

SOLAR POWERED PORTABLE THERMOELECTRIC REFRIGERATION SYSTEM FOR RURAL AREAS

Pranav G. Mandhare*¹, Pravin P. Sawwalakhe*², Pravin P. Badwaik*³, Pallavi V.
Kshirsagar*⁴, Harsh D. Rahandale*⁵, Prashant S. Bhivankar*⁶, Samir C. Meshram*⁷,
Lalina R. Goswami*⁸

*^{1,2,3,4,5,6,7}Student, Electrical Engineering, MPCOE, Bhandara, Maharashtra, India.

*⁸Assistant Professor, Electrical Engineering, MPCOE, Bhandara, Maharashtra, India.

ABSTRACT

Increasing global demand for refrigeration in the fields of air conditioning, food preservation, medical services, vaccine storage, and temperature control of electronic components increases electricity production and consequently increases atmospheric CO₂ concentrations, resulting in global warming and many climate changes. Thermoelectric refrigeration is a new alternative to reducing power consumption for cooling effects and solving today's energy challenges. Therefore, the demand for thermoelectric cooling in developing countries where long lifespan and low maintenance is required is very high. The purpose of this study is to develop a working thermoelectric refrigerator for internal cooling of 5 liters that uses the cooling Peltier effect to maintain the temperature in a selected range between 5°C and 25°C. The design of the cooling chamber includes a thermoelectric module (TEM) that acts on the Peltier effect and cools the juicer to nearly 18°C. Solar panels have the added benefit of providing energy. The design and manufacture of solar thermoelectric coolers for demanding applications is presented.

Keywords: Solar Energy, Thermoelectric Generator, Heat Sink, Refrigeration Unit Etc.

I. INTRODUCTION

As the demand for refrigeration in various fields increases and the electricity production increases, the emission of harmful gases such as CO₂ is increasing worldwide, which is causing global warming and climate change. Thermoelectric cooling is a new alternative method. Thermoelectric modules are made of semiconductor materials that are electrically connected in series and thermally connected in parallel to create a cold and hot surface. Although less efficient than vapor compression systems, they are very light, inexpensive, quiet in operation and environmentally friendly.

Traditional refrigeration systems in use today require a refrigerant that undergoes a phase change through heat exchange and a compressor that compresses the refrigerant. The compressor required more power and space. Refrigerants are also not environmentally friendly, increase global warming and are a major cause of ozone layer depletion.

The eco-friendly mini refrigerator is cooled by using a thermoelectric element called a Peltier element based on the PELTIER EFFECT. MEFR refrigerators do not require a compressor or refrigerant. Semiconductor thermoelectric coolers with temperature control ($\pm 0.1^\circ\text{C}$) (also called Peltier coolers) can be achieved with Peltier coolers. However, the efficiency is low compared to conventional refrigerators. It is therefore used in niche applications where the inherent advantages outweigh the low performance. Although some large-scale applications (submarines and watercraft) have been considered, Peltier coolers are generally used for applications that require small size and do not have too large cooling requirements, such as cooling electronic components.

The main aim of this project is to develop a portable thermoelectric cooling system capable of maintaining vaccine temperatures between 8°C and 13°C. The main system consisted of a thermoelectric module as a cooling generator with an isolated cabin, battery and charger. Thermoelectric elements perform the same cooling function as vapor compression or absorption refrigerators based on Freon. Several criteria must be met to ensure the success of this project, such as portability, system size, and cost. The conservation design is based on the principle of a thermoelectric module (ie the Peltier effect) to create a hot side and a cold side. The cold side of the thermoelectric module is used for cooling. Make sure the vaccine chamber is cool.

II. PROBLEM FORMULATION

The system is designed for use in residential homes, offices, small vendors, and more. to provide a low-energy alternative to expensive and energy-intensive mobile solar refrigeration system refrigerators. The system was designed with size in mind. The inner chamber uses thermoelectric modules to cool the internal environment. Thermoelectric modules (TEMs) work based on the Peltier effect, where a temperature difference is created across the module when an electric current is applied. Heat is absorbed by the surface on the cold side and removed on the hot side of the module. TEMs have been used as an alternative to compressors and condensers because they are low-maintenance and solid-state, making them applicable to small-scale cooling. After the cold chamber has cooled, the user can discharge the chamber to reach the cold filter environment of the portable machine, measured through the temperature sensor.

III. OBJECTIVE

The main objective of our project was to design and analyze a unique energy source (i.e. solar) heating and cooling system using a model- Thermoelectric heaters work on the principle of the Peltier effect. It will be a suitable and affordable system for people living in remote parts of India where load balancing is an important issue.

