A PROJECT REPORT

ON

"REGULATED THERMOELECTRIC ORGAN STORAGE CONTAINER FOR AERIAL TRANSPORT"

Submitted by

BAMNE SAQIB JAMIL	**17ME09**
SAYYAD ILTAM ILYAS	**17ME18**
KHAN FAISAL AQIL	**17ME29**
MALIK AHETESAB ASHAB	**17ME50**

In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. ATUL MESHRAM

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2020-2021

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recg. By Maharashtra Govt. DTE, Affiliated to Mumbai University)

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL, NAVI MUMBAI-410206, Tel.: +91 22 27481247/48 * Website: www.aiktc.org

CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University of Mumbai**, is approved.

Internal Examiner (Prof. Atul Meshram)

External Examiner (   )

Head of Department (Prof. ZAKIR ANSARI)

Director (Dr. ABDUL RAZAK HONNUTAGI)

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APPROVAL OF DISSERTATION

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(Internal Examiner) **(External Examiner)**

____________________ ____________________

Date: ___________

Acknowledgement

After the completion of this work, we would like to give our sincere thanks to all those who helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound gratitude to our guide **Prof. ATUL MESHRAM** whose constant encouragement enabled us to work enthusiastically. His perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

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Last but not the least I would also like to thank all the staffs of Kalsekar Technical Campus (Mechanical Engineering Department) for their valuable guidance with their interest and valuable suggestions brightened us.

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SAYYAD ILTAM ILYAS	**17ME18**
KHAN FAISAL AQIL	**17ME29**
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Declaration

I declare that this written submission accurately reflects my ideas in my own terms, and that where other people's ideas or words were used, I properly cited and referenced the original sources. I also declare that I have followed all academic honesty and integrity standards in my submission and have not misrepresented, fabricated, or falsified any concept, data, fact, or source. I understand that any breach of the above would result in disciplinary action by the Institute, as well as legal action from the sources who were not properly cited or from whom proper permission was not obtained when required.

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SAYYAD ILTAM ILYAS	**17ME18**
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Abstract

Organ transplantation has become one of the important aspects for one's life. Lungs, heart, pancreas, kidneys, liver, and intestine are among the organs that can be transplanted, and face and body transplants have recently become more common. The most prevalent type of organ transplant is kidney transplantation, which has a high success rate. While organ transplantation has become more prevalent in wealthy countries like the United States, the procedure remains complex, involving many delicate steps and needing a highly competent team of surgical experts. A battery of tests is used to determine the type of donor organ that is most suited to the recipient and to prevent organ transplant rejection. Matching of donor is the major part of organ transplantation.

After matching of donor and receiver most of the time the receiver is not operated in the near areas so transportation becomes mandatory. and due to constraints, such as required temperature and lifespan of an organ outside the body, fast transportation is necessary. Aerial transportation such as from aeroplane is done if the distance is more, and the organ is taken by means of road if the distance is less. This transportation by road is very risky as traffic accidents can make it hard to reach the hospital in time. So aerial transport such as a drone is used.

Drone can be used for aerial transport of the organ but it has some constraints such as limitation of weight. temperature inside the container should be maintained as per the requirement of the organ. In this project we intend to make such a container which is light weight, can regulate temperature, and can be easily carried.

Regulated thermoelectric organ storage container for aerial transport was designed, analyzed, fabricated and experimented. 3d modelling and design was made in Fusion 360 and analysis was performed on Ansys workbench. The entire explanation is provided in the following report with figures of 3D models and results of various analyses.

Chapter 1

Introduction

1.1: Problem definition

Life span of every organ is limited and so fast transportation with proper conditions being taken care of is mandatory.

A medical organ transport container is to be designed to be used in medical equipment transport drones with constraints on weight, size and maintaining required temperature this project is meant to do the same with respect to above constraints

1.2: Aim/Objective/Purpose of the Study

- To make a regulated thermoelectric medical storage/transportation container for aerial transport.
- To make it cost-efficient.
- To reduce its power consumption by controlling power supply.
- To improve its overall cooling effect distribution.

Chapter 2

Literature Survey

New and emerging preservation/transportation technologies for solid organs retrieved for transplantation by *Teladia, Zaheda & Packer, Claire & Simpson, Sue.*

This Author has written the goal of this review is to find novel and emerging technologies for transporting solid organs collected for transplantation, with the goal of maintaining or improving the quality, and eventually the yield, of recovered organs. Preservative maintenance fluids and conveyance devices will be among the technologies used. The heart, lung, liver, pancreas, kidney, and small bowel are all important solid organs to consider.

Heat transfer and airflow characteristics enhancement of compact plate-pin fins heat sinks by *Amer Al-damook, FahadSaleh Al Kasmoul*

The energy consumption of racs has been studied in this paper under various heat-load conditions and activities. Water is cooled in a refrigerator by refrigerant, which circulates throughout the freezer chamber. A refrigerator can freeze one litre [1] of water from 400C in as little as 5000 seconds (about 1.5 hour). Working on Peltier effects, Thermoelectric Modules (tems) can deliver high cooling rates while using DC electric sources. In a few of seconds, tems may achieve sub-zero surface temperatures. The use of TEM to freeze water has been attempted. With the use of such tems, water may be frozen without the use of any refrigerant, and the freezing period can be reduced to just 3 minutes. This paper discusses the design of a quick icing machine based on the thermoelectric effect. The ideal selection of TEM on the basis of cooling capacity and current consumption is reviewed in order to achieve rapid icing, and a 500ml cooling box is constructed to deliver icing in 1.5 minutes. According to the design results, the quick icing machine will require 16 tems (TEC1-12706) and four copper heat sinks with 26 fins each.

Rapid Water Freezer Using Thermoelectric Module by *Khodegaonkar, Ameya & Patil, Sudhir*

In this Authors have researched for Heat transfer and airflow characteristics enhancement of compact plate-pin fins heat sinks. Plate-pin heat sinks are widely used for the electronic cooling system, internal combustion IC engine, cooling of gas turbine blades and other different applications to enhance the thermal performance of heat sinks due to simplicity, low cost, and a reliable manufacturing process. However, compact heat sinks give higher pressure drop compared with other types of heat sinks. The purpose of this article is to summarize the main advantages and disadvantages of the compact heat sink with some recommendation studies for future works of heat sink thermal airflow experiment and simulations. Furthermore, the research attempts to highlight the importance of balancing the relationship between the hydraulic performance and the thermal performance of compact heat sinks.

Chapter 3

Methodology

3.1: Design Methodology

In this project, to obtain various data related to stress and thermal analysis of different components of the setup, we followed virtual methods as well as experimental verifications.

The methodology that is followed to attain the research objectives is divided into the following work phases:

1. Literature review
2. Design of system
3. Fabrication of system
4. Analysis of electrical system
5. Perform a complete Thermal analysis of the system to achieve the efficiency of the system

Software used for different modelling and analysis purposes are as follows:

- Inventor
- Fusion 360
- Ansys
- Ansys Workbench

3.2: Design Procedure

Regulated thermoelectric organ storage container for aerial transport is to be designed by taking consideration of weight, temperature regulation, strength, etc.

3.2.1: Selection of material

As per the requirement of the system material with light weight and low heat transfer coefficient (should have high insulation properties) should be selected for making of container.

3.2.2: Structure Selection

Design the structure of a container with proper dimensions by considering strength of material, space requirement and efficiency.

3.2.3: Selection of components

Selection of material for heat sink is critical as it has direct effect on the performance and cost, thermal conductivity should also be considered. selecting a battery as per the requirement is necessary

3.2.4: Fundamentals of Design

Heat transfer rate, weight of the container, regulation of temperature are basic parts of design. Compactness is also a factor as the container is intended to be used by drones.

Chapter 4

Project management

4.1: Members and Capabilities

MEMBER	TASK
BAMNE SAQIB JAMIL	Fabrication, practical analysis, Study of peltier module.
SAYYAD ILTAM ILYAS	Design and analysis of systems, study of insulation material.
KHAN FAISAL AQIL	Fabrication, study of Heatsinks.
MALIK AHETESAB ASHAB	Procurement of material, study of temperature controller.

(Table 4.1 Members and capabilities)

4.2: Project Management Approach

Our guide led the project flawlessly, and he dispersed the work according to everyone's skill level. We all did our jobs according to the guide's instructions and completed them successfully.

4.3 Total costing of fabrication of the project is as follows:

Component	Expected Cost/piece (Rupees)	Quantity
Peltier Module	300	1
XPS Foam board	600	1
Heat sink	1400	2
Fan	700	3
Battery	3900	1
Temperature Controller Module	200	1

(Table 4.2 total costing)

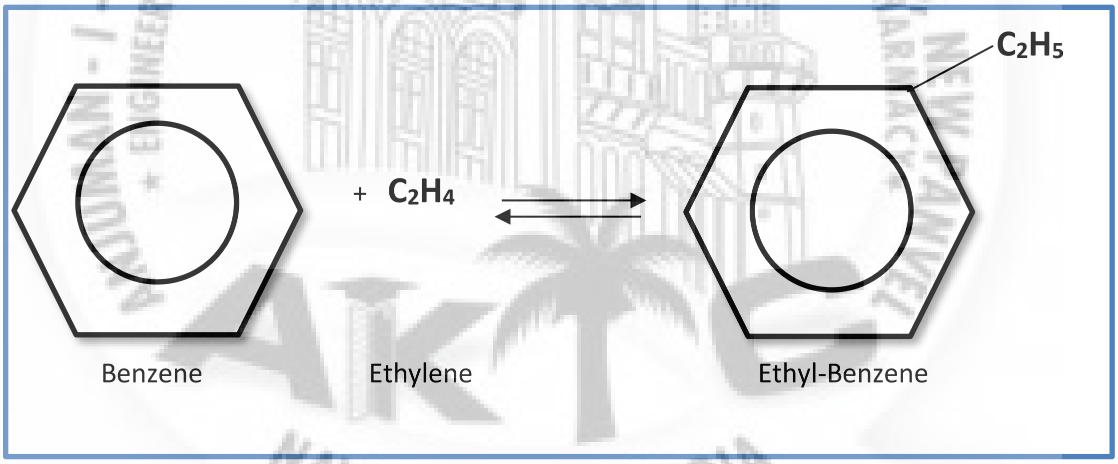
Chapter 5

Extruded polystyrene

Extruded Polystyrene is a foam board manufactured from polystyrene. Polystyrene is a synthetic hydrocarbon made from benzene and ethylene.

