COMPRESSOR LESS SOLAR REFRIGERATOR

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ABSTRACT

The concentration of Carbon dioxide is increasing day by day due to increase in Industrialization and modernization which is causing several health and environment problems. Health related problems such as skin cancer, cataract, etc. whereas Environmental problems are drought, floods, etc. The increase in Carbon dioxide concentration and CFC's and HCFC's released by the several equipment also leads to the depletion of ozone layer causing Greenhouse Effect. The Equipment which causes this effect includes Refrigerator, AC's, etc. Thus, this project mainly focuses on solving this problem.

This paper is designed for implementation of compressor less solar refrigerator. In this solar refrigerator, we are using solar panels for charging a Lead acid Battery (12V, 7.5 Amp hr.), two Peltier thermoelectric device(20 W) which when connected to the battery generates cooling effect on inner side and the heat is generated on the other side which is drawn off using cooling fan of each of heat sink.

The Temperature Sensor senses the temperature and converts it into electrical signal which is digitally shown on the connected Mutlimeter. The main advantage of this project is that it is portable, economically cheap and eco-friendly in nature as Peltier device is used in place of Compressor.

Keywords: *Lead Acid battery, Peltier thermoelectric device, Temperature Sensor, Multimeter.*

1. INTRODUCTION

As we know Global Warming is increasing day by day and Electricity Generation is the leading cause in Industrial Pollution in our country. Since most of electricity is produced by nuclear, coal, and other Renewable Power Plants which caused adverse impact on our environment, polluting our air and land. Thus, we can use Renewable Energy resources to produce electricity without producing Carbon Dioxide with fewer environmental impacts.

In our project, we are using solar energy as Renewable Energy resources to power the unit, allowing it to be completely off of the Electric Grid. The basic principle of an Absorption Refrigeration System is that it uses a source of heat to provide the energy needed to drive the cooling process. If we use solar power to provide heat to such a system, it may do so in two forms, Thermal or Photovoltaic. Solar Thermal harnesses solar heat directly using focused mirrors to heat a transfer fluid whereas Solar Photovoltaic uses solar panels that operate using the photo-electric effect to produce DC current which can be inverted to power AC Electronics and can also be used to create heat via a Resistive heat source. Since it is a Renewable source of energy it can widely use in various Industrial and Domestic Applications.

Fig-1: Compressor Less Solar Refrigerator

This system consists of Solar Panel, two Peltier devices, two Battery, Temperature Sensor, two cooling fan with heat sink attached with each peltier device and insulating material Thermocol. The Solar Panel is applied to convert heat energy into electrical energy which is used to charge Lead Acid Battery (12 V, 7.5 amp hr). Peltier Thermoelectric device which is connected to the battery is used to generate cooling effect inside the cooling chamber from both sides which is drawn off by the cooling fan of heat sink attached to each device on both sides of refrigerator. The cooling Effect generated by both peltier devices is sensed by the Temperature sensor attached between the heat sink and peltier device inside the cooling chamber, which is digitally shown by the Multimeter.

The objective of this project is to design Compressor less Solar Refrigerator which utilize Peltier Effect to refrigerate and maintain a specified temperature in cheaper and eco-friendly manner.

2. WORKING SETUP:-

In this project, we have used various equipment and materials for proper functioning and performance of the refrigerator. These equipment and materials are as follows:

2.1 **Peltier device:** The two Peltier module device used in this refrigerator is TEC1-12706. It works on 12V DC and takes maximum current of 6A at full load, having power rating of 92W.

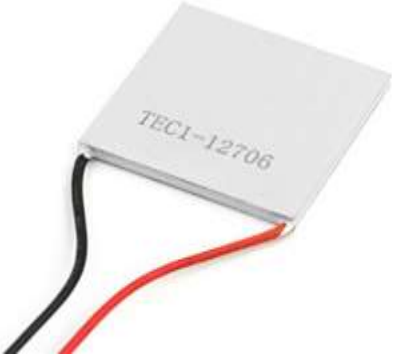

Fig-2: Peltier device

2.2 Solar Panel: Solar Panel is a device that absorbs the sun's energy in form of photons, which are very small packets of Electromagnetic Radiation energy and convert them into electric current which can be used to power electrical loads. Hence, in this project solar panel is used for charging the battery.

Fig-3: Solar Panel

2.3 Cooling Fan: In this project, we have two cooling fans which are respectively mounted on each heat sink attached to both Peltier devices from both sides of refrigerator. The main purpose of this equipment is to dissipate heat from the heat sink by taking fresh air. The cooling fans used in this refrigerator works on 12 V DC and draws 0.18 A having power consumption of 2.16 W of each fan.

Fig-4: Cooling Fan

2.4 Battery: In this refrigerator, the main Battery (7.5 amp hr. 12V) is used to provide electrical source to both peltier device and cooling fans whereas the secondary battery is used to provide electrical source to temperature sensor and digital meter. Both battery are connected to solar panel which provide charging of battery from solar energy.

Fig-5: Battery

2.5 Heat Sink: The heat sink used in this refrigerator is of dimension 7.5cm x 8cm x 4.5cm (L x B x H). The main purpose of heat sink is to expel heat from a generating source i.e. Peltier device.

Fig-6: Heat Sink

2.6 Insulation Material: In our project, we are using Thermoplastic as an insulation material. Since they can be repeatedly heated, softened, and formed into any shape when hot, due to their chain of molecules that separate when heat is applied which makes it a great insulation material. They are usually lower in cost, light in weight and easier to color which makes them economically cheap and portable to use.

