Peltier Device Based Thermoelectric Generator

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ABSTRACT

Peltier device based thermoelectric generator is the environment friendly methodology than conventional cooling system. The main purpose to this system is cooling of different biomedical contents which are to be kept cold during travelling. Another purpose of this system is to design environment friendly cooling system. As in conventional cooling systems, there is lots of emission of gases which are harmful to environment as well as they harms ozone layer also. It leads to the severe problem like global warming. To overcome from this problem we designed a system which is friendly to the environment and which does not emits gases. Based on the theory given by scientists Thomas Seeback (1823) and Jean Peltier (1834) which are known as Seeback effect and peltier effect. We designed our system which is efficient and best alternative to the conventional cooling systems. When a DC current is passed through a Peltier device, the low temperature side absorbs heat and the high temperature side emits heat, so that a temperature difference exists across the sides of the peltier devices. A Peltier Module fitted between a aluminum cage and a heat extractor like an aluminum block for use as a cooling device is called a Cooler Unit. While using thermoelectric effect in system the efficiency of the system also increases. In this paper we give small details of thermoelectric generator. The model is tested and verified with proper hardware and software and results are found to be satisfactory.

KEYWORDS: - *Peltier Device, Thermoelectric Generator, Microcontroller (ATMEGA16), Temperature Sensor (LM35), Bluetooth Module.*

I. INTRODUCTION:-

As electrons move from holes to electrons i.e. p type to n type material, electrons jump to a higher energy state absorbing energy, in this case heat, from the surrounding area. The reverse is also true. As electrons move from n type material to p type material, electrons fall to a lower energy state releasing energy to the surrounding area. The thermoelectric phenomenon deals with the converting of thermal energy into electrical energy and vv. When operating as an energy-generating device the thermoelectric device is termed a thermoelectric generator (TEG). The source of thermal energy manifests itself as a temperature difference across the Thermoelectric Generator. When operating in a cooling or heating mode the thermoelectric device is termed a thermoelectric cooler (TEC). Thermoelectricity can be used for electric power generation (Seeback effect) or for heating/cooling application (Peltier effect). Thermoelectric camping coolers are because the lack of fluids and pumps makes TE option the most robust and reliable alternative for portable equipment. We make use of the property that when we apply a voltage to a thermocouple; a temperature difference develops between two junctions of the thermocouple. The direction of heat transfer is controlled by the polarity of the applied voltage.

The thermoelectric device produces heating or cooling that takes the form a heat sink which then creates a temperature difference across the Thermoelectric cooler. Thermoelectric devices are solid-state devices that are capable of producing three effects without any intermediary fluids or processes. With modern techniques, we can now produce thermoelectric modules that deliver efficient solid state heat-emitting for both cooling and heating. Many of these units can also be used to generate DC power at reduced efficiency. New and often elegant uses for thermoelectric continue to be developed each day.