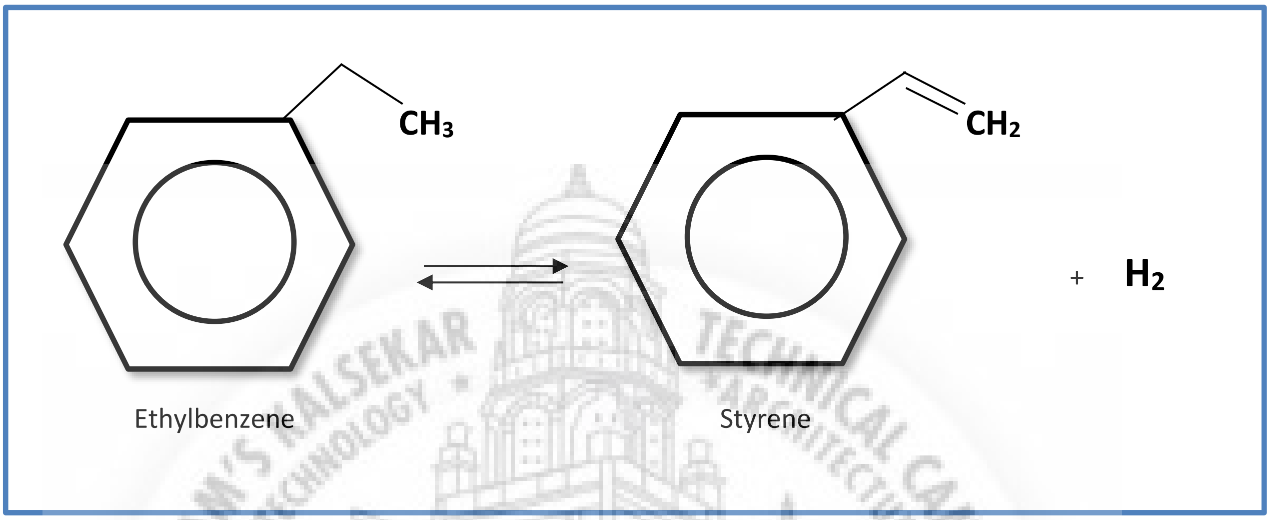
5.1 Synthesis of extruded polystyrene

Ethylbenzene is prepared by reaction of ethylene and benzene in the presence of catalyst such as aluminum chloride at about 95°C.



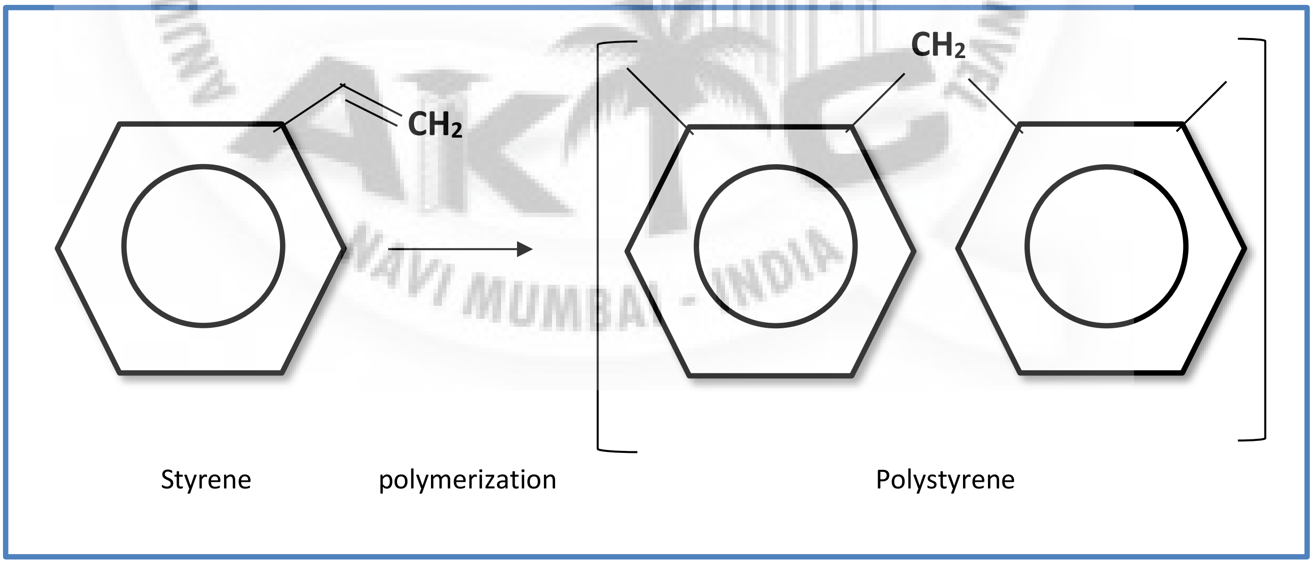
(Figure 5.1 Synthesis of ethylbenzene)

Then Ethylbenzene is then dehydrogenated using superheated steam and iron oxide catalyst to form monomer styrene.



(Figure 5.2 Synthesis of Styrene)

Then using addition polymerization styrene is converted into polystyrene



(Figure 5.3 Synthesis of Polystyrene)

Extruded Polystyrene is made by heating solid granules of polystyrene and certain additives and then extruding it. This process requires careful maintenance of temperature and pressure.

5.2 Mechanical properties of extruded polystyrene

Extruded Polystyrene is a strong and rigid material mainly used in insulation works due to its low thermal conductivity and adequate strength. It is also chemically resistant and has water resistant

Extruded Polystyrene is an anisotropic material with density of about 29 kg/m^3; Its Young's Modulus in X-direction is 24.4 mpa, in Y-direction is 15.9 mpa and in Z-direction is 20.2 mpa; Its Shear Modulus in X- direction is 7.26 mpa, in Y-direction is 10.3 mpa and in Z-direction is 8.55 mpa; Its Poisson's Ratio in XY-plane is 0.58, in YZ-plane is 0.44 and in XZ-plane is 0.46.

Density(kg/m^3)	Young's Modulus (MPa)			Shear Modulus (MPa)			Poisson's Ratio		
	X	Y	Z	X	Y	Z	XY	YZ	ZX
29	24.4	15.9	20.2	7.26	10.3	8.55	0.58	0.44	0.46

(Table 5.1 Structural Properties of Extruded Polystyrene.) [3]

5.3 Thermal properties of extruded polystyrene

Thermal Conductivity values of extruded polystyrene are between 0.025 and 0.040 W/(m.°C); Specific Heat of Extruded Polystyrene is 1500 (J/kg °C).

Thermal Conductivity W/(m.°C)	Specific Heat (J/kg °C)
0.033	1500

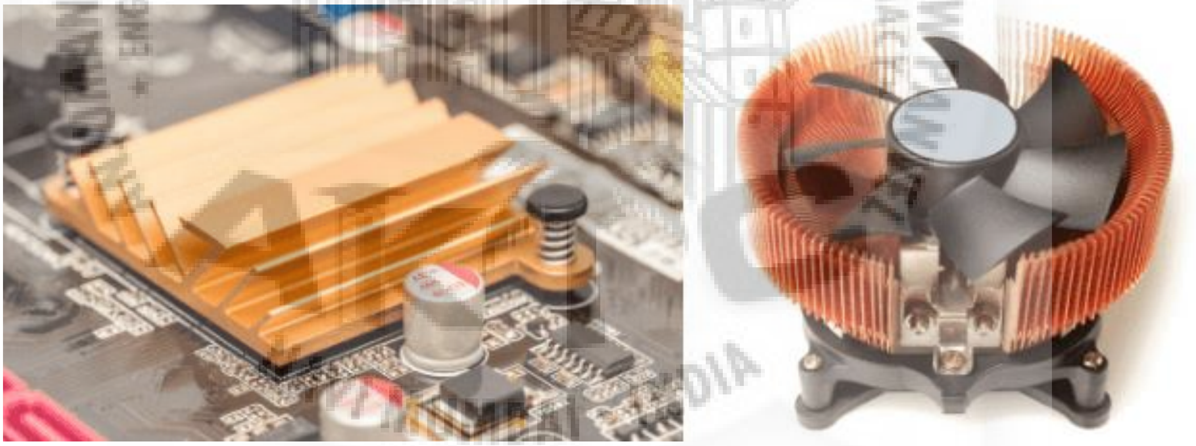
(Table 5.2 Thermal Properties of Extruded Polystyrene.) [4]

Chapter 6

Heat Sink

Heat sink is a metal heat distributor that helps dissipate the heat. It has fins of desired height and length for desired applications. Performance of thermoelectric cooler can be improved by working on hot side. To obtain the best performance, a Peltier cooler must be designed with heat sink with good thermal conductivity. The conventional heat sink unit utilized at the Peltier hot side is composed of fins and a fan. The fins are employed to increase heat transfer area. The fan conducts heat transfer through convection. Although the thermal resistance of such a unit can be as low as 0.1 K/W, it is usually larger in size.

6.1 Classification based on airflow



(Figure 6.1 Passive and Active Heat Sink)

6.1.1 Passive heat sink

Passive heat sink when there is no external power source helping dissipate the heat i.e. depending purely on natural convection. This type of heat sink is slow and dissipates less heat and takes more time compared to active heat sink.

6.1.2 Active heat sink

Active heat sink is when there is a force to make the hot air flow off the heat sink quickly. Air can be forced by attaching a fan or sometimes a blower to the heat sink. This type of heat sink dissipates more heat and takes less time to cool things. It is used widely in electronic components as chips heat up quickly.

