

Solar Refrigerator

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Abstract— This paper is a demonstration of an eco-friendly methodology for the implementation of solar powered thermoelectric refrigeration system. Solar energy is the most abundant and renewable source of energy in environment, and hence it is used in our paper. In conventional refrigerators, moving parts or rotating parts like compressor, expansion valve, coolants etc. are involved which leads to some vibrations and noise. Even coolants are not eco-friendly and much more costly. But in thermoelectric refrigeration system, these mechanical parts and coolants get eliminated and a thermoelectric module is used instead. Still there are many rural areas where people have to deal with electricity problems; this module will be very helpful to them as it runs on solar energy. Food items and other different required things can be stored in it. The paper is designed for implementation of solar fridge with temperature monitoring as well as controlling. This implementation uses solar panels for charging a Lead Acid Battery (12V, 7.2 Amp hrs.), a peltier thermoelectric device which when connected to battery generates cooling effect on one side and heat is generated on the other side which unwanted and is drawn off using a cooling fan of heat sink.

Keywords: Solar Refrigerator, Cooling, Peltier Effect, Solar Energy

I. INTRODUCTION

The principle of SOLAR REFRIGERATOR is based on the basic concept of solar energy and Peltier effect. As we know that the globalwarming is being increasing year by year and thereasons for this increase may include pollution, deforestation, water contamination, etc. By keeping in mind this severe problem, we are designing a mini solar based refrigerator which is cheaper as well as eco-friendly. Solar energy is emerged as a vital source of energy over the past two or three decades. As this is renewable source of energy which can be generated again and again it is widely used for a variety of industrial and domestic applications. Some systems based on a solar collector are designed to collect the sun's energy and to convert it into either electrical power or thermal energy.

Domestic cooling systems such as refrigerators, Ac's 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 (peltier coolers) offer many advantages over domestic systems.

The methodology used in this paper is descriptive, library and analytical. The descriptive aspect of this paper is based on identification of its required materials and information has been compiled using related scientific papers.

II. NEED OF SOLAR REFRIGERATOR

Eco-friendly cooling is very important to the entire world today. Due to the difficulty in disposal of Chlorofluoro carbon (CFCs) and Hydro Chlorofluoro carbons (HCFCs), conventional sources are being used so as to decrease the environmental degradation. As mentioned in the past years, fluoro carbons were used in the refrigerators, Using the CFC's and other gases have caused and continuously cause serious problems, such as air pollution, global warming, and the rapid depletion of the Power resources.

Solar energy being abundant in nature, thermo electricity can be used in the generation of power for cooling and heating applications. Therefore, the need of thermo electric refrigeration is on demand particularly for the upcoming developing countries where long life of appliances and low maintenances are needed.

Here are few of the top advantages of having a solar refrigerator-

- Environmentally friendly.
- Financial benefits.
- No more dependency on Electricity.
- Temperature monitoring over an app.
- Built from light materials.
- Higher resale value.

III. SOLAR REFRIGERATOR

The block diagram representation of the solar refrigerator is shown below. This figure describes how the renewable source of energy are producing electricity which are further stored in the battery. Now the peltier module used in the refrigerator uses the power from this battery and make the exhaust fan in motion.

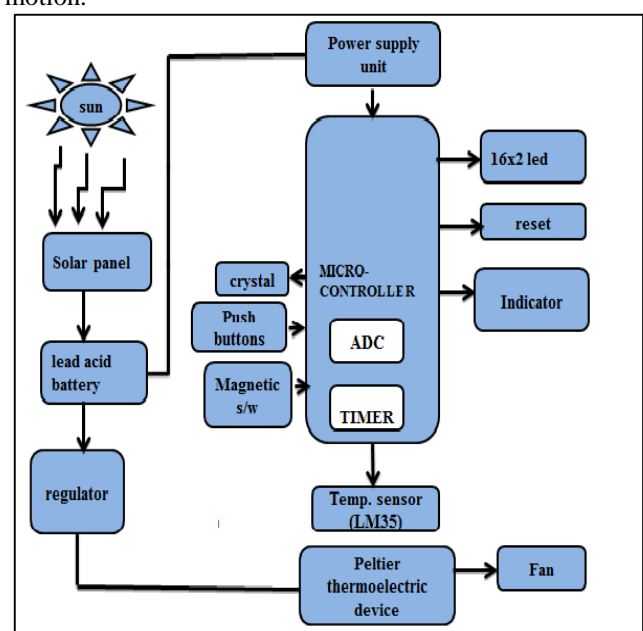


Fig. 1: Block Diagram

The inner cabinet is made air tight with 4 mm of medium density fiber board which is internally covered with aluminum sheet from all sides having a total capacity of 12.5 liters. The cabinet is insulated by 3 cm thick polystyrene sheet from outside for thermal insulation from surrounding and the polystyrene sheet is covered with 4 mm of medium density fiber board for maintaining the rigidity of the cabinet. The door is attached with hinges for better and easy movement of it.

IV. COMPONENTS USED

SOLAR REFRIGERATOR is extracting electricity and LDR sensor is mounted on the both end of solar panel to rotate via gear motor so that the panel absorbs most of the sunlight.

A. Solar Energy:

It comes with a solar panel which feeds nearly 12 V to the battery. A solar panel of rating 12V/7.2A is mounted separately to the solar refrigerator as shown in the figure below. Solar panels arranged to generate electricity are becoming more and more frequent these days. Electricity generated from solar panels are free, nearly infinitely abundant, and non-polluting.

