IJMRSETM

e-ISSN: 2395 - 7639

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING, TECHNOLOGY AND MANAGEMENT

Volume 10, Issue 5, May 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.580

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International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580| A Monthly Double-Blind Peer Reviewed Journal |

| Volume 10, Issue 5, May 2023 |

Solar Based of Mini Refrigerator using Peltier Plates

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ABSTRACT: Everyone currently confronts a number of difficulties, such as the energy crisis, the environmental damage brought on by rising CO2 emissions, and the weakening of the ozone layer, which has an equal impact on industrialized and developing countries. Solar energy is employed to power our project. solar refrigeration is used. The Peltier module is one of the most effective, pure, and ecologically advantageous technologies. The Peltier effect enables cooling with a single mechanism. There are no mechanical components necessary for the operation of this paper, such as a compressor or prime mover. The primary goal of this approach is to provide refrigeration devices to remote regions without power. Refrigeration systems that run on solar energy reduce reliance on the electric grid and the need to burn crude oil. This research used solar photovoltaic.

KEYWORDS: Refrigeration, Peltier effect, Battery, Solar Panel, charge controller, 16X2 LCD display)

I.INTRODUCTION

This abstract provides a concise summary of a solar-powered mini refrigerator that utilizes Peltier plates as the cooling mechanism. The system is designed to operate using solar energy, making it suitable for off-grid and remote locations where conventional power sources are limited or unavailable.The solar-based mini refrigerator incorporates Peltier plates, which are solid-state devices capable of generating a temperature difference across their surfaces when an electric current is applied. This phenomenon allows one side of the plate to become cooler while the other side becomes hotter. By leveraging this effect, the mini refrigerator can achieve cooling without the need for traditional refrigeration systems.The system comprises several components, including solar panels, battery storage, Peltier plates, heat dissipation mechanisms, insulation, temperature control, and power management. Solar panels convert sunlight into electricity, which is stored in a rechargeable battery for use during periods of low sunlight or at night.The Peltier plates are integrated into the mini refrigerator and utilize the thermoelectric effect to create a temperature differential, resulting in cooling on one side. Heat generated on the hot side of the plates is dissipated using a combination of a heatsink and a fan for efficient heat transfer.To optimize the cooling performance, the mini refrigerator is well-insulated to minimize heat transfer from the surroundings. A thermostat or temperature sensor regulates the cooling process, adjusting the power supplied to the Peltier plates based on the internal temperature.An electronic circuit manages the flow of electricity from the solar panels and the battery to the Peltier plates, ensuring efficient operation and preventing power fluctuations or overcharging.While solar-powered mini refrigerators using Peltier plates have limitations in terms of efficiency and cooling capacity compared to traditional refrigeration systems, they offer a viable solution for smaller cooling needs in remote areas with limited power access. Careful engineering and optimization are crucial to achieving the desired cooling performance while maximizing energy efficiency.

II.OBJECTIVES

The objective of the proposed approach is to obtain a stable temperature range in solar-powered refrigerators, to provide optimum storage conditions for materials like medicines, vaccines, and perishable food items. The focus of this project work is based on portable solar refrigeration systems being used in transit and for storage in remote or inaccessible regions that may or may not have electricity available. The suggested model, when successfully implemented, can be used as a lightweight appliance that serves as a way to store and transport emergency medical supplies, and perishable goods in the hour of need. It can also be used for recreational purposes and personal utilities such as camping, office use, and road travel. The end goal is to design and develop a device that is cost-effective, energy-efficient, easy to move around, and occupies less storage space.

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III. LITERATURE SURVEY

1. S. W. Kim, J. Y. Choi, and H. G. Jang, "Development of Solar Powered Thermoelectric Refrigerator Using Peltier Modules and Arduino," International Journal of Precision Engineering and Manufacturing, vol. 14, no. 9, pp. 1605-1610, 2013.This paper presents the development of a solar-powered thermoelectric refrigerator using Peltier modules and Arduino. The authors discuss the design and implementation of the system, including the selection of Peltier modules and the control algorithm using Arduino. Experimental results and performance analysis are provided.

2. P. W. Marigowda and A. S. Sondkar, "Design and Fabrication of Solar Powered Portable Refrigerator Using Peltier Effect," International Journal of Engineering Research and Applications, vol. 6, no. 6, pp. 29-34, 2016. This study focuses on the design and fabrication of a portable solar-powered refrigerator using the Peltier effect. The authors discuss the selection of Peltier modules, solar panels, and battery systems. Arduino is utilized for temperature control and monitoring. The paper provides experimental results and discusses the system's performance and efficiency.