6.1.3 Hybrid heat sinks

These are a combination of active & passive heat sinks; it is very rarely used. In hybrid type when temperature reaches a certain value, forced heat dissipation starts to take place, before that heat was dissipated passively. Once the temperature gets lower active heat dissipation is stopped thus saving energy.

6.2 Classification based on material

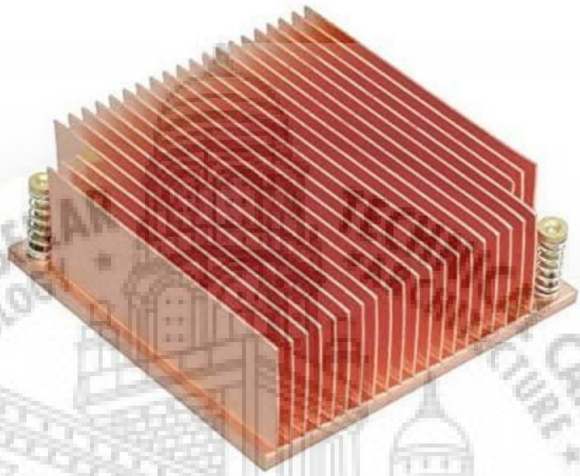
6.2.1 Aluminum heat sink

Aluminum is a light metal therefore it is used in heatsinks more often. It can be manufactured easily and is cost effective. Thermal conduction of aluminum is almost half to that of copper, so it cannot move heat as quickly as copper. This is the limitation of the aluminum heat sink.

(Figure 6.2 Aluminum Heat Sink)

6.2.2 Copper heat sink

This metal is a good conductor of heat but at the same time it is almost three times heavy and also costly in comparison with aluminum. It is used in heat sinks when there is a need for high efficiency and quantity of heat removal. Bonded fin type can be made from both materials using one as base and other as fins.



(Figure 6.3 Copper Heat Sink)

6.3 Classification based on Heat Dissipation Method

(Figure 6.4 Solid and Liquid Dissipator Heat Sinks)

6.3.1 Solid metal heat sink

Heat sink with a metal base and fins on them that helps dissipate the heat comes under solid metal heat sink. These are very commonly used in electronics and other things. Aluminum and copper are the two metals mainly used for production of those heat sinks.

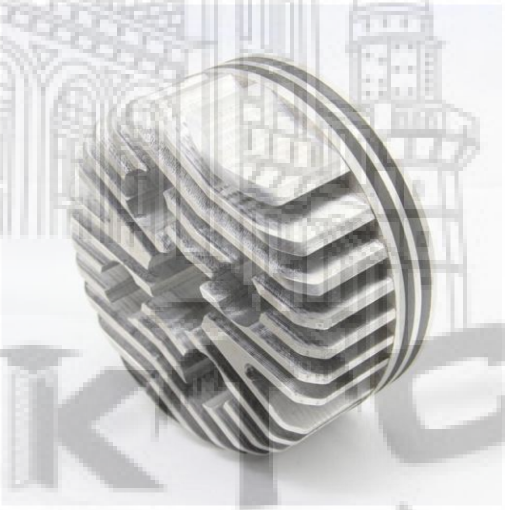
6.3.2 Pumped liquid heat sink

The method rarely used to cool electronics is the liquid pumping method. Liquid passes through hot plates and then circulated towards the fins to be cooled and back to heat side. This method is effective in heat removal but is costly and takes more space hence not used widely.

6.4 Classification based on manufacturing method

6.4.1 CNC machined heat sink

CNC machined heat sinks can be made in many complex designs and patterns. But the cost of machining, time taken and wastage of machining is more hence making this process less business efficient.



(Figure 6.5 CNC Machined Heat Sink)

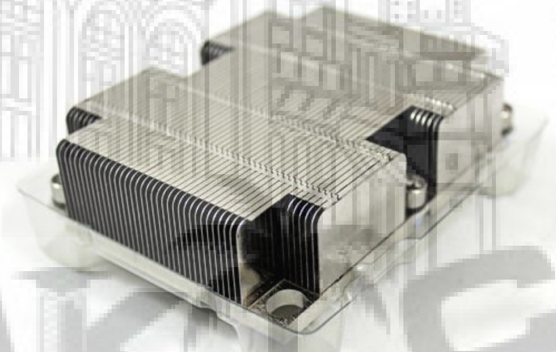
6.4.2 Forged and die cast heat sinks

Forged and die casted heat sinks offers great thermal conductivity, both have low cost of production per units. Forging makes it flexible to make different designs of heat sinks while die gives thicker fins and that's why is used in natural convection process.

(Figure 6.6 Forged and Die Heat Sink)

6.4.3 Zipper fin heat sink

Fins closely packed together and heat pipes going through them is one of the widely used type of heat sink. Its called a Zipper fin heat sink. It is very effective in heat transfer and is used in cooling to a very low temperature.



(Figure 6.7 Zipper Fin Heat Sink)

6.4.4 Skived fin heat sink

Skived fins give an extraordinary thermal conduction, it has very thin fins and it also costs very less for tooling work on this heat sink. The only drawback is that fins can easily bent under pressure or force.

(Figure 6.8 Skived Fin Heat Sink)

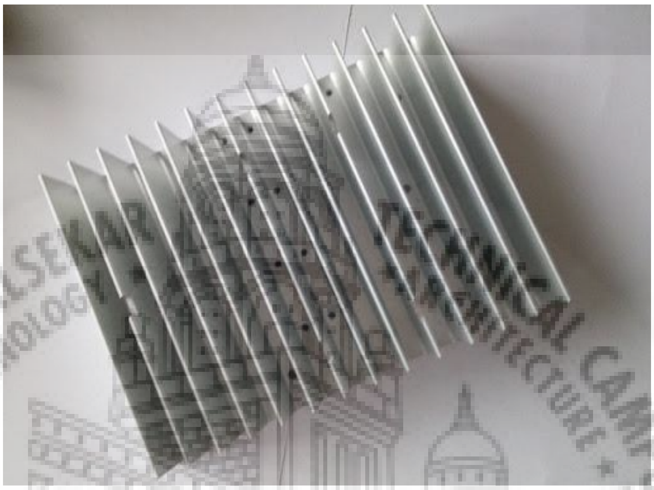
6.4.5 Bonded fin heat sink

When big heat sinks are necessary it is hard to be produced but it can be done by bonded heat sinks. These heat sinks can be made from different metals, one for fin and other for base.

(Figure 6.9 Bonded Fin Heat Sink)

6.4.6 Extruded heat sink

Heat sinks can also be made by extrusion but it has its own limitations. Some other operation should be done after the extrusion or else it will limit the range of designing that could be done. Extrusion is a cost-effective process.



(Figure 6.10 Extruded Heat Sink)

Chapter 7

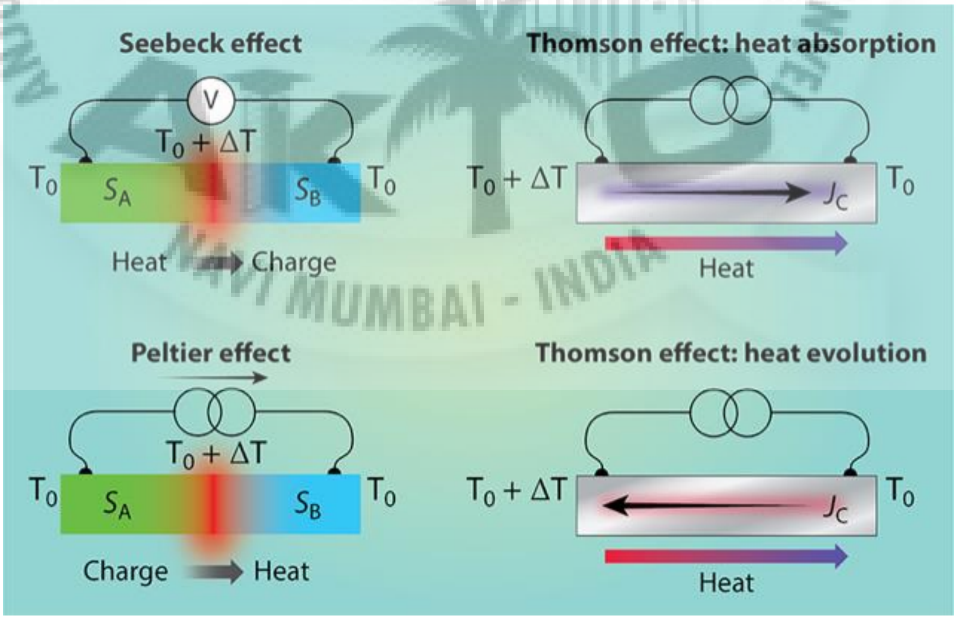
Peltier device

Peltier module is an electronic device which pumps heat from one side of the device to the other using electrical energy. Its efficiency is low but it has no moving parts and it is very compact. This makes it useful where size and weight is constrained.