- Research on air conditioning based on efficiency, economy and application.
- Fabrication of machines using solar energy
- Construction of parts for processing mobile refrigeration machines.
- Air conditioner cost analysis.
- Environmentally friendly prevents ozone layer depletion.

IV. LITERATURE SURVEY

- Mayank Awasthi, et.al. October 2012, the goal of the project is to realize long-term cooling in the event of a power failure of the refrigerator. The TER cooling system has been designed and developed to provide active cooling using a single stage 12V TE module used to provide adequate cooling. Initially, the cooling load calculations for this TER compartment under study were presented. Laboratory simulation tests confirmed the theoretical design parameters and established the feasibility of providing cooling with the tested single-stage thermoelectric cooler in a climate chamber.
- Antoine Varghese, et. In April 2016 We designed a system that met the stated goals. However, we are aware of the limitations of this system. The current design can only be used for a light thermal load to lower its temperature to a specific temperature. The system cannot handle load fluctuations. Significant changes must be incorporated before it can be released for effective use in the field. This is one of the favorable projects using low power to control the refrigerator. This project work has given us a great opportunity and experience to use our limited knowledge.
- Uttam Kumar Chaudhary, et al. April 2018, From this project, we can conclude that no compressor is needed and refrigerant can still cool the system. There are several types of coolers available to remove heat from industrial enclosures as well as medical enclosures, but as technology advances, thermoelectric cooling is emerging as a really viable method that can be convenient. beneficial in handling a number of small to medium sized applications. As the efficiency and effectiveness of thermoelectric cooling steadily increases, the benefits it offers, including a self-contained, solid-state construction that eliminates the need for refrigerant or connection to a power supply chilled water, greater flexibility and lower maintenance costs thanks to greater reliability, will also increase. it can be used in ambulance to store medical equipment can be used in remote areas to store medicine etc.

V. CONCEPT AND METHODOLOGY

A. Block Diagram

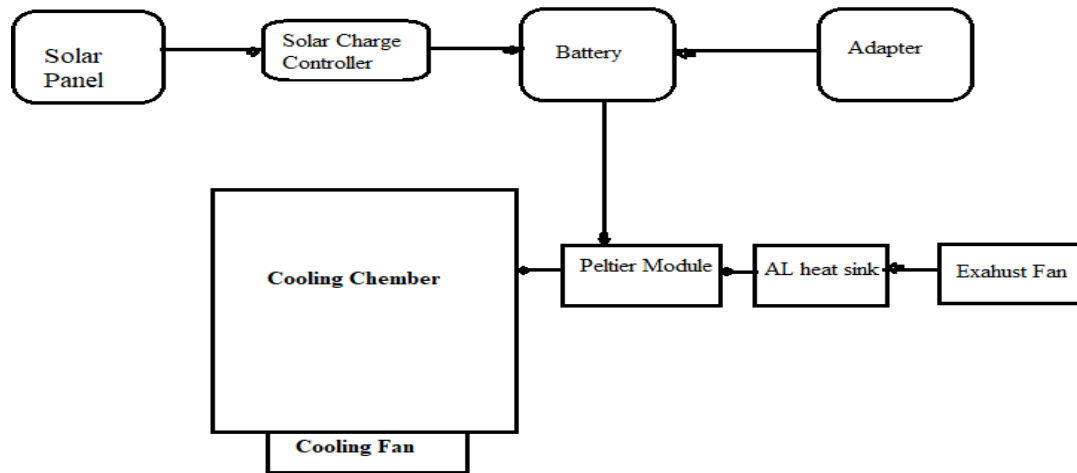


Figure. 1 Block Diagram of system

B. Working of System

- Renewable energy sources such as solar energy are used in this project. 12v 10w solar panel used to extract solar energy and convert it into electrical energy.
- This electrical energy is stored in a 12v, 8 Amp battery. The entire system works with this stored energy.
- An external power source also adds benefits for emergency situations when their batteries are nearing the minimum available.
- The control unit also allows each function to be activated. When the product is installed in the cooling chamber unit. Try to close the door in front of the cabin. The entire cabin is insulated with an aluminum sheet, in order to maintain and distribute the cooling temperature throughout the cabin/chamber.
- Refers to the temperature inside the container. The thermoelectric unit (in block aluminum, aluminum sink and exhaust fan) is covered on both sides of the tank. And try to cool the internal temperature. A high-speed fan is also added to the interior of the tank for more efficient operation.
- The Total 2 thermoelectric system is used to cover approx. 2 liter chamber capacity. Inside this compartment, a high-speed fan with LED lights gives a proper refrigerator feel. Outside the chamber is located a temperature sensor to measure the cooling chamber temperature.

