

“DESIGN AND FABRICATION OF HEATING AND COOLING BOX USING TEG”

Submitted in partial fulfilment of the requirements for the award of

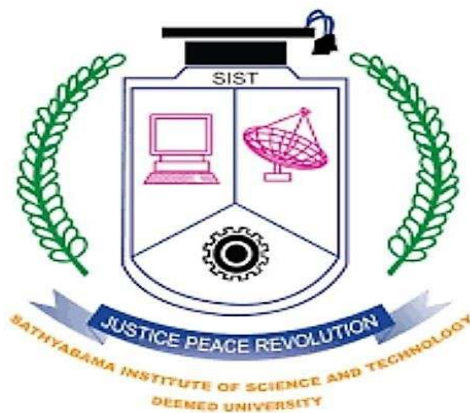
Bachelor of Engineering degree

In Mechanical Engineering

By

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DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

MARCH-2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of BOLISSETTY SURAJ (Reg. No. 37150036) and BALDA YESWANTH (Reg.37150026) who carried out the project entitled "**DESIGN AND FABRICATION OF HEATING AND COOLING BOX USING TEG**" under my supervision from October 2020 to March 2021.

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DECLARATION

I BOLISETTY SURAJ (Reg. No. 37150036) and BALDA YESWANTH (Reg. No. 37150026) hereby declare that the Project Report entitled **“DESIGN AND FABRICATION OF HEATING AND COOLING BOX USING TEG”** done by us under the guidance of **Dr. A. KARTHIKEYAN, M.E., Ph.D.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

DATE: 30.03.2021

PLACE: CHENNAI

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ABSTRACT

In the recent years, we all are facing electricity crisis. It is an eco-friendly project, made by using thermoelectric module. The project supports both heating and cooling. The project has various applications like, military or aerospace, medical and pharmaceutical equipment and food maintenance etc. Thus, it proves to be very helpful. The entire model is fabricated in soft cast steel with appropriate dimensions. The temperature sensor is placed to watch and note the temperature inside the cabin. The TEG is placed in conductor behind the fan. The fan rotates and blow the warm air into the atmosphere. This idea is driven by TEG using solar energy. Components included in this concept are solar panel, battery, charge controller, battery, inverter, blower, ceramic slabs and cooling pads. Solar panel is utilized to convert sun light into electrical energy by implying photovoltaic effect. The generated electrical energy is sent to the battery for storage where in between charge controller is used for reducing power fluctuations. As AC blower is utilized for cooler, so conversion of DC load from the battery to AC load by the assistance of inverter is done. Inverter changes the load from DC to AC. Presently AC power can be provided to the blower. When the blower is switched ON, blower sucks atmospheric air into the cabin through the cooling pads, within the mean solar time heat transfer occurs, so that the cool air enters into the area hence giving required thermal comfort conditions.

The whole concept is fully based on TEG (Thermoelectric Generator).

The Thermoelectric module works on two different principles:

- 1) Peltier Effect: This effect gives power to the module with a significant cooling on one side and heating on the opposite side.
- 2) Seebeck Effect: The seebeck effect produces a temperature difference across the module by heating one side and cooling the opposite side.

The Seebeck module is like a power generator and Peltier module is a cooling one which uses heating module.

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LIST OF SYMBOLS AND ABBREVIATIONS

TEG	Thermoelectric Generator
DC	Direct Current
AC	Alternating Current
RAPS	Remote Area Power Supply
PV Module	Photo Voltaic Module
TC	Cooling Temperature
V	Voltage
Eout	Energy out
Ein	Energy in
EMF	Electromotive Force
K	Kelvin
C	Celsius
QC	Cooling Effect
QH	Heating Effect
MCU	Microcontroller Unit
MOS	Metal Oxide Semiconductor
IC	Integrated Circuit
CPU	Central Processing Unit
RAM	Random Access Memory
ROM	Read Only Memory
m	meters
min	minutes
rpm	rotations per minute
Db	decibels

CHAPTER 1

INTRODUCTION

1.1 HISTORY AND BACKGROUND

The growing concern with exhaustion of energy resources are increasing day by day. The present tendency of the primary world is to look at renewable energy resources and also the development of new technologies based on renewable energy resources as a source of energy. They are solar energy, hydroelectric energy, bio and wind energy, etc.

Ideal solution for an alternative form of energy is RAPS (Remote Area Power Supply) used in electric grid connection. A study done by the College of Cape Town's energy Development Research Centre came up with curious truths that can be utilized to bolster the application of PV panel framework to Third World housing. The thermoelectric cooler will utilize the electric energy from the PV panels when the battery is completely charged, and during night time it will utilize a little amount of electric energy to preserve the temperature within the cooler box.

In other words, on the off chance that the battery of the framework is completely charged, and if there's no machine to retain the energy received through the PV panels, it would become useless, resulting in a poor efficiency factor for the full PV panel framework. The cooler box coordinates with RAPS that would permit for a productive framework utilizing the abundant energy from the sun.

In spite of the fact that commercial thermoelectric modules were not accessible until nearly 1960, the physical standards upon which cutting edge thermoelectric coolers are based upon, dates back to the early 1800s. However already in 1794 famous scientist of Italy, Allesandro Volta observed that a metal rod which ends were at very unlikely temperatures caused a sudden involuntary muscular contraction in frog muscles. Then a critical disclosure relating to thermoelectricity happened in 1821 when German researcher Thomas Seebeck who found that an electric current would stream persistently in a closed circuit made up of two different metals, given that the intersections of the metals were kept up at two distinctive temperatures. Seebeck did not really comprehend the scientific basis for his discovery, and falsely accepted that streaming heat delivered the same impact as streaming electric current.

In 1834, a French physicist named Jean Peltier, when exploring the Seebeck effect, found that there was an inverse marvel where warm energy may be retained at one dissimilar metal crossing point and discharged at the other crossing point when an electric current spilled in the interior of the closed circuit. After a very long time, William Thomson (inevitably known as Ruler Kelvin) issued a comprehensive clarification on the Seebeck and Peltier Impacts and depicted their relationship. At that time, in any case, these phenomenon were still considered to be insignificant research facility interests and were without viable application. Within the 1930s, Russian researchers started considering a few of the prior thermoelectric work in an exertion to develop thermoelectric generators for the utilization of their needs in the inaccessible areas all through their nation. This Russian intrigued in thermoelectricity inevitably caught the consideration of the rest of the world and motivated the advancement of viable thermoelectric modules. Today's thermoelectric coolers makes utilization of advanced semiconductor innovation in which doped semiconductor fabric takes the place of the disparate metals utilized in early thermoelectric tests. Mainly Seebeck and Peltier effects are the backbone of this concept together with Thomson effect and several other phenomena, form the basis of functional thermoelectric modules.

1.2 WORKING PRINCIPLE OF TEG

TEG works on the principle that electric potential and heat can be converted. The Seebeck effect generally states that electric potential can be generated in between two junctions at two different temperatures. The Peltier effect generally the reverse of Seebeck effect states that that the temperature can be controlled between two junctions if electric potential is applied between two different metals. TEG uses the Seebeck effect as power generator and the Peltier effect as thermal managing one. This uniqueness of TEG is desirable for applications like precise temperature control. A TEG consists of a large number of thermocouples formed by n-type and p-type semiconductor materials connected electrically in series and thermally in parallel. A thermoelectric module (TEG) by and large comprises of warm sinks on both hot and cold sides with interface and protection layers to avoid warm dissemination to the cold side.

