BHAGALPUR COLLEGE OF ENGINEERING

(Dept. of Science & Technology, Govt. of Bihar)

[Approved by AICTE & Affiliated to AKU]

A PROJECT REPORT ON

"DESIGN OF AUTOMATIC SOLAR THERMOELECTRIC REFRIGERATOR"

A Project report submitted in partial fulfillment of the requirements for 8th semester and the award of the degree of

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

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CERTIFICATE

This is to certify that the project entitled **"DESIGN OF AUTOMATIC SOLAR THERMOELECTRIC REFRIGERATOR** has been successfully carried out by ***Saurabh Kumar (17102108027), Rohit Raj (17102108042), Ujjwal Prakash (17102108041)*** *and* ***Anand Kumar Jaiswal (17102108028)*** in partial fulfillment of the requirements for the award of degree of ***Bachelor of Technology*** in ***Mechanical Engineering Department*** of ***Bhagalpur College Of Engineering, Bhagalpur*** during the academic year 2020-2021. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in Report deposited in departmental library. This project has been approved as it satisfies the academic requirements in respect of Project study prescribed for the Bachelor of Technology Degree.

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DECLARATION

We Do hereby declare that this submission is our own work conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute and that, to the best of our knowledge and belief, it contains no material previously written by another neither person nor material (data, theoretical analysis, figures, and text) which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

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ABSTRACT

In this research article, prototype of thermoelectric refrigeration system working has been designed and fabricated. This fabricated system is working on DC voltage, which is generated by the photo voltaic cells. The developed experimental prototype is having a refrigeration space of 0.38 m^3 capacity, which is refrigerated by using four numbers of Peltier module and a heat sink fan assembly used to increase the heat dissipation rate from hot side of Peltier module. In the recent years, we have many problems such as energy crises and environment degradation due to the increasing emission of CO2 and ozone layer depletion has become the primarily concern in both the developed and developing countries. Our project utilizes the solar energy for its operation. Solar refrigeration using thermoelectric module is going to be one of the most cost effective, clean and environment friendly system. This project does not need any kind of refrigerant and mechanical device like compressor, prime mover, etc for its operation. The main purpose of this project is to provide refrigeration to the remote areas where power supply is not possible.

Nowadays microcontroller based automatic temperature (heating and cooling) control system is designed and constructed for the Refrigeration system. The main function of heating and cooling are done by thermoelectric module (i.e. Peltier Module) The Microcontroller is used as the main controller of the control system which decides the cabin temperature. It is also intended to design a control system for a home appliance simply and to maintain and upgrade easily.

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INTRODUCTION

This Project relates to produce the refrigeration effect with the use of solar energy and Peltier module. We use solar panel here to save energy and Peltier module to eliminate most of the moving parts in common refrigeration system. Generally, we see that common refrigeration system has compressor, refrigerant which required electric energy to run which is also a noisy operation. So, we use pettier module to reduce such type of problem. presented in our study that thermoelectric refrigeration emerges as alternative green refrigeration technology due to their distinct advantages as noiseless and wear less due to no moving parts, reliable, portable and compatible with Solar PV cell generated DC power, making them complete environment friendly. A detailed comparative study of vapor compression, thermoelectric and absorption refrigeration system has been conducted to compare the development cost, energy consumption, noise intensity production and COP for these three refrigeration systems. Thermoelectric cooling works on the principle of Peltier effect, when a direct current is passed between two electrically dissimilar materials heat is absorbed or liberated at the junction. The direction of the heat flow depends on the direction of applied electric current and the relative Seebeck coefficient of the two materials. A Peltier module or thermoelectric cooling module is a solid-state active heat pump which consist a number of p- and n- type semiconductor couples connected electrically in series and thermally in parallel are sandwiched between two thermally conductive and electrically insulated substrate.

PELTIER EFFECT:

The Peltier effect is the reverse phenomenon of the Seebeck effect; the electrical current flowing through the junction connecting two materials will emit or absorb heat per unit time at the junction to balance the difference in the chemical potential of the two materials. Thanks to this effect, an electronic refrigerator can be made, which is known as the Peltier cooler. The Peltier cooler has been applied to niche areas such as infrared detectors, CPU coolers, wine cellars, etc., because the cooling power is lower than that of compressor-based refrigerators. This technique is called thermoelectric, and is discussed in the next section.

In 1834, a French watchmaker and part time physicist, Jean Peltier found that an electrical current would produce a temperature gradient at the junction of two dissimilar metals. The Peltier effect is the main contributor to all thermoelectric cooling applications. It is responsible for heat removal and heat absorbance. It states that when an electric current flows across two dissimilar conductors, the junction of the conductors will either absorb or emit heat depending on the flow of the electric current. The heat absorbed or released at the junction is proportional to the input electric current. The constant of proportionality is called the Peltier coefficient.

