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Solar Based Mini Refrigerator Using Peltier Module

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ABSTRACT: The objective of this project work is to develop portable thermoelectric refrigeration system capable of maintaining vaccine temperatures between 8 °C and 13 °C. The main system consisted of thermoelectric module as cooling generator along with insulated cabin, battery and charging unit. Thermoelectric elements perform the same cooling function as Freon-based vapor compression or absorption refrigerators. To ensure the success of this project several criteria's are to be satisfied such as portability, size and cost of the system. The design of the preservation is based on the principles of thermoelectric module (i.e. peltier effect) to create a hot side and a cold side. The cold side of the thermoelectric module is used for refrigeration purposes; provide cooling to the vaccine chamber. On the other hand, the heat from the hot side of the module is rejected to the surroundings with the help of heat sinks and fans. After gathering experimental data's and necessary guidelines from research papers on the thermoelectric refrigeration systems, the initial design of the model was made. Based on the heat load calculations, the thermoelectric module is selected. The system was fabricated and was experimentally tested for the cooling purpose. The capability of the system to maintain the required temperature and the time for reaching the same were analyzed.

KEYWORDS: COLD STORAGE, Peltier Module, Heat Sink, Compactivity.

I. INTRODUCTION

The conventional cooling systems are used now days are requires the refrigerant whose phase change takes place in heat exchanging and compressor are required for the compression of the refrigerant. The compressor required more power and space. The refrigerant is also not eco-friendly and increases the global warming and the major cause of ozone layer depletion. The mini eco-friendly refrigerator is based on the Peltier Effect and a thermoelectric device called peltier device is used for the cooling purpose. In the MEF-Refrigerator there is no need of compressor and refrigerant. Semiconductor thermoelectric coolers (also known as peltier coolers) off temperature control (< ± 0.1 °C) can be achieved with peltier coolers. However, their efficiency is low compared to conventional refrigerators. Although some large scaled applications have been considered (on submarines and surface vessels), peltier coolers are generally used in applications where small size is needed and cooling demands are not too great, such as for cooling electronic components.

II. LITERATURE SURVEY

(1) INTEGRATION OF A THERMOELECTRIC SUB COOLER.

Jonathan Michael Schoenfeld et at in his thesis submitted on integration of a thermoelectric sub cooler in 2008. There are two general research areas focused on increasing TEC performance; materials Research on thermoelectric semiconductors and system level assembly and heat dissipation techniques. The former is focused on

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developing advanced thermoelectric materials with superior thermoelectric properties. The most important parameter of a thermoelectric semiconductor is the figure of merit Z. which is given by α2/ (kρe).

(2) USE OF THE MULTILAYER QUANTUM WELL.

Bass et al. (2004) investigated the use of multi-layer quantum well (MLQW) used in a thermoelectric cooling application. MLQW thermoelectric material is a composite of thin layers of alternating semiconductor material with differing electronic band gaps deposited on a substrate. In this way, the thermal and electrical conductivity of the material can be decoupled. The non-dimensional figure of merit of such composite materials has been determined experimentally to be as high as 3 or 4.

(3) USE OF A MICRO CHANNEL HEAT SINK ON A THERMOELECRIC MODULE.

Chain and Chen et al. (2005) investigated the use of a micro channel heat sink on a TE module used to cool a water tank. The micro channels were etched into a silicon wafer with a glass cover plate. Four micro channel heat exchangers were fabricated with a differing number of ports and hydraulic diameters (D h), from 89 ports at a Dh of 65 µm to 44 ports at a Dh of 150 µm. Remove at heat from hot side of the module. The micro channel was placed on top of a 4 cm x 4 cm TE module. The lowest measured thermal resistance for the heat sink was 1.68 K/W. The authors suggested that the thermal resistance could be reduced to 0.5 K/W by increasing 6 the aspect ratio of the micro channel ports and by using a more conductive material like copper.

(4) THERMO SYPHON AS THE HEAT SINK OF A THERMOELECTRIC MODULE.

Webb et al (1998) investigated the use of a thermo syphon as the heat sink of a TE module used for electronics cooling. A porous aluminum surface was employed to enhance the boiling heat transfer in the evaporator. The condenser was constructed with internal micro fins to enhance condensation. An experimental study was conducted with simulated heat loads typical of a thermoelectric module heat rejection. At 75 W a thermal resistance of 0.0505 K/W was calculated for a 45 mm square enhanced boiling surface. The authors also recognized that the thermal resistance decreased slightly with increasing heat flux. As the figure of merit continues to increase through a continued research effort, the use of thermoelectric for air cooling has become more feasible.