7.1 Thermoelectric effect:

When two conductors of different materials touch each other, thermoelectric effect happens. Given below are the different manifestation of thermoelectric effect

- Seebeck effect
- Peltier effect
- Thomson effect

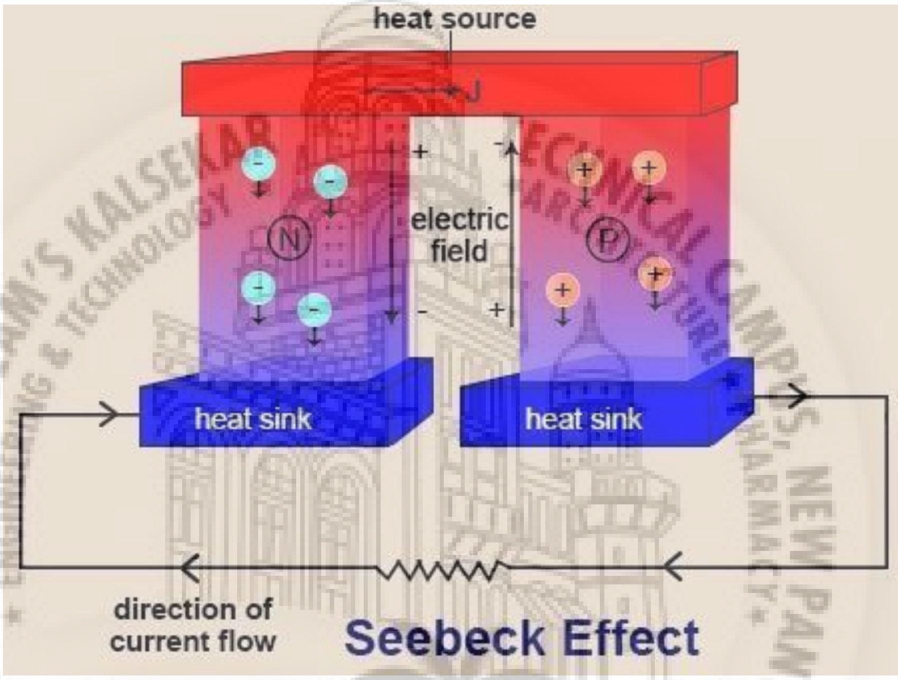


(Figure 7.1 Thermoelectric effect)

7.1.1 Seebeck effect

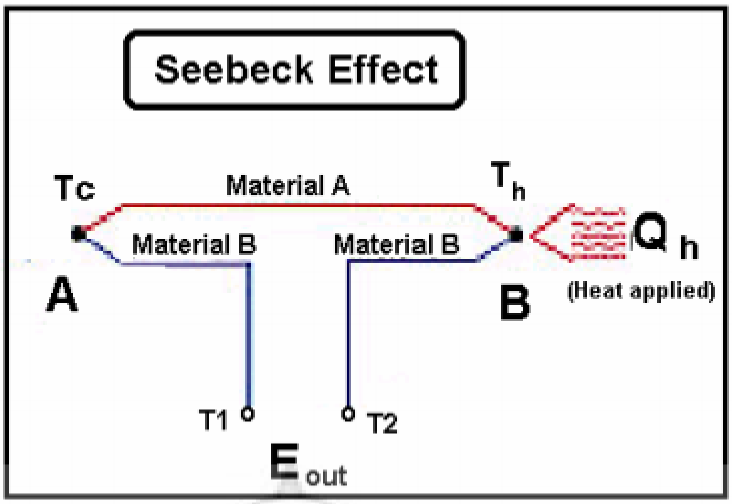
When there is a temperature difference between the junction of two material and rest of it a voltage is created across the junction and acts like a generator. Typically, voltage is very small but increases with increase in temperature difference.

At the junction of different electrical conductors, seebeck effect converts heat directly into electricity. It is depicted in the following figure:



(Figure 7.2 Seebeck effect)

The conductors are two different metals, material A and material B, as indicated in Figure 1. The junction temperature at A serves as a reference point and is kept at a cool temperature (TC). Temperature greater 3 than temperature TC is utilised as the junction temperature at B. When heat is added to junction B, a voltage (Eout) appears between terminals T1 and T2, resulting in a continuous electric current flowing in this closed circuit. This voltage is known as the Seebeck EMF.



(Figure 7.3 Seebeck effect)

This voltage can be expressed as

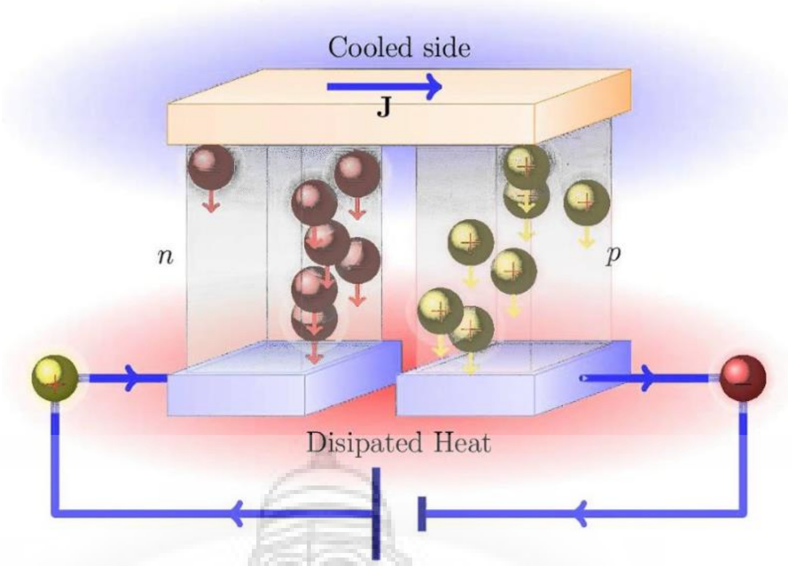
$$E_{out} = \alpha(T_H - T_C)$$

Where:

- $\alpha = dE / dT = \alpha_A - \alpha_B$
- α is the differential Seebeck coefficient or (thermo electric power coefficient) between the two materials, A and B, positive when the direction of electric current is same as the direction of thermal current, unit is V/K.
- E_{out} is the output voltage in volts.
- T_H and T_C are the hot and cold junction temperatures, respectively, in Kelvin.

7.1.2 Peltier effect

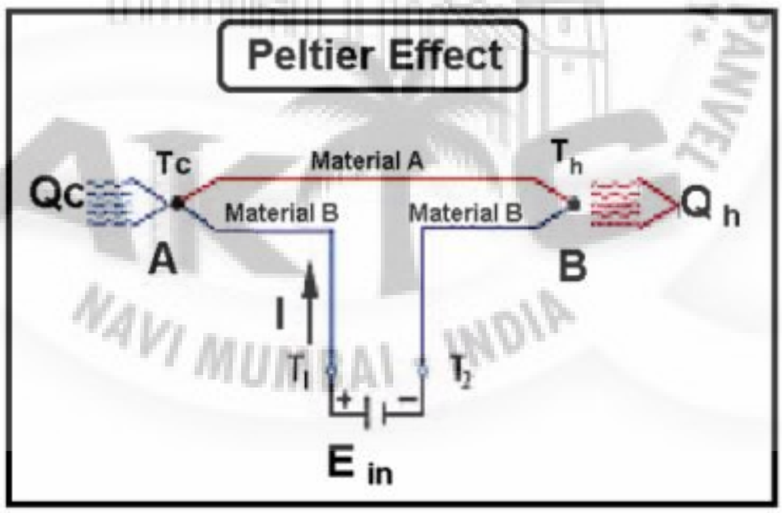
When voltage is delivered across the two junctions of dissimilar electric conductors, a constant temperature difference is created between them, resulting in heating and cooling on each side respectively. When an electric current is maintained in a circuit of material consisting of two dissimilar conductors, the Peltier effect causes one junction to cool and the other to heat.



(Figure 7.4 Peltier effect)

Peltier cooler works on Peltier effect and by working on thermoelectric refrigeration, it provides cooling by using thermoelectric effects rather than using conventional methods such as vapour absorption or vapour compression methods.

Laser diodes, blood analyzers, and portable picnic coolers all use Peltier coolers as a cool ing element.



(Figure 7.5 Peltier Effect)

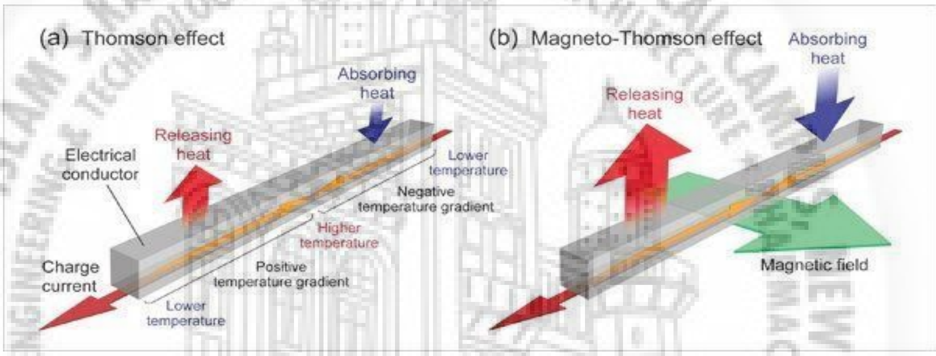
The Peltier effect can be expressed mathematically as

$$Q_c \text{ or } Q_H = \beta \times I = (\alpha T) \times I$$

Where:

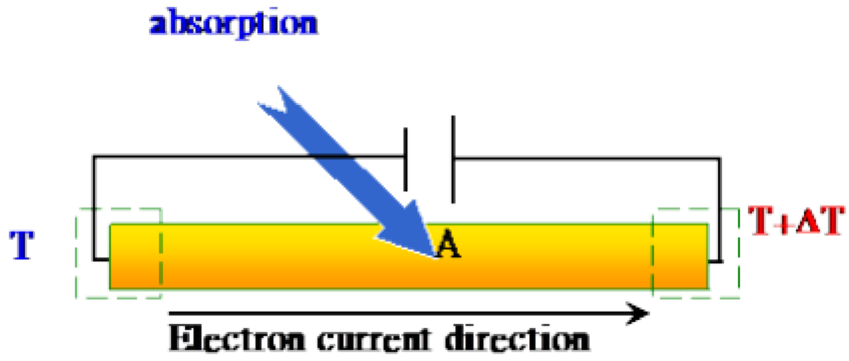
- β is the differential Peltier coefficient between the two materials A and B in volts.
- I is the electric current flow in amperes.
- Q_C and Q_H are the rates of cooling and heating, respectively, in watts.