This type of portable solar powered chillier brings more benefits to the poor in India.

VI. SCOPE

Real-time modeling that replaces both air conditioners and room heaters in one system, i.e. hot and cold room electric thermostats.

We believe that thermoelectric cooling offers several advantages over traditional refrigeration methods, such as:

- System with no moving parts,
- Requires no liquid or gas Freon or other liquid or gaseous refrigerant,
- Precise temperature control,
- High reliability and durability We 5 year lifetime guarantee. Trouble-free hours,
- Compact size and light weight,
- Quiet operation,
- Relatively low cost and high efficiency,
- Easy maintenance,
- Environmentally friendly, CFC-free insulation Pentane.

VII. ADVANTAGES

We believe that thermoelectric cooling offers a number of advantages over traditional refrigeration methods, as:

1. System have no moving parts,
2. No Freon's or other liquid or gaseous refrigerants required,
3. Precise temperature control,
4. High reliability & durability - We guarantee 5 years hours of no failures,
5. Compact size and light weighted,
6. Noiseless operation,
7. Relatively low cost and high effectiveness,
8. Easy for maintenance,
9. Eco-friendly C-pentane, CFC free insulation

VIII. DISADVANTAGES

1. C.O.P. Is less as compared to conventional refrigeration system.
2. Suitable only for low cooling capacity.

IX. LIMITATION

In rainy season it cannot be possible to charge battery due to irregular atmospheric condition as our project is totally based on solar energy. This is the limitation of our project, but this problem can be solved by giving direct electric supply.

X. APPLICATIONS OF SYSTEM

1. Can be uses for remote place where electric supply is not available,
2. Medical and pharmaceutical equipment,
3. Military applications,
4. Laboratory, scientific instruments, computers and video cameras.
5. In restaurants /hotels.

XI. FUTURE SCOPE

To build a real time model replacing both air conditioner & room heater in one system i.e. thermoelectric hot & cold room conditioner.

XII. CONCLUSION

A solar powered portable Cooling/refrigeration system was fabricated using thermoelectric module & electric control unit & tested for the cooling purpose. The system is self powers & can be used in isolated & a remote part of the country where load-shading is a major problem. The important aspect to be noted is that it is a onetime investment & is free from maintenance. We have been successful in designing a system that fulfils the proposed goals. However we do realize the limitations of this system. The present design can be used only for maintaining a particular temperature. The system is unable to handle fluctuations in load. Extensive modifications need to be incorporated before it can be released for efficient field use.

XIII. REFERENCES

- [1] Jonathan Michael Schoenfeld, Master of Science,2008 "Computational Model for Refrigerators Based on Peltier Effect Application", Applied Thermal Engineering, Vol. 25, No. 13, pp. 3149-3162.
- [2] Bass et al. (2004), "Multi-layer quantum well (MLQW) thermo electrics in a cooling application" International journal of research in aeronautical and mechanical engineering ISSN (online): 2321-3051
- [3] Chain and Chen Vol. 120 (2011) "Performance Prediction and Irreversibility Analysis of a Thermoelectric Refrigerator with Finned Heat Exchanger" Wuhan 430033, P.R. China, ACTA PHYSICA POLONICA No.03

-
- [4] Riffat and Qiu (2005) "Air conditioning systems with an air and water cooled heat sink" International Journal of Emerging Technology and Advanced Engineering Volume 3, Special Issue 3: ICERTSD 2013, Feb 2013, ISSN 2250-245
- [5] Zhang H Y (2010), "A General Approach in Evaluating and Optimizing Thermoelectric Coolers", Int. Journal of Refrigeration, Vol. 33, No. 10, pp. 1187-1196.
- [6] Angström, S.W., 1971. Direct Energy Conversion (Allyn and Bacon, Inc., Boston, MA,).
- [7] Ismail, B. I., Ahmed, W. (2009). Thermoelectric Power Generation using Waste-Heat Energy as an Alternative Green Technology. Recent Patents on Electrical Engineering, 2(1), 27–39.
- [8] Riffat, S. B., Ma, X. (2004). Improving the Coefficient of Performance of Thermoelectric Cooling Systems: a Review. International Journal of Energy Research, 28, 753–768.
- [9] Omega.(n.d.)The thermocouple. Retrieved October 10, 2010, from <http://www.omega.com/temperature/z/pdf/z021-032.pdf>
- [10] Riffat SB. Xiaolima Thermo-Electric: A Review of Present and Potential Applications. Applied Thermal Engg. International Journal of Engineering(IJE),Volume(5): Issue(1):2011, 2003:23:913– 35.