(5) THERMOELECTRIC AIR CONDITIONING SYSTEM WITH AN AIR & WATER COOLING HEAT SINK.

Riff at and Qiu et al. (2005) investigated TE air conditioning systems with an air and water cooling heat sink. A cylindrical heat sink was designed through the optimization of the interior fin length and pitch as well as fluid velocity. The cylindrical design was capable of reducing heat exchanger volume and thermal resistance. An evaporative water “condenser” was suggested as the outdoor unit, which would cool the circulated water down close to the wet bulb temperature through convective and evaporative cooling.

(6) SMALL DC THERMOELECTRIC REFRIGERATOR

Muhammad khazratul et al development of small D.C. thermoelectric refrigerator.The refrigerator is one of the most innovative and important inventions of the twentieth century. The basic function of a domestic refrigerator is to preserve the quality of perishable food products. Several studies have shown that the quality of food products directly depends on temperature and air distribution inside the storage chambers. Hence, unsuitable temperatures and air velocities may cause food to undergo a premature deterioration. Even if the average temperature inside the refrigerator cabinet is adequate, uncontrolled rise or fall in local temperatures may affect the quality of food products. A device described as a "refrigerator" maintains a temperature a few degrees.

III. EXISTING SYSTEM

In the existing system high cooling capacity TE coolers, in combination of air cooling or liquid cooling techniques, are being pursued to extend the conventional air cooling limits for high power dissipating microprocessors. Compact in size and silent in operation, the TE cooler is easy to be integrated into a system in comparison with the vapor compression cooling technology. The variety of TE products is quite large and is ever increasing with the imaginations of design engineers for heating and cooling applications.

DISADVANTAGES

- It require a continuous electricity supply to function.
- When the power is out for an extended period of time, you risk losing a lot of money in groceries.

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- It does not have any temperature sensors to monitor the cooling.

IV. PROPOSED SYSTEM

In the proposed system temperature sensor and Thermoelectric has use to improve the compactivity and reliability of the Mini Refrigerator. The mini eco-friendly refrigerator is based on the PELTIER EFFECT and a thermoelectric device called peltier device is used for the cooling purpose.

ADVANTAGES

- **Compact size:** Very little space is required by the cooling system. The thermoelectric module is the size of a matchbook.
- **Light weight:** 36 qt. capacity unit weighs only 17 lbs.
- **Portable:** Carries with one hand and is unaffected by motion
- **Lower price:** 20% to 40% less expensive than compressor or absorption units.
- **Low battery:** Averages approximately 4.5 amps - less than your cars headlights.
- **Heating option:** Thermoelectric can be operated in heating mode for a short time period.
- **Reliability:** Thermoelectric have a 40-year proven track record in military, aerospace, laboratory, and no of consumer applications.