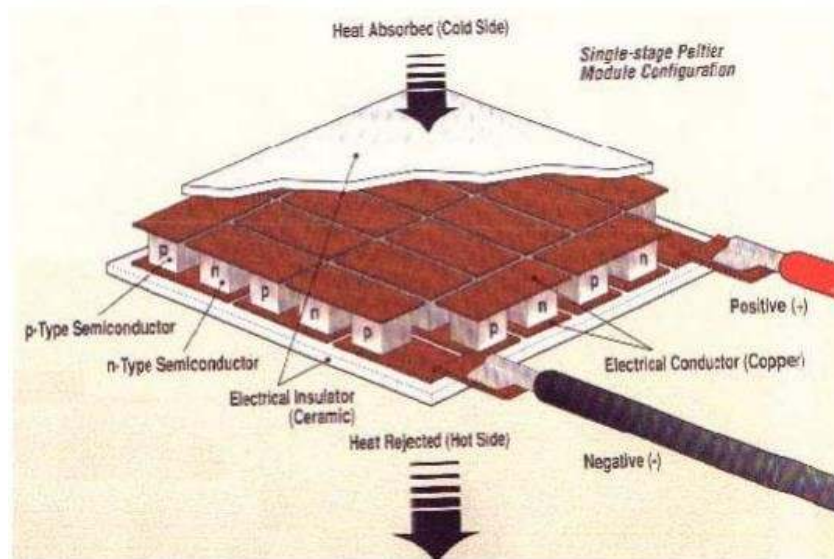


Fig 1.1 TEG Principle of Operation

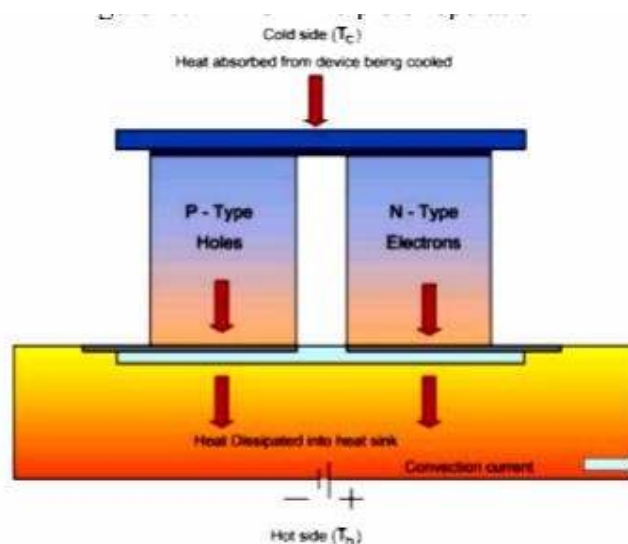


Fig 1.2 Cross section of a thermoelectric cooler

As the electrons move from the P sort fabric to the N sort fabric through an electrical connector, the electrons hop to a better energy state retaining warm energy (cold side). Proceeding through the cross section of fabric; the electrons stream from the N sort fabric to the P sort fabric through an electrical connector dropping to a lower energy state and discharging energy as warm to the warm sink (hot side).

Thermoelectricity can be utilized to warm and to cool, depending upon the heading direction of the current. In an application requiring both warming and cooling, the plan ought to focus on the cooling mode. Employing a thermoelectric within the warming mode is exceptionally proficient since all the inner warming (Joulian warm) and the stack from the cold side is pumped to the hot side. This diminishes the control required to attain the required heating.

1.2.1 Seebeck Effect

The conductors are two disparate metals signified as fabric A and fabric B. The intersection temperature at A is utilized as a reference and is kept up at a generally cool temperature (TC). The intersection temperature at B is utilized as temperature higher than temperature TC. With warm connected to intersection B, a voltage (Eout) will show up over terminals T1 and T2 and consequently an electric current would stream persistently in this closed circuit. This voltage is known as seebeck Effect, also known as the Seebeck EMF, can be expressed as

Where:

- $\alpha = dE / dT = \alpha_A - \alpha_B$
- α is the differential Seebeck coefficient or (thermoelectric control coefficient) between the two materials, A and B, positive when the heading of electric current is same as the course of thermal current, in volts per OK.
- Eout is the output voltage in volts.
- TH and TC are the hot and cold thermocouple temperatures, respectively, in OK.

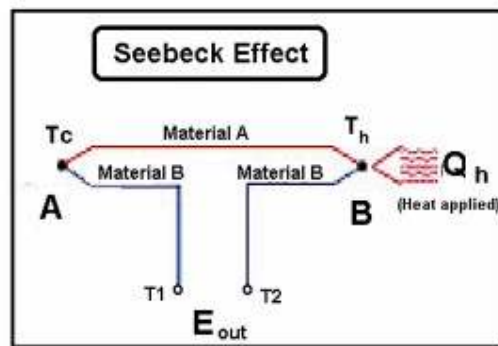


Fig 1.3 Seebeck Effect

1.2.2 Peltier Effect

Peltier found there was an inverse phenomenon to the Seebeck Impact, whereby heat energy may well be sucked at one different metal intersection and released at the other intersection when an electric current streamed inside the closed circuit. The thermocouple circuit is adjusted to get a distinctive setup that outlines the Peltier effect, a phenomenon inverse that of the Seebeck Impact. In case a voltage (E_{in}) is connected to terminals T1 and T2, an electrical current (I) will stream within the circuit. As a result of the current stream, a slight cooling impact (QC) will happen at thermocouple intersection A (where hotness is sucked in), and a warming impact (QH) will happen at intersection B (where hotness is ousted). Note that this impact may be switched whereby an alteration within the course of electric current stream will invert the heading of heat stream. Joule heating, having a level of $I^2 \times R$ (where R is the electrical resistance), moreover happens within the conductors as a result of current stream. This Joule warming impact acts in resistance to the Peltier effect and causes a net decrease of the accessible cooling. The Peltier effect can be communicated numerically as Where:

- β is the differential Peltier coefficient between the two materials A and B in volts.
- I is the electric current stream in amperes.
- QH and QC are the rates of cooling and warming, separately, in watts.

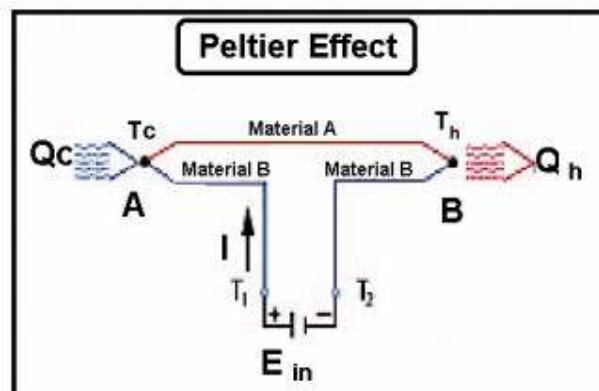


Fig 1.4 Peltier Effect

Peltier coefficient β has imperative impact on Thermoelectric cooling as following:

- a) $\beta < 0$; Negative Peltier coefficient. In this case, electrons move from right to left. The temperature gradient and electric current stream in inverse directions.
- b) $\beta > 0$; Positive Peltier coefficient. In this case, electrons move from left to right. The temperature gradient and electric current stream in the same direction.

1.3 WORKING PRINCIPLE OF SOLAR CELLS AND SOLAR PANELS:

When the photovoltaic cells assimilate solar radiation, photovoltaic effect leads to the generation of the electromotive force at the ends of the cells. Hence, the solar cells act as a source of power. Each solar cell is composed of a majority of diode. The cells can be associated together in series and in parallel to deliver the required voltage. Thirty-six cells associated in series can give a voltage of 12 volts. In this way, we get a solar cell module in which the cells are protected and secured from unfavorable climate conditions.

1.4 APPLICATIONS OF THERMOELECTRIC GENERATOR (TEG):

The various applications of Thermoelectric Generator are discussed below

1.4.1 APPLICATION OF THERMOELECTRIC GENERATOR IN GAS PIPELINES

Common application of Thermoelectric Generator is mainly in gas pipelines. For example, for cathodic protection, radio communication and other telemetry. On gas pipelines for power consumption of up to 5kW, thermal generators are preferable to other power sources. The manufacturer of generators for gas pipelines is Gentherm Global Power Technologies.

1.4.2. APPLICATION OF THERMOELECTRIC GENERATOR IN OFF-GRID POWER GENERATION

Thermoelectric Generators are basically utilized as far-field and off-grid thermoelectric generators for unmanned destinations. They are the foremost solid thermoelectric generator

in such situations as they don't have moving parts (hence essentially maintenance-free), work day and night, perform beneath all climate conditions and can work without battery reinforcement. In spite of the fact that Solar based Photovoltaic frameworks are moreover executed in farther destinations, Solar powered PV may not be a reasonable arrangement where solar radiation is less, that ranges from higher scopes with snow or no daylight, zones with much cloud or tree canopy cover, dusty deserts, timberlands, etc.

1.4.3. APPLICATION OF THERMOELECTRIC GENERATOR IN AUTOMOBILE INDUSTRY

Cars and other automobiles produce waste heat (in the exhaust and the cooling agents). Harvesting that heat energy, using a thermoelectric generator, can increase the fuel efficiency of the car. Thermoelectric generators have been examined to supplement the alternators in cars illustrating a 3.45% decrease in fuel utilization showing billions of dollars in reserve funds every year. Projections for future improvements are up to a 10% increase in mileage for hybrid vehicles. It has been stated that the potential energy savings could be higher for gasoline engines rather than for diesel engine.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Method for producing control such as burning of wood, petrol, diesel, coal, is persistently exhausting with nature, so that surpassed utilization of power concurring to the buyer request. Worldwide warming is the increment within the normal measured temperature of the Earth's close surface air and Seas since the mid-20th century, and its anticipated continuation. Worldwide surface temperature expanded 0.74 ± 0.18 °C (1.33 ± 0.32 °F) amid the Thomas Jon Seebeck (1934) concocted that a temperature shaped between two different conductors produces a voltage and current. At the heart of the thermoelectric generator effect is the fact that a temperature distinction in a conducting marterial comes about in heat stream between one side to another side.

2.2 HEATING AND COOLING BOX USING THERMOELECTRIC GENERATOR

Adarsh Mohan Dixit, Arjit Raj Sahu (student) (2013), “Water Cooler Double Purpose: To produce hot and cold water at the same time”. Evaporator and condenser are used in this simultaneously. Evaporator in the water cooler is not used when condenser is removed and it is replaced by another exchanger.

