Original Research Paper

Volume-9 | Issue-7 | July - 2019 | PRINT ISSN No. 2249 - 555X

Engineering

PORTABLE SOLAR REFRIGERATOR BY USING PELTIER MODULE

Swathi S Kumar	Dept of Electrical and Electronics, College of Engineering Perumon
Akhil R*	Dept of Electrical and Electronics, College of Engineering Perumon *Corresponding Author
Arun Vijay	Dept of Electrical and Electronics, College of Engineering Perumon
Irfan Rabeeh	Dept of Electrical and Electronics, College of Engineering Perumon

ABSTRACT In this era, energy crisis and environment degradation due to the increasing CO2 emissions and ozone layer depletion has become the primary concern to both developed and developing countries. Solar refrigeration using Peltier module does not need any kind of refrigerant and mechanical devices like compressor, prime mover etc. for its operation.Solar refrigeration using Peltier module is going to be one of the most cost effective, clean and environment friendly system. Cooling can be done in a single system which is possible due to the thermoelectric effect. The temperature controllable system makes it possible to fix the inside temperature at the desired level. It is a portable and economical system. The main purpose of the proposed system is to provide refrigeration systems to the remote areas where power supply is not possible.

KEYWORDS : Peltier module, Peltier cooling, Refrigeration, Thermo-electric module, Solar energy

1.INTRODUCTION

Refrigeration has now become a most important factor in the daily chores. Energy saving and low environmental impact are the primary concerns while designing a refrigeration system. Conventional refrigeration systems consumes enormous energy and releases emissions leading to ozone layer depletion. In this scenario, solar refrigeration is getting more and more attention. Solar refrigeration is one of the alternative technologies that use solar power in combination with Peltier effect[1].

When an electrical current is applied across the junction of two dissimilar metals, heat is removed from one of the metals and transferred to the other. This is the basis of thermoelectric refrigeration. Thermoelectric modules are constructed from a series of tiny metal cubes of dissimilar exotic metals which are physically bonded together and connected electrically. When electrical current passes through the cube junctions, heat is transferred from one metal to the other. Solid state thermoelectric modules are capable of transferring large quantities of heat when connected to a heat absorbing device on one side and a heat dissipating device on the other.

The Koolatron's internal aluminium cold plate fins absorb heat from the contents, (food and beverages), and the thermoelectric modules transfer it to heat dissipating fins under the control panel. Here, a small fan helps to disperse the heat into the air. [2].

More than a billion people lack access to electricity and refrigeration, which means they also lack access to important vaccines that need to be kept cool. Non profits are pouring millions into developing vaccines that don't need refrigeration, but tech venture capitalist Adam Grosser has a different idea: change the fridge[3]. The design requirement of the heat sink is to cool a volume to a temperature within a less time period and to provide retention of atleast next half an hour[4].

An experimental and numerical study of of a thermoelectric cooling and heating system provided a cooling power of 50W per module, with a COP between 1.5 and 2, by supplying an electric intensity of 4A and maintaining the 5^{o}C temperature difference between the hot and cold sides[5].

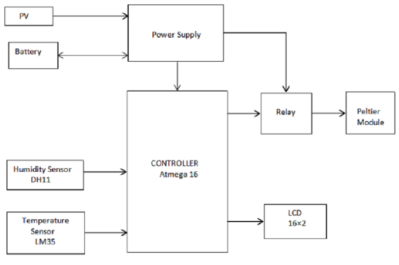
2.CONCEPT

Refrigeration may be defined as the process of achieving and maintaining a temperature below that of the surroundings, the aim being to cool some product or space to the required temperature. The Seebeck coefficient is the ratio between the electric field and the temperature gradient or the ratio between the voltage difference and temperature difference between the ends of the sample. The Peltier coefficient of the junction is a property depending on both materials and is the ratio of the power evolved at the junction to the current flowing through it. The Thomson coefficient is the ratio of the Power evolved per unit volume in the sample to the applied current and temperature gradient.

