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Design and Analysis of Solar Refrigeration Using Peltier Plate

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ABSTRACT

Refrigeration is a process in which work is done to move heat from one location to another. Refrigerator which runs on electricity provided by solar energy is known as solar refrigeration. We require huge amount of power supply to refrigeration with compressor. It causes to CF, HF gases. So, we are implementing a technology with respect to peltier effect. The system was designed based on the principle of a thermoelectric module to create hot and cold sides. Thus our project concludes that solar energy systems must be implemented to overcome increasing electricity crisis. In this work a portable solar operated system unit was fabricated and tested for the cooling and heating purpose.

Keywords: Thermoelectric Module, Peltier Effect, Solar Panel, Cops.

I. INTRODUCTION

Conventional cooling systems such as those used in refrigerators utilize a compressor and a working fluid to transfer heat. Thermal energy is absorbed and released as the working Fluid undergoes expansion and compression and changes phase from liquid to vapour and back, respectively. Semiconductor thermoelectric coolers (also known as peltier coolers) offer several advantages over conventional systems. They are entirely solid-state devices, with no moving parts; this makes them rugged, reliable, and quiet. They use no ozone depleting chlorofluorocarbons, potentially offering a more environmentally responsible alternative to conventional refrigeration. They can be extremely compact, much more so than compressor-based systems. Precise temperature control (< ± 0.1 °C) can be achieved with Peltier coolers. However, their efficiency is low compared to conventional refrigerators. Thus, they are used in niche applications where their unique advantages outweigh their low efficiency. Although some large-scale applications have been considered (on submarines and surface vessels), Peltier coolers are generally used in applications where small size is needed and the cooling demands are not too great, such as for cooling electronic components.

The objectives of this study is design and develop a working thermoelectric refrigerator interior cooling volume of 5L that utilizes the Peltier effect to refrigerate and maintain a selected temperature from 5 °C to 25 °C. The design requirements are to cool this volume to temperature within a time period of 6 hrs. And provide retention of at least next half an hour. The design requirement, options available and the final design of thermoelectric refrigerator for application are presented

II. LITERATURE REVIEW

Early 19th century scientists, Thomas Seebeck and Jean Peltier, first discovered the phenomena that are the basis for found that if you placed a temperature gradient across the junctions of two dissimilar conductors, electrical current would flow. Peltier, on the other hand, learned that passing current through two dissimilar electrical conductors, caused heat to be either emitted or absorbed at the junction of the materials. It was only after mid-20th Century advancements in semiconductor technology, however, that practical applications for thermoelectric devices became feasible. With modern techniques,

We can now produce thermos electric efficient solid state heat-pumping for both cooling and heating; many are of these units can also be used to generate DC power at reduced efficiency. New and often elegant uses for thermo-electrics continue to be developed each day.

III. CONSTRUCTION

This system heat or cool the product using thermo-electricmodule.the construction set up for this system require following parts

1. Solar panel 2.Battery 3.Fins, thermister
4. Exaust fan or water container, circuit kit
5. Thermoelectric module.
6. Metal (aluminum box, sheets)

A. Solar Panel

The direct conversion of solar energy is carried out into electrical energy by means of the photovoltaic effect i.e. the conversion of light or other electromagnetic radiation into electricity. Heat can be converted directly into electrical energy by solar cell, more generally a photovoltaic cell. The solar panel use in this fabrication having an input capacity 16v and output capacity 21v.

B. Battery

The battery is an electrochemical device for converting chemical energy into electrical energy. The main purpose of the battery is to provide a supply of current for operating the cranking motor and other electrical units. Capacity of battery-12v.

C. Thermoelectric Module

A typical thermoelectric module is composed of two ceramic substrates that serve as a foundation and electrical insulation for P-type and Bismuth Telluride dice that are connected electrically in series and thermally in parallel between the ceramics. The ceramics also serve as insulation between the modules internal electrical elements and a heat sink that must be in contact with the hot side as well as an object against the cold side surface. Electrically conductive materials, usually copper pads attached to the ceramics, maintain the electrical connections inside the module. Solder is most commonly used at the connection joints to enhance the electrical connections and hold the module together [6]. Most modules have and even number of P-type and N-type dice and one of each sharing an electrical interconnection is known as, "a couple." [6]. While both P-type and N-type materials are alloys of Bismuth and Tellurium, both have different free electron densities at the same temperature. P-type dice are composed of material having a deficiency of electrons while N-type has an excess of electrons. As current (Amperage) flows up and down through the module it attempts to establish a new equilibrium within the materials. The current treats the P-type material as a hot junction needing to be cooled and the N-type as a cold junction needing to be heated. Since the material is actually at the same temperature, the result is that the hot side becomes hotter while the cold side becomes colder. The direction of the current will determine if a particular die will cool down or heat up. In short, reversing the polarity will switch the hot and cold sides