II. PROPOSED SYSTEM ARCHITECTURE

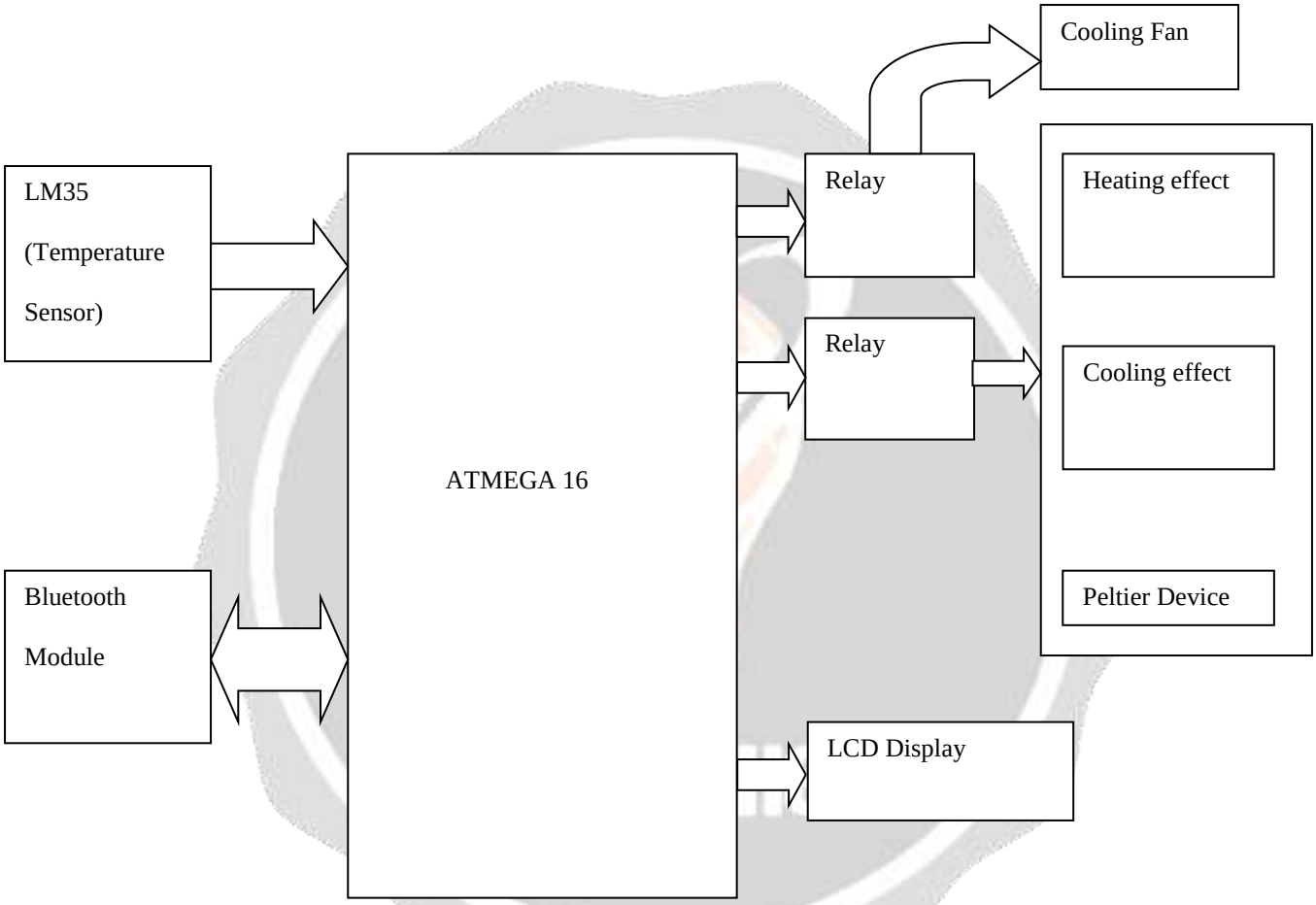

Figure1 - Block Diagram of Thermoelectric generator

For controlling we use the microcontroller ATMEGA 16. This device is used for cooling as well as heating effect but our main application is of cooling. So heating side or hot side is fixed with heat sink and cooling fans. On the other hand, cooling side is mounted with Styrofoam material for keeping material for cooling.

When we give power supply to peltier device, it starts cooling as well as heating rapidly in some seconds. The temperature on both sides of model is measured by temperature sensor LM35. Measured temperature is then sending to microcontroller and microcontroller displays temperature on LCD display.

On the other hand, Bluetooth module is connected in model for wireless controlling by mobile. One application is designed for controlling the Bluetooth module. By using mobile we can set the temperature of model. Relays are used for switching the cooling fan and peltier device. Microcontroller ATMEGA16 is programmed in such a way that it can control Bluetooth module, temperature sensor and LCD display.

The detailed description of the different modules used in the project. The different Modules are:

- Refrigeration unit(Aluminum cage)

  The Refrigeration unit consists of a Peltier element attached to an insulated aluminum enclosure. The Peltier element is attached to a heat sink to dissipate the heat generated during thermoelectric cooling. A switching circuit is also used to change the polarity of the current being given to the Peltier element. This enables the user to use the device for cooling as well as for heating, according to his requirements. A 12 volt fan is also fitted in the enclosure to blow the cool air from inside the enclosure to its immediate surroundings. This aluminum cage is surrounded by Styrofoam material on both sides. One side is fixed with cooling fans and heat sinks and other side is kept open for cooling.

- Temperature sensor unit(LM35)

  LM35 temperature sensor is placed inside the enclosure to sense the temperature. The Temperature sensor circuit consists of a LM35 temperature sensor that is connected to an LCD, after interfacing it with microcontroller ATMEGA16, to display the temperature in the enclosure. Temperature sensors are connected on the both sides to measure minimum as well as maximum temperature of the device. LM35 is designed to operate over a temperature range -55 degree C to +155 degree C. there are various temperature sensors available in market such as LM35C, LM35CA, LM35D, TO46, TO220, TO92 transistor packages.

- Peltier control unit(TEC1-12706TEC125)

  The Peltier device connected to circuit is used for cooling as well as heating effect. Different relays are used for switching purpose. The peltier device consists of two different metal plates for conducting maximum as well as minimum temperature. P and N type of semiconductors are placed between these two metals. By combination of holes and electrons there is absorption and dissipation of heat from two sides of peltier plate. Peltier plate requires minimum 10 mW current supply for heating and cooling operation. It takes very less time for cooling as well as heating. Peltier plates can generate maximum of 80 to 100 degree C and minimum of 1 to 5 degree C temperature.

- Bluetooth Module unit(HC05/06)

  Bluetooth module is used in model for controlling the temperature wirelessly by using mobile application. A Mobile device which includes application for controlling temperature is connected to Bluetooth module. Bluetooth module is connected to microcontroller for controlling the temperature. Bluetooth module has a 2.4 GHz digital wireless transceiver. The range of Bluetooth module is upto 100m distance. As we select one value of temperature in mobile device, Bluetooth module sends information to microcontroller and device obtains that temperature by switching.