Akhilesh Yadav, Rajatkumar Bachan, Dattaprasad Tendolkar, Sankesh Torashkar (2018), “Design and fabrication of 360degree Cooler Cum Heater”. This paper helps us to understand the process of evaporative cooling. In this they have created a 360degree simple evaporative air cooler in which cooling is achieved by direct contact between the water particles and air stream.

S. A. Abdalla, Kamal N (2016),” A radiant air conditioning framework utilizing solar powered fluid desiccant evaporative water cooler”. They portrayed that the solar powered fluid “desiccant” evaporative cooling framework and strategy utilized for exploring it’s execution is giving cold water for radiant discuss conditioning framework.

Vijay Kumar Kalwa, R Prakash, 2012, "Design and Development of solar power air cooler".
This paper gives the data around the issues confronted by the overabundant utilization of the non-renewable assets.

CHAPTER 3

3.1 AIM OF THE PROJECT

- The aim of the present work is to generate heating and cooling simultaneously using Thermoelectric principle based on seebeck and peltier effect.
- Solar energy is used as a power supplier instead of conventional sources of energy. The TEG used is made up of a Alumina (Al_2O_3) and Bismuth Tin (BiSn).
- The least temperature that can be attained in this project is 25 degrees Celsius and highest temperature that can be attained is 75 degrees Celsius.
- It is a cost effective process.
- By using electricity and backup batteries which are charged during day time can be used for operating in night time.

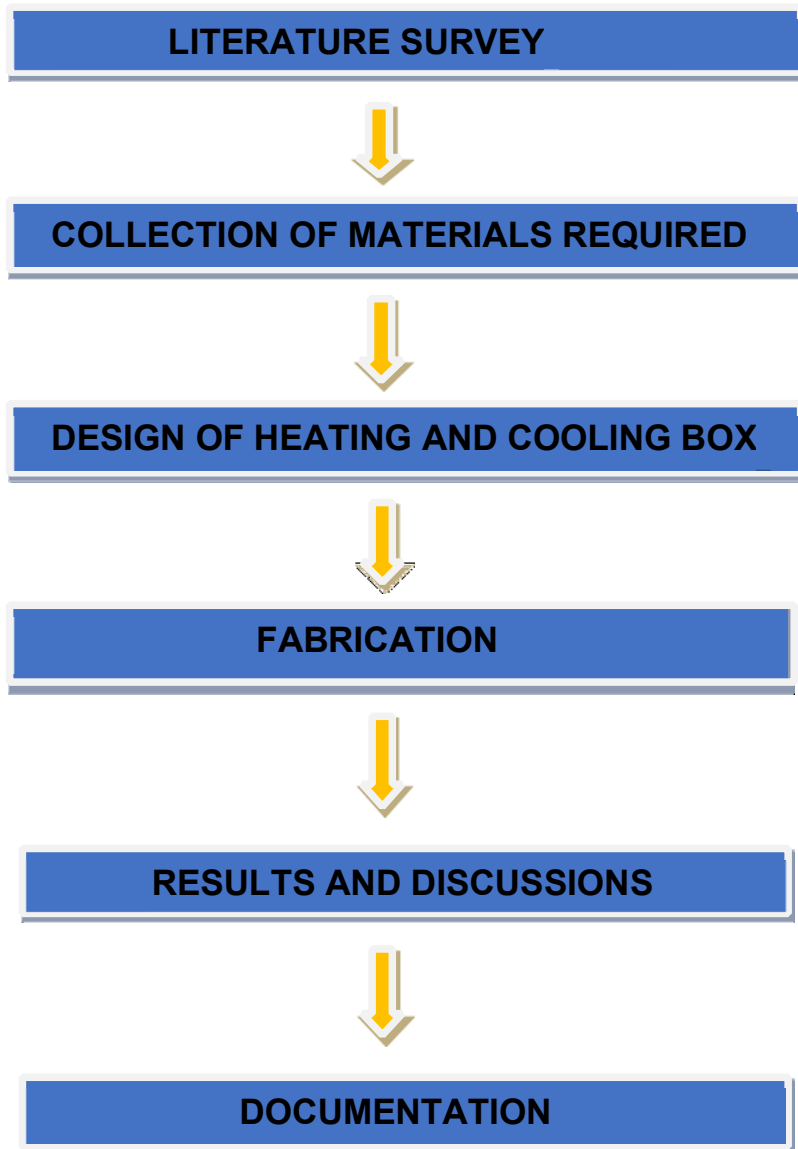
3.2 SCOPE OF THE PROJECT

The scope of the project is a product which can simultaneously perform heating and cooling. It can be worked with solar power and also in rainy seasons by using electricity. This process can be used in remote areas and hill stations also. The process works on thermoelectric generator.

CHAPTER - 4

MATERIALS AND EXPERIMENTAL METHODS

4.1 METHODOLOGY



4.2 MATERIALS

4.2.1. MILD STEEL:

Particularly steel in my humble opinion, is the most prominent fabric mankind has for development. It is cheap, solid, promptly accessible, effectively cut, joined, and shaped. Wood can be light and firm, but not exceptionally solid. The best aluminum is solid and light, but exceptionally difficult to connect. Titanium is sublime in terms of quality to weight proportion and solidness but it's fantastically costly, difficult to get, and indeed more difficult and costly to machine appropriately. There's no way you're ever attending to perform a battery-welded-fix on a portion made from 7075-T6 aluminum or titanium.

In the conclusion we come back to steel from mellow carbon to a few of the more exotic combination steels pound for pound it is the foremost righteous fabric accessible for our needs. Where does steel come from? Steel isn't an actually happening substance - it is entirely artificial. Steel is chiefly a combination of two normally happening components: press and carbon together with little sums of other components.

The process by which man makes steel, would, once more, fill a few volumes. Here is my novice abstract Press is mined from the ground within the frame in the event that a reddish brown shake called iron-ore. This metal is at that point crushed up, strained, filtered, chemically treated etc., until eventually it is softened in gigantic impact heaters into something called pig press. The method employments coke (a sort of coal), which in turn confers huge sums of carbon to the pig iron. As a result, pig iron itself is full of debasements, delicate, and unmaking-able - for all intents and purposes futile. But - it is the crude fabric from which all other irons and steels are made. Pig iron is so produced in either huge vats of molten material, or it is cast into ingots (in fact, pig iron got its name because the ingots or "chunks" produced were thought to have resembled piglets). Pig iron is at that point refined into either metallic iron or steel utilizing specialized radiators and shapes. The capability between the two is that metallic iron has between 2-6A final words nearly carbon. Carbon is essentially basic to our whole conversation since it is the closeness of carbon that turns the component of iron that's regularly sensitive and feeble, into the strong, unbendable materials we know as iron and steel.



Fig 4.1 Frame



Fig 4.2 Mild Steel

The quality, hardness and durability that make the ferrous based metals valuable to us are significantly influenced by the surprising affectability of the physical and chemical properties of iron precious stones to generally little rates of carbon break up inside their frameworks (really, the affectability is to the development of separations inside the crystal space grid). This affectability to be dissolved carbon is in reality, the very root of ferrous metallurgy.

4.2.2 SOLAR PANEL:

A PV module is a get together of photo-voltaic cells mounted in a system for establishment. Photo-voltaic cells utilize sunshine as a source of imperativeness and make facilitate current control. A collection of PV modules is called a PV Board, and a system of Sheets is a Cluster. Clusters of a photovoltaic framework supply solar power to electrical equipment. A solar board works by permitting photons, or particles of light, to thump electrons free from particles, producing a stream of power. Sun based board really contain numerous, littler units called photovoltaic cells. Ground-mounted photovoltaic frameworks are more often than not expansive, utility-scale solar control plants. Their solar modules are held in by racks or outlines that are joined to ground-based mounting supports. Ground based mounting supports include:

- Pole mounts, which are driven directly into the ground or embedded in concrete.
- Foundation mounts, such as concrete slabs or poured footings.

- Ballasted footing mounts, such as concrete or steel bases that use weight to secure the solar module system in position and do not require ground penetration. This sort of mounting framework is well suited for locals where unearthing isn't a conceivable option such as capped landfills and rearranges decommissioning or migration of solar powered PV module systems. Roof-mounted solar control frameworks comprise of solar modules held in by racks or outlines connected to roof-based mounting underpins. Roof-based mounting bolsters incorporate:
- Rail mounts, which are joined specifically to the roof structure and may utilize extra rails for joining the module racking or outlines.
- Ballasted balance mounts, such as concrete or steel bases that utilize weight to secure the board framework in position and don't require through penetration. This mounting technique licenses for decommissioning or relocation of solar panel systems with no opposing effect on the roof structure.
- All wiring meddle abutting solar fueled modules to the energy harvesting equipment must be presented concurring to adjacent electrical codes and need to be run in a conduit needed for the climate conditions.



Fig 4.3 Solar Panel

4.2.3 TRACKERS:

Solar trackers increment the sum of energy delivered per module at a fetched of mechanical complexity and require for support. They sense the course of the Sun and tilt or pivot the modules as required for most extreme presentation to the light.

