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Design of Compressor less Solar Powered Refrigerator

Saghar Mehdi
Master Of Technology Inthermal Engineering

Abstract
The thermoelectric effect has been proven as a source of cooling and small power generation as defined by the Peltier-Seebeck effect. Thermoelectric modules, optimized by semiconductors, have been used for temperature regulation by operating as a heat pump to maintain computing devices and integrated circuits at optimum temperatures for improved processing efficiency. Thermoelectric modules have also been used to capture microwatt electrical power from personal computing and other small scale devices by way of utilizing the waste heat rejected through its heat sink. In modern data centers and server farms, water cooling of electronics has been widely adapted as a more efficient cooling method than standard air conditioning and ventilation systems due to its vastly larger thermal capacity. However, even high density electronics cabinets and processing units are low level heat applications unfit for waste heat recovery by standard thermodynamics cycles and heat pumps. When applying the thermoelectric effect to the temperature difference between the heat source of the processing electronics and the heat sink of a water cooling system, potential exists for practical and economic energy recovery.
This study demonstrates the feasibility of waste energy recovery from high power density electronics in data centers and server farms by way of the practical and economic application of thermoelectricity. An overview of thermoelectricity and the thermoelectric effect is given, including a review of semiconductor materials and electronics cabinet cooling techniques. This report describes an investigation into the efficiency of applying thermoelectricity to low temperature waste heat situations. Conclusions are presented concerning the effectiveness of this application towards waste heat utilization for power recovery.

INTRODUCTION

Electricity generation is the leading cause of industrial air pollution in the country. Most of our electricity comes from coal, nuclear, and other non-renewable power plants. Producing energy from these resources takes a severe toll on our environment, polluting our air, land. Renewable energy sources can be used to produce electricity with fewer environmental impacts. It is possible to make electricity from renewable energy sources without producing CO_2.

Renewable energy is energy derived from natural resources that replenish themselves over a period of time without depleting the Earth's resources. These resources also have the benefit of being abundant, available in some capacity nearly everywhere, and they cause little, if any, environmental damage. Energy from the sun, wind, and thermal energy stored in the Earth's crust are examples. For comparison, fossil fuels such as oil, coal, and natural gas are not renewable, since their quantity is finite once we have extracted them they will cease to be available for use as an economically-viable energy source. While they are produced through natural processes, these processes are too slow to replenish these fuels as quickly as humans use them, so these sources will run out sooner or later.

So this project is intended at the development of a solar based compressor free mini fridge. This fridge will be suitable for cooling purposes meant for small objects and will have a relatively small chilling time as compared to the normal refrigeration systems. Also for the backup, this

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fridge will be attached to a dynamo based charging system which will maintain the smooth operation of fridge in case of non-availability of solar power.

In most of the rural areas of our country, the electric supply is either sporadically available or not available at all. The most severe effect of this problem is on the Primary Health Care Centers. Due to no electricity, most of the PHC's do not maintain adequate supply of medicines and equipment which need to be kept in a cold environment. So in case of any emergency, the patient is to be referred either to the town or city hospital which results in loss of precious time and may prove fatal for the patient.

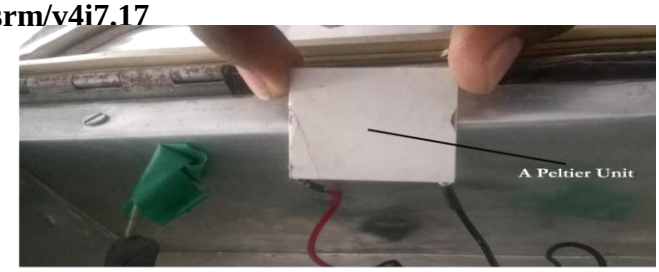
Problem Description

The objective of this project is to analyze the efficiency of applying TE devices to a data center to assess the practicality and feasibility of waste heat recovery. Data centers produce relatively low temperature waste heat when compared to other applications. The efficiency of the electrical conductors used in thermoelectric waste heat recovery can be used to assess the magnitude of power generation. Material selection is necessary to optimize the efficiency of the thermoelectric modules while maintaining an economic solution as well as selection of the optimum heat sink to make execution of TE devices in a data center realistic.

MATERIALS USED

In this project, various equipment's and materials are used for the proper functioning and performance of the fridge. These equipment's and materials are as follows:

Peltier Unit



Peltier Unit in Fridge

The peltier unit used in this fridge is TIC 12073. This unit works on 5 volts DC and takes maximum current of 4 amps at full load. The power rating of this unit is 20 watts.

Cooling Fan

Cooling Fan

We are using two Cooling fans in our refrigerator which are respectively mounted on one heat sink each. The main purpose of a cooling fan is to Dissipate heat from the heat sink by taking in fresh air. The fans used in this fridge work on 12 volts DC and draws 0.18 amps. The power consumption of each fan is 2.16 watts.

