Thermoelectric Cooling Chamber

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Abstract:- Conventional refrigeration systems can use or generate harmful gasses like Chlorofluorocarbons (CFCs) and Hydro Chlorofluorocarbons (HCFCs).The peltier module can't use or generate these harmful gasses. In recent years, with the rise awareness towards environmental degradation thanks to the assembly, use and disposal of CFCs and HCFCs as heat carrier fluids in conventional refrigeration and air con systems has become a topic of great concern and resulted in extensive research into development of novel refrigeration. Thermoelectric cooling provides a promising alternative R&AC technology because of their distinct advantages. The relevance of this project relies on the concept of refrigeration which is employed to stay food items, fruits and vegetables fresh. We will make a transportable and straightforward to use mini cooling chamber supported the concept of peltier effect (reverse phenomenon of the Seebeck effect).Being small and convenient this peltier module is capable of maintaining desired temp and might be used for keeping juice, dairy products, vegetables, meat, fruits etc. fresh while traveling in car over long distances furthermore because it will be used for various medical purpose.

Keywords:- *Peltier Module, Thermoelectric Cooling, Cooling Chamber.*

I. INTRODUCTION

The Peltier impact was found in 1834 by a French watchmaker and low maintenance physicist Jean Charles Athanase Peltier. Peltier tracked down that the applying of a current at an interface between two different materials prompts the assimilation/arrival of warmth. Peltier module can change over nuclear power into power or when power is given to the peltier module then assimilation of heat(cool side) on one side and dismissal of heat(hot side) on opposite side. A thermoelectric cooling framework ordinarily utilizes a grid of semiconductor pellets sandwiched in the middle of two huge cathodes. At the point when a DC voltage source is associated between the anodes, the contrarily charged side becomes cooler while the emphatically charged side gets hotter. The negative terminal is set in the know regarding the segment, gadget or medium to be cooled, while the positive cathode is associated with a conductor that emanates or scatters nuclear power into the outside climate. Objective of the undertaking is to style and foster a functioning thermoelectric cooling chamber that uses the peltier impact to refrigerate and keep a temperature between 5 °C to 25 °C according to prerequisite for 19 lit limit of cooling chamber. The look necessities are to sit down the degree to a temperature inside a quick time and supply maintenance of at least next thirty minutes. so on satisfy more awful situation, albeit the framework is to intended for keeping a pack chamber temperature all through the operational period, the arranging ought to be determined it can versatile for refrigerating the chamber from encompassing temperature to the ideal temperature. The thermoelectric modules function as brilliant boards by taking electrical flow. The epic framework includes loads of benefits including it utilizes no liquids, and don't need massive funneling and mechanical blowers utilized in fume cycle cooling frameworks. Such solidness favour thermoelectric cooling over customary refrigeration in specific circumstances. The reduced size and weight prerequisites, moreover as convey ability inside the plan, dependable activity on account of no moving part, preclude the utilization of regular refrigeration.

II. METHODOLOGY

Refrigeration impact can be produce by direct utilization of peltier modules. To get such impacts we will plan thermoelectric cooling chamber with an inward volume of 19 lit. The peltier module going to utilize is 'TEC 12706'. The Peltier module is provided with 12V 6A (72W) current for every module. Warmth is freed by one side and consumed by the other one. The side which assimilate the warmth is looked inside. On the both side of peltier module aluminium heat sink are appended with cooling fan. Warmth sinks are equipped for diverting temperature which is created by peltier module. Cooling fans are utilized to course the air for making the thermoelectric impact more productive. The external packaging of the chamber is comprised of compacted wooden sheet and to keep away from heat misfortune from the framework we will utilize polystyrene sheets since this are light weight, modest in cost, with contrast with value their proficiency is acceptable, effectively accessible. Information supply is given to peltier module and fans through the temperature regulator. Temperature regulator is utilized to set the necessary temperature. At the point when the temperature ranges to required worth temperature regulator cuts off the stock and save the force. In view of polystyrene sheets the temp inside the chamber is kept up for long time.