The main source of solar panel is Sunlight. Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. As long as the sun is present the battery will never run out empty and even if the sun is not present at that time there are other sources.



Fig. 2: Solar Panel

B. Fan:

Many older refrigerators and most small refrigerator do not have fans but modern frost-free refrigerator has two. One is under the refrigerator to cool the compressor and force air through the exterior coils and second is inside and moves air around the coils inside the refrigerator. This second fan helps provide more even cooling.

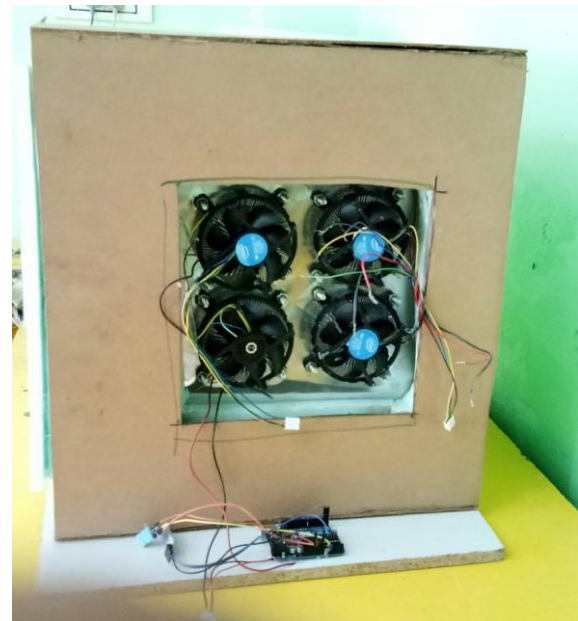


Fig. 3: Cooling Fan for Peltier Module/Chip

C. TEC Module:

A typical thermo electrical (TE) module is composed of two ceramic substrates sandwiching many pairs or “couple” of bismuth telluride dice. Alumina ceramic substrates are commonly used for making TE modules.

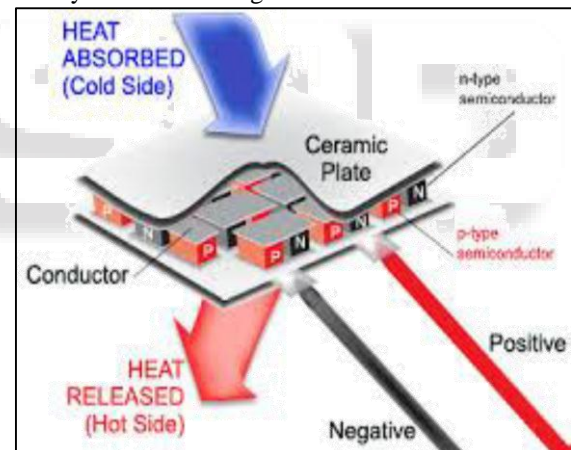


Fig. 4: Peltier Module/Chip

D. Heat Sink:

A heat pump is a machine or device that device that moves heat from one location at a lower temperature to another location at a higher temperature using mechanical works or a high temperature heat source. Thus heat pump may be thought of as a “heater” if the objective is to warm the heatsink or a refrigerator if the objectives is to cool the heat source.

E. Cooling Chamber:

It is the cabinet where the refrigeration effect is produced. It also consists of heat sink, tec plate, and fan. It is fabricated with inner volume. The volume of the chamber is kept low for better insulation purpose. For better cooling aluminum casing is done in the inner side of insulation.

F. Temperature Sensor:

The temperature sensor(LM35) senses the analog temperature generated by peltier device and provide it to the inbuilt ADC of PIC 18F4520.

With the help of Solar Refrigerator the need of eco-friendly refrigeration is possible at very low cost and can be affordable to every groups of society. It's mechanism will successfully replace the current refrigeration system. It is light weighted low power environment friendly refrigeration technology designed to cut the electricity cost and use the renewable energy resources. It offers an excellent opportunity to develop further technologies that can be applied to practical application.

V. SPECIFICATIONS

The specifications of the different components used in the Solar Refrigerator is given below-

S.no	Component Used	Rating
1	Solar Panel	12 V/7.2A 160W
2	D.C Brushless Motor	12V, 150rpm
3	LDR Sensor	5kohm
4	Battery(Lead Acid)	12 V, 7.2Ah
5	Peltier Module	TEC1-12706

Table 1: Specifications of different components used

Specific attention was paid for the specification and rating of components at the time of designing ensuring high reliability, eases of manufacture and light weight construction without compromising efficiency of refrigerator. The motor used is Brush Less DC Motor for the rotation of Solar Panel and the portability of the batteries is a high value concerned and shall be met with proper result to the refrigerator. The battery will be reused for further purposes and can be charged by solar energy whenever required.

VI. ADVANTAGES

- Light weight and compact for very small heat loads.
- Reversing the direction of current. Transforms the cooling unit into a heater.
- Operates in any orientation. Not affected by gravity or vibration.
- Very low cost device for cooling in small appliances.
- Precision temperature and control capability.
- Saves electricity.
- It can be used at backward and remote places where there is scarcity of electricity.

VII. CONCLUSION AND FUTURE PROSPECTS

Solar power nowadays is playing a major role in meeting the energy requirement 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.

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:

- 1) Number of peltier units can be increased to further decrease the temperature inside the fridge.
- 2) 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.
- 3) 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.
- 4) This fridge can be made of the wooden material to make it more sturdy in constructions. Wood will also act as an additional insulator for the cooling compartment.
- 5) This fridge can be installed in the four wheeler at the time of manufacturing of vehicles.



Fig. 5: Solar Refrigerator

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