7.1.3 Thomson effect



(Figure 7.6 Thomson Effect)

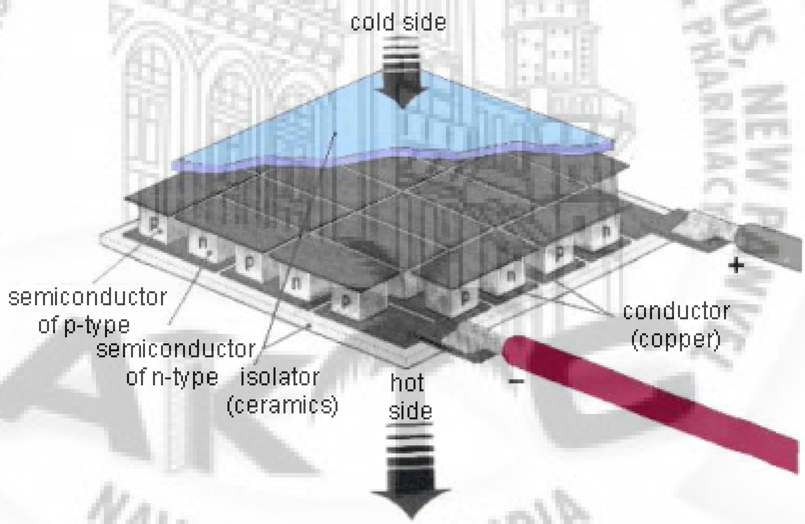
When an electric current flow through a conductor with a temperature gradient along its length, hat is either absorbed or released by conductor according to Thomson effect. The direction electric current and the temperature gradient determines whether the heat is absorbed or released.



(Figure 7.7 Thomson Effect)

7.2 Classification based on semiconductor type

Peltier devices works on the same principal of Peltier effect but instead of single junction there are many junctions of two different material made of P and N junctions.



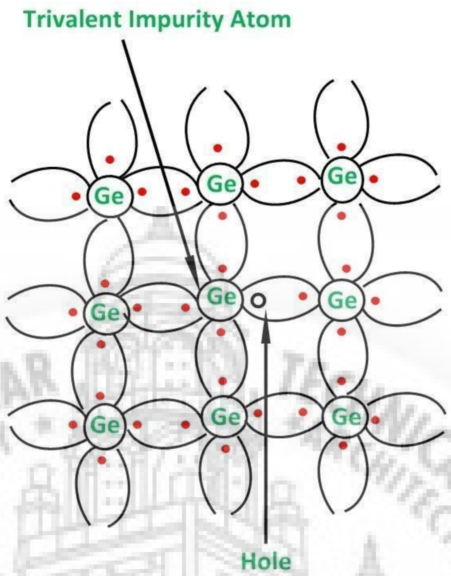
(Figure 7.8 Peltier Device)

These are of classified as follows:

- P-type semiconductors
- N-type semiconductors
- P&N type semiconductors

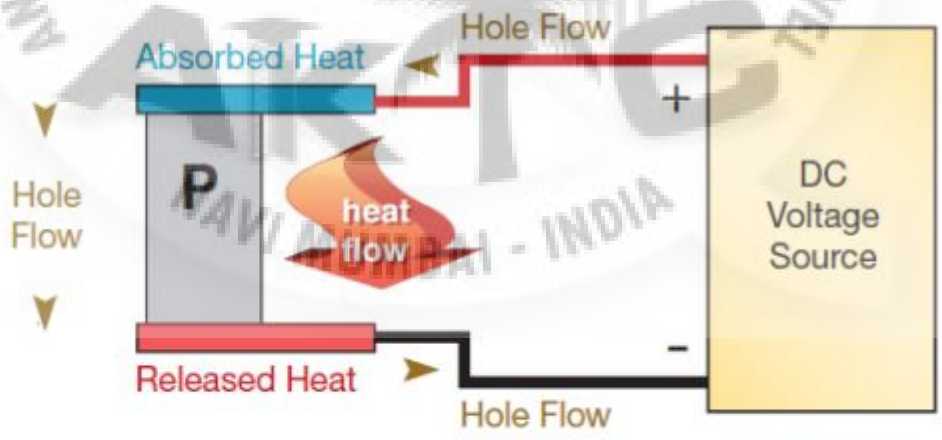
7.2.1 P type

The Pallet is made of "P-type" semiconductor material, which allows holes having a positive charge to be the primary charge carriers in the Peltier effect.



(Figure 7.9 P-type Semiconductor)

When DC power source is connected through the circuit holes moves towards negative terminals of the source resulting in motion of holes towards negative terminal by releasing heat. Holes from conduction band moves to fermi level due to continuous supply of current.

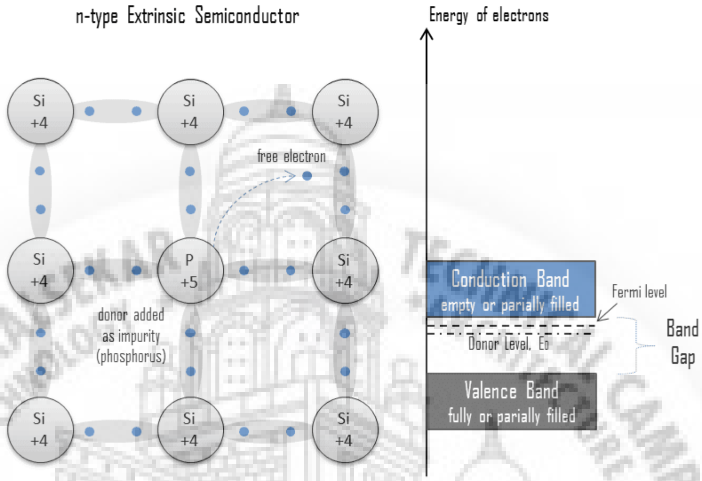


(Figure 7.10 Heat flow in p-type Peltier device)

Hence in Peltier cooling using P-type of semiconductor, heat is rejected at negative and heat is absorbed at positive terminal.

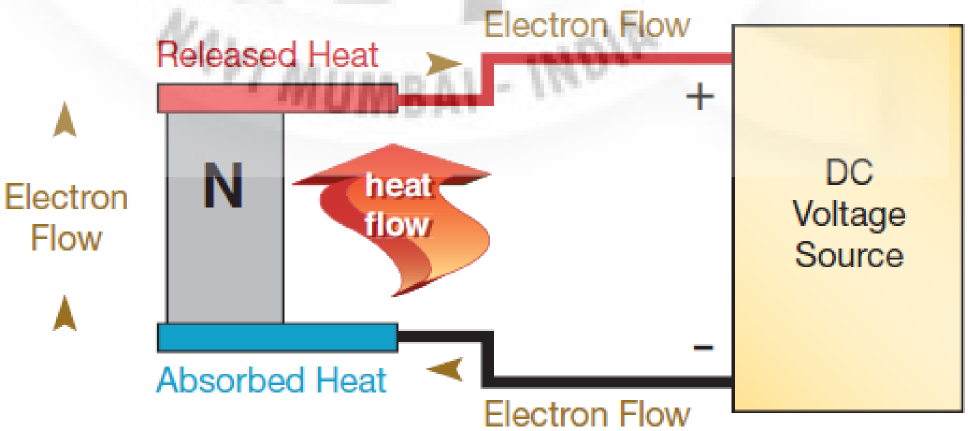
7.2.2 N type

The pellet is made of "N_type" semiconductor material, which allows electrons (with a negative charge) to be the primary charge carrier in the Peltier effect. In the Fermi level of an N type semiconductor, there is an additional electron (higher energy level).



(Figure 7.11 N-type Semiconductor)

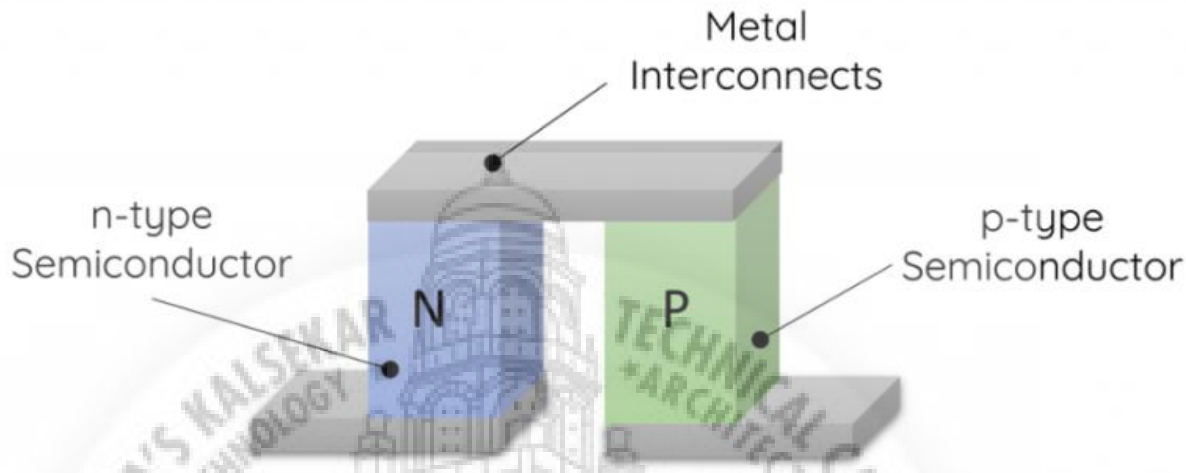
When a DC voltage source is connected as indicated, electrons are repelled by the negative pole of the supply and attracted by the positive pole; as a result of this attraction, electrons at the Fermi level flow towards the positive terminal, producing heat and forming holes in the Fermi level. Now, due to the constant flow of current, electrons absorb energy from the junction and travel from the valance band (lower energy band) to the Fermi level.