3.CONSTRUCTION

The construction setup of the proposed refrigerator is as follows:

a) Peltier module
b) Refrigeration chamber
c) Battery
d) Solar cell
e) Controller
f) LCD display
g) Temperature senssor
h) Humidity sensor

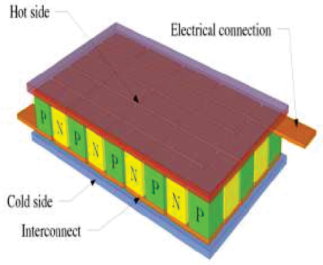


Fig(1) Block Diagram

As per study, a wooden box is made and is provided with insulation of aluminium foil and thermocol. A Peltier module is installed and tested. The micro controller circuit and program is implemented for the control unit.Solar panel and charge controller circuit are tested and all the components are assembled systematically. Humidity and temperature sensors along with the LCD display provides information on the tempetrature level and moisture content in the chamber. MPPT(Maximum Power Point Tracking) based solar system is used in the proposed refrigeration system[6]. The block diagram of Solar refrigeration system by using peltier in fig(3).

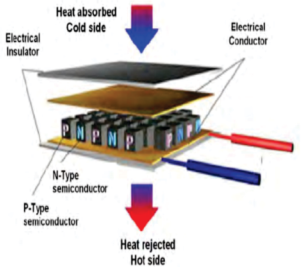
4.WORKING

The Peltier module consist of pairs of P-type and N –type semiconductor thermo element forming thermocouple which are connected electrically in series and thermally in parallel. The module are considered to be a highly reliable component due to their solid state, for most application they will provide long, trouble free service. In cooling applications, an electric current is supplied to the module and the result is that one side of the module becomes cold and other side hot as shown in fig(2).



Fig(2) Working principle of Peltier module

During operation, DC current flows through the Peltier module causing heat to be transferred from one side of themodule to the other, creating a cold and hot side as in fig(3).The COP for heating and cooling are different, because the heat reservoir of interest is different. The COP is the ratio of the heat removed from the cold reservoir to input work.

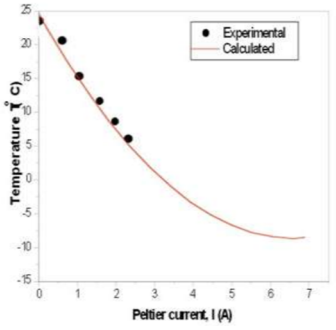


Fig(3) Working of Peltier module as refrigerator

For right selection of the Peltier module, following points are considered:

1) Its operating temperature must be within required limits.
2) Heat rejected by hot side of module should be less than its total power capacity.
3) For desired cooling proper heat sink should be provided on hotter side.
4) Peltier module should be selected according to the volume which has to be cooled.

Fig(4) shows the cooling effect of single stage Peltier.



Fig(4) Cooling effect of a single stage peltier

5.ADVANTAGES

Thermoelectric cooling offers a number of advantages over traditional refrigeration methods as:

1. No moving parts, eliminating vibration, noise, and problems of wear.
2. No Freon's or other liquid or gaseous refrigerants required
3. High reliabity and durability.
4. Compact size and light weighted
5. Relatively low cost and high effectiveness,
6. Eco-friendly C-pentane, CFC free insulation
7. Reversing the direction of current transforms the cooling unit into a heater.

6.DISADVANTAGES

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

7.EXPECTED OUTCOMES

1. Cooling of drinking water to a satisfactory cold temperature (10-20^{o}C lower than normal temp)
2. An efficient controlled cold storage unit for medicine storage.
3. Control of the temperature, i.e, Maintaining the temperature inside the chamber at a desired level.
4. Portable unit which can be transported safely to places in emergency like medical camps.

8.CONCLUSIONS

There are several different types of cooling devices available to remove the heat from industrial enclosures as well as medical enclosures, but as the technology advances, thermoelectric cooling is emerging as a truly viable method that can be advantageous in the handling of certain small-to-medium applications. As the efficiency and effectiveness of thermoelectric cooling steadily increases, the benefits that it provides including self-contained, solid-state construction that eliminates the need for refrigerants or connections to chilled water supplies, superior flexibility and reduced maintenance costs through higher reliability will increase as well.it can use in ambulance for storing medical equipments, can use in remote area for storing medicines etc.

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