4.2.4 FIXED RACKS:

Fixed racks hold modules stationary as the sun moves over the sky. The settled rack sets the point at which the module is held. Tilt points identical to an installation's scope are common. Most of these settled racks are set on posts over ground.

4.2.5 BATTERY:

In secluded systems away from the grid, batteries are utilized for capacity of overabundance solar energy changed into electrical energy. The only exemptions are separated daylight stack such as water system pumps or drinking water supplies for capacity. In truth for little units with yield less than one kilowatt. Batteries appear to be the only technically and

financially accessible capacity implies. Since both the photovoltaic framework and batteries are high in capital costs. It is vital that the by and large framework be optimized with regard to accessible energy and nearby request design.



Fig 4.4 Battery

To be financially alluring the capacity of sun powered power requires a battery with a specific combination of properties:

- 1) High general efficiency
- 2) Long life
- 3) Low discharge
- 4) Low cost
- 5) Minimum maintenance
- 6) High reliability
- (7) Ampere hour efficiency
- (8) Watt hour efficiency

Specifications:

Battery capacity: 12V, 1.3Ah.

- This is chargeable one.
- Battery charging time: 20min.

4.2.6 D.C. MOTOR (PERMANENT MAGNET):

An electric motor could be a machine which changes over electrical energy to mechanical energy. Its activity is based on the guideline that when a current-carrying conductor is set in an attractive field, it encounters an attractive constrain whose heading is given by Fleming's left hand rule.

When a motor is in operation, it creates torque. This torque can produce mechanical rotation. DC engines are too like generators classified into shunt wound or arrangement wound or compound wound motors.



Fig 4.5 DC Motor

4.2.7 ELECTROMAGNETS AND MOTORS

To get it how an electric motor works, the key is to get it how the electromagnet works. An electromagnet is the premise of an electric motor. You'll be able get it how things work within the motor by envisioning the taking after situation. Say that you just made a basic electromagnet by wrapping 100 circles of wire around a nail and interfacing it to a battery. The nail would become be a magnet and have a North and South Shaft whereas the battery is associated.

Presently say simply take your nail electromagnet, run a pivot through the middle of it, and you suspended it within the center of a horseshoe magnet. In case you were to join a battery to the electromagnet so that the North conclusion of the nail showed up as appeared, the fundamental law of attraction tells you what would happen.

The North conclusion of the electromagnet would be repulsed from the north conclusion of the horseshoe magnet and pulled in to the south conclusion of the horseshoe magnet. The South conclusion of the electromagnet would be repulsed in a comparable way. The nail would move around half a turn and after that within the position appeared. You'll be able see that this half-turn of movement is basic and self-evident since of the way magnets actually draw in and repulse one another. The key to an electric engine is to at that point go one step assist so that, at the minute that this half-turn of movement completes, the field of the electromagnet flips. The flip causes the electromagnet to total another half-turn of movement.

4.2.8 TEG (PELTIER MODULE):

Peltier modules are electronic gadgets planned for cooling objects to underneath the surrounding temperature or keeping up objects at a particular temperature by controlled warming or cooling. Thermoelectric generator gadgets utilize the Seebeck impact to create voltage. When a voltage is connected to thermoelectric cooler, an electrical current is created. This current actuates the Peltier impact. With this impact, hotness is moved from the cold side to the hot side.

Hot Side Temperature (°C)	25°C	50°C
Qmax (Watts)	50	57
Delta Tmax (°C)	66	75
I _{max} (Amps)	6.4	6.4
V _{max} (Volts)	14.4	16.4
Module Resistance (Ohms)	1.98	2.30

Table 4.1 Specifications of TEG

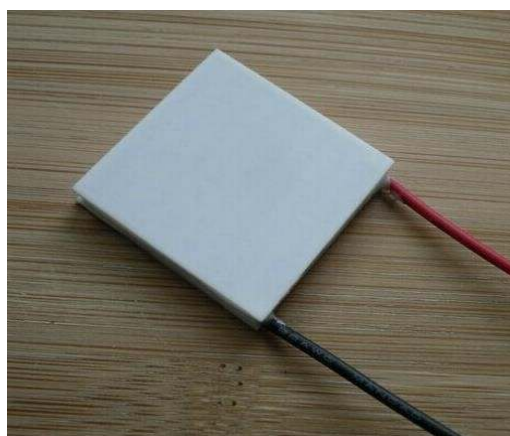


FIG 4.6 (TEG) Peltier module

4.2.9 MICROCONTROLLER:

A microcontroller (MCU for microcontroller unit) could be a little computer on a single metaloxide-semiconductor (MOS) coordinates circuit (IC) chip. A microcontroller contains one or more CPUs (processor centers) at the side memory and programmable input/output peripherals. Program memory within the shape of ferroelectric Slam, NOR streak or OTP ROM is additionally regularly included on chip, as well as a little sum of Slam.

Microcontrollers are outlined for inserted applications, in differentiate to the chip utilized in individual computers or other common reason applications comprising of different discrete Chips. Microcontrollers are utilized in naturally controlled items and gadgets, such as car motor control frameworks, implantable therapeutic gadgets, farther controls, office machines, machines, control devices, toys and other inserted frameworks. By lessening the estimate and taken a toll compared to a plan that employs a partitioned chip, memory, and input/output gadgets, microcontrollers make it prudent to carefully control indeed more gadgets and forms. Blended flag microcontrollers are common, joining analog components required to control non-digital electronic frameworks. Within the setting of the web of things, microcontrollers are a prudent and prevalent implies information collection, detecting and activating the physical world as edge gadgets.



Fig 4.7 Microcontroller



Fig 4.8 Microcontroller with LCD display

4.2.10 FANS:

Basically the fans used in Thermoelectric Generators rated for a voltage of DC 12V and a standard operating voltage range of DC 10.8 to 13.2V. It has starting voltage of DC 7V. Operating current is 0.6W. The maximum rotating speed of the fan is 1500 rpm. Maximum

airflow is 57.2 CFM 1.618 m³/min. The noise level is also very limited to 27.2 dB. It has 7 blades consisting of 4 poles. It has a DC brushless fan motor. It has a ball bearings and lead wire termination.



Fig 4.9 Fan

4.3 EXPERIMENTAL SETUP



Fig 4.10 Fabrication

Metal cutting and joining the through welding to give the frame a rectangular shape.



Fig 4.11 Fabrication
Sheet cutting to cover upon the rectangular frame.



Fig 4.12 Fabrication
Attaching the sheet metal to the rectangular frame



Fig 4.13 Fabrication
Microcontroller with temperature showing LCD display is fixed to the frame.



Fig 4.14 Fabrication
Fans fitted on either side of the cooling and heating box.



Fig 4.15 Fabrication
Fully assembled cooling and heating box along with the Peltier module.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 2D LAYOUT:

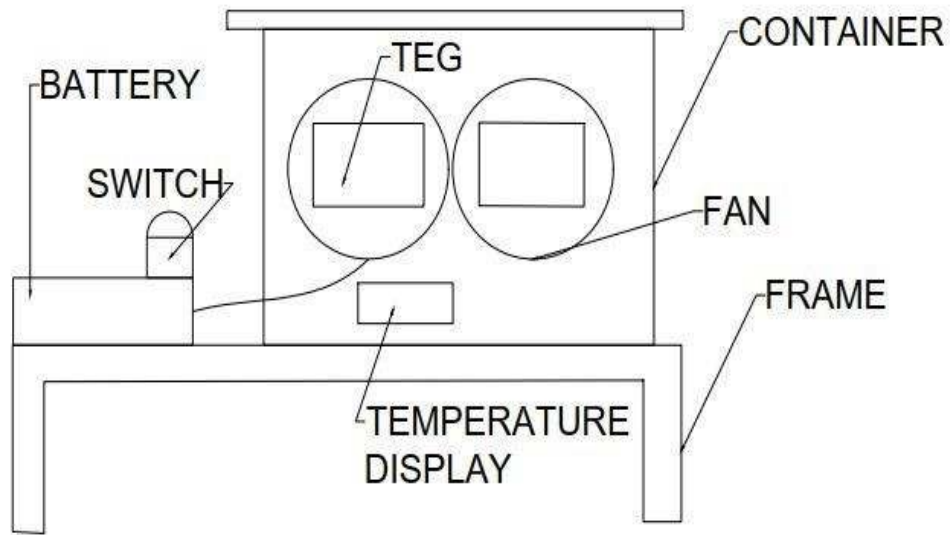


Fig 5.1 2D Layout

2D Layout shows a rough two - dimensional design of heating and cooling box which is having a solar panel, a battery for receiving solar power, a switch, temperature display, TEG (Peltier module), 2 fans which of all these are mounted on a rectangular frame to support the setup.