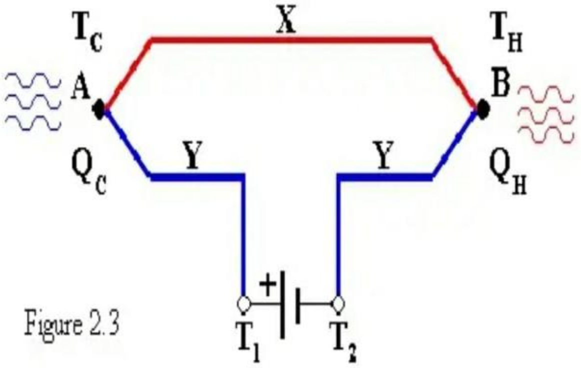
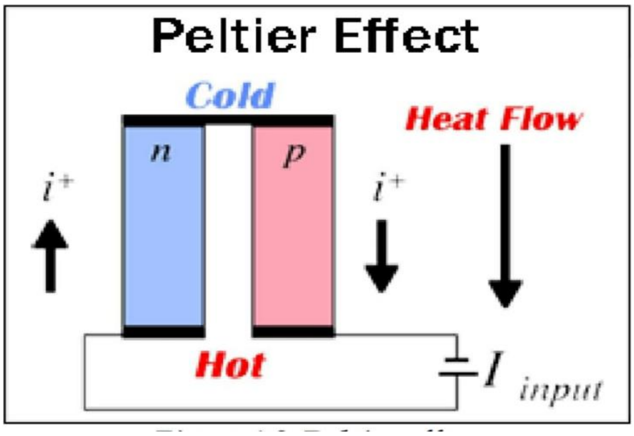
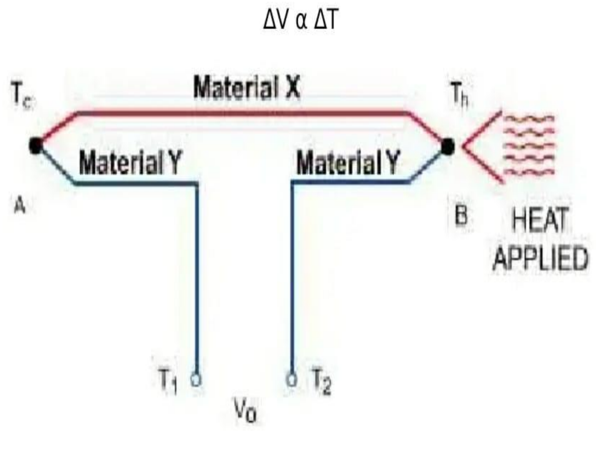


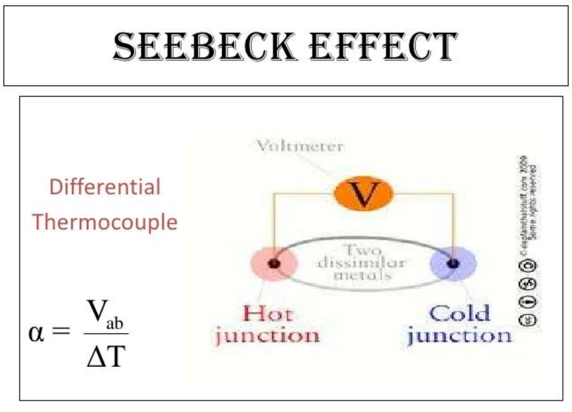
Figure 2.3



SEEBECK EFFECT:

In 1821-31 Thomas Johann Seebeck found that a circuit made from two dissimilar metals, with junctions at different temperatures would deflect a compass magnet. However, it was quickly realized that a "Thermoelectric Force" induced an electrical current, which by Ampere's law deflects the magnet. More specifically, the temperature difference produces electric potential (voltage) which can drive an electric current in a closed circuit. Today, this is known as the Seebeck effect. The Seebeck effect is a direct energy conversion of heat into a voltage potential. The Seebeck effect occurs due to the movement of charge carriers within the semiconductors. In doped n-type semiconductors, charge carriers are electrons and in doped p-type semiconductors, charge carriers are holes. Charge carriers diffuse away from the hot side of the semiconductor. This diffusion leads to a buildup of charge carriers at one end. This buildup of charge creates a voltage potential that is directly proportional to the temperature difference across the semiconductor.





NEED

Refrigerator and air conditioners are the most energy consuming home appliances and for this reason many researchers had performed work to enhance performance of the refrigeration systems. Most of the research work done so far deals with an objective of low energy consumption and refrigeration effect enhancement. Thermoelectric refrigeration is one of the techniques used for producing refrigeration effect. Thermoelectric devices are developed based on Peltier and Seebeck effect which has experienced a major advances and developments in recent years. The coefficient of performance of the thermoelectric refrigeration is less when it is used alone, hence thermoelectric refrigeration is often used with other methods of refrigeration. This paper presents a review of some work been done on the thermoelectric refrigeration over the years. Some of the research and development work carried out by different researchers on TER system has been thoroughly reviewed in this paper. The study envelopes the various applications of TER system and development of devices. This paper summarizes the advancement in thermoelectric refrigeration, thermoelectric materials, design methodologies, application in domestic appliances and performance enhancement techniques based on the literature. With recent development taking place in field of thermoelectric and nanoscience different thermoelectric material with high temperature difference to be explored this will further help to reduce the temperature, current below and can also perform better at higher ambient conditions. To improve the power retention in this thermoelectric cooler sandwich heater needs to be explored with quick switching mechanism from thermoelectric cell off state of heater to on state, so that temperature drop in thermoelectric cell can be reduced.

COMPONENTS REQUIRED

1. SOLAR PANEL
2. CHARGE CONTOLLER
3. PELTIER MODULE
4. BATTERY
5. ALUMINIUM BLOCK
6. ALUMINIUM HEAT SINK
7. RADIATOR FAN
8. MICROCONTOROLLER
9. RELAY
10. THERMOCOL BOX

DESCRIPTION

1. SOLAR PANEL:

A **solar panel,** or **photo-voltaic (PV) module**, is an assembly of photo-voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy to generate direct current electricity. A collection of PV modules is called a PV panel, and a system of PV panels is called an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

2. BATTERY:

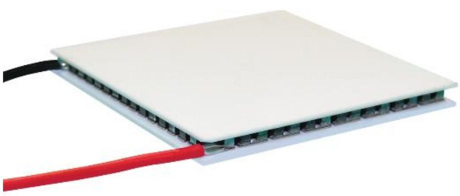
Battery, in electricity and electrochemistry, any of a class of devices that convert chemical energy directly into electrical energy. Although the term battery, in strict usage, designates an assembly of two or more galvanic cells capable of such energy conversion, it is commonly applied to a single cell of this kind.