3. DESIGN ANALYSIS:-

3.1 WORKING:

The Refrigerator is provided power supply from a 12V DC 7.5 A battery which is charged by 12V Solar panel by converting solar energy into electrical energy. To start the Refrigerator, the switch is turned on which leads to glowing off LED light indicating that the refrigerator is online.

Now the two Peltier Device (TEC1-12706) which are insulated on both sides of refrigerator (i.e. insulated thermoplastic box), generates cooling effect on inner side and heat is dissipated on outer side. On the heat side of the Peltier device, a heat sink along with cooling fan on both sides works to dissipate the heat from the peltier unit to environment. The peltier device is properly arranged in a proper insulation system and heat sink to

get efficient cooling effect at all the time when the refrigerator is ON. The cooling effect generated by the Peltier device inside the refrigerator is automatically sensed by the Thermostat placed near the cooling side of the peltier device, and then the cooling rate is digitally shown on the Digital-meter. The secondary battery of 12V DC 7.5 A is used to supply power to thermostat and digital-meter while the main battery supplies power to peltier device and thermostat.

To turn OFF the refrigerator, the switch can be turned off, which stops the glowing off the LED light indicating the refrigerator is OFF.

3.2 OBSERVATION:

For proper evaluation of performance of our Compressor less Solar Refrigerator, we tested it in a room temperature and the data is recorded.

	Start Time	Atmospheric temp.	Cooling temp.	Description
1	10:15 AM	35°C	35°C	Stable
2	10:16 AM	35°C	34.6°C	Stable
3	10.17 AM	35.2°C	33.7°C	Stable
4	10:18 AM	35.3°C	32.8°C	Stable
5	10:19 AM	35.2°C	31.9°C	Stable
6	10:20 AM	34.9°C	30.0°C	Stable
7	10:21 AM	34.8°C	29.1°C	Stable
8	10:22 AM	34.7°C	28.2°C	Stable
9	10:23 AM	34.9°C	27.3°C	Stable
10	10:24 AM	35.0°C	26.4°C	Stable
11	10:25 AM	35.1°C	25.5°C	Stable
12	10:26 AM	35.3°C	24.6°C	Stable
13	10:27 AM	35.4°C	23.7°C	Stable
14	10:28 AM	35.5°C	22.8°C	Stable
15	10:29 AM	35.7°C	21.9°C	Stable
16	10:30 AM	35.9°C	20.0°C	Stable
17	10:31 AM	36.0°C	19.1°C	Stable
18	10:32 AM	36.2°C	18.2°C	Logging out

Table-1: Obseravtion Table

From the data recorded in the observation table, following observations can be made:-

- Initial Cooling Temperature = **35ºC**
- Starting Time = **10:15 AM**
- Final Cooling Temperature achieved = **18.2ºC**
- Final Time = **10:32 AM**
- Average Cooling Rate = **0.9ºC / min**

3.3 Coefficient of Performance Calculation (COP)

COP is as measure of the performance of a heat pumping device. It is defined as the heat required removing the heat divided by the actual heat removed. The device was measure to draw 5.2 Amps of current at 11.2 Volts. This results in a power consumption of 58.5 Watts.

For the calculation of COP, it was assumed that only the air inside the box was cooled together with the aluminium heat sinks. Heat loss from the inside of the cooler to the outside was assumed to be zero during the cooling of the box as it is a transient process.

it took 6000 seconds for the temperature of the air to reach 5 degrees Celsius from a starting temperature of 20 degrees Celsius. The volume of the inside air is 0.015625m^3 and the volume
of the internal heat sinks are 2*0.0001487m^3. Using:

COP = P (delivered) * time / [MC(T2-T1)|air +MC(T2-T1)|aluminium]

Where:
P (delivered) = (5.22A)(11.2V)(6000s) = 351 KJ

MC(T2-T1)|air = (0.015625m^3*1.2kg/m^3)*(1000J/KgC)(25-15)=281.25 J

MC(T2-T1)|aluminium=(2*0.0001487 m^3*2700 kg /m^3)(900 J/KgC)*(25-15) = 10840J

Then:
COP = 11121.25/351,000
COP = 0.0317

4. RESULT:-

4.1 CONCLUSION AND FUTURE SCOPE:-

In today's Era, Solar Power is widely used in meeting the energy requirement of our country. Being developed at a very fast rate, its applications have been explored in many areas. The Refrigerator 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.
The main objective was to develop a Compressor less Solar Refrigerator and it has been successfully done. The application of this Refrigerator can be enormously used in various places for variety of operations.

Though this refrigerator is working successfully to its full capacity, still many changes and improvements can be made to make it more user-friendly and sophisticated in nature. Some of these changes are:

1. We can increased the number of Peltier units by keeping the size of refrigerator same and further decreasing the temperature inside it.

2. Same refrigerator may be used as a heating unit, if we introduce the heating side of the refrigerator inside the system.

3. We can also increase the volume of refrigerator by increasing the heat sink and peltier unit, while maintaining the same temperature inside the refrigerator.

4. We can increase the efficiency of our refrigerator by using wood instead of thermoplastic as an insulation material. Since wood acts as an additional insulator for cooling compartment.

5. The application of this refrigerator can also be used in Four Wheeler by installing it at the time of manufacturing of vehicle.

6. APPLICATION:

1. **At Remote places:** It can be used at backward and remote places where there is scarcity of electricity.

2. **In Restaurants or hotels:** It can be used for preservation of perishable items.

3. **Laboratory:** It can be used for preservation of several chemicals in lab and as well as in scientific instruments.

4. **Medicinal and Pharmaceutical Equipment:** It can be used for preserving the medicines and injections at cool temperature specially at Primary Heath Care Centre's and Pharmaceutical shops where there is sporadic and no power supply.

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