5.2 CAD DESIGN:

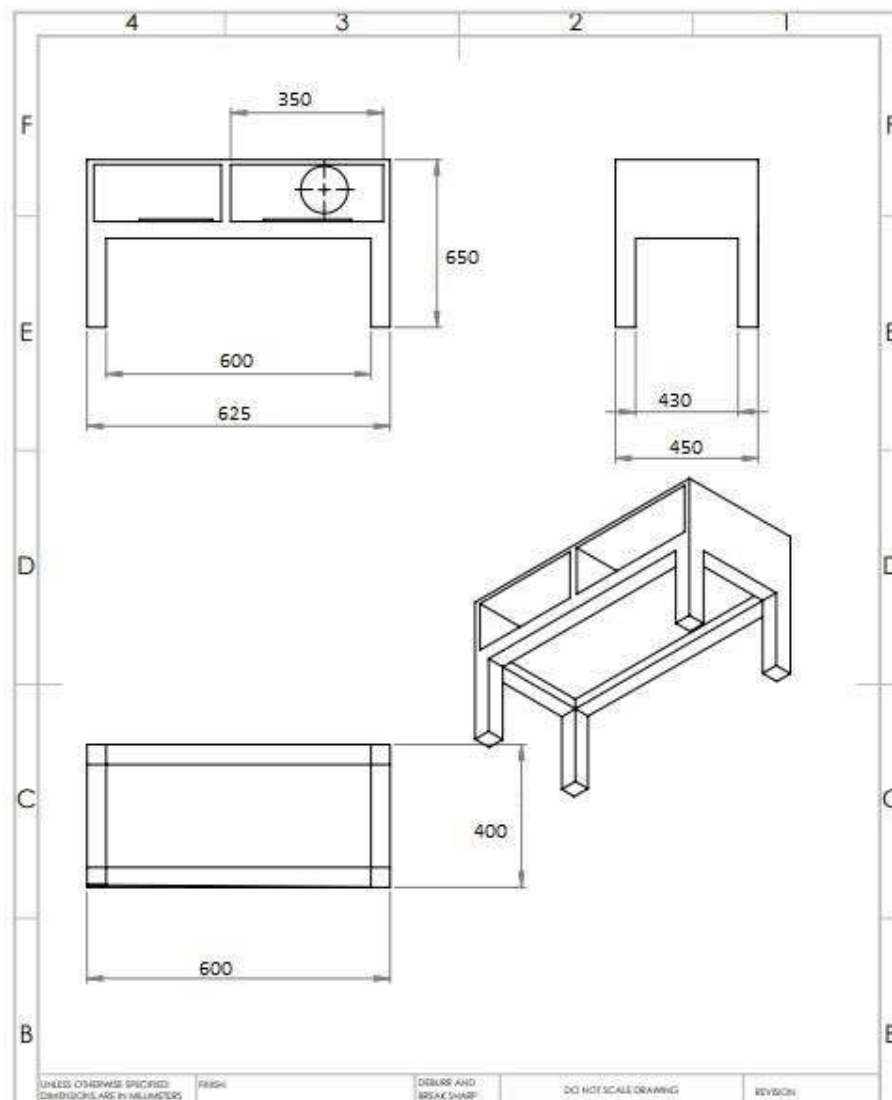


Fig 5.2 CAD Design

CAD design provides the accurate dimensions of the heating and cooling box. The cuboid box has length of 600mm, width of 400mm and height of 650mm.

5.3 3D LAYOUT



Fig 5.3 3D Layout

3D layout basically shows a small rectangular box which is having 4 legs and having two separate chambers for each one heating and cooling and a hole for insertion of whole TEG setup and fans on both sides.

5.4 OUTCOME OF THE PROJECT



Fig 5.4 Outcome of the project

Front view



Fig 5.5 Outcome of the project

Top view



Fig 5.6 Outcome of the project
Rear view

5.5 TEG (PELTIER MODULE) SPECIFICATIONS:

- Current (I) = 0.93A
- Open Circuit voltage (V_{oc}) = 5.29V
- Seebeck (α) = 0.056V/k
- Number of PN couple(N) = 127N
- Air temperature (T_{air}) = 30 degree C
- Max temp (T_{max}) = 100 degree C
- Electrical resistance (R_e) = 3.85 Ω
- Thermal conductance (k) = 0.35 W/k
- Resistance intersection to case (R_{jc}) = 2.45 k/W
- Resistance case to source (R_{cs}) = 1 k/W
- heat stream on hot side (Q_{hot}) = 53.1
- Temperature contrast (ΔT) = 50degree C

- Operating voltage = Greatest 100 Mvdc
- Rating = Most extreme 100 amps
- Power = Most extreme 5 watts
- Number of p-n intersections = 127
- Cooling Framework = wind cooling fan

5.5.1 PELTIER IMPACT CALCULATIONS:

Calculating the warm stream on the hot side, $Q_{hot} = (Re/2 \times I^2) - (\alpha \times I \times T_{max}) - (k \times \Delta T) = (3.85/2 \times 0.93 \times 0.93) - (0.056 \times 0.93 \times 100) - (0.35 \times 50) = 20.39 \text{ degree C/W}$

Now I find the Resistance surface to air

$$R_{sa} = ((T_{max} - T_{air}) / Q_{hot}) - R_{jc} - R_{cs} = ((100 - 30) / 20.39) - 2.45 - 1 = 0.0192 \text{ degree C/W}$$

Now calculate the Rmodule,

$$R_{module} = R_{cs} + R_{jc} + R_{sa} = 2.45 + 1 + 0.0192 = 3.46 \text{ degree C/W}$$

Now using the formula for power,

$$P = (N \times \alpha^2 \times \Delta T^2) / (4 \times R_{module}) = (127 \times 0.0031 \times 50^2) / (4 \times 3.46) = 71.1 \text{ Watts}$$

5.6 Heating graph of Temperature vs Time

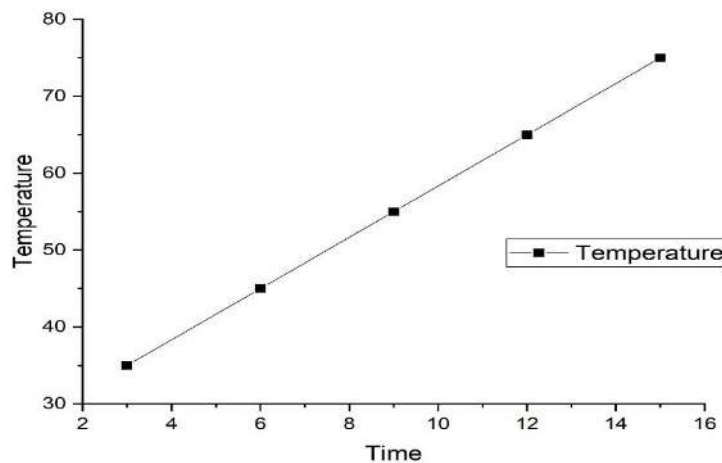


Fig 5.7 Heating graph of Temperature vs Time

Temperature vs Time graph showing the heating curve in which room temperature of 35 degree Celsius rises upto 75 degree Celsius in just 15 minutes maintaining a constant rise in the temperature every 3 minutes.

As it is the heating part the electrical energy produced here will just be converted into heat energy then to heat.

5.7 Cooling graph of Temperature vs Time

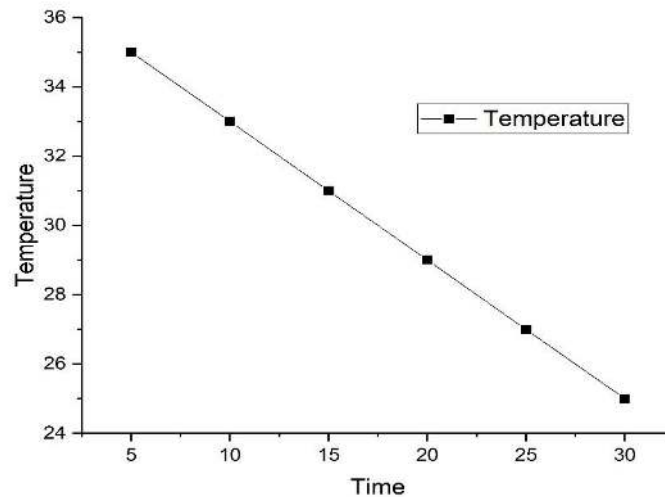


Fig 5.8 Cooling graph of Temperature vs Time

Temperature vs Time graph showing the cooling curve in which room temperature of 35 degree Celsius declines to 25 degree Celsius gradually in 30 minutes maintaining a constant decline in temperature of 2 degrees every 5 minutes.

As it is the cooling part the electrical energy produced here gets converted into heat energy then to coldness by Peltier module. Temperature vs Time graph showing the heating curve in which room temperature of 35 degree Celsius rises upto 75 degree Celsius in just 15 minutes maintaining a constant rise in the temperature every 3 minutes.

As it is the heating part the electrical energy produced here will just be converted into heat energy then to heat.

