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RESEARCH ARTICLE OPEN ACCESS

Solar Refrigeration using Peltier Module

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Abstract:

In the recent year, energy crisis and environment degradation due to the increasing CO_2 emission and ozone layer depletion has become the primarily concern to both developed and developing countries. Solar refrigeration using Peltier module does not need any kind of refrigerant and mechanical device like compressor, prime mover etc. for its operation. Our project utilizes the solar energy 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 main purpose by this methodis to provide refrigeration system to the remote areas where power supply is not possible.

Keywords — **Refrigeration, Peltier effect, Thermo-electric module, Solar energy.**

I. INTRODUCTION

From last century till now refrigeration has been one of the most important factors of our day to day life. The current tendency of the first world is to look at renewable energy resources as a source of energy. This is done for the following two reasons; firstly, the lower quality of life due to air pollution; and, secondly, due to the pressure of the ever increasing world population puts on our natural energy resources. From these two facts comes the realization that the natural energy resources available will not last indefinitely [1].

The basic idea is implementation of photovoltaic driven refrigerating system powered from direct current source or solar panel (when needed) with a battery bank.

II. LITERATURE SURVEY

Jean Peltier et. al.[1834]noted that 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.

Matthieu Cosnier et.Al. [2008]presented an experimental and numerical study of a thermoelectric air-cooling and air-heating system. They have reached a cooling power of 50W per module, with a COP between 1 .5 and 2, by supplying an electrical intensity of 4A and maintaining the 5°C temperature difference between the hot and cold sides.

Adam Grosser et.Al.[2007]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.

"Design and Development of Thermoelectric Refrigerator ", Mayank Awasthi International journal of mechanical engineering and robotics.From above research paper we have studied about thermoelectric component like heat sink. The design requirements are to cool this volume to temperature within a less time period and provide retention of at

least next half an hour. The design requirement, options available

III. 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.

IV. CONSTRUCTION

The construction setup of the refrigerator is as follows,

a) Thermo-electric module
b) Refrigeration chamber
c) Battery
d) Solar cell
e) Charge controller

A. Thermo-electric module (Model no. – TEC1-12706)

A thermo-electric module (TEM) is a solid state current device, which, if power is applied, move heat from the cold side to the hot side, acting as a heat exchanger. This direction of heat travel will be reversed if the current is reversed. Combination of many pairs of p and n semiconductors allows creating cooling units - Peltier modules of relatively high power [5]. As shown in the model no. there are 127 number of p–n coupling Specification,

1) Material used- Silicon - Bismuth
2) A = 0.04 x 0.04 = 0.0016 m2

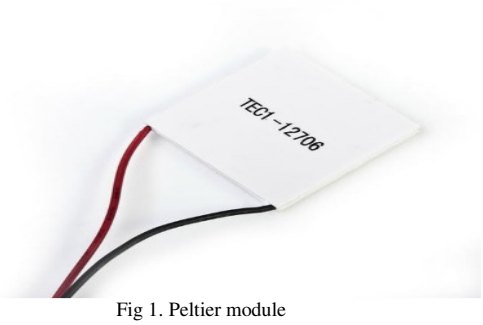

Fig 1. Peltier module

B. Refrigeration chamber

The chamber used is same as that of the chambers used in conventional refrigeration. The chamber can be of any volume, shape and size. We have used 7.8 L capacity cooler box. For experimentation purposes the volume of the chambers is kept low. Insulation provided to the chamber is done by polystyrene. And aluminium casing is done in the inner side of insulation to provide better cooling.

C. Battery

The battery is an electrochemical 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 [2].

Specification,

1) Voltage 12 V
2) Current 7.2Ah

D. Solar cell

The direct conversion of solar energy is carried out into electrical energy by conversion of light or other electromagnetic radiation into electricity.

1) Voltage – 17 V dc
2) Current – 1.16amp
3) Power - 10 W
4) Solar irradiation – 1000 W/m2
5) No. of subcells – 72

E. Charge controller

A charge controller is an essential part of solar refrigeration system that charge battery. Its purpose is to keep a battery properly fed and safe for the long term. The basic function of a controller are quite simple. Whenever the sunrays fall on a solar panel then there is a fluctuation of solar rays on solar panel. To avoid the fluctuation of sunrays on solar panel, we use charge controller in solar refrigeration system. Also, charge controller

prevent battery overcharge and electrical overload. We are using MPPT(Maximum Power Point Tracking) base solar charger in our solar refrigeration system [3].

