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Thermoelectric Refrigerator Using Peltier Effect

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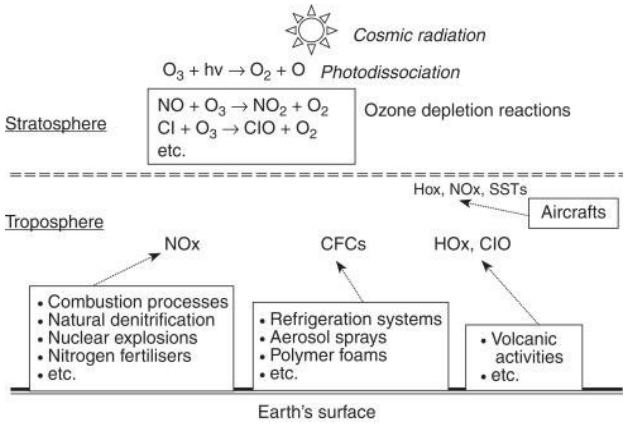
Abstract: *This project is a demonstration of an eco-friendly methodology for the implementation of a solar powered thermoelectric refrigeration system. Solar energy is the most abundant and renewable source of energy in the environment, and hence it is used in our project. In conventional refrigerators, 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 a 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. Thermoelectric module consists of peltier plates and a heat sink module which will be placed on each side of the peltier device. We are using a microcontroller for this project to detect the temperature and display it to the user.*

Keywords: Microcontroller, Peltier, Refrigerator, Sensors, etc.

I. INTRODUCTION

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. Use of these kind of refrigerators are forbidden as this led to derogation of ozone layer. Moreover, the problem regarding environment is piling up in recent years. Presently the energy saving strategy is one of the top most priority of the world. In particular, the sector of cooling having a heavy influence on the total electrical energy consumption and hence need to be optimized so as to increase the overall performance. 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 thermos-electric refrigeration is on demand particularly for the upcoming developing countries where long life of appliances and low maintenances are needed.



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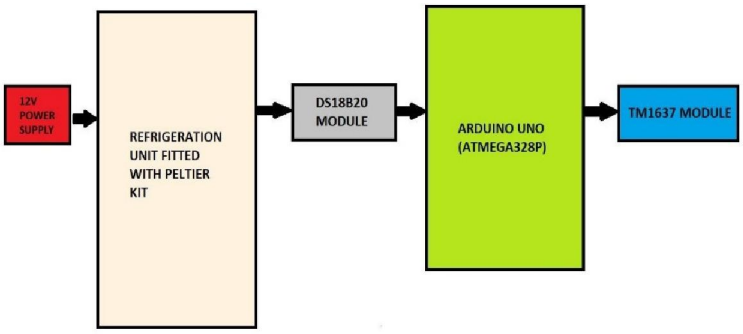
The working of thermo-electric module is based on the peltier effect in which a temperature difference is developed between the two junctions of the thermocouple due to which one side of the peltier becomes cold and other hot. In refrigerator space, cool side of the thermocouple model is used whereas hot side is used for the rejection of heat to atmosphere with the help of heat sink. The size of the peltier varies from very small to very large size according to the requirement and application.

II. PROPOSED SYSTEM

Below shown is the block diagram representation of the " Thermoelectric Refrigerator using Peltier Effect ".



1) Microcontroller:

The Arduino Uno is a small, complete, and breadboard-friendly board based on the atmega328 (Arduino Uno 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

Figure: Arduino Uno Board.

2) DS18B20 Module:

This sealed digital temperature probe lets you precisely measure temperatures in wet environments with a simple 1-Wire interface. The DS18B20 provides 9 to 12-bit (configurable) temperature readings over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor.

Figure: DS18B20 Module

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3) TM1637 Module:

TM1637 is a kind of LED (light-emitting diode display) drive control special circuit with keyboard scan interface and it's internally integrated with MCU digital interface, data latch, LED high pressure drive and keyboard scan.

Figure: TM1637 Module

4) TEC1-12706 Module:

Peltier Element TEC1-12706 is thermoelectric cooling element that uses the Peltier effect to create a heat flux at the junction of two different types of materials. This version is supporting 12V and current rating of 6A.