6 SUMMARY AND CONCLUSION

We would conclude that, The Air Cooler Cum Heater is a model of minimum investment providing both heating and cooling effect as required. The easy displacement of the model can be achieved. The utilization of renewable resources like solar energy makes a difference in keeping up eco-friendly climate. The main thing here is to notice is that the Thermoelectric Module (Peltier module) is used to produce cooling effect. This means that the food or medicinal stuff cooling is done without the use of greenhouse gases which would ultimately reduce the global warming which is usually caused by other refrigeration system. Thermoelectric cooling, also known as "The Peltier Effect", is a solid-state method of heat transfer through dissimilar semiconductor materials. Thermoelectric cooler (TEC), or Peltier Cooler uses the Peltier effect for the exchange of heat. The present commercial TEC comprises of a number of p- and n- sort semiconductor couples. The heat pumping course can be changed by changing the extremity of the charging DC current. Heat will be rejected through the module from inward side to the external surface. Inward module face will be cooled whereas the outward face is at the same time heated. The Temperature drop at the cooling side and the rise in temperature in heating side is measured by temperature sensor and it is displayed on LCD display.

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APPENDIX



Plagiarism SMT Checker Report

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ABSTRACT In the recent years, we all are facing electricity crisis. It is an eco-friendly venture, made by utilizing thermoelectric module.. It is an eco-friendly project, made by using thermoelectric module. The project supports both heating and cooling. The project has various applications like, military or aerospace, medical and pharmaceutical equipment and food maintenance etc. Thus, it proves to be very helpful. The entire model is fabricated in mild steel with appropriate dimensions. The temperature sensor is placed to monitor the temperature of the cabin. The TEG is placed in heat sink behind the fan. The fan rotates and blow the heat air to the atmosphere. This concept is driven by TEG using solar power. Components included in this concept are sun oriented board, battery, charge controller, battery, inverter, blower, ceramic pieces and cooling cushions. Solar panel is utilized to change over sun light into electrical vitality by implies of photovoltaic impact. The generated electrical vitality is provided to the battery for capacity reason through charge controller which anticipates from control variances. As AC blower is utilized for cooler, so have to be change over DC load from the battery to AC stack by the assistance of inverter. Inverter changes over DC stack to AC. Stack, presently AC control can be provided to the blower. This blower is encompassed by cooling cushions through which persistent water supply is given. When the blower is switched ON, blower sucks atmospheric air into the cabin through the cooling pads, mean time heat transfer occurs between water and air, so the cool discuss enters into the room hence giving required warm consolation conditions. The whole concept explained is fully based on TEG (Thermoelectric Generator). The Thermoelectric module works on two different principles: 1) Peltier Effect: These effect gives power to the module with a significant cooling on one side and heating on the other side. 2) Seebeck Effect: The seebeck effect produces a temperature difference across the module by heating one side and cooling the other side. The Seebeck module is a power generator and Peltier module is a cooling with heating module

CHAPTER 1 INTRODUCTION 1.1 HISTORY AND BACKGROUND The growing concern with exhaustion of energy resources are increasing day by day. The current tendency of the first world is to look at renewable energy resources and the development of new technologies based on renewable energy resources as a source of energy. They are solar energy, hydroelectric energy, bio and wind energy, etc. Ideal solution for an alternative form of energy is RAPS (Remote Area Power Supply) used in electric grid connection. A study done by the College of Cape Town's Vitality Advancement Inquire about Middle came up with curious truths that can be utilized to bolster the application of PV frameworks to Third World lodging. The thermoelectric cooler it'll utilize the control from the PV boards when the battery is completely charged, and at night, will utilize a little amount of control to preserve the temperature within the cooler box. In other words, on the off chance that the battery of the framework is completely charged, and there's no machine to retain the control created from the PV board, it would be squandered, coming about in a 'poor efficiency factor for the full PV framework. The cooler box coordinates in a RAPS would permit for an awfully productive framework utilizing all the abundance created control from the sun. In spite of the fact that commercial thermoelectric modules were not accessible until nearly 1960, the physical standards upon which cutting edge thermoelectric coolers are based really date back to the early 1800s. The primary critical disclosure relating to thermoelectricity happened in 1821 when German researcher Thomas Seebeck found that an electric current would stream persistently in a closed circuit made up of two different metals, given that the intersections of the metals were kept up at two distinctive temperatures. Seebeck did not really comprehend the logical premise for his revelation, be that as it may, and dishonestly accepted that streaming warm delivered the same impact as streaming electric current. In 1834, a French watchmaker and part-time physicist, Jean Peltier, whereas exploring the Seebeck Impact, found that there was an inverse marvel where warm vitality may be retained at one dissimilar metal crossing point and discharged at the other crossing point when an electric current spilled interior the closed circuit. Twenty a long time afterward, William Thomson (inevitably known as Ruler Kelvin) issued a comprehensive clarification of the Seebeck and Peltier Impacts and depicted their relationship. At the time, in any case, these marvels were still considered to be insignificant research facility interests and were without viable application. Within the 1930s, Russian researchers started considering a few of the prior thermoelectric work in an exertion to develop control generators for utilize at inaccessible areas all through their nation.

This Russian intrigued in thermoelectricity inevitably caught the consideration of the rest of the world and motivated the advancement of viable thermoelectric modules. Today's thermoelectric coolers make utilize of advanced semiconductor innovation in which doped semiconductor fabric takes the put of the disparate metals utilized in early thermoelectric tests. The Seebeck, Peltier and Thomson effects, together with several other phenomena, form the basis of functional thermoelectric modules.

1.2 WORKING PRINCIPLE OF TEG

TEG works on the principle that electric potential and heat can be converted. The Seebeck effect generally states that electric potential can be generated between two junctions at two different temperatures. The Peltier effect which is generally the reverse of Seebeck effect states that that the temperature can be controlled between two junctions if electric potential is applied between two dissimilar metals. TEG uses the Seebeck effect in power generation mode and the Peltier effect in thermal management mode, as shown in Figure 1. This versatility of TEG is attractive for niche applications such as precise temperature control. A TEG consists of a large number of thermocouples formed by n-type and p-type semiconductor materials connected electrically in series and thermally in parallel. A thermoelectric module (TEG) by and large comprises of warm sinks on both hot and cold sides with interface and protection layers to avoid warm dissemination to the cold side. As the electrons move from the P sort fabric to the N sort fabric through an electrical connector, the electrons hop to a better vitality state retaining warm vitality (cold side). Proceeding through the cross section of fabric; the electrons stream from the N sort fabric to the P sort fabric through an electrical connector dropping to a lower vitality state and discharging vitality as warm to the warm sink (hot side). Thermoelectric can be utilized to warm and to cool, depending on the heading of the current. In an application requiring both warming and cooling, the plan ought to focus on the cooling mode. Employing a thermoelectric within the warming mode is exceptionally proficient since all the inner warming (Jouliau warm) and the stack from the cold side is pumped to the hot side. This diminishes the control required to attain the required warming.

1.2.2 Peltier Effect

Peltier found there was an inverse marvel to the Seebeck Impact, whereby warm vitality may well be ingested at one different metal intersection and released at the other intersection when an electric current streamed inside the closed circuit. The thermocouple circuit is adjusted to get a distinctive setup that outlines the Peltier Impact, a marvel inverse that of the Seebeck Impact. In case a voltage (E_{in}) is connected to terminals T1 and T2, an electrical current (I) will stream within the circuit. As a result of the current stream, a slight cooling impact (QC) will happen at thermocouple

intersection A (where warm is ingested), and a warming impact (QH) will happen at intersection B (where warm is ousted). Note that this impact may be switched whereby a alter within the course of electric current stream will invert the heading of warm stream. Joule warming, having a greatness of $I^2 \times R$ (where R is the electrical resistance), moreover happens within the conductors as a result of current stream. This Joule warming impact acts in resistance to the Peltier Impact and causes a net decrease of the accessible cooling. The Peltier impact can be communicated numerically as Where: • β is the differential Peltier coefficient between the two materials A and B in volts. • I is the electric current stream in amperes. • QH and QC are the rates of cooling and warming, separately, in watts. Peltier coefficient β has imperative impact on Thermoelectric cooling as following: 5 a) $\beta < 0$; Negative Peltier coefficient Tall vitality electrons move from right to cleared out. Warm current and electric current stream in inverse directions. b) $\beta > 0$; Positive Peltier coefficient Tall vitality gaps move from cleared out to right. Warm current and electric current stream in same course

1.3 WORKING PRINCIPLE OF SOLAR CELLS AND SOLAR PANELS: When the photovoltaic cells assimilate sun powered radiation, photovoltaic impact leads to the generation of the electromotive drive at the closes of the cells. Hence, the sun oriented cells gotten to be a source of power. Each sun based cell is composed of a majority of diode. The cells can be associated together in arrangement and in parallel to deliver the comparing voltage. Thirty-six cells associated in arrangement can give voltage of 12 volts. In this way we get a sun based cell module in which the cells are settled and secured from unfavorable climate conditions.

1.4 APPLICATIONS OF THERMOELECTRIC GENERATOR (TEG): The various applications of Thermoelectric Generator are discussed below

1.4.1 APPLICATION OF THERMOELECTRIC GENERATOR IN GAS PIPELINES Common application of Thermoelectric Generator is mainly in gas pipelines. For example, for cathodic protection, radio communication and another telemetry. On gas pipelines for power consumption of upto 5kW thermal generators are preferable to other power sources. The manufacturers of generators for gas pipelines are Gentherm Global Power Technologies.