V. WORKING OF THERMOELECTRIC COOLER

It is an equipment, which work on principle of conversion of solar energy into electrical energy. A solar cell is used to develop 17 V & 1.16 amps current DC supply and 10W. This electrical energy is stored in a battery which is of 12 volts DC supply which then supplies the power to transformers.The transformer control three fan out of which two-fan work as exhaust fan & remove heat from heat sink plate. The third in side fan work as heat extractor, this fan remove heat from system and add to heat sink. During operation, DC current flows through the TEM causing heat to be transferred from one side of the TEC to the other, creating a cold and hot side.The COP for heating and cooling are different, because the heat reservoir of interestis different. The COP is the ratio of the heat removed from the cold reservoir to input work. However, for heating, the COP is the ratio of the heat removed from the cold reservoir plus the input work to the input work:

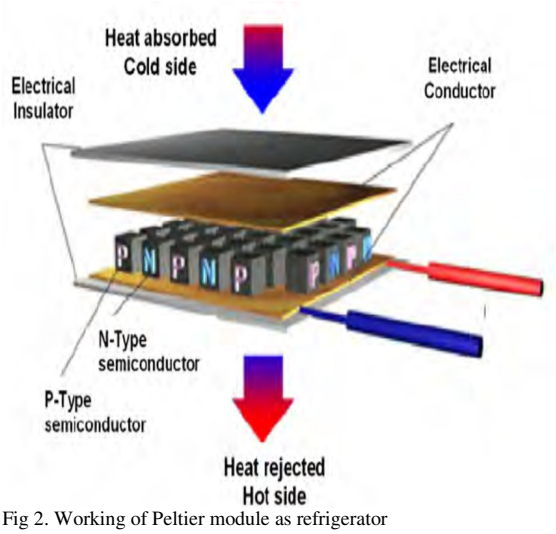

Fig 2. Working of Peltier module as refrigerator

A. Working Design

As project is based on Peltier effect our first main step is selection of right Peltier module. For selection of module following factors should be consider,which is taken from previous data.

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.

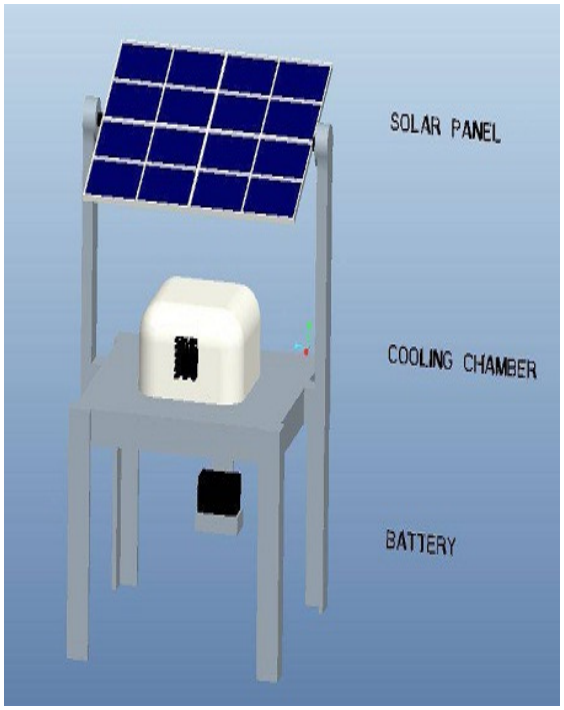

Fig 3. Design structure of solar refrigerator using Peltier module

VI. OBSERVATION

Observation table

Module used: TEC1-12709
Compartment dimensions (mm): 260×150 × 175
i.e., (Volume of 6825000mm^3).
Temperature 30^0 C

Sr.no.	*Time*		*Temperature*	
	Sec.	*Min.*	*°C*	*°F*

1.	0	0	30	86
2.	32	0:32	29	84.2
3.	49	0:49	28	82.4
4.	62	1:02	27	80.6
5.	76	1:16	26	78.8
6.	88	1:28	25	77
7.	100	1:40	24	75.2
8.	120	2:00	23	73.4
9.	135	2:15	22	71.6
10.	152	2:32	21	69.8
11.	168	2:48	20	68
12.	196	3:16	19	66.2
13.	216	3:36	18	64.4
14.	244	4:04	17	62.6
15.	292	4:52	16	60.8
16.	332	5:32	15	59
17.	416	6:56	14	57.2
18.	524	8:44	13	55.4
19.	780	13:00	12	53.6

VII. ADVANTAGES

We believe that 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.

DISADVANTAGE

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

VIII. CONCLUSION AND FUTURE SCOPE

From this project we can conclude that without the use ofCompressor and the Refrigerant It is possible to cool thesystem. There are several different types of cooling devicesavailable to remove the heat from industrial enclosures as wellas medical enclosures, but as the technology advances,thermoelectric cooling is emerging as a truly viable methodthat can be advantageous in the handling of certain small-tomediumapplications. As the efficiency and effectiveness ofthermoelectric cooling steadily increases, the benefits that itprovides including self-contained, solid-state construction thateliminates the need for refrigerants or connections to chilledwater supplies, superior flexibility and reduced maintenancecosts through higher reliability will increase as well**.** it can usein ambulance for storing medical equipment can use in remotearea for storing medicines, etc. Blood plasma and antibioticsare manufactured using a method called freeze drying.

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

ACKNOWLEDGEMENT

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