(Figure 7.12 Heat flow in n-type Peltier device)

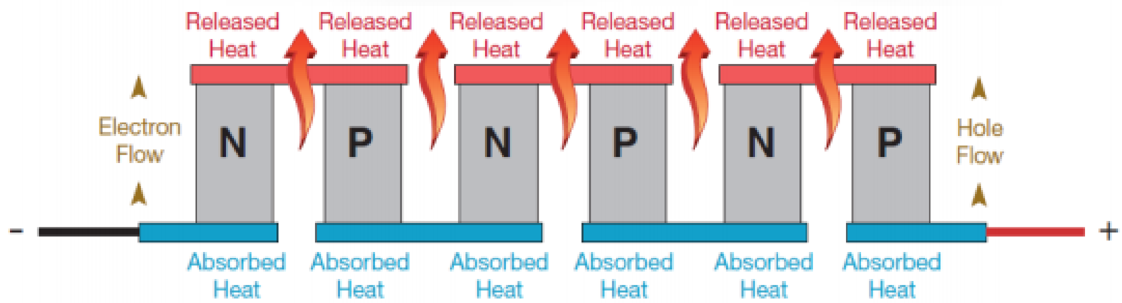
7.2.3 P&N type

It is feasible to create a series circuit that keeps all of the heat travelling in the same direction by grouping N and P-type pellets in a "couple" and establishing a junction between them with a plated copper tab.



(Figure 7.13 P&N type semiconductor)

As illustrated in the diagram, the P-type pellet's free 9 (bottom) end is connected to the positive voltage potential, while the N-type pellet's free (bottom) end is connected to the negative voltage potential. Heat is absorbed from the junction at the negative terminal and released at the junction near the positive terminal for N-type semiconductors, as we saw in the previous section. Heat is absorbed from the junction at the positive terminal and discharged at the junction near the negative terminal in P-type semiconductors. It is feasible to emit heat on one side and absorb heat on the other by constructing the circuit as shown in Figure 8. It is possible to team numerous pellets together in rectangular arrays to produce viable thermoelectric modules using these particular qualities of the TE ``couple."



(Figure 7.14 Heat flow in P&N type Peltier device)

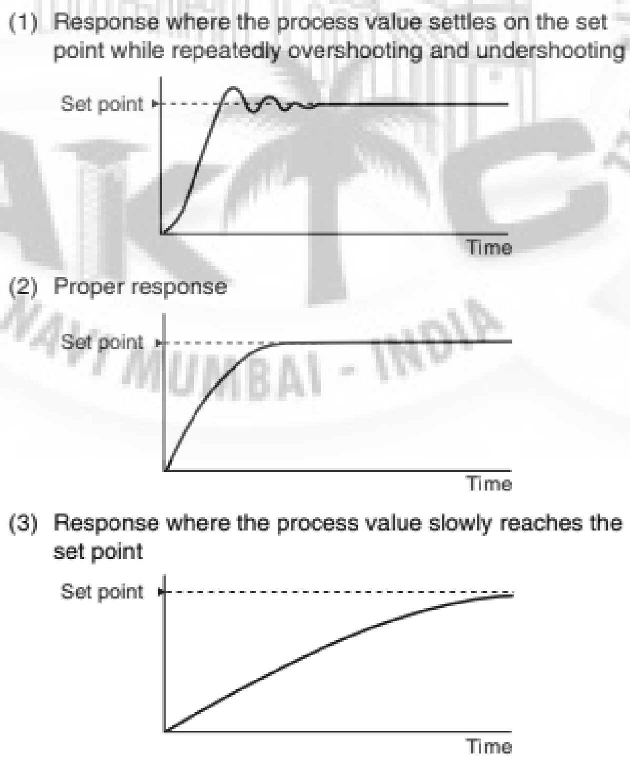
Chapter 8

Temperature controller

Temperature is a fundamental quantity which shows the level of coldness or hotness of material or a surrounding. Temperature control is a method of adjusting the flow of heat energy into or out of a space or substance to produce a desired temperature. Temperature controllers control temperature as per the required conditions or according to the setting made by the user.

8.1 Response of Temperature Controller

According to the characteristics of the controlled object or by the controlling method of the temperature controller response may differ. Some of the responses are listed below.



(Figure 8.1 Response of Temperature Controller)

A temperature controller is a device used to hold a desired temperature at a specified value.

8.2 Applications of temperature controller:

- Homes.
- Morgues.
- Industries.
- Jet and aircrafts.

Chapter 9

Governing Equations

9.1 Cooling power of Peltier

$$Q_{Peltier} = (\alpha_p - \alpha_n)IT_1 - (T_2) * (K_p + K_n) - \frac{I^2(R_p + R_n)}{2}$$

where α_p and α_n = seebeck coefficient of two branches

I = current passed through the couple

K_p and K_n= Thermal conductance of the branches

$R_p$and R_n= thermal resistance of the branches.

9.2 Power Consumed

$$W = (\alpha_p - \alpha_n) * I(T_2 - T_1) + I^2(R_p + R_n)$$

where α_p and α_n = seebeck coefficient of two branches

I = current passed through the couple

K_p and K_n= Thermal conductance of the branches

$R_p$and R_n= thermal resistance of the branches.

9.3 Coefficient of Performance

$$COP = \frac{Heat\ Removed\ In\ watts\ (Q_{Peltier})}{Power\ Consumed\ In\ watts (W)}$$

$$\frac{Q_1 = (\alpha_p - \alpha_n)IT_1 - (T_2 - T_1) * (K_p + K_n) - \frac{I^2(R_p + R_n)}{2}}{W = (\alpha_p - \alpha_n) * I(T_2 - T_1) + I^2(R_p + R_n)}$$

where α_p *and* α_n = seebeck coefficient of two branches

I = current passed through the couple

K_p and K_n= Thermal conductance of the branches

$R_p$and R_n= thermal resistance of the branches.

9.4 Maximum cooling power

$$Q_1 = (\alpha_p - \alpha_n)IT_1 - (T_2 - T_1) * (K_p + K_n) - \frac{I^2(R_p + R_n)}{2}$$

where α_p *and* α_n = seebeck coefficient of two branches

I = current passed through the couple

K_p and K_n= Thermal conductance of the branches

$R_p$and R_n= thermal resistance of the branches.

Chapter 10

Design

10.1 Design of box:

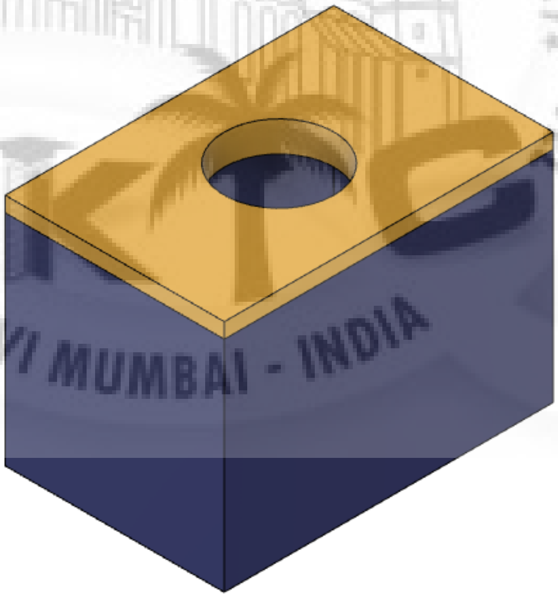
Thickness of the box is 25 mm.

Length of the box is 320 mm.

Width of the box is 260 mm

Height of the box is 225 mm

The Thickness of box is optimized between constraints of thermal conductivity and available standard size. Length and Width of the box is selected to contain the organ and be compact enough to fit in the medium sized drone.

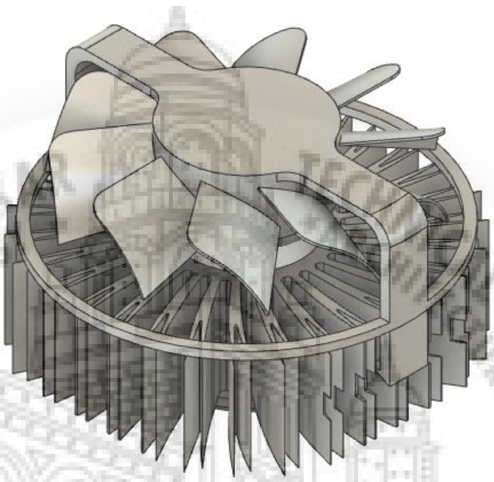


(Figure 10.1 CAD model of Xps Box)

10.2 Design of heat sink and selection of fan

Heat Sink is selected based on size and ability to dissipate generated heat. Heat Sink which is used in model is smaller due to difficulty in obtaining proper heatsink.

Fan is selected by calculating needed air flow over heat sink for effective operation of the system. The fan used in the model is not according to the selected fan during design.



(Figure 10.2 CAD model of heatsink and fan)

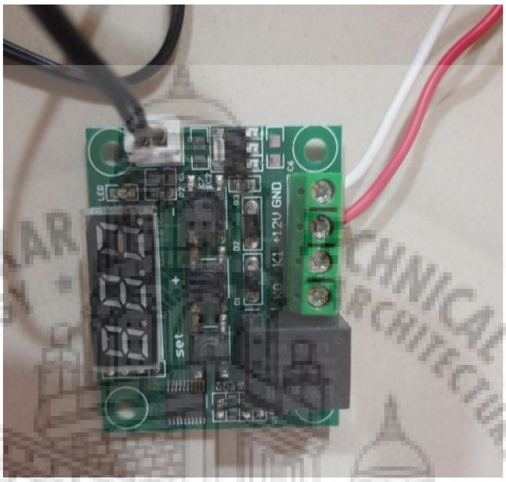
10.3 Selection of peltier:

Selection of Peltier is based on ease of availability of Peltier and good temp difference between hot and cold sides TEC1-12706 is used.

(Figure 10.3 Peltier Device)

10.4 Selection of temperature controller:

A basic temperature controller is used. it can be used to regulate the temperature inside the container by turning on the system as it reaches the highest temperature and can turn off the system if it reaches the lowest temperature. If the temperature is set as 4°C – 6°C it will turn on the system as the temperature reaches 6C and will turn off the system at 4°C.



(Figure 10.4 Temperature controller W1209)

10.5 Selection of battery

As we have to make the container as light as possible so it can easily be transported by drone and for working of the components power supply is necessary. Hence Li-Po Battery is used because of its good energy density and its lightweight.