3. M. Mustakim, M. N. M. Zubir, and S. K. Subramaniam, "Development of Solar-Powered Thermoelectric Refrigerator with Arduino Microcontroller," Journal of Advanced Research in Applied Sciences and Engineering Technology, vol. 12, no. 1, pp. 16-23, 2018.This research paper presents the development of a solar-powered thermoelectric refrigerator using Arduino as the control system. The authors discuss the system design, including the selection of Peltier modules, heat sinks, and solar panels. The performance analysis and experimental results are provided, highlighting the effectiveness of the proposed system.

4. A. Kumar and M. K. Das, "Design and Development of Solar-Powered Mini Refrigerator Using Arduino Microcontroller," International Journal of Electrical, Electronics and Data Communication, vol. 7, no. 1, pp. 69-74, 2019.This paper focuses on the design and development of a solar-powered mini refrigerator using Arduino as the control system. The authors discuss the selection of Peltier modules, heat sinks, and solar panels. They also provide details on the Arduino programming for temperature control and energy management. Experimental results and performance analysis are presented.

5. S. N. S. Sagar, A. Anand, and A. K. Singh, "Design and Development of Solar Powered Portable Refrigerator Using Peltier Effect and Arduino," Journal of Mechanical and Civil Engineering, vol. 15, no. 4, pp. 37-44, 2018. This study presents the design and development of a portable solar-powered refrigerator using the Peltier effect and Arduino. The authors discuss the system components, including the selection of Peltier modules and solar panels. They provide experimental results and discuss the system's performance and limitations.

IV.CURRENT SCENARIO OF THERMOELECTRIC REFRIGERATION

Thermoelectric refrigeration, also known as the Peltier effect, is a method of refrigeration that utilizes the thermoelectric effect to create a temperature difference across a junction of two different materials. When an electric current flows through this junction, heat is transferred from one side (the cold side) to the other side (the hot side), resulting in cooling of the cold side.Here are some key points about the current scenario of thermoelectric refrigeration:

1. Efficiency: Thermoelectric refrigeration systems have traditionally had lower efficiency compared to conventional compressor-based refrigeration systems. This is due to the relatively low coefficient of performance (COP) of thermoelectric materials. The COP is a measure of the cooling capacity provided per unit of electrical power input. However, research and development efforts have been focused on improving the efficiency of thermoelectric materials and systems.

2. Applications: Thermoelectric refrigeration systems have found applications in niche areas where size, weight, portability, or the absence of moving parts is advantageous. These include portable coolers, electronic component cooling, specialized medical equipment, and certain space-constrained cooling needs.

3. Advantages: Thermoelectric refrigeration has some advantages over traditional refrigeration technologies. It does not require refrigerants or mechanical compressors, making the systems more compact, lightweight, and vibration-free. They can also provide precise temperature control and have a longer lifespan due to the absence of moving parts.

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4. Limitations: The main limitation of thermoelectric refrigeration is its relatively low efficiency compared to compressor-based systems. Thermoelectric materials typically have a low figure of merit (ZT value), which limits their cooling capacity. Another limitation is the cost-effectiveness of the technology, as thermoelectric materials can be expensive compared to traditional refrigeration components.

It's worth noting that the field of thermoelectric materials and devices is an area of active research and development. New materials and advancements in manufacturing techniques could potentially improve the efficiency and expand the applications of thermoelectric refrigeration in the future.

V. METHODOLOGY

- The graphic below displays the experimental block diagram of the solar Peltier refrigerator, which functions as the refrigeration system in many features.

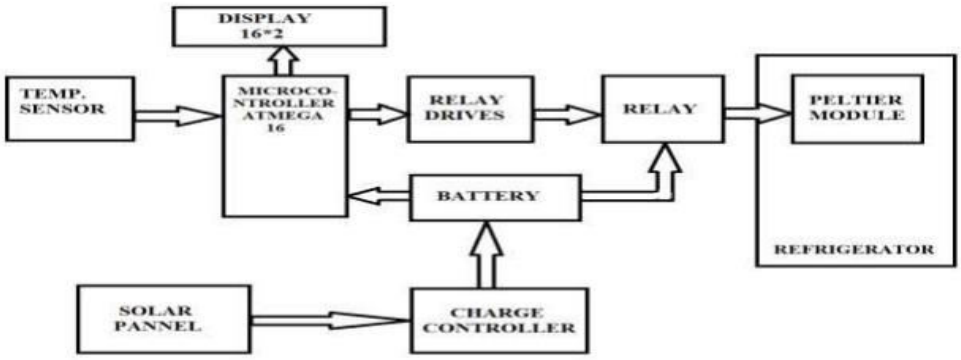

Fig (1)Block Diagram of solar based mini refrigerator using peltier plates.

