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Smart Peltier Thermoelectric Cooling System

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Abstract: *It generally say 'Energy can Neither be Created Nor be Destroyed', only it can be transformed from one form to another form. This is the Universal Truth and in concern with that many scientists given their laws. The existing air conditioning system works on the compressor and these depends on refrigerant gases like Freon, Ammonia, CFCs etc. One of the major disadvantages for these refrigerant gases are global warming and harmful gas emission which contributes in environmental problems. So, to reduce the intensity of the discharge gases eco-friendly alternative had found. Research shows that thermoelectric cooler is the best option for this problem.*

Motive of this project is to analyzed the working of the TEC and to design the system. The system uses TEM which works on Peltier effect. This is the effect whereby heat is given out or absorbed when an electric supply is given across a junction between two semiconductor materials. One surface of the module gets cool and the other surface become hot. On this phenomenon this project had developed, a new air conditioning system which works on Peltier effect of thermoelectric module (TEM) which is completely eco-friendly air condition and portable, no vibration, Small in size unlike the existing cooling system.

In the project it is analyzed to protect the environment, these problems can be solved by using thermoelectric modules (Peltier Modules). This advancement is very useful to reduce the pollution and is according to conservation of energy. This model can be implemented in the application for compact, in undesirable vibration. This project has one more parameter where the cooling system is controlled wirelessly with the help of mobile application to make the system more convenient and advanced..

Keywords: Air Conditioning, Eco-friendly, Peltier Effect, Thermoelectric Module (TEM), Thermoelectric cooler (TEC)..

I. INTRODUCTION

Refrigeration, including air conditioning and other conventional cooling systems are necessary in life and will continue to expand worldwide. But its impact on environment is huge ascompare to its cooling purpose. In fact, one kilogram of the refrigerant has the same greenhouse impact as two tons of carbon dioxide, which is the equivalent of running your car for six months.

Many efforts have already been made. However, reduction in CO2 emissions and fluorinated gas emissions are challenges to be addressed on an ongoing basis. As heat carrier fluidsin conventional refrigeration systems has become a subject of great concern and resulted in extensive research into development of refrigeration technologies. It is found by some researchersthat Thermoelectric operated devices can be the best alternative in refrigeration technology due totheir distinct advantages.

According to applications, refrigeration consists of air-cooled, water- cooled and compression type refrigeration. In certain situations, temperature control system often needs to have heating and cooling functions at the same time, then the temperature control method is not convenient. And the semiconductor temperature control system which uses the thermoelectric cooler as the executive device of the temperature control can convert the refrigeration and heating by changing the direction of the current flow through the cooler, which is very convenient. Meanwhile, due to the semiconductor temperature control system using the Peltier element, so compared with the traditional temperature control method, it also has the advantages of small volume, light weight, long service life, no noise, no mechanical movement, rapid refrigeration, high precision temperature control, no need of refrigerant, no pollution to the environment.

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1.1 Objective

Objectives of Smart Peltier Thermoelectric Cooling System are as follows.

- Designing an alternative and efficient system for cooling.
- Experimental analysis of performance of thermoelectric cooler to cool the required space using Peltier effect.
- To Reduce the Cost of Air Condition that is process cost and maintenance cost and increasethe efficiency of system.
- To reduce the greenhouse gases emissions by designing eco-friendly alternative forconventional cooling system.
- Exploring methods to improve the efficiency of Peltier cooling systems and study theadvancements in the field of thermoelectric.

II. METHODOLOGY

An experiment was conducted by the researcher in one of the paper which identify the behaviour of TEC under availability of different cooling mechanisms at the hot surface. The researcher has conducted test in 3 different cases and results were obtained.

Case1: TEM is used alone, case2: Heat sink isplaced on the TEM and case3: Heat sink and fan is placed on the TEM

For case 1 result is observed that while using the TEM alone the cold surface temperature was not able to maintain the constant temperature and the desired value. After some time the temperature is drastically increased.

For case 2 results shows that there was slight improvement in the system ,by using heat sinkthe hot surface dissipate heat more efficiently. Cold surface has reduce its temperature to 20°C within 30 seconds. But after some time the cool surface temperature has started increasing.

For case 3 results shows better improvement in the results when the heat sink and fan has used. The cool side temperature has reduce till 17°C and that temperature is maintain constant .

According to results, it is prove that a TEC cannot be used alone without a proper cooling mechanism at the hot surface. And using only a passive cooling would not be sufficient for the System to maintain the cold side temperature. The heat should be removed efficiently by combiningboth active and passive cooling.This project is created by combining three main circuits namely Microcontroller, Peltier Module, Power supply unit. This project required a lot of procedures from getting information about how each part functions, what are previous researches has been done based on this, software learning, constructing the circuit and combining all the three circuits with other parts like Temperature Sensor, LCD Display, Draught fans etc.

The Peltier Module and all the components using each circuit is important in order to understand the process and details on how this circuits operates in individual and when it is combined. While making hardware model of this, it is important to know various graphs like voltage v/s Temperature. By considering their variation active cooling technique (Heat sink+Draught fan) is used. Based on all information gathered all three circuits have different functions but receiving the same power supply from the SMPS. The function of each circuit is explained with the help of block diagram (Fig) to clearly illustrate how all circuits flow. After once the hardware model has been done it get tested and optimization of it can be done.

Later optimization final submission has been done.