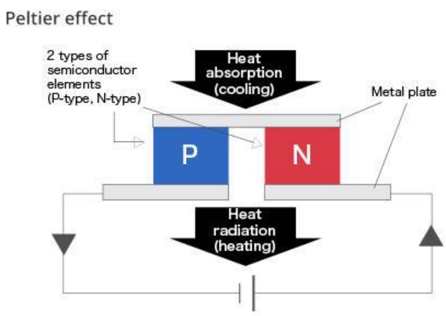
Every battery (or cell) has a cathode, or positive plate, and an anode, or negative plate. These electrodes must be separated by and are often immersed in an electrolyte that permits the passage of ions between the electrodes. The electrode materials and the electrolyte are chosen and arranged so that sufficient electromotive force (measured in volts) and electric current (measured in amperes) can be developed between the terminals of a battery to operate lights, machines, or other devices. Since an electrode contains only a limited number of units of chemical energy convertible to electrical energy, it follows that a battery of a given size has only a certain capacity to operate devices and will eventually become exhausted. The active parts of a battery are usually encased in a box with a cover system (or jacket) that keeps air outside and the electrolyte solvent inside and that provides a structure for the assembly.

3. PELTIER MODULE:

The Peltier effect is the reverse phenomenon of the Seebeck effect; the electrical current flowing through the junction connecting two materials will emit or absorb heat per unit time at the junction to balance the difference in the chemical potential of the two materials.

The **Peltier device** consists of pairs of P-type and N-type semi-conductor thermo element forming thermocouple which are connected electrically in series and thermally in parallel. The modules are considered to be highly reliable components due to their solid state construction. For most application they will provide long, trouble free service. In cooling application, an electrical current is supplied to the device, heat is pumped from one side to the other, and the result is that one side of the module becomes cold and the other side hot.





4. ALUMINIUM BLOCK

Aluminum block has a dimension of 40mm X 40mm is attached at the hot side for the liquid cooling of Peltier. This is used for the liquid cooling of the Peltier module. It contains an inlet and outlet. At the inlet is attached a pump which circulated the cooled coolant coming out from radiator and the outlet is attached to the radiator.

Figure 3: Aluminum Block

Figure 4: Aluminum Heat Sink

5. ALUMINIUM HEAT SINK

A **heat sink** is a passive heat exchanger that transfers the heat by convection from the refrigeration chamber. This is connected at the cold side of the Peltier. They cool down to a temperature of about 0 C and air passing through them gets cooled up by convection and then is transferred to the chamber which in turn helps in bringing down the temperature of the chamber. A heat sink transfers thermal energy from a higher-temperature device to a lower-temperature fluid medium. The fluid medium is frequently air, but can also be water, refrigerants or oil. If the fluid medium is water, the heat sink is frequently called a cold plate. In thermodynamics a heat sink is a heat reservoir that can absorb an arbitrary amount of heat without significantly changing temperature.

Practical heat sinks for devices must have a temperature higher than the surroundings to transfer heat by convection, radiation, and conduction.

6. RADIATOR FAN:

Fan is used for throwing heat from Peltier module to increase the efficiency of refrigeration effect. It is used because one side other than cooling side get heated which needs to be cooled down. To cool the other side the fan is uses to throw heat to the environment. Fans are used to draw cooler air into the case from the outside, expel warm air from inside and move air across a heat sink to cool a particular component. Both axial and sometimes centrifugal (blower/squirrel-cage) fans are used. Cooling fans commonly come in standard sizes, such as 120 mm (most common), 140 mm, 240 mm, and even 360 mm. fans are powered and controlled using 3-pin or 4-pin fan connectors.

7. MICROCONTOROLLER:

A microcontroller is a computer present in a single integrated circuit which is dedicated to perform one task and execute one specific application. It contains memory, programmable input/output peripherals as well a processor. Microcontrollers are mostly designed for embedded applications and are heavily used in automatically controlled electronic devices such as cell phones, cameras, microwave ovens, washing machines.

In our project we use microcontroller to feed required instruction like temperatures and as a result it process and perform the task accordingly making the refrigeration system automatic.

8. RELAY

A **relay** is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

9. THERMOCOL BOX

In this we use thermocol box as a cabin or space too be cooled. EPS features a closed cell structure and thus supports low thermal conductivity. It is highly preferred for thermal insulation. Other materials possess an open cell structure and are thus incompetent when subject to moisture. Secondly, thermocol is tasteless, odorless and fungi-resistant. It is one of the most reliable and cost-effective means to protect your goods from transit damage. It is extremely light. It can be moulded into any desired shape and is yet sufficiently rigid to absorb shocks and physical impact.

1. It is light in weight.
2. It has low thermal conductivity.
3. It is tasteless, odorless and fungi resistance.
4. Reliable.

WORKING PRINCIPLE AND METHODOLOGY

PRINCIPLE:

The **refrigeration process** of this project is based on Thermoelectric Effect When two dissimilar metals are joined together with some semi-conductor sandwiched between, and when electric current passes through these plates and temperature difference is established, i.e. one side becomes cold one side becomes hot. This thermoelectric effect is known as Peltier Effect.