Insulation Material

Two materials have been used as insulator in constructing the body of refrigerator. For preventing air leakage proper fixing has been done. The two materials used are given as follows:

Thermocol

Thermocol

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As we know the ice vendors take advantage of thermocol for its economic value and good insulation property as it does not allow the inner temperature of cooling medium to go down. Hence it is also an economic source of insulation.

Battery

The battery used in this fridge has following specifications:

7.5 ampere hour

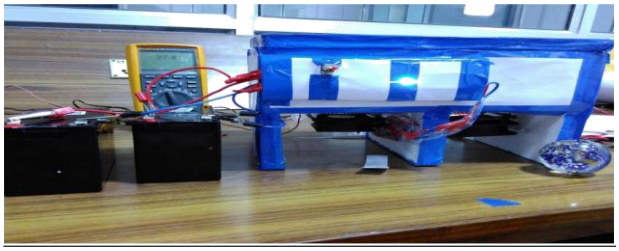
12 volt

In this fridge one battery is used as a time for the working of the fridge. Also the extra connections for the second battery in the fridge are also provided if more cooling is required.

Solar Charge Controller

The batteries used in the fridge are rated at 12 volts DC, 7.5 Amphrs. To charge these batteries from the solar panel, a charge controller rated 12 volts, 10 amps is used as shown in the figure.

CONSTRUCTION AND DESIGN



Steps in the construction of the fridge

Firstly a box of thermocol is made of given dimensions and then the inner walls of the box are covered with the aluminium sheet and the outer walls by the chart paper.

The taping of the box from outer side is done so as to provide mechanical support and blocking of air.

The two Peltier units are well placed in the two holes made in the box and kept on the heat sink with hot side attached to the heat sink surface and cold side inside the box.

The heat sink is linked with a fan which is used to dissipate the heat of heat sink into the outer atmosphere i.e. out of the thermocol box. So, the hot side of peltier unit is unable to affect the temperature inside the box.

All the electrical connections are made putting a switch for on/off and a LED as an indicator whether the fridge is working or not. Two batteries each of 12 Volts DC, 7.5 Ah are connected in parallel with the peltier units connected in series and the two cooling fans.

All the electrical connections are made strong by soldering them and all the wires are arranged properly so as to avoid any inconvenience for the user.

WORKING OF THE PROJECT

Fridge

The fridge is provided power supply form a 12 volt DC 7.5 ampere battery.

To start the fridge, the switch on the fridge is turned on.

When the switch is turned on, a led starts glowing indicating that the fridge is now online.

Now two Peltier thermoelectric devices which are insulated from the cooling side and arranges in the fridge generates cooling effect on inner side and heat is dissipated on outer side.

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On the heat side of the peltier unit, a heat sink along with the fan works to dissipate the heat from the peltier unit in the outer environment.

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. Then the glowing led will also stop glowing indicating no power for the fridge.

Battery charging

The batteries used in the fridge are charged from the solar panels using a charge controller rated 12volts, 10 amps. The battery is connected to the charge controllers which get supply from the solar panels and feeds it to the battery.

OBSERVATIONS

For evaluating the performance of our mini compressor-less solar fridge we tested it using a Fluke multimeter - 287 and data is recorded. Afterwards graph was prepared for the same by taking the data from the multimeter.

Working Fridge with temperature monitoring

As shown in the above figure, it can be observed that the refrigerator is operational as led is glowing. Also in the background the multimeter is showing the temperature inside the refrigerator simultaneously in the real time.

The following observations were recorded using the Multimeter:

