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Thermo Electric Refrigerator Using Peltier Effect

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ABSTRACT
Aim of the project is to reduce the usage of electricity and minimization of carbon dioxide evaporation compare with normal refrigerator. Thermoelectric refrigeration is done with the Peltier effect setup. As we know that refrigerator and air conditioners are the most energy consuming home appliances and due to this many researchers had come up with plenty of research in this field to overcome these issues, so we have come up with thermoelectric refrigerator as an advancement in this field. It has resolved the problems of power consumption, cooling performance, vibrations and maintenance. It has been proved to be one of the finest advancements in this scenario, which has overcome the above-mentioned issue, in this project, battery, is connected to the Peltier and followed with the fin which is inside the aluminium box.

Keywords: Refrigeration, Thermo-electrical system, Peltier effect

I. INTRODUCTION

In the field of military and medical science there are refrigerators used to cool samples or specimens for preservation. They include refrigeration units for storing blood plasma and other blood products, as well as vaccines and other medical or pharmaceutical supplies.They differ from standard refrigerators used in homes or restaurant because they need to be very hygienic and completely reliable. However, in case of transportation of component from one place to another place there is no refrigeration system.Due to such problem, portable refrigeration system is to be used. Thermoelectric refrigeration is new alternative because it can convert waste electricity into useful cooling, is expected to play an important role in meeting today fossil energy challenges.

Therefore, thermoelectric refrigeration is greatly needed, particularly for developing countries where long life and low maintenance are needed.As per globally increasing demand for refrigeration, food preservations, vaccine storage, air conditioning of thespace, medical services, cooling of electronic device led consumption of more electricity and ultimately morerelease of CO2 in the environment causing global warming.

1.1 Definition

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junctions of two different types of materials. They can be used either for heating or for cooling (refrigeration), although in practice the main application is cooling. Thermoelectric cooler (TEC). Many researchers and companies are trying to develop Peltier coolers that are both cheap and efficient.

1.2 Basic Principles of Thermoelectric Modules

Thermoelectricity is based upon following basic principles:

1. Seebeck Effect
2. Peltier Effect
3. Thomson Effect

1.21 Seebeck effect

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances.

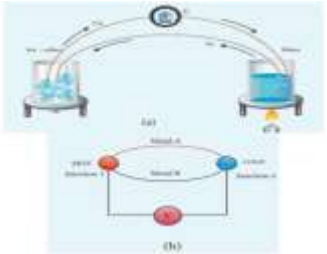

Fig 1.1: Seebeck effect

1.22 Peltier effect

The Peltier effect is the phenomenon that a potential difference applied across a thermocouple causes a

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temperature difference between the junctions of the different materials in the thermocouple.

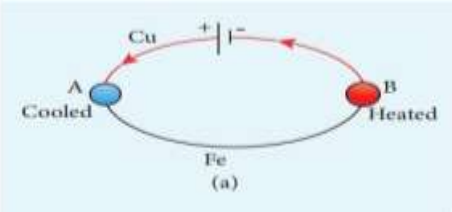

Fig 1.2(a): Schematic diagram of peltier effect

1.23 Thomson effect

It states when an electric current is passed through a conductor having a temperature gradient over its length, heat will be either absorbed by or expelled from the conductor.

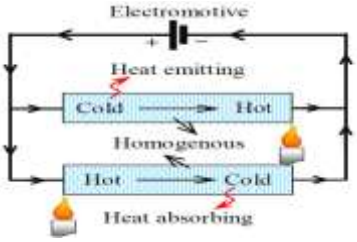

Fig 1.3: Thomson effect

1.3 Working principal

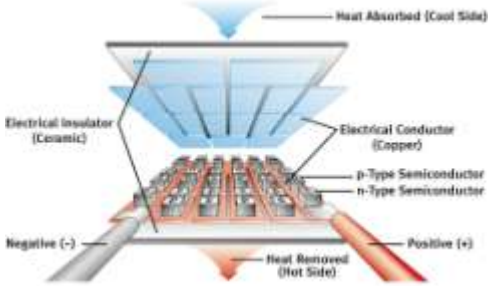

Fig 1.4: Thermoelectric module

A typical thermoelectric module is composed of two ceramic substance that serve as a foundation and electrical insulation for P-type and N-type Bismuth Telluride dice that are connected electrically in series and thermally in parallel between the ceramics

II. LITERATURE SURVEY

1. Harvind Yadav Durgesh Srivastav, Gaurav Kumar, Amit Kumar Yadav, Akshay Goswami, (March-April 2019)

The researchers carried out the work on thermoelectric refrigerators with multiple modules. They concluded that thermoelectric refrigerators are compact and consumes less Energy Which use of renewable energy resources such as solar, tidal, wind power, medical uses etc.

