WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

DESIGN AND FABRICATION OF THERMOELECTRIC REFERIGERATOR

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ABSTRACT

In this design, we're banning the Conventional mechanical factors to avoid climate, noise, and pollution due to dangerous refrigerants from the being mode of refrigeration systems. Rather of these factors, we're using the Peltier module to produce the Refrigeration effect and thereby guarding the terrain. It's compact, light in weight, high trustability. A Peltier module with water blocks is more effective than using Peltier module with the aluminium heat Gomorrah (fins). In this design, we're using three layers conception i.e., Iron covering, Thermocol sequestration and Aluminium cabin which acts as a cooling chamber. As per our knowledge, it's one of the most cost-effective, clean and terrain-friendly systems to save food particulars, medical operations, and other different effects that can be stored in it and It also acts as a movable refrigerator. In this current paper, peltier effect is used to get cold as well as hot water contemporaneously with cheapest cost and applicable to used in domestic area also. This paper aims toward developing a system which will give cooling and hotting effect contemporaneously without moving mechanical corridor. In this system we used water cooler system for removing heat.

Keywords: thermoelectric module, peltier effect, heat sink, heat pipe, valve, etc..

1.INTRODUCTION

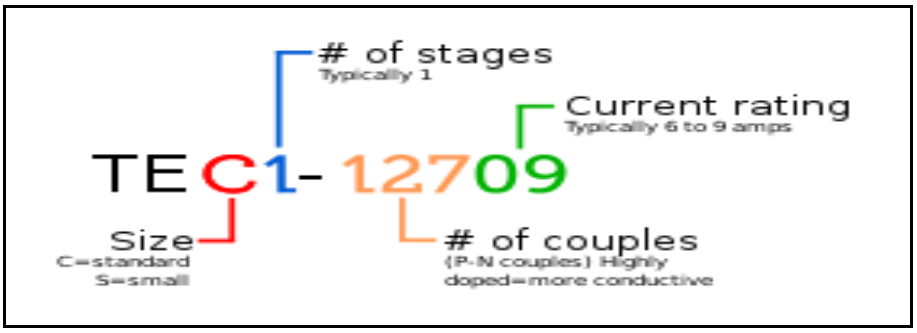
An appliance or compartment that is by artificial means unbroken cool and accustomed store food and drink. fashionable iceboxs usually create use of the cooling impact made once a volatile liquid is forced to evaporate during a sealed system during which it may be condensed back to liquid outside the refrigerator. A icebox is Associate in Nursing open system that dispels heat from a closed area to a hotter space, typically a room or another space. By dispelling the warmth from this space, it decreases in temperature, permitting food and alternative things to stay at a cool temperature. The term refrigeration means that cooling an area, substance or system to lower and/or maintain its temperature below the close one (while the removed heat is rejected at a better temperature). In alternative words, refrigeration is artificial (human-made) cooling. Refrigeration is outlined because the method of achieving and maintaining a temperature below close, with the aim of cooling a product or area to the desired temperature. it's conjointly outlined as artificial cooling FIG. 1.1 REFERIGERATOR Types of Referigerator Following square measure the kinds of refrigeration square measure explained below: 1. Mechanical compression refrigeration 2. phase transition cooling 3. Absorption refrigeration 4. thermoelectrical refrigeration 5. Vapour compression refrigeration 6. Vapour absorption refrigeration Principle of thermoelectrical cooler The thermoelectrical cooler supported these 3 principle- The Seebeck, Peltier, and Thomson Effects, beside many alternative phenomena, kind the premise of useful