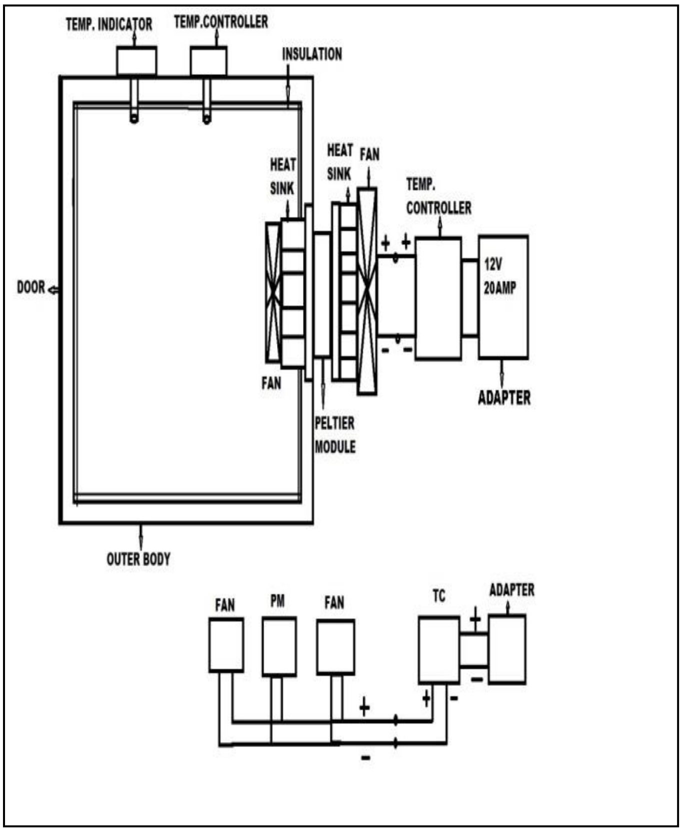

Figure 1: Thermoelectric cooling chamber

❖ *Material used*

A. Thermoelectric module-

It comprises of sets of P-type and N-type semi-conduit thermo component framing thermocouple which are associated electrically in arrangement and thermally in equal. The modules are viewed as profoundly dependable parts because of their strong state development. For most application they will give long, inconvenience free assistance. In cooling application, an electrical flow is provided to the module, heat is siphoned from one side to the next, and the outcome is that one side of the module gets cold and the opposite side hot.

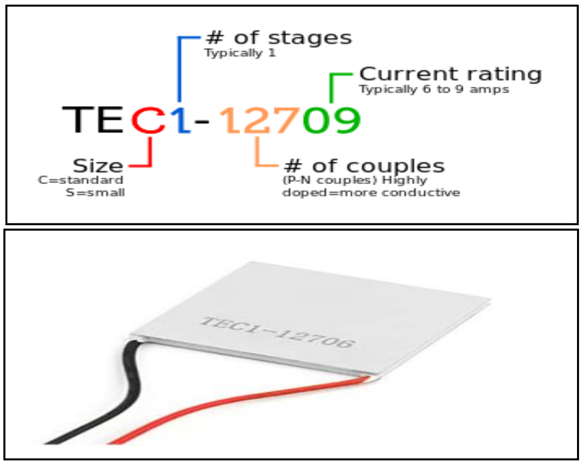

Figure 2: Nomenclature of Peltier module

B. Heat sink with fan

Figure 3: Heat sink with fan

The warmth sink generally made of aluminum, is in touch with the hot side of a thermoelectric module. At the point when the positive and negative module leads are associated with the individual positive and adverse terminals of an Immediate Current (D.C) power source, warmth will be dismissed by the modules hot side, the warmth sink assists the evacuation of warmth. Warmth sink ordinarily is intermediates stages in the warmth evacuation measure whereby heat streams into warmth sink and afterward is moved to an outer medium. Normal warmth sinks incorporate free convection, constrained convection and liquid cooled, contingent upon the size of the cooler.

C. Cold side

The cold side additionally made of aluminum is in touch with the cold side of a thermoelectric module, when the positive and negative module leads are associated with the particular positive and adverse terminals of an immediate flow (D.C) power source, warmth will be consumed by the module cold side. The hot side of a thermoelectric module is typically positioned in touch with the article being cold.

Figure 4: Thermoelectric refrigerator compartment

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D. Power source information

As a Peltier module require 12V and 6A supply so that we are using DC power source as power source for our project. We are utilizing 3 Peltier modules for our venture model subsequently a rectifier of 12V and 20A is utilized for project model.

Figure 5: Power source (Rectifier 12V 20A)

- **Design specification**

Parameters		Value(cm)
Outside Dimensions	Length	40
	Width	25
	Depth	30
Inside Dimensions	Length	36
	Width	21
	Depth	26
Door Dimensions	Length	40
	Width	25
	Thickness	2.5

Table 1: Specifications of rectangular box

❖ *Inputs to heat load*

Parameter	Values
Outside Temperature (^{0}C)	33
Inside Temperature (^{0}C)	15
Internal Fan Motor Wattage (W)	2.4
Insulation Thickness (mm)	18
Outside Sheet Thickness(mm)	8
Inside Sheet Thickness(mm)	8
Inside Heat Transfer Coefficient(W/m^{2}k)	10
Outside Heat Transfer Coefficient(W/ m^{2}k)	10
Thermal Conductivity of Polystyrene (W/mk)	0.033
Thermal Conductivity of MDF Sheet	0.3
Thermal Conductivity of Aluminium Sheet(W/m k)	167
Peltier Module Dimensions (cm)	4*4*0.4

