Benchtop Cooler for Laboratory (e-ICE Tray)

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ABSTRACT

The idea is to develop a benchtop cooler for short term storage of samples for general laboratory purpose.

Cell culture, protein analysis and many other workflows requires handling of multiple small vials with different samples. During the processing stage of these samples, researchers require a portable cooling device for short term storage of vials.

The proposal is to develop a portable electric benchtop cooler for handling samples which require a temperature range of $0^oC – 15^oC$. The primary technology being scoped is Thermo Electric cooling which uses Peltier Effect, given its advantages of tight temperature control, compact arrangement and less moving parts. Other technologies are also being scoped as a part of development which include the TEC Controller, MCU board etc. The product being envisioned is a portable device which can accommodate individual vials of different size and one standard storage box of vials.

INTRODUCTION

Currently, an ice bucket is used predominantly on these applications which are a 3 and a half hours process. The main problem with this traditional flow is the melting of ice, ice cannot be in same state until the process ends, and temperature is not maintained precisely and as desired. Once the ice starts melting the vials stay afloat in the tray which leads to sample spillage and user needs to replace the melted water with the ice cubes periodically. Though found to be a simple solution, it does have shortcomings in serving the purpose as below:

- Water management and floor space is required for making ice and ice maker.
- Melting of the ICE leads to sample's contamination.
- Samples are maintained in a range of temperature instead of precise temperature.
- Continuous working is not possible.
- Work window is very small.
- Wet cooling medium.
- Unnecessary foot traffic within the facilities.
- Chance of sample spillage as there is no proper support for vials.
- Need for frequent replenishment of ice.
- Wastage of water.

METHODOLOGY

Methodology involves the following steps.

1. Specifications and Power calculations:

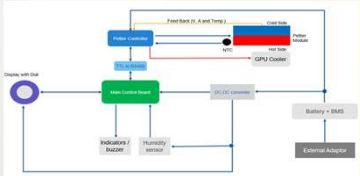
- Both AC (external adaptor) and DC power source (battery built in).
- Cooling Technology: Thermo Electric Cooling (Peltier Module)
- Touch Screen: OLED Round Touch Screen
- Providing Indicators and Buzzers.
- Humidity Sensor to detect condensation.
- Battery Backup: 45 Minutes
- Cooling Chamber Dimensions: 316 x 247 x 50 mm³
- Overall Unit Size: 422 x 422 x 142 mm³
- Cooling Medium: Aluminium Beads/ Plastic Beads

TOTAL POWER CALCULATIONS		
INITIAL STATE (27 TO 0 DEGREES)		
Description	Lid is closed(W)	Lid is open(W)
Cooling medium	136.59	136.59
Heat Lost through the walls	2.80	4.76
Heat lost from beads to atm.	-	13.18
Total Power	159.89	154.53
STEADY STATE		
Reserved Capacity	81.67	81.67
Total Power	84.47	99.61

Fig. 1: Power Calculation Table

2. Architecture Design and Components:

- Developing the High Level Architecture
- Hardware Components



Peltier Module - **TEC1-28715L1**
TEC Controller - **TEC-1161-10A**
MCU Board – TI LaunchPad
Display with Touch – Round OLED with Knob
Battery – UB12590
BMS – UBI-PMM240
DC-DC Controller - **TSR 1.5E**
PT1000 & NTC
Humidity Sensor
LED's
Buzzers
Power Adaptor – Dell
GPU Cooler – Corsairs 120ML

Fig. 2 & 3: Architecture Diagram and List of components

3. Firmware Workflow : From the firmware workflow the Peltier module can be controlled through the TEC controller by developing the algorithm and PID controls.

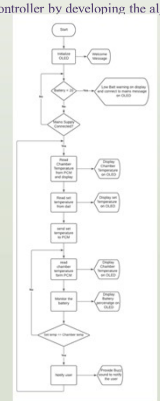


Fig. 4: Workflow of the complete process to obtain the desired outcomes. The MeComAPI provided by the TEC controller is used to develop the algorithm.

MAIN RESULTS

The method explained above was implemented. For the demonstration the outer enclosure, the positioning of the Hardware Components and the new workflow vs the old workflow is shown as the result.

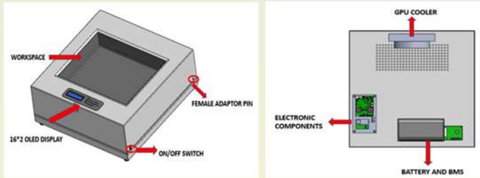


Fig. 5: Outer Enclosure and Hardware Components Placing.

The New Workflow Vs The Old Workflow in the Laboratory

Step 1: On the device
Step 2: Set the required temperature/Use default (4°C – cooling medium)
Step 3: Wait to till unit reach the set temperature/default temperature
Step 4: Placing the samples into the cooling chamber from the freezer
Step 5: Lysate preparation
Step 6: Adding anti-bodies
Step 7: Keeping samples back to freezer

CONCLUSIONS

This portable product (e-ICE Tray) can be used for short term storage of samples which helps us in avoiding sample spillage and can maintain the vials in a certain temperature for a longer time with no issues and problems.

KEY REFERENCES

1. N. Jakhar, N. Baheti, M. C. Gurjar and P. Sharma, "Model development of refrigerator and heater based on Peltier module and Fresnel lens," 2016 International Conference on Recent Advances and Innovations in Engineering (ICRAIE), 2016, pp. 1-4, doi: 10.1109/ICRAIE.2016.7939500.
2. S. Kumar, A. Gupta, G. Yadav and H. P. Singh, "Peltier module for refrigeration and heating using embedded system," 2015 International Conference on Recent Developments in Control, Automation and Power Engineering (RDCAPE), 2015, pp. 314-319, doi: 10.1109/RDCAPE.2015.7281416.
3. A. Jose, A. D'souza, S. Dandekar, J. Karamchandani and P. Kulkarni, "Air conditioner using Peltier module," 2015 International Conference on Technologies for Sustainable Development (ICTSD), 2015, pp. 1-4, doi: 10.1109/ICTSD.2015.7095879.
4. M. Algusri and D. Redantan, "Analysis of Peltier Characteristic and Cold Side Treatment for Thermoelectric Generator Module at Brick Kiln Furnace," 2018 2nd International Conference on Electrical Engineering and Informatics (ICon EEI), 2018, pp. 134-139, doi: 10.1109/ICon-EEI.2018.8784141.
5. M. D. Thakor, S. K. Hadia and A. Kumar, "Precise temperature control through Thermoelectric Cooler with PID controller," 2015 International Conference on Communications and Signal Processing (ICCSP), 2015, pp. 1118-1122, doi: 10.1109/ICCSP.2015.7322677.

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