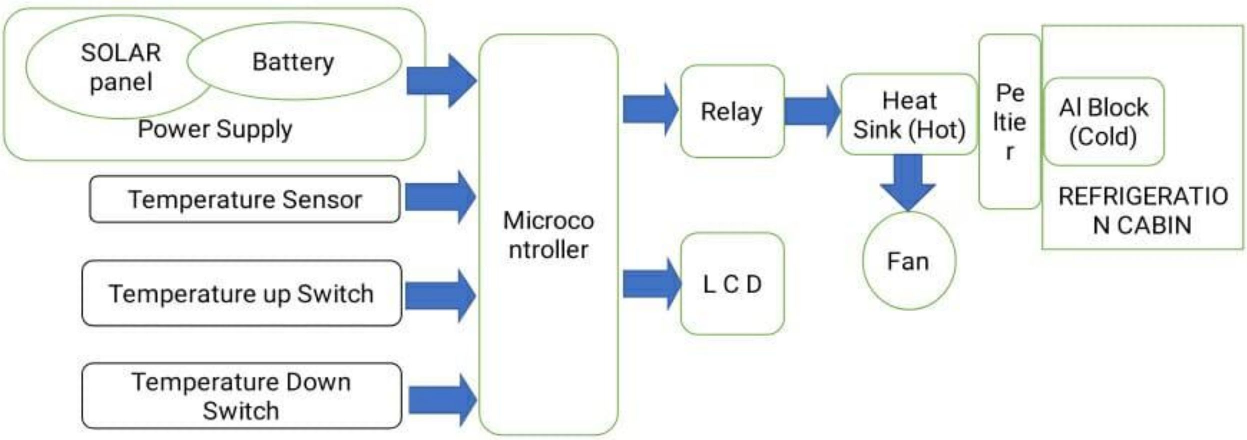
In 1834, a French watchmaker and part time physicist, Jean Peltier found that an electrical current would produce a temperature gradient at the junction of two dissimilar metals. The Peltier effect is the main contributor to all thermoelectric cooling applications. It is responsible for heat removal and heat absorbance. It states that when an electric current flow across two dissimilar conductors, the junction of the conductors will either absorb or emit heat depending on the flow of the electric current. The heat absorbed or released at the junction is proportional to the input electric current. The constant of proportionality is called the Peltier coefficient.

The automatic temperature control and power switching is done using a microcontroller and a relay switch. microcontroller, PIC16F887 is the main controller and the power source of the control system is applied from the switching mode power supply. The switching mode power supply is regulated to the 5V DC by using the relay switch. Because of the controller is needed the 5V DC. The 62x2 LCD is used to display the temperature of the system. The output of the system the thermoelectric Peltier plates are used. But the

PIC16F887 cannot control these devices directly so the relay and its driver circuits are designed to control the thermoelectric Peltier plate

WORKING METHODOLOGY:

This paper focuses on water heating and cooling using thermoelectric theory. It is easy to contrast the water dispenser and cooler. It is based on material theory of elements. The thermoelectric theory is applied to implement the module that is call Peltier module. The market has many modules but the TEC is commonly used. The module has two sides: cool and hot. The block diagram of the proposed system is as shown in figure . In this system there is two sections: software and hardware. In the hardware, the microcontroller is used as the main controller in this system. The PIC 16F887 is used in this system. And other compontes required such as temperature sensor, relay, and switch, Solar power supply and thermoelectric module. In this system operation is working as the software as user programmed.



. **The block diagram of the proposed system**

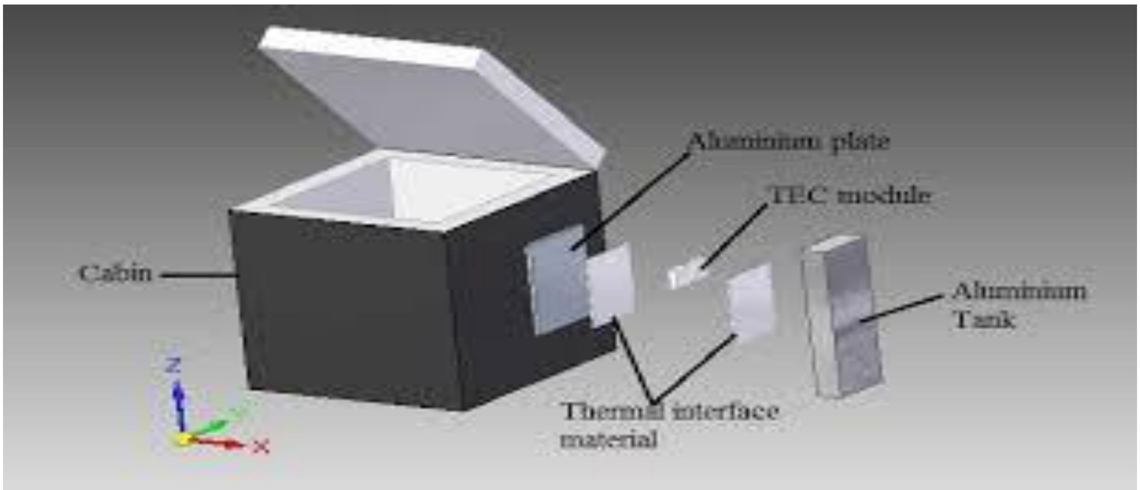
The thermoelectric devices used in thermoelectric refrigeration (or thermoelectric coolers) are based on the Peltier effect to convert electrical energy into a temperature gradient. A conventional thermoelectric cooler is composed of a number of N-type and P-type semiconductor junctions connected electrically in series by metallic interconnects (conducting strips, in general made of copper) and thermally in parallel, forming a single-stage cooler . If a low-voltage DC power source is applied to a thermoelectric cooler, heat is transferred from one side of the thermoelectric cooler to the other side. Therefore, one face of the thermoelectric cooler is cooled and the opposite face is heated.