thermoelectrical modules. i. SEEBECK EFFECT: let's say the Seebeck impact allow us to consider an easy thermometer circuit as shown in Figure (1.1). The thermometer conductors square measure 2 dissimilar metals denoted as Material x and Material y. Fig.1.6 Seebeck impact In a typical temperature activity application, thermometer A is employed as a “reference” and is maintained at a comparatively cool temperature of Tc. thermometer B is employed to live the temperature of interest (Th) that, during this example, is over temperature Tc. With heat applied to thermometer B, a voltage can seem across terminals atomic number 81 and T2. This voltage (Vo), referred to as the Seebeck electromotive force, may be expressed as: Vo = axy x (Th – Tc) Where, Vo = the output voltage in volts axy = the differential Seebeck constant between the 2 materials, x and y, in volts/°K Th and Tc = the recent and cold thermometer temperatures, severally, in °K ii. PELTIER EFFECT: If we tend to modify our thermometer circuit to get the configuration shown in Figure (1.2), it'll be attainable to look at Associate in Nursing opposite development referred to as the Peltier impact. Fig.1.7 Peltier impact If a voltage (Vin) is applied to terminals atomic number 81 Associate in Nursingd T2 an electrical current (I) can flow within the circuit. As a results of the present flow, a small cooling impact (Qc) can occur at thermocouple A wherever heat is absorbed and a heating impact (Qh) can occur at junction B wherever heat is expelled. Note that this impact is also reversed whereby a amendment within the direction of electrical current flow can reverse the direction of warmth flow. The Peltier impact may be expressed mathematically as: Qc or Qh=pxy x I wherever, pxy is that the differential Peltier constant between the 2 materials, x and y, in volts I is that the electrical phenomenon flow in amperes Qc, Qh is that the rate of cooling and heating, severally, in watts. Joule heating, having a magnitude of I x R (where R is that the electrical resistance), conjointly happens within the conductors as a results of current flow. This Joule heating impact acts con to the Peltier impact and causes a web reduction of the on the market cooling. iii. THOMSON EFFECT: once an electrical current is tried and true a conductor having a gradient over its length, heat are going to be either absorbed by or expelled from the conductor. whether or not heat is absorbed or expelled depends upon the direction of each the electrical current and gradient. This development, referred to as the Thomson impact, is of interest in regard to the principles concerned however plays a negligible role within the operation of sensible thermoelectrical modules. For this reason, it's neglected. Thermoelectric Module or thermoelectrical Cooler A thermoelectrical (TE) cooler, generally known as a thermoelectrical module or Peltier cooler, may well be a semiconductor-based electronic part that functions as a touch equipment. By applying Associate in Nursing occasional voltage DC power supply to a TE module, heat goes to be captive through the module from one aspect to the