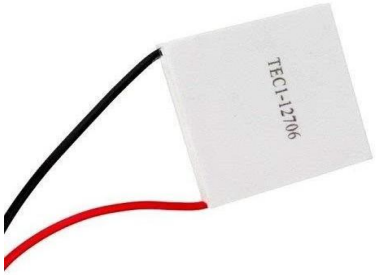

Figure: TEC1-12706 Module

5) DC Fan:

The direct current fans, or DC fans, are powered with a potential of fixed value such as the voltage of a battery. Typical voltage values for DC fans are, 5V, 12V, 24V and 48V. In contrast, the alternating current fans, or AC fans, are powered with a changing voltage of positive and of equal negative value.

Figure: DC Fan

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6) Heat Sink:

A heat sink is a component that increases the heat flow away from a hot device. It accomplishes this task by increasing the device's working surface area and the amount of low-temperature fluid that moves across its enlarged surface area.

Figure: Heat Sink

III. WORKING

The working of the system can be understood by studying peltier effect and then the step-by-step actual working of the system. Peltier effect, the cooling of one junction and the heating of the other when electric current is maintained in a circuit of material consisting of two dissimilar conductors; the effect is even stronger in circuits containing dissimilar semiconductors. In a circuit consisting of a battery joined by two pieces of copper wire to a length of bismuth wire, a temperature rise occurs at the junction where the current passes from copper to bismuth, and a temperature drop occurs at the junction where the current passes from bismuth to copper.

The working of Thermoelectric Refrigerator using Peltier Effect is explained step by step below,

- 12 V Power supply provided to DC fans and Peltier Module through SMPS.5V Power supply provided to Arduino Uno.
- Peltier Module heats from one side and simultaneously cools from the other side.
- Heat Sink and the Fan release the temperature on both sides of the Peltier Module in the atmosphere. Hence, the cool side is placed inside the refrigerator cabinet starts cooling the cabinet.
- The Temperature Sensor continuously senses the temperature and sends the input to the Arduino UNO.
- Arduino UNO then spends the output to the seven-segment display, which then displays the temperature inside the refrigerator cabinet to the user.

IV. ADVANTAGES

- No Moving Parts: A TE module works electrically without any moving parts so they are virtually maintenance free.
- Small Size and Weight: The overall thermoelectric cooling system is much smaller and lighter than a comparable mechanical system. In addition, a variety of standard and special sizes and configurations are available to meet strict application requirements.
- Ability to Cool Below Ambient: Unlike a conventional heat sink whose temperature necessarily must rise above ambient, a TE cooler attached to that same heat sink has the ability to reduce the temperature below the ambient value.
- Ability to Heat and Cool with the Same module: Thermoelectric coolers will either heat or cool depending upon the polarity of the applied DC power. This feature eliminates the necessity of providing separate heating and cooling functions within a given system.
- Precise Temperature Control: With an appropriate closed-loop temperature control circuit, TE coolers can control temperatures to better than +/- 0.1°C.

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- High Reliability: Thermoelectric modules exhibit very high reliability due to their solid-state construction. Although reliability is somewhat application dependent, the life of typical TE coolers is greater than 200,000 hours.
- Electrically "Quiet" Operation: Unlike a mechanical refrigeration system, TE modules generate virtually no electrical noise and can be used in conjunction with sensitive electronic sensors. They are also acoustically silent.
- Operation in any Orientation: TEs can be used in any orientation and in zero gravity environments. Thus, they are popular in many aerospace applications.
- Convenient Power Supply: TE modules operate directly from a DC power source. Modules having a wide range of input voltages and currents are available. Pulse Width Modulation (PWM) may be used in many applications.
- Spot Cooling: With a TE cooler it is possible to cool one specific component or area only, thereby often making it unnecessary to cool an entire package or enclosure.
- Ability to Generate Electrical Power: When used "in reverse" by applying a temperature differential across the faces of a TE cooler, it is possible to generate a small amount of DC power.

V. OBSERVATIONS

Sr. No.	Time (24hr IST)	Temperature ()
1	12:57	30°C
2	12:59	28°C
3	12:59	26°C
4	13:02	23°C
5	13:04	21°C
6	13:20	18°C

VI. CONCLUSION

The Thermoelectric Refrigerator is a perfect cooling unit which can be used by almost every category of user as it can be convenient, affordable, portable and at the same time eco-friendly. Hence, the project is of a great importance and a lot of future researches and development is a need of time.

VII. FUTURE SCOPE

- The Refrigerator requires a 12V power supply which can be provided using a solar panel, this makes the refrigerator eco-friendlier and more efficient.
- The outer casing of cabinet can be reconstructed with more heat insulating material, to increase the cooling effect.
- An automation of cooling can be done using the Arduino i.e., when the temperature goes down below a certain point the cooling unit starts and when it reaches a desired temperature the cooling unit stops.

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