Chapter 11

Analysis

11.1 Structural analysis

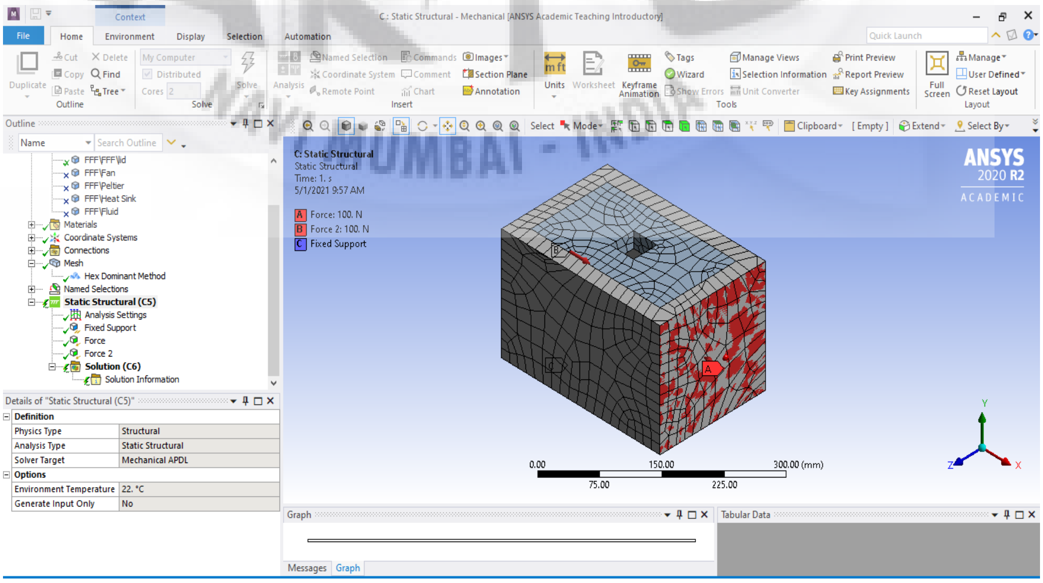
Structural Analysis of the system was performed using the CAD model prepared in Fusion 360. The analysis was done in ANSYS Workbench Software.

A compressive load was applied on the model and stresses were found.

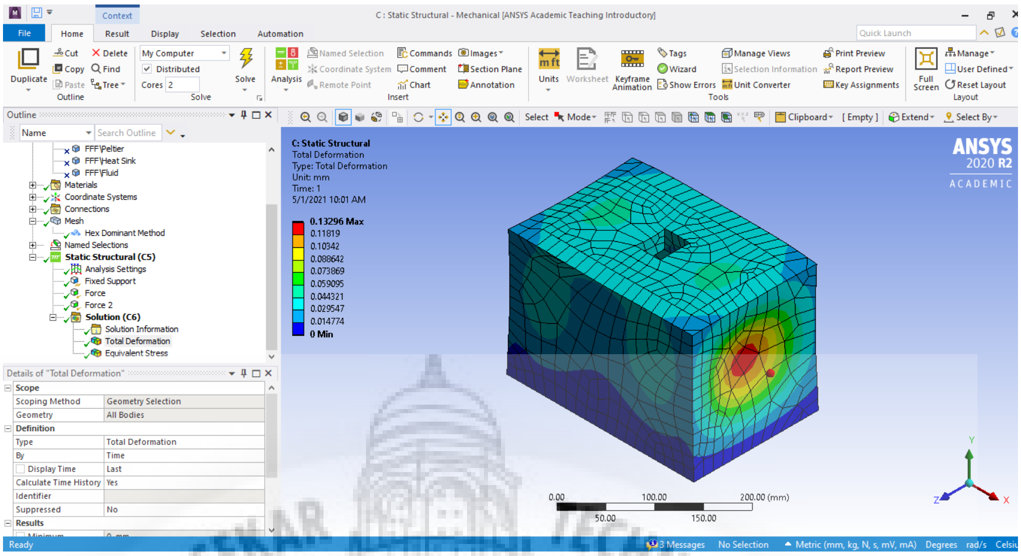
The results are given in the following table:

Name	Force 1 (N)	Force 2 (N)	Total Deformation (mm)	Maximum Stress (mpa)
Case 1	100	100	0.132963312	0.026250999
Case 2	50	50	0.066481656	0.0131255
Case 3	500	500	0.664816558	0.131254996
Case 4	250	250	0.332408279	0.065627498
Case 5	1000	1000	1.329633116	0.262509992

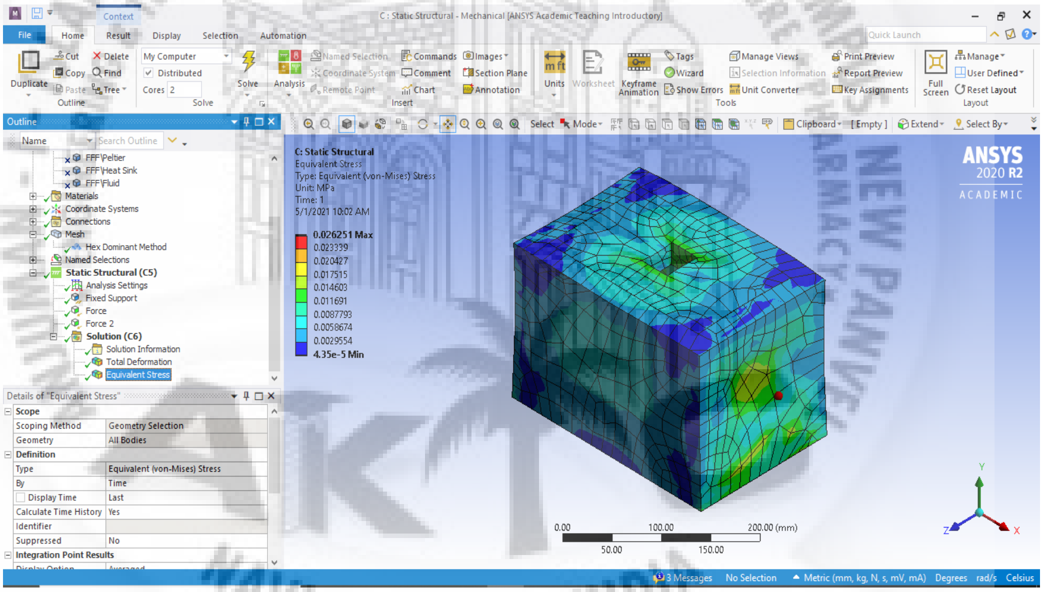
(Table 11.1 Results of structural analysis)



(Figure 11.1 Meshed Model with constraints)



(Figure 11.2 Result of Displacement)



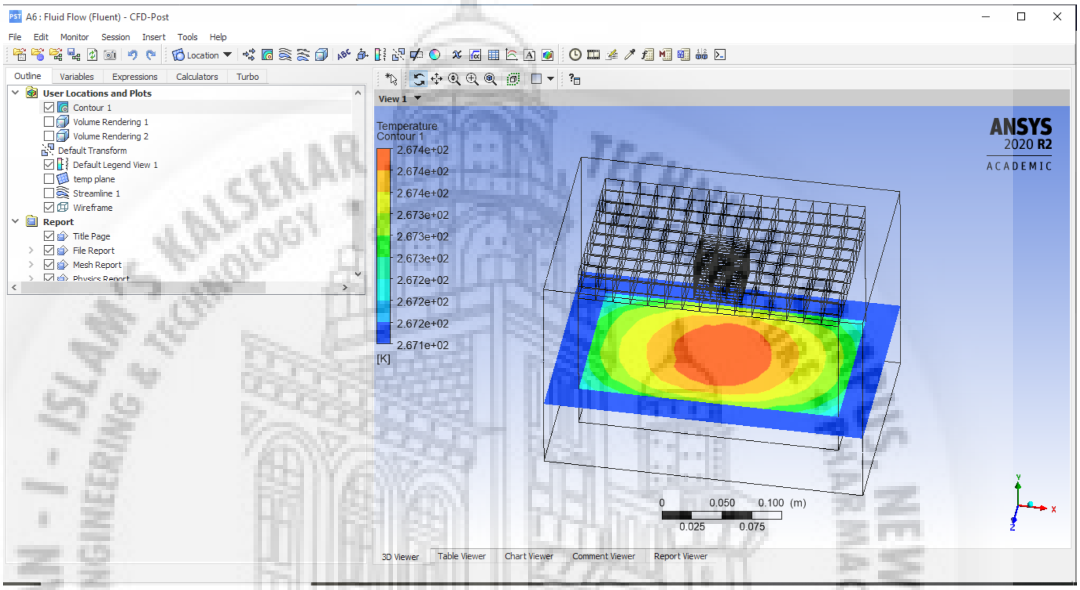
(Figure 11.3 Result of Stresses)

11.2 Thermal analysis

Thermal Analysis of the System was also performed using the Ansys Workbench Software. Solver used was ANSYS fluent. A mesh was created using the 3D model, some changes were made to the Model to simplify it for the analysis. There seemed to be a problem in meshing the fins of the heat sink as they were very thin. But workable mesh was obtained of adequate quality by changing some default settings.

Then the energy equation was enabled in fluent to take into account temperature of air along with flow of air. Fixed value of 263 K was given to the heat sink and other required values were given as we assumed a 40 K temperature difference between hot and cold side of Peltier and we also assumed that the hot side would be maintained at 303 K.

The results were as follows:



(Figure 11.4 Temperature contour)

The minimum temperature that the solver gave was of 267 K which is way less than what was experimentally achieved.

Although it will be possible to get 267 K temperature with high performance peltier and properly insulated container with good heat dissipation apparatus at the hot side of the peltier.

Chapter 12

Fabrication

The basic material is XPS FOAM BOARD, 25mm thick board was cut into squares and joined to make a box. Four walls, base and roof were made and then glued together with a hot glue gun. The roof is then further modified into a lid that can fit on top of the box. A square hole is made in the roof to fit Peltier and a small heatsink in the box. Larger heat sink will be right above the hole made on the roof and will be attached to Peltier's hot side for dissipating heat. Further, the temperature controller and Peltier will be joined to the battery with a switch in between the connections. Temperature controller's sensor will be dropped inside the box to calculate real time temperature.