V. BLOCK DIAGRAM

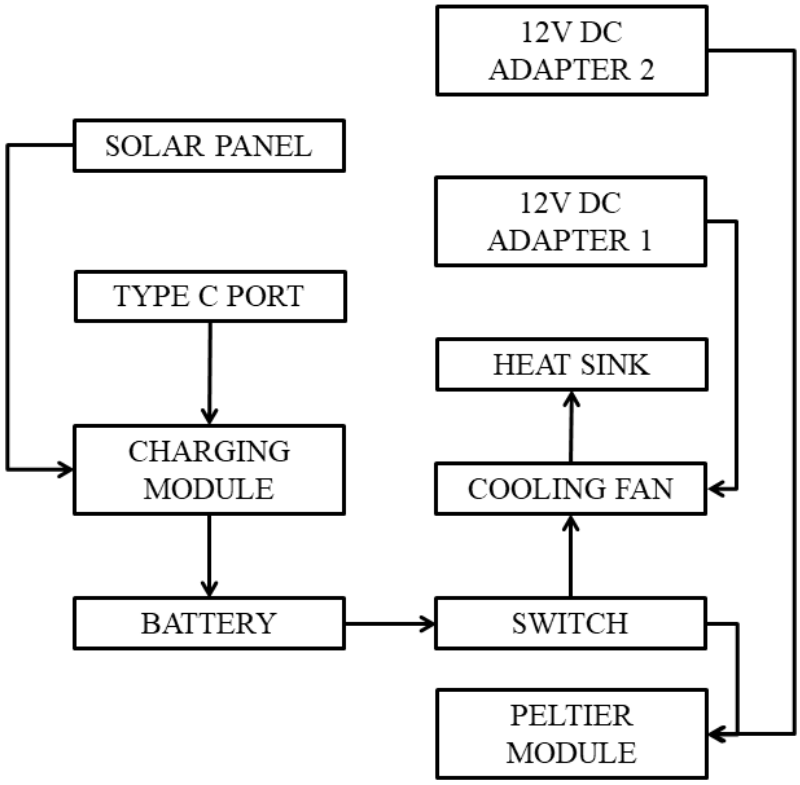

Fig 1. Block diagram Receiver Section

VI. COMPONENTS

PELTIER MODULE: The Peltier effect thermoelectric heat pump is a semiconductor based electronic component that functions as a heat pump. Just by applying a low DC voltage to this module, one surface gets cold and the other surface gets hot. And just by reversing the applied DC voltage, the heat moves to the other direction. this thermoelectric device works as a heater or a cooler. The Peltier thermoelectric heat pumps have been used for medical devices, sensor technology, cooling integrated circuits, automotive applications and military application. This project is about the

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validation of a Spice model of the Peltier thermoelectric heat pump suitable for transient simulations.

COOLING FAN: DC cooling fan is an important cooling device for modern industrial machinery, which is widely used in machinery cooling because of its good cooling effect, long service life, simple structure, easy installation, and many other features, can also be used in automobiles, power supplies and household equipment. Brushless DC cooling fans have the characteristics of low noise, stable operation and longer service life. You can choose from a variety of sizes and speeds. DC cooling fan is a combination of rotor, stator, fan blades and other auxiliary components.

HEAT SINKS: This Electronic device cooling system is capable of satisfying required capacity electronic device. This paper details the results of a study to develop a geometrical based optimization tool for heat sink design. Variation in the design aspects of the heat sink components, the cooling of electronic devices is possible. Geometry of heat sink, effect heat convention capability, size and weight of the component. Electronic warfare devices, obviously uses electronic chips. These components generate Power as they function. This power generation goes hand in hand with the generation of heat.

TEMPERATURE MONITOR: Temperature measurement in today's industrial environment encompasses a wide variety of needs and applications. To meet this wide array of needs the process controls industry has developed a large number of sensors and devices to handle this demand. In this experiment you will have an opportunity to understand the concepts and uses of many of the common transducers, and actually run an experiment using a selection of these devices. Temperature is a very critical and widely measured variable for most mechanical engineers.

BATTERY: A lithium-ion battery or Li-ion battery (abbreviated as LIB) is a type of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications. In the batteries, lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge, and back when charging.

BATTERY CHARGING MODULE: In 3S 10A 12V 18650 Lithium Battery Charger Board Protection Module, 3S stands for 3 18650 batteries or polymer lithium battery series combination. With 10.8V rated voltage for polymer battery, 11.1V 18650 or 3.7V lithium battery rated voltage and 12.6V lithium battery can be charged. And discharge 10A (referring to the maximum discharge current limit) Lithium battery protection board it also comes with over-charge, over-discharge, over-current, short circuit protection.

SOLAR PANEL: A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cells are made of materials that produce excited electrons when exposed to light. The electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules.

CHARGING PORT: Adam Tech ADC Series DC Power Jacks are a complete line of miniature and sub-miniature power jacks primarily used for the transmission of wall current transformed to DC power, for detached and hand held on instruments. Adam Tech power jacks are manufactured with a variety of center pin sizes for all standard applications including 1.00mm, 1.30mm, 2.00mm and 2.50mm. Our contact is designed using a wide spring grade plated copper alloy for exceptional plug retention and low contact resistance.

SPST SWITCH: Switches work by mechanically connecting a power wire to turn a motor on or disconnecting a power wire to stop a motor. Essentially a switch mechanically switches the power on or off, hence the name switch. Imagine a simple electric circuit: a battery connected to a light. In this example, power comes out of the positive side of the battery and enters the light via a wire. The power comes out of the light and returns to the battery via another wire. This set-up is called a loop. As long as this loop is connected and the battery is charged, the light turns on. This simple circuit can be built with a light, battery and some wire.

BOOST CONVERTER: Necessitated by the proliferation of devices requiring unique voltage rails, the single-voltage, intermediate-bus architecture has gained in popularity over using a centralized, multi voltage source. Localized point-of-load converters optimized for specific loads remove from the system the overhead of multiple-voltage distribution. While stepping the intermediate-bus voltage down to a lower voltage with buck converters is the most common requirement, there is the occasional need for a boost converter to step the bus voltage up.