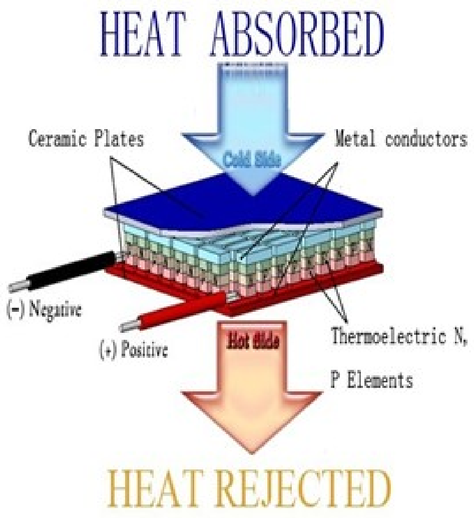

Figure 1

IV. WORKING PROCEDURE

The fridge is provided power supply form a 12 volt DC 7.5 amps battery. To start the fridge, the switch on the fridge is turned on. When the switch is turned on the Peltier device start functioning. The water from the sump is pumped to the upper smaller rectangle and directs to the hotter side of the Peltier (P1).

The hot side of the second Peltier is cooled by the sump. Cold sides of the both Peltier transfers the chilling effect to the evaporator. The Peltier thermoelectric Device will be so arranged in a box with proper insulation system and heat sink so that efficient cooling takes place at all the time. To turn off the fried, switch can be turned off.

V. CALCULATIONS AND RESULTS

1. Input power = product of current and voltage = --12v×7amps= 84W
2. Initial temperature of the evaporator when cooling= 300K
3. Final temperature of the evaporator when cooling = 285k
3. Final temperature of the evaporator when heating =330k
4. Total amount of heat removed = Total cooling effect produced
5. Total amount of heat removed = Mw* cp * change in temperature.
6. Coefficient of performance = refrigeration effect / input

Cop of cooling of found to be about 0.92

Cop of heating is found to be about 1.15

CHARTS

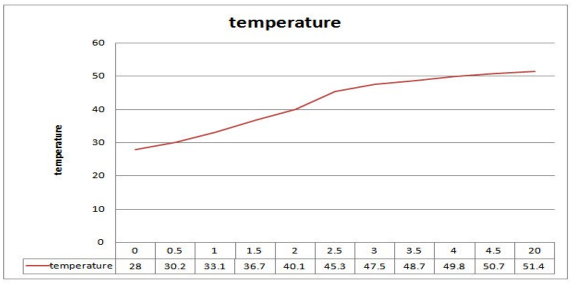

Figure 2. temp v/s time when peltier is cooling

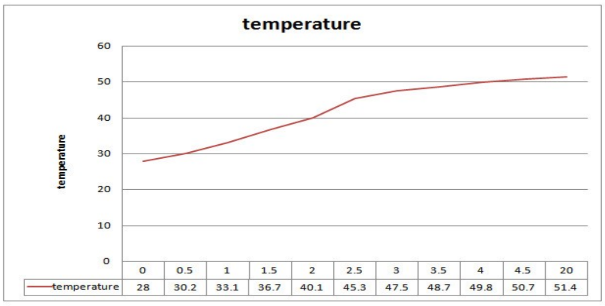

Figure 3. temp v/s time when peltier is heating

VI. CONCLUSION

Solar power nowadays is playing a major role in meeting the energy requirements of our country. It is being developed at a very fast rate and its applications in many areas are being explored. The fridge is intended at exploring the same and provides an efficient and economical solution to the areas where there is no electricity and cooling is required.

This project main objective was to develop a mini compressor less solar fridge and this has been successfully done. The applications of this fridge are very wide and it can be used in various places for variety of operations. Also the main purpose for which this fridge is made is being fulfilled as the space inside the fridge is sufficient enough to cool appropriate amount of medicines and injections needed at the primary health care centres in the villages where there is sporadic or no power supply.

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