alternative. One module face, therefore, square measure planning to be cooled whereas the choice face at the same time is heated. This methodology uses the principle of peltier impact throughout that heat is dissipated or absorbed once Associate in Nursing electrical current flows across a junction between 2 materials. The investigator has p-type and n- kind semiconductors connected asynchronous and coated by semiconductor metal coating. The one aspect of the module gets colder and another aspect gets hotter at the same time. Figure. 1.10 thermoelectrical module TYPES OF thermoelectrical COOLER Different types of thermoelectrical cooler largely used are:- 1. TEC1-12705 2. TEC1-12706 3. TEC1-12709 4. TEC1-12715

Table No. 1 Types of thermoelectric element

Sr.No.	Name of Element	Specification
1.	TEC1-12705	Qmax=50Watt Volt max=12, Tmax=90 degreecelcius
2.	TEC1-12706	Qmax=57watt Imax=6.4amp , Volt max=16.4 volt and Resistance=2.30ohm
3.	TEC1-12709	Qmax=80watt Imax=9 Ampere, Volt max=15volt and Resistance=2.30ohm
4.	TEC1-12715	Qmax=57watt Imax=6.4amp, Volt max=16.4v and Resistance=2.30ohm

The meaning of TEC1-12709 is
Figure.1.10



Selected thermoelectric cooler TEC1-12706

The TEC1-12715 part is economical quite TEC1-12706, however if I used TEC1-12706 part therefore the part is employed a lot of and additionally heat transferring space obtainable a lot of and cooling turn up quicker. And, if I used TEC1-12715 part therefore the heat transferring rate is a smaller amount than TEC1-12706 part due to a lot of cooling capability of cooling part used less thence space isn't obtainable a lot of to transfer heat to atmosphere than TEC1-12706. thence I used electricity cooler TEC1-12706. Parameters of a electricity Module Once it's set that electricity cooler is to be thought-about for cooling system, future step is to pick the electricity module or cooler that may satisfy a selected set of needs. Modules ar obtainable in nice sort of sizes, shapes, operative currents, operative voltages and ranges of warmth pumping capability. The minimum specifications for locating Associate in Nursing acceptable policeman by the designer should be supported the subsequent parameters. The cutaway of a policeman is shown Fig.1.11 cutaway of electricity module • Cold facet temperature (Tc) • Hot facet temperature (Th) • operative temperature distinction, that is that the temperature distinction between Th and Tc . • Amount of warmth to be absorbed at the TEC's cold surface. this could even be termed as heat load. it's drawn as (Qc) and therefore the unit is Watts. • Operating current (I) and operative voltage (V) of the policeman.

2.METHODOLOGY

In our project we have a tendency to used electricity module, heat sink, fan, thermal paste, insulation tape, device, pipes, valve, etcc. Take electricity module on it applied the thermal paste on it hooked up sink for removal or absorbed heat hot and cold facet, on it sink fan is hooked up for higher flow and flow into the air.. conjointly sink used for flowing water in terms of water and transfer the warmth and acquire sensible cooling result. conjointly whole the arrangement and assembly hooked up on box provide} the ability supply and create it the electricity icebox.

Fig. 1.8 operating of electricity referigerator When the give the ability by mistreatment power offer of SMPS, to the fan, electricity module . once give the provision system is begin and also the module is started heating and cooling. on it electricity module thermal paste applied for not removed heat from one half to alternative and on it sink hooked up forgood heat dissipiation and on it applied the fan for flow into the air within within the box for cooling facet and transfer the warmth in atmosphere type heating facet. The operating of this project is solely supported Peltier Module with a water block. the complete refrigeration method takes place among the cupboard of thirty.48cm*35.56cm*38.1cm. during this project, we have a tendency to square measure mistreatment four Pairs of Peltier modules. every combine of Peltier modules square measure hooked up to one Water block. every elector block is hooked up to every facet of the cabin. So, four Pairs of modules with four water blocks square measure organized within the four sides of the tank. These Modules and water blocks square measure hooked up to the Al cabin. we have a tendency to square measure mistreatment Al material for this layer, due to its nature of extremely chemical material to heat at a coffee worth. Whenever DC power offer 12V,6A is given to the Peltier module and pump the operating fluid is equipped to the Water pockets with the help of hydraulic pumps from the surge tank and also the water pockets acts a sink from the icebox. the warmth within the icebox cabin absorbs by the Peltier module and to water pockets. The operating fluid that is passing through the water pockets absorbs the warmth from the Peltier module and sends back to the surge tank and during this approach, heat is removed and also the icebox gets cooled. in the main Project depends on the choice of correct Peltier module and power offer because it varies the refrigeration result conjointly will increase by increasing the voltage and current to a definite limit consistent with Peltier. For choice of Peltier Module, the subsequent factors ought to be considered: • The in operation temperatures should be within the needed limits • Heat rejected by the warmer facet of the Peltier module ought to be but its total power capability • consistent with the degree that must be cooled, the Peltier module ought to be elite • For desiderate cooling the correct water block ought to be elite. Processes In our project we have a tendency to used electricity module, heat sink, fan, thermal paste, insulation tape, device, pipes, valve, etcc. Take electricity module on it applied the thermal paste on it hooked up sink for removal or absorbed heat hot and cold facet, on it sink fan is hooked up for higher flow and flow into the air.. conjointly sink used for flowing water in terms of water and transfer the warmth and acquire sensible cooling result. conjointly whole the arrangement and assembly hooked up on box provide} the ability supply and create it the electricity icebox.