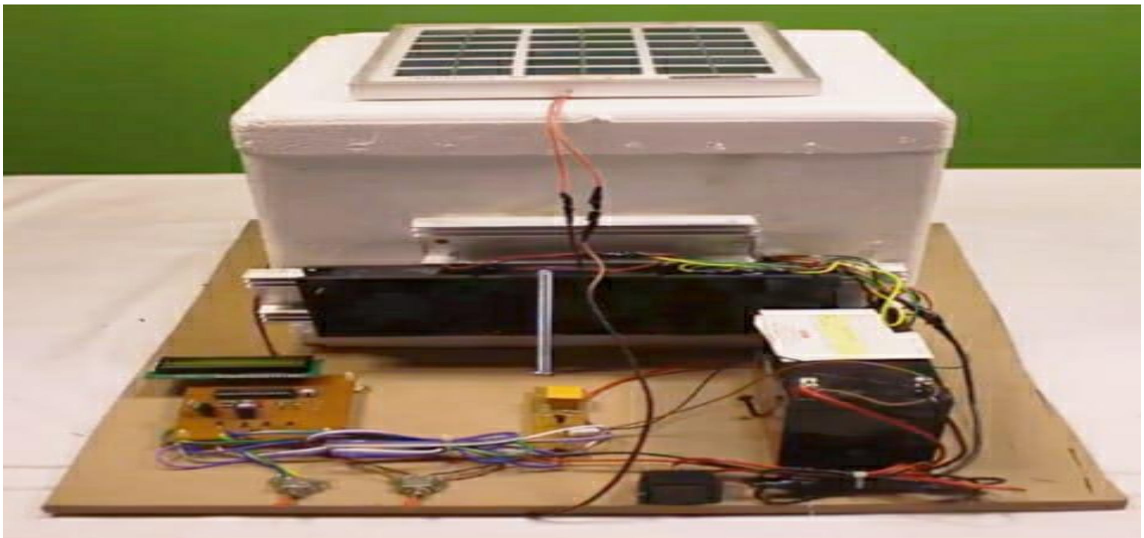
Fig. 1 depicts a thermoelectric cooling module considered as a thermoelectric refrigerator, in which the electrical current flows from the N-type element to the P-type element . The temperature of the cold junction decreases and the heat is transferred from the environment to the cold junction at a lower temperature. This process happens when the transport electrons pass from a low energy level inside the P-type element to a high energy level inside the N-type element through the cold junction. At the same time, the transport electrons carry the absorbed heat to the hot junction which is at temperature . This heat is dissipated in the heat sink, whilst the electrons return at a lower energy level in the P-type semiconductor (the Peltier effect). If there is a temperature difference between the cold junction and hot junction of N-type and P-type thermoelements, a voltage (called Seebeck voltage) directly proportional to the temperature difference is generated .

The quality of a thermoelectric cooler depends on parameters such as the electric current applied at the couple of N-type and P-type thermoelements, the temperatures of the hot and cold sides, the electrical contact resistance between the cold side and the surface of the device, the thermal and electrical conductivities of the thermoelement, and the thermal resistance of the heat sink on the hot side of the thermoelectric cooler . The number of thermoelements in a thermoelectric module mainly depends on the required cooling capacity and the maximum electric current .

The characteristics and performance of a thermoelectric refrigerator are described by parameters like the figure of merit, the cooling capacity, and the coefficient of performance . This review is specifically focused on these parameters, addressing the concepts in a different way with respect to various review papers appearing on thermoelectric cooling in the past years. Specific aspects such as thermoelectric cooling system design, experimental assessment, numerical analysis and simulation are outside the scope of this review.

The remainder of this paper is organized as follows. Section 2 presents a synthetic overview of recent review papers dedicated to aspects relevant to thermoelectric materials, applications and parameters. Section 3 recalls the basic definitions of figure of merit, cooling capacity, and coefficient of performance. It addresses some analytical formulations and experimental results referring to the thermoelectric figure of merit. Section 5 presents an assessment of the relevant concepts and literature concerning the cooling capacity. It deals with the coefficient of performance, starting from its classical expression and introducing specific formulations including the impact of the Thomson effect, the dependence on temperature of the characteristics of the materials, the effect of electrical contact resistances and thermal resistances on the , with some indications on improvement. The last section contains the concluding remarks.





FABRICATION PLAN

- First we have the thermocol box.
- Then we make section in it with equal dimension of fin to make fit in it.
- We fit the fan in box .
- We fit the Peltier module on back side of heat sink (fin).
- Place the fin ,Peltier ,and fan in the section.
- Connect all to the battery.
- Connected the circuit and make the connection of diode with solar panel and Connect battery to solar panel & then
  a) Battery to display unit
  b) Battery to Peltier module
  c) Battery to fan
  d) Battery to microcontroller and relay.
- We check the proper working of all the components and do the calculation according to it.

In this design we have fabricated a high density thermo cool chamber of 395mm height, 252mm depth and 385mm length, to the wall of the chamber is attached a Peltier of 12V 6A, an aluminum water block attached on the hot side of the Peltier, an aluminum heat sink on the cold side of the Peltier along with a delivery fan. Aluminum water block has an inlet and outlet which is connected to the radiator through delivery pipes. Through the delivery pipes flows the coolant which is used to dissipate the heat from the aluminum block which is due to the hot side of the Peltier. The delivery pipes are connected to the inlet and outlet of a radiator, the work of the radiator is to dissipate the heat into the atmosphere from the coolant. The outlet of the radiator consists of circulating pump which facilitates the flow of the coolant to the aluminum block. The power supply to the Peltier is provided by the Switched Mode Power Supply (SMPS) which helps in regulating the input voltage to the Peltier. Automatic thermostat with a digital indicator is used to indicate the temperature inside the chamber and that of the heat sink too. When the setup is supplied with AC supply the SMPS regulates the voltage that is to be supplied to the Peltier, when the current is supplied one side of the Peltier turns hot and one side cold due to thermoelectric effect. To the cold side of the Peltier is connected an aluminum heat sink to which a circulation fan is connected which supplies the cold air throughout the chamber and cools the chamber due to convection.

$$
\begin{aligned}
\text{Area of Chamber} &= L \times B \times H \\
&= 385 \text{ mm} \times 252 \text{ mm} \times 395 \text{ mm.} \\
&= 0.385 \text{ m} \times 0.252 \text{ m} \times 0.395 \text{ m} \\
&= 0.038 \text{ m3}
\end{aligned}
$$

EXPERIMENTAL PROCEDURE

The automatic thermostat records the temperature of the chamber and automatically cuts off the Peltier if the temperature exceeds or goes below the desired temperature. Temperature of the heat sink is recorded with a thermometer. Temperature of the chamber, coolant and heat sink is recorded at an interval of fifteen minutes.