Reading	Sample	Start Time	Duration	Max Time	Max	Average	Min Time	Min	Description	Stop Time
1	30.9 °C	26:02.4	00:12.8	26:02.4	30.9 °C	30.5 °C	26:14.4	29.7 °C	Stable	26:15.2
2	29.6 °C	26:15.2	00:07.1	26:15.2	29.6 °C	28.9 °C	26:21.6	28.4 °C	Stable	26:22.3
3	28.3 °C	26:22.3	00:08.7	26:22.3	28.3 °C	27.8 °C	26:30.6	27.2 °C	Stable	26:31.0
4	27.1 °C	26:31.0	00:18.9	26:31.0	27.1 °C	26.5 °C	26:44.2	26.1 °C	Stable	26:49.9
5	26.0 °C	26:49.9	04:39.9	29:23.6	26.6 °C	26.1 °C	31:28.7	25.0 °C	Stable	31:29.8
6	24.9 °C	31:29.8	00:08.7	31:29.8	24.9 °C	24.4 °C	31:37.0	24.0 °C	Stable	31:38.5
7	23.9 °C	31:38.5	00:17.3	31:38.5	23.9 °C	23.5 °C	31:54.3	23.0 °C	Stable	31:55.8
8	22.9 °C	31:55.8	00:45.7	31:55.8	22.9 °C	22.4 °C	32:37.0	22.0 °C	Stable	32:41.5
9	21.9 °C	32:41.5	01:02.2	32:43.8	22.1 °C	21.7 °C	33:42.6	21.0 °C	Stable	33:43.7
10	20.9 °C	33:43.7	00:17.3	33:43.7	20.9 °C	20.4 °C	33:59.5	20.0 °C	Stable	34:01.0
11	19.9 °C	34:01.0	00:28.6	34:01.0	19.9 °C	19.4 °C	34:25.9	19.0 °C	Stable	34:29.6
12	18.9 °C	34:29.6	01:29.0	34:34.9	19.0 °C	18.3 °C	35:36.0	17.9 °C	Stable	35:58.6
13	17.8 °C	35:58.6	03:30.7	39:27.0	18.8 °C	17.6 °C	38:42.6	17.2 °C	Stable	39:29.3
14	17.4 °C	39:29.3	00:06.8	39:35.4	19.8 °C	19.3 °C	39:29.3	18.9 °C	Stable	39:36.1
15	17.4 °C	39:36.1	00:17.0	39:40.6	20.4 °C	19.7 °C	39:51.6	19.0 °C	Stable	39:53.0
16	17.3 °C	39:53.0	00:44.9	39:53.0	18.9 °C	18.5 °C	40:35.3	18.0 °C	Stable	40:37.9
17	17.1 °C	40:37.9	00:24.5	40:38.7	18.0 °C	18.0 °C	40:37.9	17.9 °C	Interval	41:02.5
18	17.0 °C	41:02.5	03:48.8	41:35.3	18.1 °C	17.5 °C	44:33.1	17.0 °C	Stable	44:51.2
19	16.9 °C	44:51.2	03:17.1	48:05.4	17.5 °C	16.9 °C	46:34.5	16.6 °C	Stable	48:08.3
20	16.9 °C	48:08.3	00:00.0						Logging Stop	48:08.3

As shown in the table, from the readings given following observations can be made:

- Starting temperature: 30.9 °C
- Starting time: 26 minutes 2 seconds
- Final stable temperature: 16.9 °C
- Final time: 48 minutes 8 seconds

RESULTS

The aim of the development of the fridge is to provide efficient and effective cooling in the designated locations and places. As observed from the data above, this fridge is capable of maintaining an inner temperature of 16.5 ^{o}C after 20 minutes of continuous power supply and is maintaining it at a constant rate. Also when the battery will be fully charged, Fridge will remain operational for the time period of 3.2 hours after which the battery will be discharged and the temperature inside the fridge will increase at a very slow rate due to the insulation provided.

On the basis of the above data it can be said that the above fridge can be easily used for the small chilling operations where cooling is required in a small time.

This system is provided with a solar panel charge controller which can be easily used to charge the battery from the solar panels. In addition the battery charger which runs on normal 220 volt ac supply is provided which can be used to charge the batteries.

In the above, the temperature corresponds to the value taken inside the fridge using the temperature sensor of the Multimeter. Also from the table it is clear about the start logging instance and stop logging instance of the Multimeter.

CONCLUSION AND FUTURE SCOPE

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.

Though this fridge is working satisfactorily to its full capacity, still many changes and improvements can be done in this fridge to make it more users friendly and sophisticated in nature. This measures and changes, if implemented can play an important role in the future models to be developed. Some of these measures and changes are:

Number of peltier units can be increased to further decrease the temperature inside the fridge. Same fridge can be used for heating purpose if we also insulate the other side i.e. heating side of the fridge within the box.

To increase the volume of the fridge maintaining the same temperature inside the fridge, number of peltier units and heat sink has to be increased.

PID controllers can be used for making it a temperature controlled fridge. This fridge can also be equipped with a LCD display and digital temperature sensor so that the temperature inside the fridge can bemonitored.

In this project, this fridge is made up of Thermocol and aluminium foils. Wooden material can be used to make this fridge mores sturdy in constructions. Wood will also act as an additional insulator for the cooling compartment.

REFERENCES

1. www.allaboutcircuits.com
2. www.hometoelectricals.com
3. www.peltie-info.com
4. Horway J B (1961), ―The Peltier Effect and Thermoelectric Transients‖, University of Louisvill.

5. Jaspalsinh B (2012), ―A Design Method of Thermo Electric Cooler‖, IJME, Vol. 5, No. 1, pp. 37-40.
6. MayankAwasthi, K V Mali (2012), ―Design And Development Of Thermoelectric Refrigerator‖, International Journal of Mechanical Engineering and Robotics, Vol. 1, No. 3, October 2012.