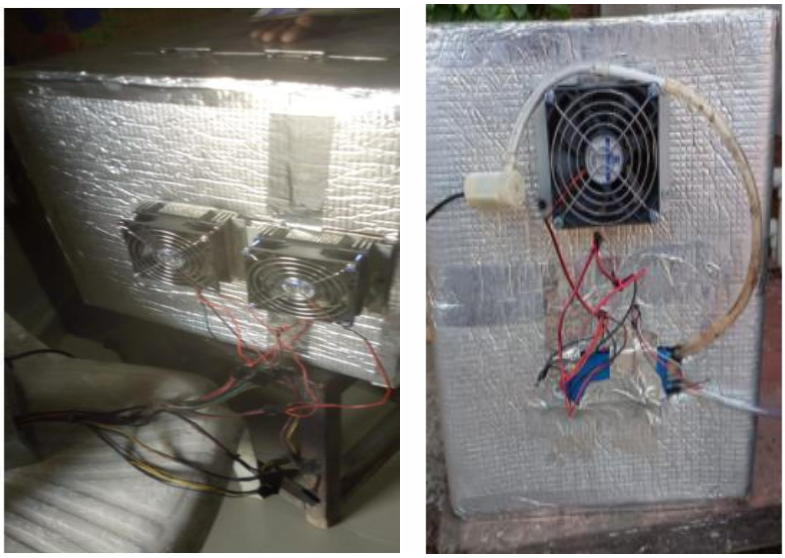


FIG. 1.9 CONSTRUCTION OF electricity REFERIGERATOR

The cabinet is created from 3 layers of insulation. Now, the icebox cupboard that is created from Al is unreal because the inner layer in needed dimensions i.e., 15inch*15inch *15inch. and currently the Peltier module is hooked up to the water block with the assistance of thermal paste for the

four facets of and reproductive structure side of the Peltier module is hooked up for the four sides of Al insulation. Now, DC power offer is connected to Peltier module then we've to form a fluid flow circuit thorough pipes within which one finish is mounted with water of water block and another finish is mounted within the water water surge tank, and another pipe is mounted with outlet of water block to the outlet water surge tank in same approach all four sides of icebox is connected. pumps square measure mounted to every pipe in water water surge tanks and also the tank is mounted at high of the icebox. Finally, the primary and second layers of insulation i.e., Iron casing and Thermocol layer ought to be unreal in needed dimensions

CALCULATION

Known data:

Selecting the thermoelectric cooler TEC1-12706 module

When I used the thermoelectric cooler according to their capacity requirement is calculated

Calculate current and power for cooling 200ml of water in 30sec

According to Thermoelectric element TEC1-12706 properties are: Specification of thermoelectric element

Table no.2 Specification of thermoelectric module

Hot Side Temperature (ºC)	25	50
Qmax (Watts)	50	57
Delta Tmax (ºC)	66	75
Imax (Amps)	6.4	6.4
Vmax (Volts)	14.4	16.4
Module Resistance (Ohms)	1.98	2.30

The dimension of TEC1-12706 element is

L*B= 40*40mm, height = 3.6mm, weight = 30gm

Using this specification power and current calculated for required to cool water 200ml in 30seconds.

1. Power calculation

Power (P) = Current (I)* (voltage) V

P =Heat (Q)/Time (T) unit in watt

P= Q/30 in watt ……equation (1)

2. Heat Calculation

Q= mass (m)*Specific heat of water (Cpw)*(Th-Tc) unit in joules

According to summer temperature inside in room as Consider, Th=40 degreecelcius

By experimental testing on 10 people and requirement of cooling water temperature for drinking is, Tc= 16 degreecelcius.

Where, Th= hot side temperature and Tc= Cold side Temperature

Mass of water or amount of water cool, m=200ml
Time, t= 30second

P=I*V

Power Supply =700watt

Current=60Amp

1. **Design the Heat Exchanger**

According to the thermoelectric cooler dimension length, width and height of the heat exchanger is decided.