Temperature of the Surface of the Peltier Device When the Load is applied on the Setup

LOAD	HOT SIDE	COLD SIDE
OFF	AT ROOM TEMP.	AT ROOM TEMP
ON	54°C(327K)	-16°C(256K)

Case 1:

In this case the circulating fan is switched on and the temperature is recorded The temperature in chamber reaches up to 13°C and that of the heat sink up to -2°C.

Air Circulation Fan is ON

S.NO.	Time (min)	Heat sink temperature	Chamber temperature	Coolant temperature
1	0	32	32	32
2	15	2	23	34
3	30	0	18	35
4	45	-1	16	37
5	60	-1	15	36
6	75	-2	14	37
7	90	-2	13	37

Reference: International Journal of Mechanical Engineering (IJME) ISSN(P): 2319-2240; ISSN(E): 2319-2259 Vol. 5, Issue 4, Jun – Jul 2016; 85-92

Case 2:

In the second setup the circulating fan is switched off and the temperature is recorded. The temperature in chamber reaches upto 16°C and that of the heat sink up to -3°C.

Air Circulation Fan is OFF

S.NO.	Time (min)	Heat sink temperature	Chamber temperature	Coolant temperature
1	0	32	32	30
2	15	08	26	34
3	30	02	22	35.5
4	45	01	19	36.6
5	60	00	17	37
6	75	-01	16	37
7	90	-03	16	38

Reference: International Journal of Mechanical Engineering (IJME) ISSN(P): 2319-2240; ISSN(E): 2319-2259 Vol. 5, Issue 4, Jun – Jul 2016; 85-92

PERFORFORMANCE:

Peltier (thermoelectric) performance is a function of ambient temperature, hot and cold side heat exchanger (heat sink) performance, thermal load, Peltier module (thermopile) geometry, and Peltier electrical parameters.The amount of heat that can be moved is proportional to the current and time. Q= PIt where P is the Peltier coefficient, I is the current, and t is the time. The Peltier coefficient depends on temperature and the materials the cooler is made of. Magnitude of 10 watt per ampere are common, but this is offset by two phenomena:

According to Ohm's law, a Peltier module will produce waste heat itself,

$\mathbf{Q_{waste} = RI^2t}$ **,** where R is the resistance.

Heat will also move from the hot side to the cool side by thermal conduction inside the module itself, an effect which grows stronger as the temperature difference grows.

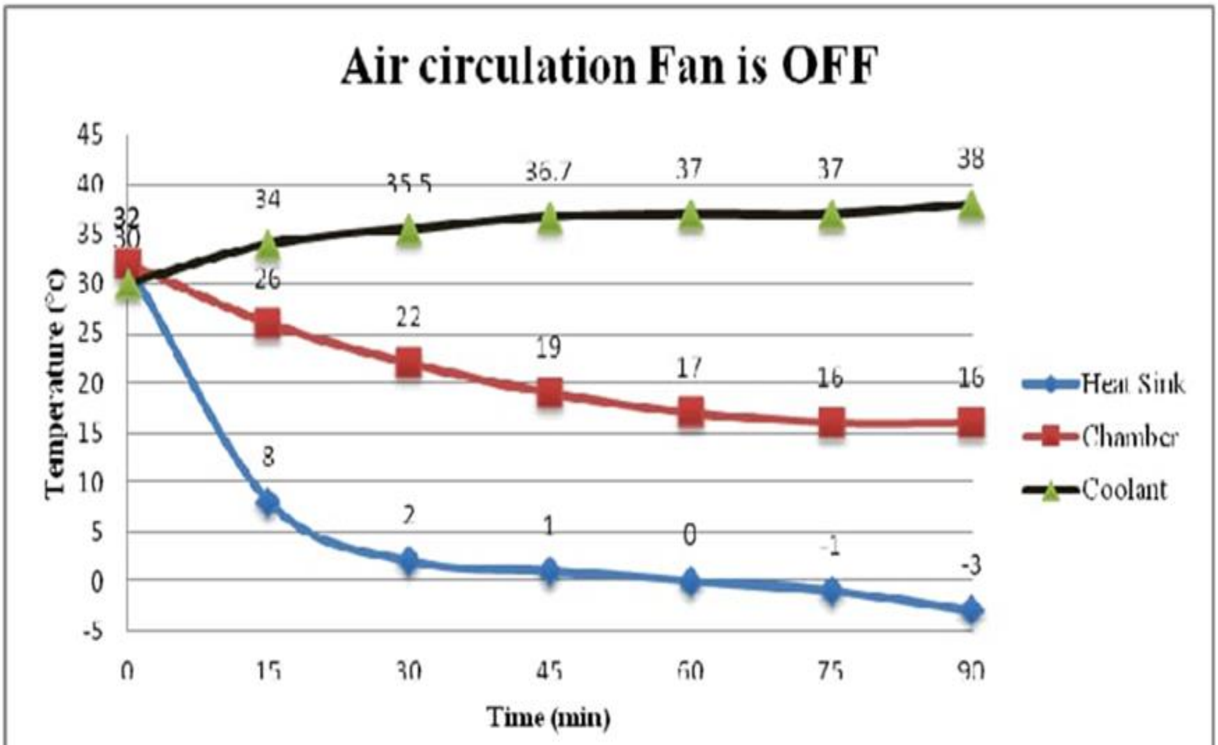
The result is that the heat effectively moved drops as the temperature difference grows, and the module becomes less efficient. There comes a temperature difference when the waste heat and heat moving back overcomes the moved heat, and the module starts to heat the cool side instead of cooling it further. A single-stage thermoelectric cooler will typically produce a maximal temperature difference of 70 °C between its hot and cold sides. Another issue with performance is a direct consequence of one of their advantages: being small. This means that the hot side and the cool side will be very close to each other (a few millimeters away), making it easier for the heat to go back to the cool side, and harder to insulate the hot and cool side from each other a common 40 mm x 40 mm can generate 60 W or more, that is, 4 W/cm2 or more, requiring powerful radiator to move the heat way.