1.4.2.APPLICATION OF THERMOELECTRIC GENERATOR IN OFF-GRID POWER GENERATION Thermoelectric Generators are basically utilized as farther and off-grid control .generators for unmanned destinations. They are the foremost solid control generator in such situations as they don't have moving parts (hence essentially maintenance-free), work day and night, perform beneath all climate conditions and can work without battery reinforcement. In spite of the fact that Sun based Photovoltaic frameworks are moreover executed in farther

destinations, Sun powered PV may not be a reasonable arrangement where sun oriented radiation is low, i.e. ranges at higher scopes with snow or no daylight,

zones with much cloud or tree canopy cover, dusty deserts, timberlands, etc. 1.4.4.

APPLICATION OF THERMOELECTRIC GENERATOR IN AUTOMOBILE INDUSTRY

Cars and other automobiles produce waste heat (in the exhaust and the cooling agents). Harvesting that heat energy, using a thermoelectric generator, can increase the fuel efficiency of the car.

Thermoelectric generators have been examined to supplant the alternators in cars illustrating a 3.45% lessening in fuel utilization speaking to billions of dollars in reserve funds every year. Projections for future improvements are up to a 10% increase in mileage for hybrid vehicles. It has been stated that the potential energy savings could be higher for gasoline engines rather than for diesel engine

CHAPTER 2 LITERATURE REVIEW 2.1 INTRODUCTION

Method for producing control such as burning of wood, petrol, diesel, coal, is persistently exhausting with nature, so that surpassed utilization of power concurring to the buyer request. Worldwide warming is the increment within the normal measured temperature of the Earth's close surface discuss and Seas since the mid-20th century, and its anticipated continuation. Worldwide surface temperature expanded 0.74 ± 0.18 °C (1.33 ± 0.32 °F) amid the Thomas Jon Seebeck (1934) concocted that a temperature shaped between two different conductors produces a voltage and current. At the heart of the thermoelectric generator impact is the reality that a temperature distinction in a conducting fabric comes about in warm stream between one side to another side.

2.2 HEATING AND COOLING BOX USING THERMOELECTRIC GENERATOR

Adarsh Mohan Dixit, Arjit Raj Sahu (student) (2013), "Water Cooler Double Purpose: To produce hot and cold water simultaneously".

Evaporator and condenser are used in this simultaneously. Evaporator in the water cooler is not used when condenser is removed and it is replaced by another exchanger.

Akhilesh Yadav, Rajatkumar Bachan, Dattaprasad Tendolkar, Sankesh Torashkar (2018), "Design and fabrication of 360degree Cooler Cum Heater". This paper helps us to understand the process of evaporative cooling.

In this they have created a 360degree simple evaporative air cooler in which cooling is achieved by direct contact between the water particles and air stream. S. A. Abdalla, Kamal N (2016), "A radiant discuss conditioning framework utilizing sun powered driven fluid desiccant evaporative water cooler". They portrayed that the sun powered driven fluid "desiccant" evaporative cooling framework and strategy utilized for exploring it's execution is giving cold water for radiant discuss conditioning framework. 8 S. Lineykin, Igor Ruchaevski, Alon Kuperman (2014),

“Analysis and Optimization of TEG -Heatsink Waste Energy Harvesting System for Low Temperature Gradients”. Full and disentangled examination of electrical circuit framework comprising of TEG, a warm source and a warm sink is displayed. For ease of utilize the framework is spoken to as an dynamic two-terminal, which incorporates a voltage source and a non-linear temperature subordinate resistor. The key role of the heat removal in the system and it's influence on the values of the output parameters are shown. Vijay Kumar Kalwa, R Prakash, 2012, “Design and Development of solar power air cooler”. This term paper gives the data around the issues confronted by the overabundance utilization of the non-renewable assets.

9 CHAPTER 3

3.1 AIM OF THE PROJECT

- The aim of the present work is to generate and heating and cooling simultaneously using Thermoelectric principle based on seedbeck and peltier effect.
- Solar energy is used as a power supplier instead of conventional sources of energy. The TEG used is made up of a Alumina (Al_2O_3) and Bismuth Tin (BiSn).
- The least temperature that can be attained in this project is 25 degrees Celsius and highest temperature that can be attained is 75 degrees Celsius.
- It is a cost effective process.
- By using electricity and backup batteries with are charged during day time can be used for operating in night time.

3.2 SCOPE OF THE PROJECT

The scope of the project is a product which can simultaneously do heating and cooling. It can be worked with solar and also in rainy seasons it can be worked by using electricity. This process can be used in remote areas and hill stations also. The process works on thermoelectric generator.

4.2 MATERIALS

4.2.1. MILD STEEL:

Why steel, in specific essentially since, in my humble supposition, it is the most prominent fabric mankind has for development. It is cheap, solid, promptly accessible, effectively cut, joined, and shaped. Wood can be light and firm, but not exceptionally solid. The best aluminum is solid and light, but exceptionally difficult to connect. Titanium is sublime in terms of quality to weight proportion and solidness but it's fantastically costly, difficult to get, and indeed more difficult and costly to machine appropriately. There's no way you're ever attending to perform a battery-welded-fix on a portion made from 7075-T6 aluminum or titanium. In the conclusion we come back to steel from mellow carbon to a few of the more exotic combination steels pound for pound it is the foremost righteous fabric accessible for our needs. Where does steel come from? Steel isn't a actually happening substance - it is entirely artificial. Steel is chiefly a combination of two normally happening components: press and carbon (together with little sums of other components - depending

on the steel in address). The prepare by which man makes steel, would, once more, fill a

a specific combination of properties: 1) High generally efficiency 2) Long life 3) Low discharge 4) Low cost 5) Minimum maintenance 6) High reliability (A) Ampere hour efficiency (B) Watt hour efficiency Specifications: • Battery capacity: 12V, 1.3Ah. • This is chargeable one • Battery charging time: 20min. 4.2.6 D.C. MOTOR (PERMANENT MAGNET): An electric engine could be a machine which changes over electrical vitality to mechanical vitality. Its activity is based on the guideline that when a current-carrying conductor is set in a attractive field, it encounters a attractive constrain whose heading is given by Fleming's cleared out hand rule. When a engine is in operation, it creates torque. This torque can produce mechanical few volumes. Here is my novice abstract Press is mined from the ground within the frame in the event that a reddish-brown shake called iron-ore. This metal is at that point crushed up, strained, filtered, chemically treated etc., until eventually it is softened in gigantic impact heaters into something called pig press. The method employments coke (a sort of coal), which in turn confers huge sums of carbon to the pig press. As a result, pig press itself is full of debasements, delicate, and unmaking-able - for all intents and purposes futile. But - it is the crude fabric from which all other irons and steels are made. Pig iron is so produced in either huge vats of molten material, or it is cast into ingots (in fact, pig iron got its name because the ingots or "chunks" produced were thought to have resembled piglets). Pig press is at that point refined into either metallic press or steel utilizing specialized radiators and shapes. The capability between the two is that metallic press has between 2-6A final words nearly carbon. Carbon is essentially basic to our whole conversation since it is the closeness of carbon that turns the component of press that's regularly sensitive and feeble, into the strong, unbendable materials we know as press and steel. The quality, hardness and durability that make the ferrous based metals valuable to us are significantly influenced by the surprising affectability of the physical and chemical properties of press precious stones to generally little rates of carbon broken up inside their frameworks (really, the affectability is to the development of separations inside the gem space grid). This affectability to broken up carbon is in reality, the exceptionally premise of ferrous 4.2.2 SOLAR PANEL: A PV module is an get together of photo-voltaic cells mounted in a system for establishment. Photo-voltaic cells utilize sunshine as a source of imperativeness and make facilitate current control. A collection of PV modules is called a PV Board, and a system of Sheets is an Cluster. Clusters of a photovoltaic framework supply sun oriented power to electrical equipment. A sun oriented

board works by permitting photons, or particles of light, to thump electrons free from particles, producing a stream of power. Sun based board really contain numerous, littler units called photovoltaic cells. Ground-mounted photovoltaic frameworks are more often than not expansive, utility-scale sun based control plants. Their sun oriented modules are held in put by racks or outlines that are joined to ground-based mounting supports. Ground based mounting supports include:

- Pole mounts, which are driven directly into the ground or embedded in concrete.
- Foundation mounts, such as concrete slabs or poured footings.
- 13 • **Ballasted footing mounts, such as concrete or steel bases that use weight to secure the solar module system in position and do not require ground penetration.**

This sort of mounting framework is well suited for locales where unearthing isn't conceivable such as capped landfills and rearranges decommissioning or migration of sun powered module systems. Roof-mounted sun oriented control frameworks comprise of sun powered modules held in put by racks or outlines connected to roof-based mounting underpins. Roof-based mounting bolsters incorporate:

- Rail mounts, which are joined specifically to the roof structure and may utilize extra rails for joining the module racking or outlines.
- Ballasted balance mounts, such as concrete or steel bases that utilize weight to secure the board framework in position and don't require through penetration. This mounting technique licenses for decommissioning or relocation of sun based board systems with no opposing affect on the roof structure.
- All wiring meddle abutting sun fueled modules to the essentialness collecting equipment must be presented concurring to adjacent electrical codes and need to be run in a conduit fitting for the climate conditions.