Table 2: Heat load specifications

❖ *Experiment and calculation*

Plan and fostered an exploratory thermoelectric cooling chamber with a refrigeration space of 19 L limit with external packaging of MDF sheet and for warm protection a Polystyrene sheet has been given inside the case to forestall inversion of warmth stream. A slight aluminum sheet (1mm) box has been fixed inside the MS box for uniform circulation of temperature. Two quantities of thermoelectric modules (TEC1-12706) have been utilized to decrease inside temperature of refrigeration space. Cold side of TEM mounted on Aluminum sheet and hot side of modules were fixed with heat sink fan gathering. Two quantities of blade heat sink fan gathering were utilized for every module to upgrade the warmth dissemination rate.

System design calculations:

- Desired temperature of cold compartment 23° C
- Ambient temperature: 33°C
- Required time for desired cooling: 30 minutes
- Mass of water to be cooled: 0.5 Kg
- Cold side temperature (Tc): 10°C

Using Newton's law of cooling,
Qc = mCp× (Tamb-Tc)
= 0.5×4180(33 - 10)
Qc =52250 J
Qc =52250 / (30 x 60)
Qc =29.03 watt

Dimensions of cabinet is 36cm x26cm x 21cm And thermal conductivity of aluminium is 167 W/M k, to find hot side temperature of TE Modules,

Th; keeping heat sink at 15°C above ambient temperature:
Th = Tamb+15° C = 33 + 15 = 48^0 C
Now, temperature difference ΔT across the TE module can be calculated as follows,
ΔT= (Th -Tc) = 48 – 10 = 38°C
So, 38°C will be used for design calculations parameters to be used for TE module selection,
Q = 60 W, ΔT = 38°C

❖ *CALCULATION OF COP*

COP = Qc / Win
Qc = m Cp ΔT
= 0.5*4180*(33-15)
=37620 J
Qc = 37620/60*60
= 10.45 W
Where,
Qc = 10.45 W
Energy supplied to cooling chamber
Win = VI = 14.4 X 6.4
Win = 92.16 W
COP = 10.45/ 92.16
COP = 0.1134

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III. RESULTS AND DISCUSSION

First experiments were conducted for performance evolution of above specified thermoelectric cooling or refrigeration. The performance of TEM evaluates at variable input electrical current conditions. In this section, we are discussed the analysis of thermoelectric refrigeration system by varying the various parameters like current and time. The experimental results figure 6 shows that variation cold side temperature with respect to time. It shows that change in cold side temperature decreases with time exponentially.

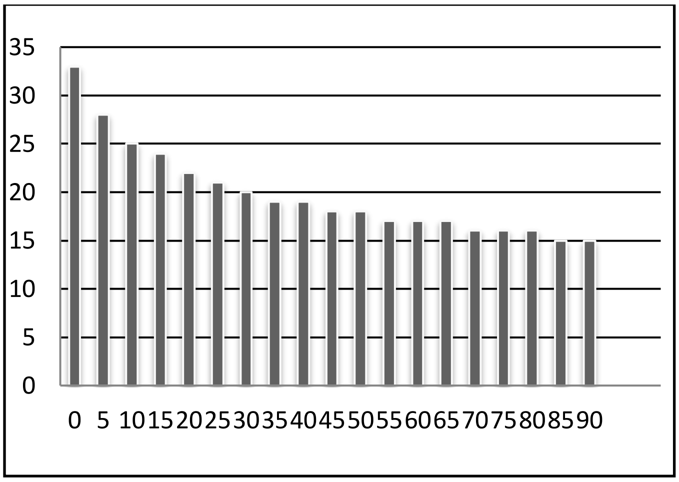

Figure 6: Temperature vs. Time graph

IV. CONCLUSION

This paper provides an overview about the design and information data that is required for the thermoelectric cooling chamber. We also get familiar with physical properties and performance of thermoelectric cooling system. This project is also additionally a created and enhanced plan strategy for thermoelectric cooler. Thermo electrical examination results have shown that under given condition, great thermoelectric module can increment all out thermal conductance that can amplify that TEC cooling limit and COP separately. The energy proficiency of thermoelectric fridges, in view of right now accessible materials and innovation, is still lower than gas cycle refrigeration and vapor compression. With acceptable COP we can use this refrigerator in market. By improving module contact resistance, thermal interfaces and heat exchanger we can improve or achieve acceptable COP. With its ecological advantage, thermoelectric fridge gives an option in contrast to customer who is environmentally cognizant and willing to spend a little digit more cash to make the most of their peaceful activity, and that's only the tip of the iceberg exact and stable temperature control.

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