2. Dr.S.SreenathReddy, G. Naveen Kumar, K. Sridhar, M. Sai Siri (April2019)

The researchers carried out the work on design and fabrication of thermoelectric refrigerator using germanium and its alloys. They concluded that thermoelectric refrigerator with interior Cooling volume of 0.0258 m^3 which is far better in comparison to conventional refrigerator.

3. Prof. Rajendra. P. Patil, Pradyumna Suryawanshi, AkshayPawar, AvdhootPawar(May 2017)

The researches emphasize that the TER system is a novel refrigeration system which will be a better alternative for conventionalrefrigeration system.

4. Meghali Gaikwad, DhanashriShevade, Abhijit Kadam and Bhandwalkar Shubham (March 2016)

The researchers carried out the work on the development of thermoelectric R & AC system. They compared the cost and efficiency of vapour compression, thermoelectric absorption refrigerator.

5. Darshan Suryawanshi, Vaibhav Pokale, Nikhil Pokharkar, AkshayWalgude, Prashant Patunkar(March 2016)

After referring study of thermoelectric refrigeration, it covered domestic and commercial solid-state heating ventilating and air cooling would become possible with the help of thermoelectric material.

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III. METHODOLOGY

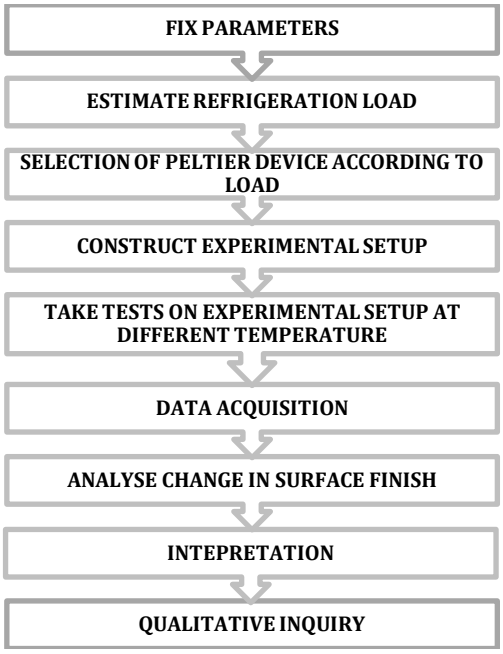

Fig 3.1: Flow diagram of methodology

3.1 Objectives

- To reduce the CO2 emission.
- To produce noiseless operation.
- To preserve the cooling product.
- Maximum cooling with minimum power consumption and thus enhancing its efficiency.
- It also requires less maintenance and has a low running cost
- Pollutants free behaviour.

IV. EXPERIMENTAL SET-UP

4.1 FABRICATION

Components used in fabrication of this project are:

1. Peltier Module.
2. CPU Heat Sinks.
3. Cooling fans.
4. 12V DC battery.
5. Thermocol box.

1. Peltier Device: These are the devices used for cooling below the ambient temperature at a specific temperature by controlled cooling/heating. It works on the phenomenon of Peltier effect. This device uses electric al energy for transferring heat from the other side.

Fig 4.1: Peltier Device

Specifications of Peltier module

Model number : TEC1-12706
Voltage : 12V, U max (V): 15.4V
IMAX (A) : 6A, Q Max (W): 92W
Internal resistance: 1.98 Ohm +/- 10%
Power Cord: 150mm, HS Code: 854150
Type: Cooling Cells
Usage: Refrigerator/Warmer
Dimensions: 40*40*3.9mm.

2. Heat Sink: It transfers the heat generated by the electronic/mechanical device to the fluid medium from where the heat is dissipated out of the system.