- B .Hardware Details:

1)Solar Panels(12V,25W,12A):Solar panels are used to capture sunlight and convert it into electrical energy. They consist of photovoltaic cells that generate direct current (DC) electricity when exposed to sunlight.

2. Solar Charge Controller: The solar charge controller regulates the charging of batteries connected to the solar panels. It ensures efficient charging and prevents overcharging or damage to the batteries.

3. Battery(12V,7AH): The batteries store the electrical energy generated by the solar panels. They act as a power source for the mini refrigerator during periods of low sunlight or at night when solar energy is not available.

4. Arduino Microcontroller: Arduino is a microcontroller platform used for controlling and monitoring various electronic devices. In this system, Arduino is used to control the operation of the mini refrigerator, including temperature regulation and power management.

5. Peltier Plates(TEC1-12706): Peltier plates, also known as thermoelectric coolers, are solid-state devices that can transfer heat from one side to the other when an electric current is applied. They are sandwiched between two ceramic plates and create a cooling effect by absorbing heat from one side and releasing it from the other.

6. Heat Sink: A heat sink is a component that helps dissipate heat generated by the Peltier plates. It provides a larger surface area to facilitate efficient heat transfer and prevent overheating of the Peltier plates.

7. Cooling Chamber: The cooling chamber is the insulated compartment of the mini refrigerator where the cooling effect generated by the Peltier plates is utilized to maintain a low temperature. It is designed to store food, beverages, or other perishable items.

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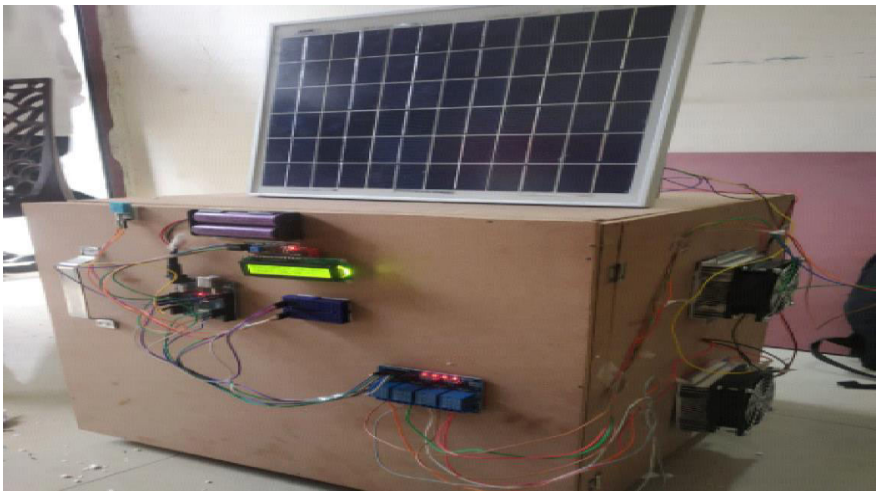
8. Temperature Sensor: A temperature sensor is used to measure the temperature inside the cooling chamber. It provides feedback to the Arduino, allowing it to adjust the operation of the Peltier plates to maintain the desired temperature.

9. User Interface: The user interface may include a display or indicators to show the current temperature, power status, and other relevant information. It can also have control buttons or switches for adjusting temperature settings or selecting operating modes.

Overall, the solar-powered mini refrigerator block diagram demonstrates the flow of energy from solar panels to the Peltier plates, controlled by the Arduino microcontroller. The Peltier plates create a cooling effect, which is utilized in the cooling chamber to maintain low temperatures for refrigeration purposes. The Arduino monitors temperature, controls the operation of the Peltier plates, and manages power usage based on the available solar energy and battery status.