4.2.3 TRACKERS: Solar trackers increment the sum of vitality delivered per module at a fetched of mechanical complexity and require for support. They sense the course of the Sun and tilt or pivot the modules as required for most extreme presentation to the light.

4.2.4 FIXED RACKS: Fixed racks hold modules stationary as the sun moves over the sky. The settled rack sets the point at which the module is held. Tilt points identical to an installation's scope are common. Most of these settled racks are set on posts over ground.

4.2.5 BATTERY: In disconnected frameworks absent from the framework, batteries are utilized for capacity of overabundance sun based vitality changed over into electrical vitality. The as it were exemptions are separated daylight stack such as water system pumps or drinking water supplies for capacity.

In truth for little units with yield less than one kilowatt. Batteries appear to be the as it were actually and financially accessible capacity implies. Since both the photo-voltaic framework and batteries are tall in capital costs. It is vital that the by and large framework be optimized with regard to accessible vitality and nearby request design.¹⁵ To be financially alluring the capacity of sun powered power requires a battery with rotation. DC engines are too like generators classified into shunt wound or arrangement wound or compound wound engines.

4.2.7 ELECTROMAGNETS AND MOTORS To get it how an electric engine works, the key is to get it how the electromagnet works. An electromagnet is the premise of an electric engine. You'll be able get it how things work within the engine by envisioning the taking after situation. Say that you just made a basic electromagnet by wrapping 100 circles of wire around a nail and interfacing it to a battery. The nail would gotten to be a magnet and have a North and South Shaft whereas the battery is associated. Presently say simply take your nail electromagnet, run an pivot through the middle of it, and you suspended it within the center of a horseshoe magnet as appeared within the figure underneath. In case you were to join a battery to the electromagnet so that the North conclusion of the nail showed up as appeared, the fundamental law of attraction tells you what would happen: The North conclusion of the electromagnet would be repulsed from the north conclusion of the horseshoe magnet and pulled in to the south conclusion of the horseshoe magnet. The South conclusion of the electromagnet would be repulsed in a comparable way. The nail would move around half a turn and after that within the position appeared. You'll be able see that this half-turn of movement is basic and self-evident since of the way magnets actually draw in and repulse one another. The key to an electric engine is to at that point go one step assist so that, at the minute that this half-turn of movement completes, the field of the electromagnet flips. The flip causes the electromagnet to total another half-turn of movement.

4.2.8 TEG (PELTIER MODULE): Peltier modules are electronic gadgets planned for cooling objects to underneath the surrounding temperature or keeping up objects at a particular temperature by controlled warming or cooling. Thermoelectric generator semiconductor gadgets utilize the Seebeck impact to create voltage. ... When a voltage is connected to thermoelectric cooler, an electrical current is created. This current actuates the Peltier impact. With this impact, warm is moved from the cold side to the hot side.

4.2.9 MICROCONTROLLER: A microcontroller (MCU for microcontroller unit) could be a little computer on a single metal-oxide-semiconductor (MOS) coordinates circuit (IC) chip. ¹⁸ A microcontroller contains one

or more CPUs (processor centers) at the side memory and programmable input/output peripherals. Program memory within the shape of ferroelectric Slam, NOR streak or OTP ROM is additionally regularly included on chip, as well as a little sum of Slam. Microcontrollers are outlined for inserted applications, in differentiate to the chip utilized in individual computers or other common reason applications comprising of different discrete chips Microcontrollers are utilized in naturally controlled items and gadgets, such as car motor control frameworks, implantable therapeutic gadgets, farther controls, office machines, machines, control devices, toys and other inserted frameworks. By lessening the estimate and taken a toll compared to a plan that employments a partitioned chip, memory, and input/output gadgets, microcontrollers make it prudent to carefully control indeed more gadgets and forms.

Blended flag microcontrollers are common, joining analog components required to control non-digital electronic frameworks. Within the setting of the web of things, microcontrollers are an prudent and prevalent implies of information collection, detecting and activating the physical world as edge gadgets

4.2.10 FANS: Basically the fans used in Thermoelectric Generators rated for a voltage of DC 12V and a standard operating voltage range of DC 10.8 to 13.2V. It has starting voltage of DC 7V. 19 Operating current is 0.6W. The maximum rotating speed of the fan is 1500 rpm. Maximum airflow is 57.2 CFM 1.618 m³/min. The noise level is also very limited to 27.2 dB. It has 7 blades consisting of 4 poles. It has a DC brushless fan motor. It has a ball bearings and lead wire termination.

CHAPTER 5 RESULTS AND DISCUSSION

5.1 2D LAYOUT: 2D Layout shows a rough two - dimensional design of heating and cooling box which is having a solar panel, a battery for receiving solar power, a switch, temperature display, TEG (Peltier module), 2 fans which of all these are mounted on a rectangular frame to support the setup.

- Current (I) = 0.93A
- Open Circuit voltage (Vol) = 5.29V
- Seebeck (α) = 0.056V/k
- Number of PN couple(N) = 127N
- Air temperature (Tair) = 30 degree C
- Max temp (Tmax) = 100 degree C
- Electrical resistance (Re) = 3.85 Ω
- Thermal conductance (k) = 0.35 W/k
- Resistance intersection to case (Rjc) = 2.45 k/W
- Resistance case to source (Rcs) = 1 k/W
- heat stream on hot side (Qhot) = 53.1
- Temperature contrast (ΔT) = 50degree C
- Operating voltage = Greatest 100 Mvdc
- Rating = Most extreme 100 amps
- Power = Most extreme 5 watts
- Number of p-n intersections = 127
- Cooling Framework = wind cooling fan

5.5.1 PELTIER Impact CALCULATION: Calculating the warm stream on the hot side, $Q_{hot} = (Re/2 \times I^2) -$

$(\alpha \times I \times T_{\max}) - (k \times \Delta T) = (3.85/2 \times 0.93 \times 0.93) - (0.056 \times 0.93 \times 100) - (0.35 \times 50) = 20.39 \text{ degree C/W}$
 27 Now I find the Resistance surface to air $R_{sa} = ((T_{\max} - T_{air})/Q_{hot}) - R_{jc} - R_{cs} = ((100 - 30)/20.39) - 2.45 - 1 = 0.0192 \text{ degree C/W}$ Now calculate the R_{module} , $R_{module} = R_{cs} + R_{jc} + R_{sa} = 2.45 + 1 + 0.0192 = 3.46 \text{ degree C/W}$ Now using the formula for power, $P = (N \times \alpha^2 \times \Delta T^2) / (4 \times R_{module}) = (127 \times 0.003150 \times 50) / (4 \times 3.46) = 71.1 \text{ Watts}$

Temperature vs Time graph showing the heating curve in which room temperature of 35 degree Celsius rises upto 75 degree Celsius in just 15 minutes maintaining a constant rise in the temperature every 3 minutes. As it is the heating part the electrical energy produced here will just be converted into heat energy then to heat.

Temperature vs Time graph showing the cooling curve in which room temperature of 35 degree Celsius declines to 25 degree Celsius gradually in 30 minutes maintaining a constant decline in temperature of 2 degrees every 5 minutes. As it is the cooling part the electrical energy produced here gets converted into heat energy then to coldness by Peltier module.

Temperature vs Time graph showing the heating curve in which room temperature of 35 degree Celsius rises upto 75 degree Celsius in just 15 minutes maintaining a constant rise in the temperature every 3 minutes. As it is the heating part the electrical energy produced here will just be converted into heat energy then to heat.

6 SUMMARY AND CONCLUSION We would conclude that, The Air Cooler Cum Heater is a model of minimum investment providing both heating and cooling effect as required. **The easy displacement of the model can be achieved.** The utilize of renewable resources like sun oriented vitality makes a difference in keeping up eco-friendly climate. The main thing here is to notice is that the Thermoelectric Module (Peltier module) is used to produce cooling effect. This means that the food or medicinal stuff cooling is done without the use of greenhouse gases which would ultimately reduce the global warming which is usually caused by other refrigeration system. Thermoelectric cooling, also known as "The Peltier Effect", is a solid-state method of heat transfer through dissimilar semiconductor materials. **Thermoelectric cooler (TEC), or Peltier Cooler employs the Peltier impact for the trade of warm.** The present day commercial TEC comprises of a number of p- and n- sort semiconductor couples. The warm pumping course can be changed by changing the extremity of the charging DC current. Warm will be rejected through the module from inward side to the external surface. Inward module confront will be cooled whereas the external

confront is at the same time warmed. The Temperature drop at the cooling side and the rise in temperature in heating side is measuring by temperature sensor and it is displayed on LCD display.

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