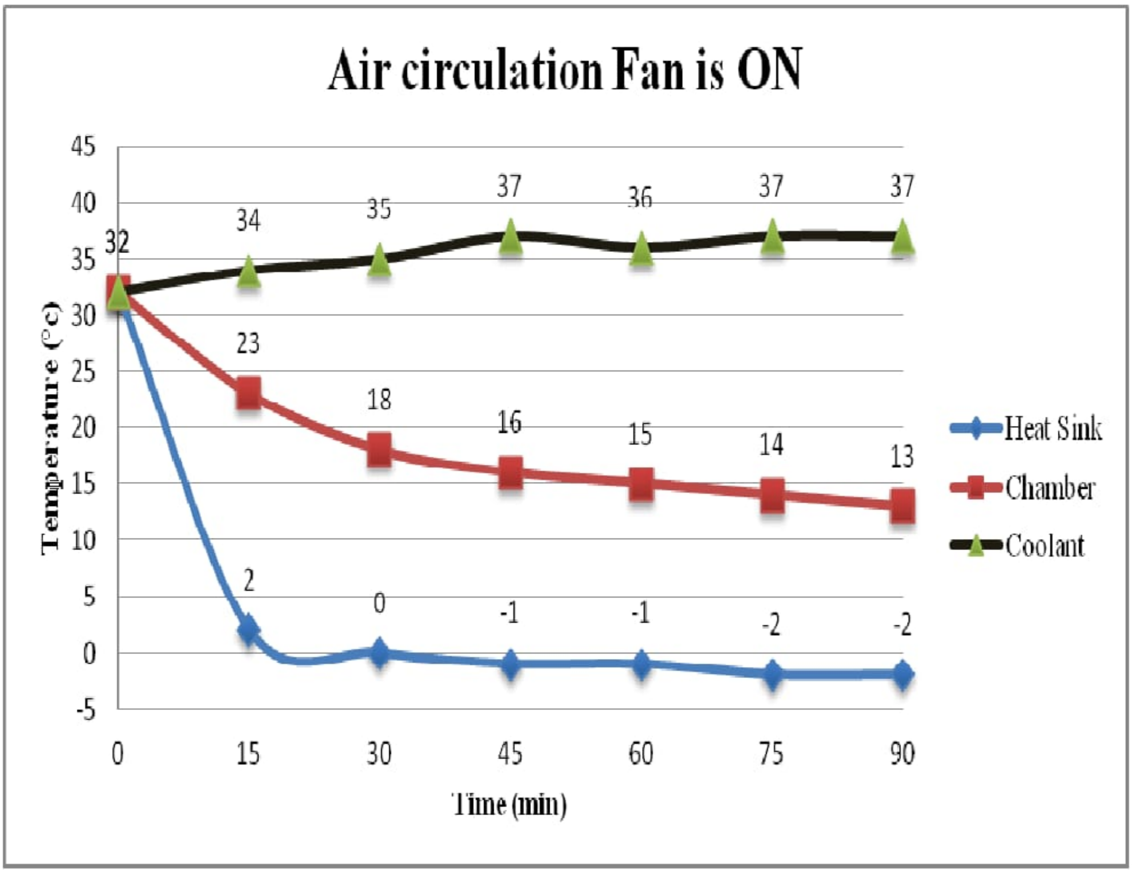
In refrigeration applications, thermoelectric junctions have about 1/4 the efficiency (COP) compared to conventional (vapor compression refrigeration) means: they offer around 10–15% efficiency of the ideal Carnot cycle refrigerator, compared with 40–60% achieved by conventional compression-cycle systems (reverse Rankine systems using compression/expansion). Due to this lower efficiency, thermoelectric cooling is generally only used in environments where the solid-state nature (no moving parts), low maintenance, compact size, and orientation insensitivity outweighs pure efficiency. While lower than conventional means, efficiency can be good enough provided temperature difference is kept as small as possible, and, the current is kept low, because the ratio of moved heat over waste heat (for same temperature on the hot and cool side) will be low.
However, since the low current also means low amount of moved heat, for all practical purpose coefficient of performance will be low.

RESULT AND DISCUSSION

The graph of fan ON condition shows that the chamber temperature reaches upto 13°C and that of the heat sink upto -2°C. Chamber temperature can be maintained constant after 90 minutes of continuous working of the TERS while coolant and heat sink temperature reduce very slightly after 30 minutes of continuous working of the TERS.

In fan OFF condition temperature reduces to 16°C from 32°C in chamber and heat sink temperature drops from 32°C to -3°C and coolant temperature rises 38°C from 32°C. Chamber and Coolant chamber reduces very negligible after 1 hour while heat sink temperature reduces very negligible after 30 minutes of continuous working of the TERS. Temperature reductions also depend upon the atmospheric conditions or outside temperature of the chamber.