- Microcontroller unit (ATMEGA 16)

  It is a 40 pin 8 bit IC used in project for controlling as well as transferring the data. Microcontroller controls LCD display, the data coming from temperature sensor is displayed on LCD display with the help of microcontroller. Bluetooth module is connected to microcontroller by which we can connect mobile device to the microcontroller. The data coming from mobile device is transferred to microcontroller with the help of Bluetooth module. In our device we are using AVR type ATMEGA 16 microcontroller. This microcontroller has 4 sets of connections for input and output data. There are 32 programmable input output lines. Microcontroller has 4 ports namely port A (PA0-PA7), port B (PB0-PB7), port C (PC0-PC7) and port D (PD0-PD7). It contains six sleep modes like Idle. Power down, Power save, ADC noise reduction, Standby, Extended Standby.

III. RESULTS

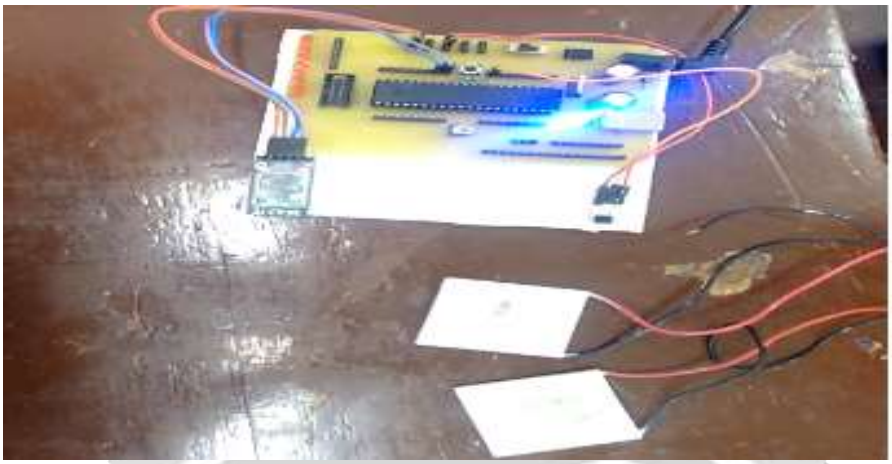

Figure2:- Complete Circuitry of Thermoelectric generator

As we see in the figure 2, complete circuitry is shown. When we give power supply of 12 V to the circuit, it is used to for microcontroller and bluetooth module. A separate power supply is given to the peltier plates. As we give 12V DC to peltier plates, they suddenly starts cooling and heating at both sides. Our application is of cooling so we design model in such a way that cooling side kept open and on heating side, we fixed cooling fans and heat sink.

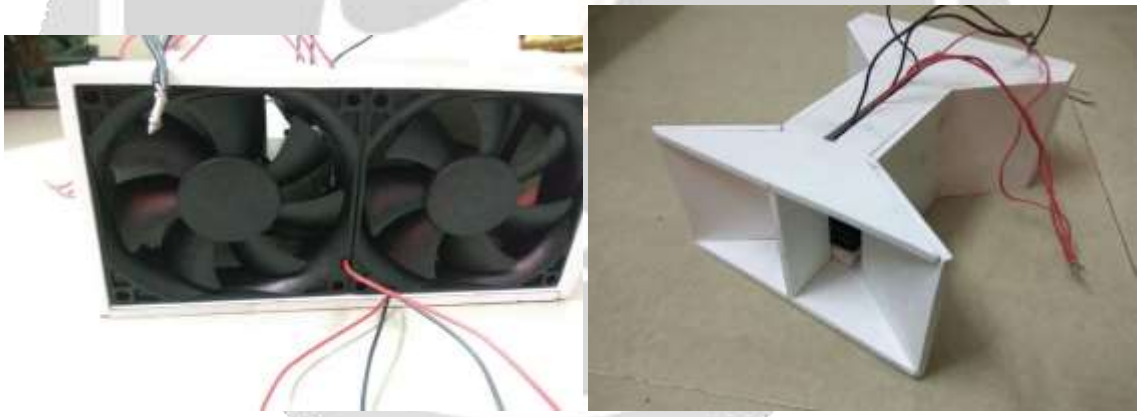

Figure3: Cooling and heating sides of thermoelectric generator

When temperature goes higher than desired value, cooling fans automatically starts and they maintain the temperature of the device. As we see in figure3, cooling side is kept open for the purpose of keeping objects as we want to keep cool. Cold temperature is kept controlled continuously by using mobile device and Bluetooth module.

As a result, our system gives minimum 1 to 5 °C temperature as our requirement and maximum temperature upto 50 to 70 °C which is exhausted using cooling fans and heat sink.

IV. CONCLUSIONS:-

- Thermoelectric cooling added a new dimension to cooling. It has major impact over conventional cooling system. It is compact in size, no frictional elements are present, no coolant is required and weight of the system is low.
- The temperature vary from 5 °C to 20 °C with temperature variation within the Thermoelectric cooler is less than 1 °C as this was we can achieve even lower temperature. The power required for this device to change temperature per °C is 10 mW
- From the above review paper, it can be inferred that thermoelectric technology using different modules used for cooling as well as heating application has considerable attention. Many researchers try to improve the efficiency of the thermoelectric air-conditioner using different material.

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