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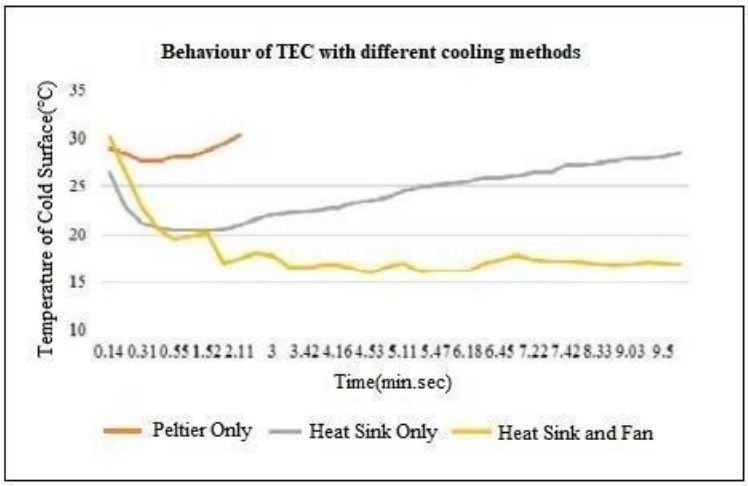

III. PROBLEM STATEMENT

One surface of the TEM starts absorbing heat and one surface starts releasing heat when the voltage is provided, this is done to maintain the temperature gradient between two surfaces ofTEM. But the problem occurs when the TEM is used alone for few minutes the cool side temperature starts to increase. If the TEM is used for cooling purpose then the heat from the hot side should be dissipated outside the system. If the heat is not properly removed from the hot surface, then to keep the cold side temperature would be an issue. However, it affects the performance and efficiency of the cooling.
Solution: To stop the heating problem in the TEM has not been discussed, but it can be overcomeby using the passive cooling and active cooling. With the forced convection the heat from the hot side of the module can be efficiently dissipated outside and will help in maintaining the cool surface temperature.
In the above research paper, the COP (Coefficient of performance) of the system is said to be concern regarding the performance. The mathematical calculations highlighted that the coefficient of performance of the TEC is less as compare to conventional cooling system.

Solution:

One of the papers has given the solution on this problem, by using the multi-stage thermoelectric module. The researcher has used 3-stage (multi-stage) module instead of singlestage module and the mathematical calculation come to a conclusion that by comparing the performance of the two modules, the coefficient of performance of the multi stage module is much greater than the single-stage module. But the only disadvantage of the multi stage module is that the cost of the module is very high.
If constant voltage (7V) supply is given or below that to the TEM module, this will help to not increase its cool side temperature and which will automatically help to increase the Coefficient of performance.

IV. CONSTRICTION & WORKING

Sr.No	Parameter	Material			
		Acrylic Sheet	Thermocol	Styrofoam	Nitrile Sheet
1	Thermal Conductivity	0.19 W/mK	0.0245 W/mK	0.033 W/mK	0.24 W/mK
2	Density	1.250 g/cm^3	0.02 g/cm^3	0.05 g/cm^3	1 g/cm^3
3	Tensile strength	69 MPa	13 MPa	34 MPa	9MPa
4	Cost	200/- (12”X 12”)	50/- (20”X 10”)	150/-(30”X 20”)	1500/- (1 m X 1 m)

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V. WORKING OF PROJECT

Initially the ambient temperature is 31℃, so the internal temperature of the block will be same. The cooling system has run for about 35 min with insulation and without insulation, and thefollowing results shows the performance of the system.

Case 1:

Without insulation provided to walls (only acrylic sheet), the internal temperature of the block iscooled down to 23.9 ℃. Figure shows the same.

Case 2:

With insulation provided to walls (acrylic sheet + styrofoam), the temperature of the block is cooled down to 21.7 ℃. Figure shows the same.

Figure shows how the arrangement looks from internal side i.e actual space with 30cmx30cm x 30cm container. Cold side of the two cooler system is placed from the inner side of the container, which has cold side heat sink and air circulating fan. With the help of this fan air is continuously circulated in the container, due to which temperature in the whole container is maintained constant

Figure. With acrylic sheet.

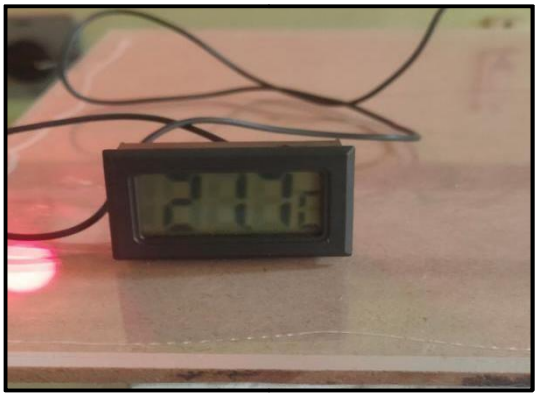

Figure. With acrylic and styrofoam.

Figure. Internal Cooling System

VI. CONCLUSION

The Project titles "**Smart Peltier Thermoelectric Cooling System**" is carrying out at very understanding way and each step was followed to make this project transparent, understanding anddomestically useful purpose.

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The project idea is very clear that to make an alternative on cooling system. Not only this but in addition on that system should be portable, not complex, Environment friendly, compact in sized and maintenance free. The objective is to cool the particular volume of room. Making the collection of data and various sheets according that made our choice very clear. Understanding the dependency of COP on various parameters and cooling methods is also taken into considerations. In this project both mathematical as well as practical outcomes has done and from the results it is clear that TEM (Thermoelectric Module) cooling system performance is less as come to conventional cooling system. Time required to cool up to that temperature is quite high as compareto conventional cooling system.

The main thing got here is that various methods to analyse the working of Thermoelectric Module.The social relevance for the project is that it does no discharge harmful gases, hence it as an Eco friendly system. But, as per observations there is a huge scope of research in this field about thermoelectric materials, its fabrication(multistage TEM module), heat sink design.

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