Fig 4.2: Heat Sink

3. DC Fan: This device is used to create a flow within the fluid. It operates using battery or some other power source.

Fig 4.3: DC Fan

Specifications of Cooling fan and unit

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Minimum speed : 1000RPM
Moderate speed : 1500RPM,
Maximum speed : 1900RPM
Dimensions :
122.5*116*80.6mm.

4. 12V DC Battery: It is a device which converts chemical energy into electrical energy with the help of a chemical reaction.

Fig 4.4: DC Battery

Specifications of DC Battery
Source :12 volts DC power unit
Module :12 volts
Fans : 7 amps
Temperature indicator : 12 volts
Minimum power : 12 volts at 6 amps.
Rated supply :12volts 10 amps.

4.2 ANALYSIS OF PELTIER MODULE
Geometric Characteristics

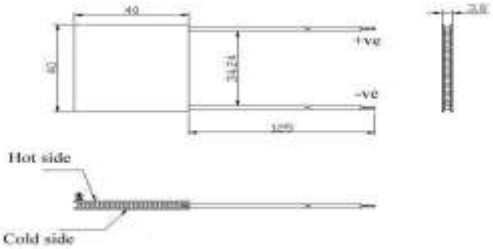

Fig 4.2.1: Geometric Characteristics of Peltier module TEC1-12706

Naming of the Module:
The Peltier module used in this project is TEC1-12706.

V. RESULT AND DISCUSSION

To increase C.O.P. there is lot of scope for developing material especially suitable for cooling purpose. Graph 5.1 shows that the temperature of the cold junction was decrease as increase the time. The result on the material TEC12706was better than remaining TEC 12710 and TEC 12703.

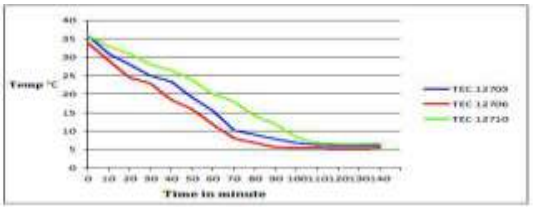

Fig 5.1: Variation of Temperature with Time

Graph 5.2 shows that in the Peltier cooler the input current is increases the cold junction temperature was decrease. The result obtained on input current and COP as follow. The maximum COP obtained for material TEC 12706 as compared to material TEC12710and TEC 12710 at given current input.

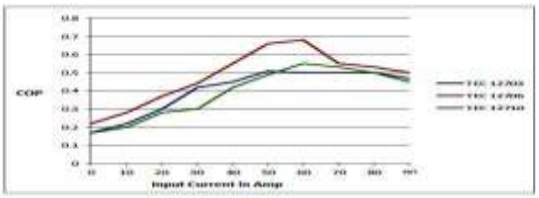

Fig 5.2: Variation of Cold Junction Temperature with Input Current (Voltage)

As the material TEC 12706 shows good result hence further improve performance of portable refrigerator multistage of TEC 12706 can be done. In multistage the result was taken in two way first was using two modules and second is using combination of three modules

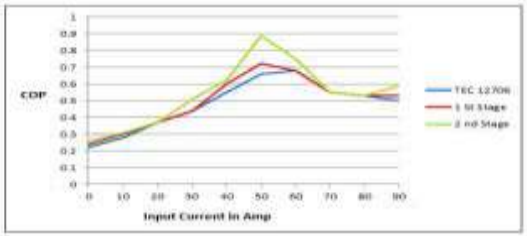

Fig 5.3: Variation of cop with staging

The result obtained on the temperature and time scale is as follow in Graph 5.4 formultistage the portable refrigerator usingTEC 12706 modules.

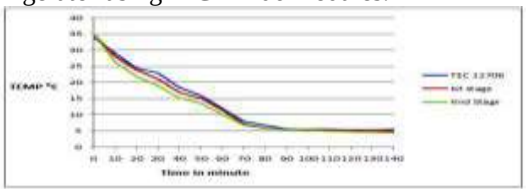

Fig 5.4: Variation of temperature with time

VI. CONCLUSION

Various ways of improving the coefficient of performance (COP) of the thermoelectric refrigeration system. Using this thermo electrical refrigeration method temperature was controllable changing the input voltage or current. The COP among three materials Bismuth telluride, Lead telluride and silicon Alumina experimentally it is found that bismuth telluride have better performance over other two.

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