lightweight, compact devices that use the Peltier effect to act as coolers. They have no moving parts as direct current is passed through the device, which is made up of soldered junctions, two semiconductor materials (copper and bismuth) and two insulator plates [1]. This will allow the temperature to be increased when the current passes from copper to bismuth, creating a temperature differential.

Results

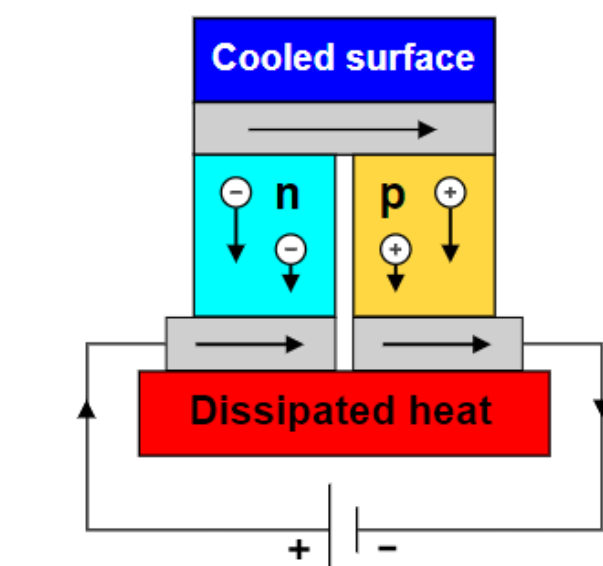
Changing the ambient temperature had notable effects on the efficiency of the thermoelectric device. The colder the ambient temperature, the colder the internal compartment temperature was. An aircraft's internal cabin temperature is 20°C which means assistance was required for cooling.

Different drink containers such as plastic, glass and Aluminium were tested to see how much of an impact this had on the fluid temperature. After measuring the fluid temperature through various test setups, there were minimal differences between the container being used.

The most significant factor that had an impact was the thickness of the insulation foam around the compartment. After testing 5mm, 10mm and 15mm foam, it was proved that the 10mm foam would be the most suitable thickness foam to use.

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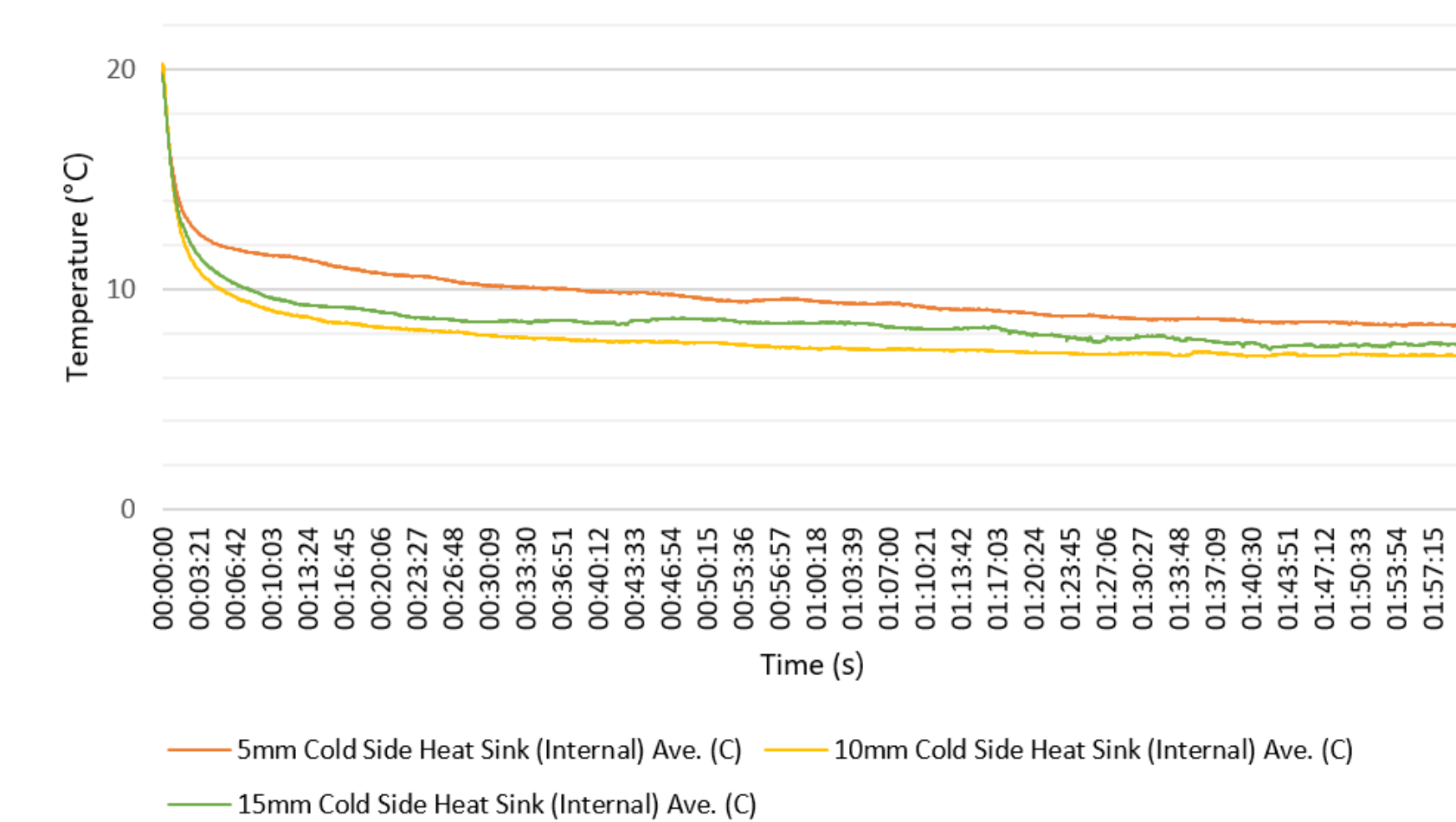


How a thermoelectric device works - [2]



Thermoelectric Device as used in solution – [3]

Comparing 5mm, 10mm and 15mm Thick Insulation Foam



Graph showing the effects of different insulation foam thicknesses



Completed concept of cooled compartment shown at AIX24