ADVANTAGES:

- Light weight and compact for very small heat loads.
- No moving parts, eliminating vibration, noise, and problems of wear.
- Reversing the direction of current transforms the cooling unit into a heater.
- Operates in any orientation. Not affected by gravity or vibration
- Very low cost device for cooling in small appliances.
- Precision temperature control capability
- High reliability
- Eco-friendly C-pentane, CFC free insulation.
- Auto power cut at desired temperature

APPLICATION:

Thermoelectric coolers are used for applications that require heat removal ranging from milliwatts to several thousand watts. They can be made for applications as small as a beverage cooler or as large as a submarine or railroad car. TEC elements have limited life time. Their health strength can be measured by the change of their AC resistance (ACR). As a cooler element wears out, the ACR will increase.[citation needed]

Consumer products

Peltier elements are commonly used in consumer products. For example, they are used in camping, portable coolers, cooling electronic components and small instruments. They can also be used to extract water from the air in dehumidifiers. A camping/car type electric cooler can typically reduce the temperature by up to 20 °C (36 °F) below the ambient temperature, which is 25 °C if the car reaches 45 °C under the sun. Climate-controlled jackets are beginning to use Peltier elements. Thermoelectric coolers are used to augment heat sinks for microprocessors.

Industrial

Thermoelectric coolers are used in many fields of industrial manufacturing and require a thorough performance analysis as they face the test of running thousands of cycles before these industrial products are launched to the market. Some of the applications include laser equipment, thermoelectric air conditioners or coolers, industrial electronics and telecommunications, automotive, mini refrigerators or incubators, military cabinets, IT enclosures, and more.

Science and imaging

Peltier elements are used in scientific devices. They are a common component in thermal cyclers, used for the synthesis of DNA by polymerase chain reaction (PCR), a common molecular biological technique, which requires the rapid heating and cooling of the reaction mixture for denaturation primer annealing and enzymatic synthesis cycles. With feedback circuitry, Peltier elements can be used to implement highly stable temperature controllers that keep desired temperature within ±0.01 °C. Such stability may be used in precise laser applications to avoid laser wavelength drifting as environment temperature changes.

The effect is used in satellites and spacecraft to reduce temperature differences caused by direct sunlight on one side of a craft by dissipating the heat over the cold shaded side, where it is dissipated as thermal radiation to space. Since 1961, some unmanned spacecraft (including the Curiosity Mars rover) utilize radioisotope thermoelectric generators (RTGs) that convert thermal energy into electrical energy using the Seebeck effect. The devices can last several decades, as they are fueled by the decay of high-energy radioactive materials.

Peltier elements are also used to make cloud chambers to visualize ionizing radiation. Just by passing an electric current, they can cool vapors below -26 °C without dry ice or moving parts, making cloud chambers easy to make and use. Photon detectors such as CCDs in astronomical telescopes, spectrometers, or very high-end digital cameras are often cooled by Peltier elements. This reduces dark counts due to thermal noise. A dark count occurs when a pixel registers an electron caused by thermal fluctuation rather than a photon. On digital photos taken at low light these occur as speckles (or "pixel noise").

Thermoelectric coolers can be used to cool computer components to keep temperatures within design limits or to maintain stable functioning when overclocking.

ADVANTAGES & LIMITATIONS

ADVANTAGES:

A significant benefit of TEC systems is that they have no moving parts. This lack of mechanical wear and reduced instances of failure due to fatigue and fracture from mechanical vibration and stress increases the lifespan of the system and lowers the maintenance requirements. Current technologies show the mean time between failures (MTBF) to exceed 100,000 hours at ambient temperatures.

The fact that TEC systems are current-controlled leads to another series of benefits. Because the flow of heat is directly proportional to the applied DC current, heat may be added or removed with accurate control of the direction and amount of electrical current. In contrast to methods that use resistive heating or cooling methods that involve gasses, TEC allows for an equal degree of control over the flow of heat (both in and out of a system under control). Because of this precise bidirectional heat flow control, temperatures of controlled systems can be precise to fractions of a degree, often reaching precision of milli Kelvin (mK) in laboratory settings. TEC devices are also more flexible in shape than their more traditional counterparts. They can be used in environments with less space or more severe conditions than a conventional refrigerator. The ability to tailor their geometry allows for the delivery of precise cooling to very small areas. These factors make them a common choice in scientific and engineering applications with demanding requirements where cost and absolute energy efficiency are not primary concerns. Another benefit of TEC is that it does not use refrigerants in its operation. Prior to their phaseout some early refrigerants, such as chlorofluorocarbons (CFCs), contributed significantly to ozone depletion. Many refrigerants used today also have significant environmental impact with global warming potential or carry other safety risks with them.

LIMITATION:

- Limited to very small refrigeration volume.
- Compared to conventional refrigerators cooling achieved is less.
- Heat sinks required to conduct heat to and from the thermoelectric modules become very heavy and bulky as the
- refrigeration capacity increases.
- C.O.P. is less as compared to conventional refrigeration

CONCLUSION

A Thermoelectric refrigeration system (TERS) was designed and built which can be used for personal and industrial refrigeration purposes. It can also be used very effectively in car for cooling and warming purpose just by changing the polarity. One Peltier was used for achieving the cooling with a DC power supply through external power supply (SMPS). It had been shown from testing results that the refrigeration system is capable of cooling the air inside the chamber with the help of heat sink and air delivery fan working combined or heat sink working individually. TERS with fan ON condition is more capable of cooling the air inside the chamber as it reduces the temperature from 32°C to 13°C.Cooling stabilizes within one hour once the air delivery fan is turned ON (with an rpm of 200). The system can establish the set target temperature range that is 10°C-15°C. The prototype can be made more effective by using multiple TECs or by using a copper heat sink instead of an aluminum one. This refrigeration system can be used as more effectively as an air conditioning system for cooling automobiles (cars) by using multiple TECs and higher rpm fan or blower. Radiator of car can be used to cool the hot side thus by eliminating the cost of the mode.

This project work explores the construction of a home appliance and the systematic approach of temperature control system design using the thermoelectric module. Microcontroller PIC16F887 is used as the main controller of the control system. It is also intended to design a control system of a home appliance using thermoelectric module (i.e. Peltier) easily.

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