V.FINAL MODEL



Fig(2) Final model of Solar based mini refrigerator Using Peltier Plates

VI.RESULTS

TIME REQUIRED (IN MIN.)	TEMPERATURE(IN DEGREE CELSIUS)
5	28
10	25
15	22
20	21
25	18
30	14
40	12
50	11
60	9.5

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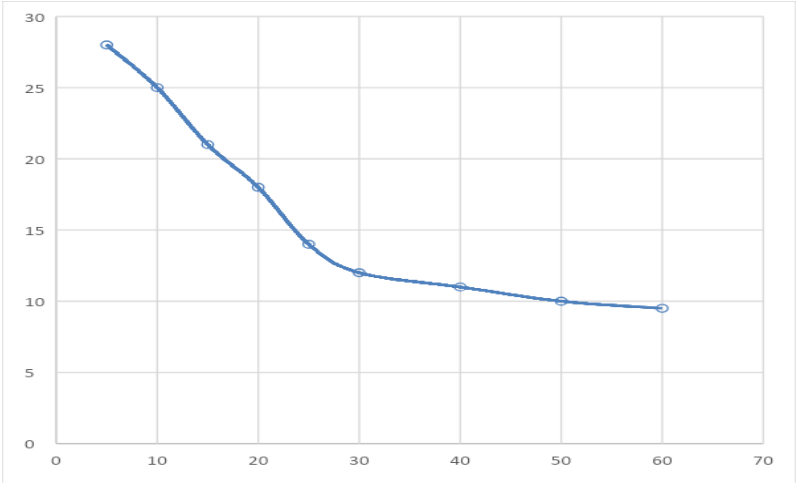
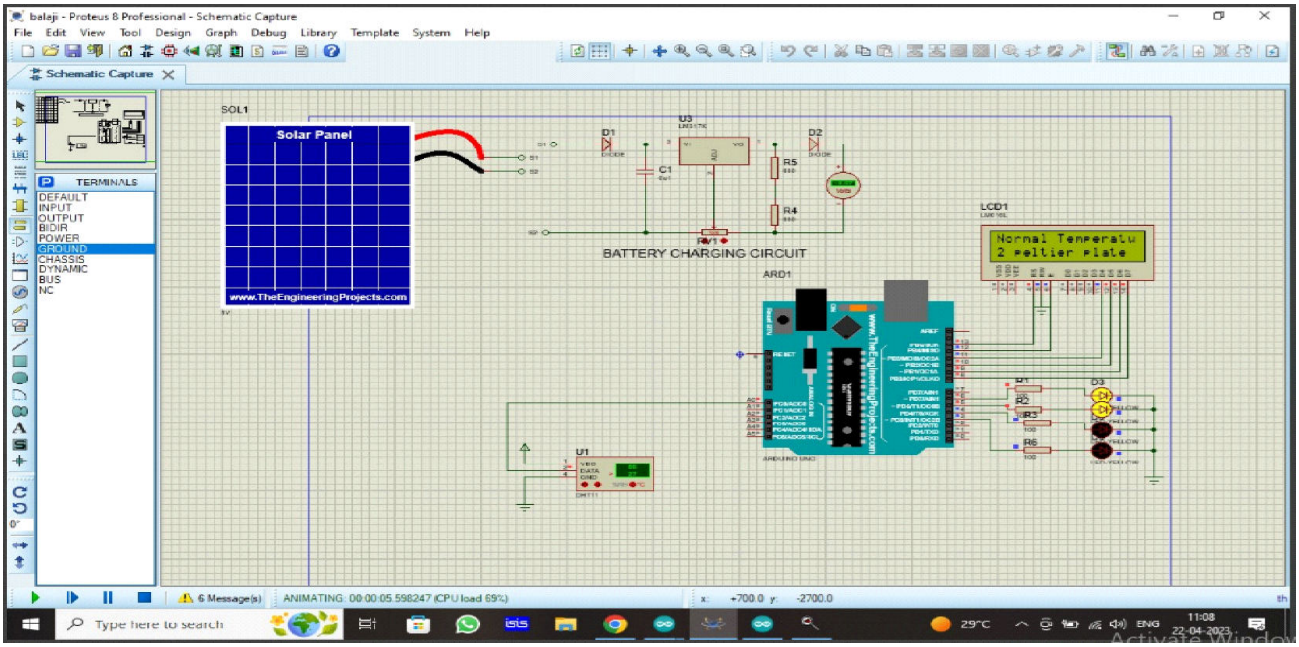


SIMULATION



VII.CONCLUSION

The experimental examination results below have led to the following conclusions:

1. The lowest temperature for chilling was 10°C, while the highest temperature for heating was 60°C.

2. There are many benefits to using a solar-powered refrigerator instead of a compressor-operated one, including financial savings and improved health.

3. Thermal energy sensors, coolers, and heat pumps are devices that exploit the thermoelectric effect.

4.The reduced coefficient of performance in thermoelectric cooling, specifically in big-capacity systems, is a significant issue that is often overlooked.

5.Examining various thermoelectric materials is necessary to improve the thermoelectric cooler's performance coefficient.

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3. Uttam Kumar Chaudhary, Adarsh Patel, Deepak Arya, Deepanshu Gautam, Prasoon Chaudhary, “Solar Refrigeration Using Peltier Module”.

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