12.1 Settings of temperature controller

P0 - Cold

P1 - 2 Required temperature difference

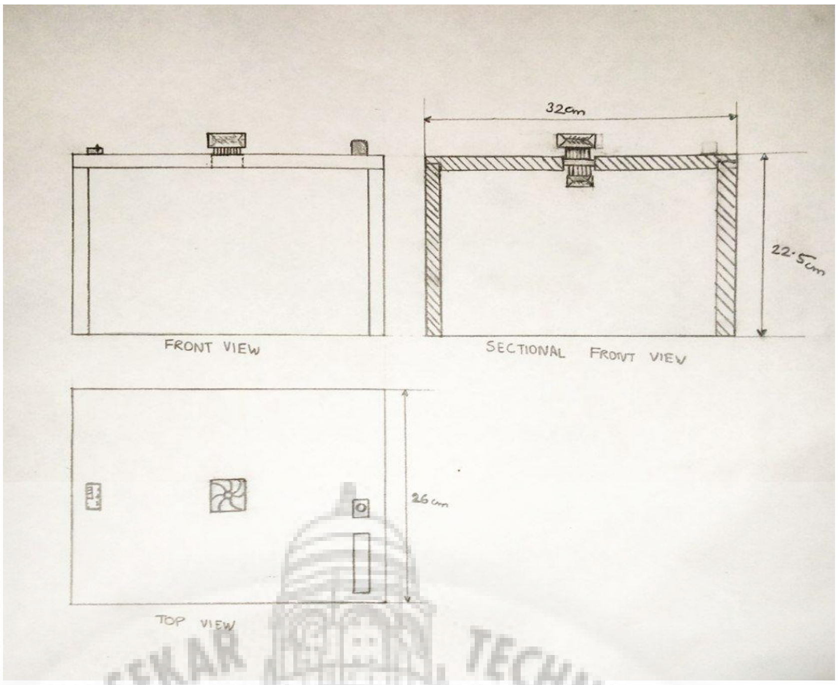
P2 - 35 maximum temperature

P3 - 4 min required temperature

P4 - 0

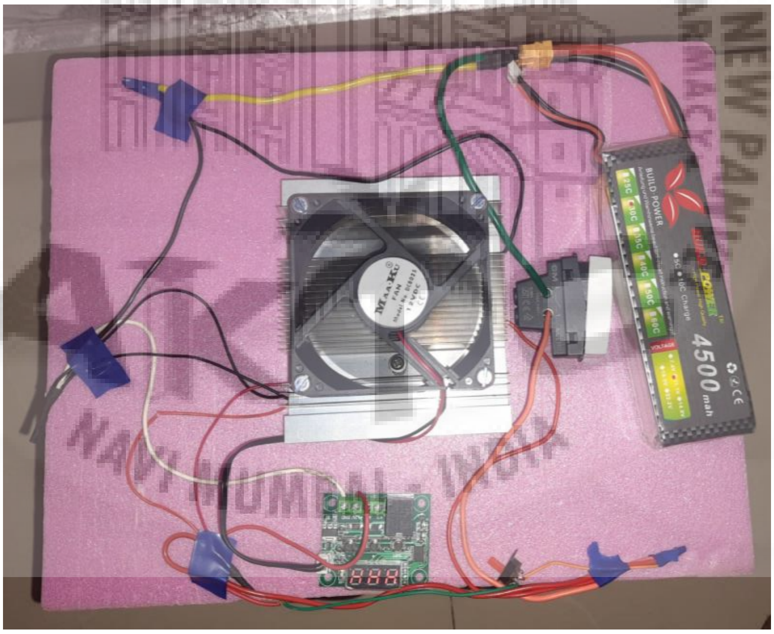
P5 - 0

P6 - Off if it reaches min temp full system is turned off



(Figure 12.1 Orthometric view)

12.2 Setup 1

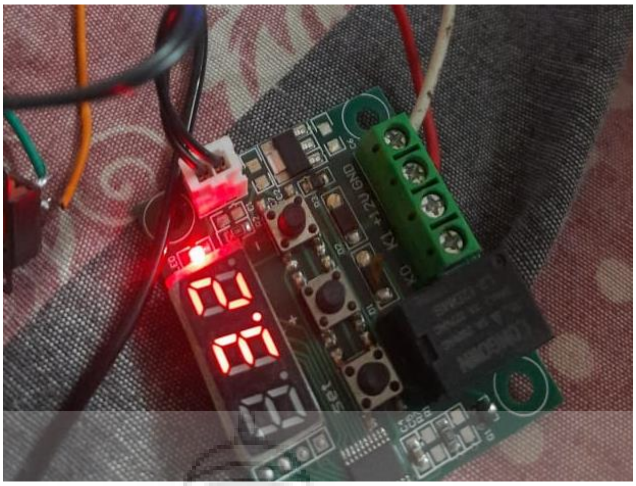


(Figure 12.2 Regulated thermo electric box Setup 1)

TOTAL WEIGHT =1300gm

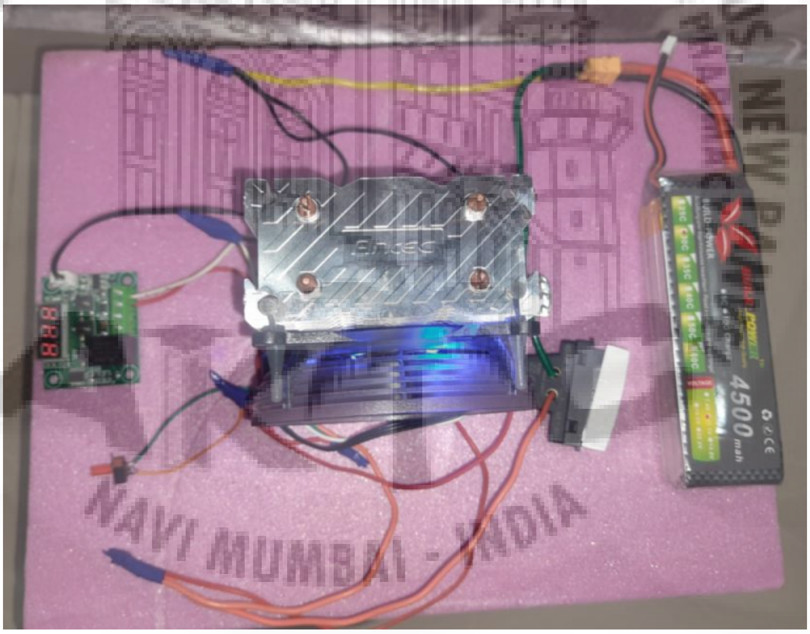
Temperature Reached = 17°C

Temperature of peltier reached = 3.2°C



(Figure 12.3 temperature of peltier in Setup 1)

12.3 Setup 2

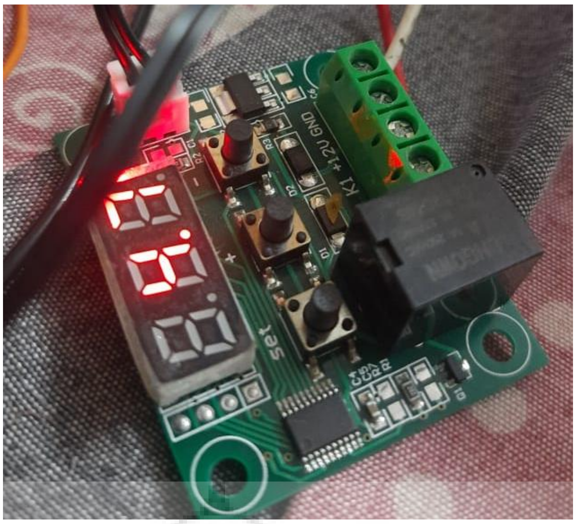


(Figure 12.4 Regulated thermo electric box Setup 2)

TOTAL WEIGHT = 1500gm

Temperature Reached = 18°C

Temperature of peltier reached = 4.7°C



(Figure 12.5 temperature of peltier in Setup 2)

Chapter 13

Result

Regulated thermoelectric medical box for aerial transportation was designed and analyzed successfully. The main component of this is the Peltier device which uses the thermoelectric principle explained in the report. It was subjected to structural analysis with 2 varying forces for 5 cases and deformation was noted. The results of thermal analysis were obtained. Required container was fabricated and experimental analysis was performed. In practical analysis the temperature of the container was not able to reach as per the requirement. As the heatsink and fan was not able to dissipate the heat from Peltier according to need. Since peltier keeps the temperature difference between both sides' constant hence dissipating heat from 1 side can cool the either. During practical analysis we were able to reach the temperature of the Peltier up to 3.2°C. This experiment was performed with 2 sets of heatsink and fan. if proper heat sink is used which can remove maximum heat from the hot side to take the cold side at subzero temperatures i.e., -10, -12 and with proper insulation we can reach the desired temperature and it can be regulated with temperature controller. weight of human heart is in the range of 250gm-350gm and both lungs are 900gm-950gm and both kidney is 440gm-500gm and our total weight of container is about 1300gm-1500gm and the weight constrain for drone was 3000gm-3500gm There is still some allowance in which ice can be used for cooling.

Chapter 14

Future scope

The Current Scenario for organ transport is Icebox which is difficult to transport using drones,

This can be changed by using the temperature regulated container which is proposed in this project.

Although this is preliminary study on such a device it can be further reinforced by studying the following points.

1. Study of different materials for box and heatsinks
2. Study of structure of Heat Sinks optimized for application in this product.
3. Medical Expert Analysis
4. Study of Peltier Modules with good COP

Chapter 15

Conclusion

Regulated thermoelectric medical box was designed, analyzed and a model was fabricated. Although the experimental results were not as predicted, the problem with the model was identified but due to lack of resource rectification was not possible.

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