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VII. PHOTOGRAPH OF MACHINE

Fig 2. Photograph of Machine

VIII. CONCLUSION

Different components with different materials having various heat capacities we design heat sink with varying geometry and number of fins. Numerical calculations and simulation are performed as per dimensions. Heat dissipation, temperatures will decide geometry of the model, selection of material and no of fins. This report gives the all information regarding design of heat sink geometry and heat sink materials.

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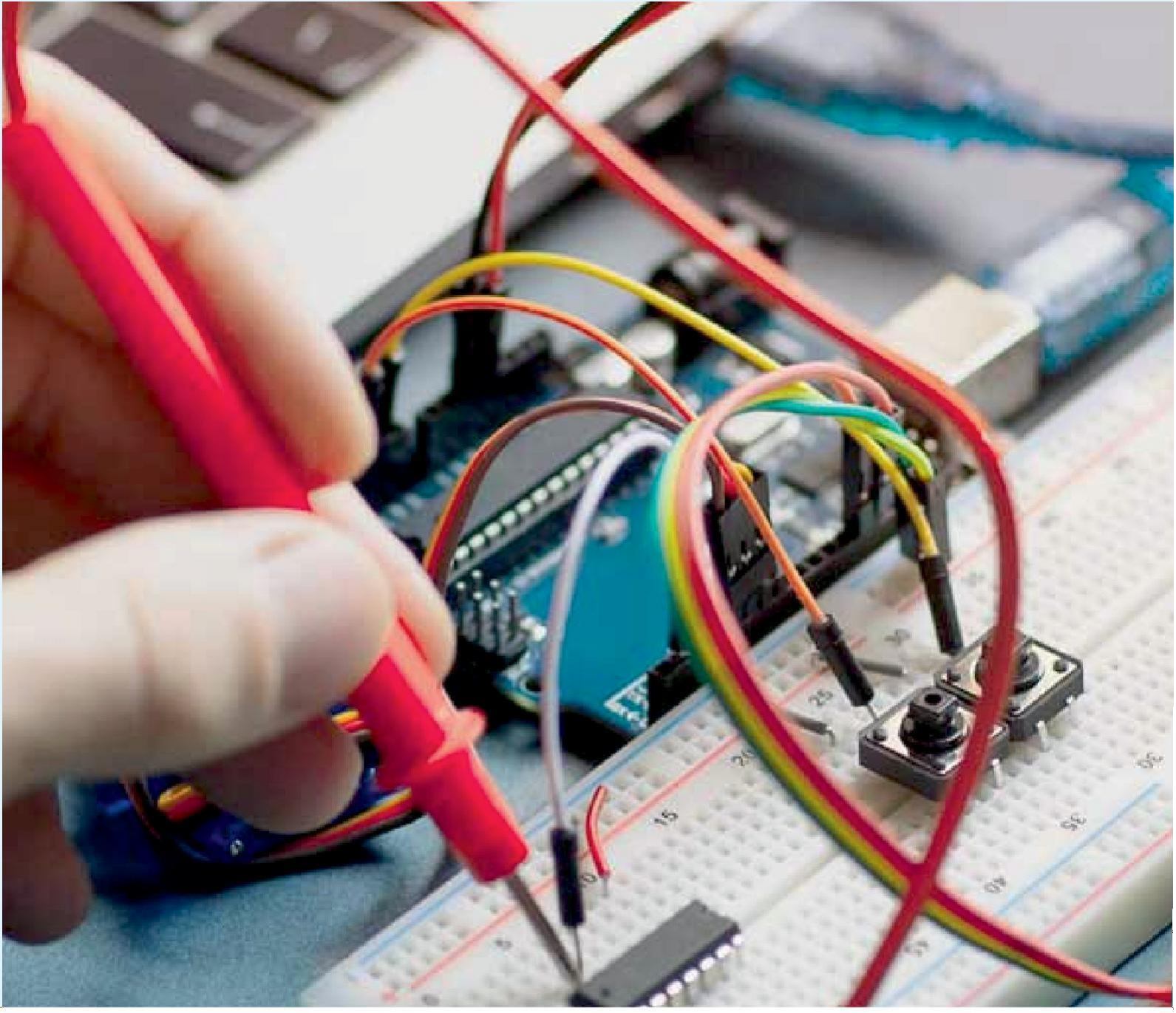

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