The thickness of the strip will be 0.05cm

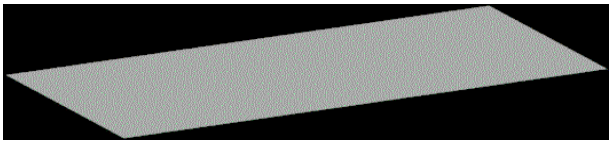


Fig. Thin sheet

For one heat exchanger dimensions are,

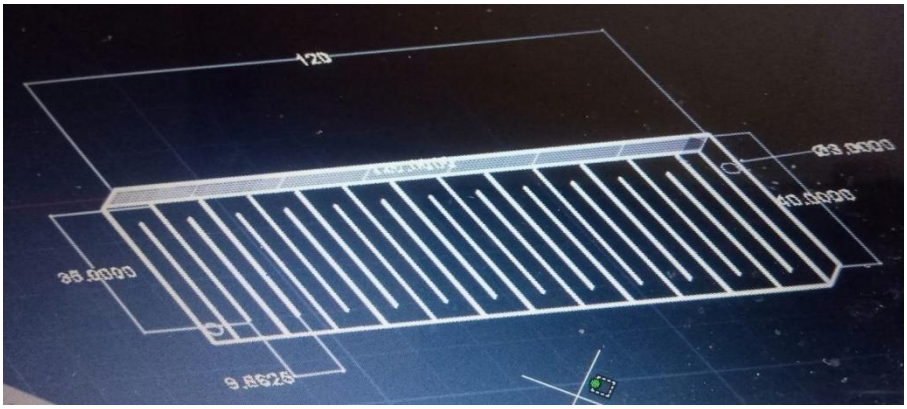
Length *width*height =12*4*0.05cm

Inside the length of 12cm number of strips will be 24

Boarder dimensions are

12*0.5*0.05cm for four walls

Fig.Heat Exchanger by design



Weight = mass * gravity = Volume * density

Density of silver is 10490kg/m3= 0.014kg/cm3

Volume of one plate = 1.4 cm^3

After deciding the dimension and material on the time of fabrication the silver material is burn on thickness of 0.005mm. If, temperature of soldering is decreases the material is not take soldering properly between two joint. And the number of baffle plate is fitted in the heat, heat exchanger by using silver material is very hard to do soldering by human and the joint will not be a sustain more than two joint. Hence, I not used silver material for heat exchanger

COP (Coefficient of performance)

Qmax= 57Watt

Imax= 6.4Amp

Vmax= 16.4V

R=2.30ohm

Th=50o^C

Tc= 16o^C

Seeback coefficient(S)= 0.01229V/k

Module thermal conductance(K)= 0.1815W/k

No. of thermocouple=127

Heat Rejection=

Qh= SITh+1/2I^2-K(Th-Tc)

Qh = 45.0898watt

Heat Absorption

QL= -[SITc-1/2I^2R-K(Th-Tc)]

= 52.0277 watt

COP= QL/Energy Supplied

Energy Supplied (W) = Qh-QL

= SI(Th-Tc)+I^2R

=96.88watt

Assume =100watt

COP= 0.52/ each of thermoelectric module

In our project we used 3 thermoelectric module.

ADVANTAGES

1) Small size and light weight. Compact and reliable.
2) Steady-state operation.No moving parts and fluids.
3) Durable and mintenance-free.
4) Very long operation life.
5) Effective in spot cooling.
6) Environmentally friendly.
7) No chlorofluorocarbons.
8) Ability to heat and cool.
9) Work in any orientation.
10) Generate no electrical noise Can powered directly by PV cells.

FUTURE SCOPE

This section presents the possible future directions to extend the presented work.

1) Improve rate of refrigeration and coefficient of performance at minimum cost of operation.
2) The power supply to a thermoelectric cooler can be obtained from a thermoelectric generator or solar energy.
3) The thermoelectric cooler generates the electricity.
4) Installing thermo sensor which can be programmed using arduino board, to vary the power supply within specified range of temperature.

CONCLUSION

This section summarizes the conclusion supported the obtained results mentioned in chapter five. From this project, we are able to conclude that while not the utilization of Mechanical components and refrigerants it's doable to cool down the system. There ar many differing types of cooling devices obtainable to get rid of the warmth. however electricity refrigeration plays an important role in its potency, cooling rate, low cost, and high reliableness. we've got been with success designed the electricity icebox that fulfills the objectives of our project. However, we have a tendency to used water pockets rather than Al sink with cooling fans for economical heat transfer from the cupboard and hydraulic pumps-for the economical flow of operating

fluid from the surge tank to water pockets. we have a tendency to ar terminal that the potency and lifetime of the Peltier icebox ar maximized by mistreatment these water pockets and also the temperature was governable by dynamic the input voltage and current therefore we are able to maintain the items within the needed temperature

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