

## Smart Jacket Using TEC Plate

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### Abstract:

Un-compensable Heat Stress (UHS) is a hazardous and potentially fatal physiological state that occurs when the cooling required to maintain a steady thermal state is more than the cooling capability of the environment. This requires additional support to cool the body until a comfortable temperature.

Soldiers work in remote areas where climatic conditions change extremely. The main climatic conditions are very high and very low temperatures. To increase productivity reduce fatigue assisting is needed to lead to a safer working environment.

Traditional systems available in the market can either perform only one operation such as cooling or heating this problem can be overcome by using TEC plates which performs both the operations of heating and cooling. The output of the temperature sensor is given to Arduino which processes this data and accordingly TEC plates perform to cool/heat the body to increase productivity.

**Keywords** —Extreme conditions, TEC plates, Arduino UNO, DC Fan, Relay, Smart Jacket.

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### I. INTRODUCTION

Hyperthermia is upstanding body temperature due to failed thermoregulation that occurs when a body produces or absorbs more heat than it squander. Extreme temperature elevation then becomes a medical emergency requiring immediate treatment to prevent impairment or death. The most common causes contains heat stroke and adverse reactions to drugs. Hyperthermia and fever are different as body's temperature set-point remains unchanged in case of fever. The opposite is hyperthermia, which occurs when the temperature drops below that required to maintain normal metabolism. In humans hyperthermia is defined as a temperature greater than 37.5-38.3 degrees Celsius, depending on the reference used that occurs without a change in the

body's temperature set point. The normal human body temperature can be high as 37.7-degree Celsius in the late afternoon. In hot conditionssignificant physical exertion can generate heat beyond the ability to cool, because, in addition to the heat, humidity of the environment may reduce the efficiency of the body's normal cooling mechanisms. Enzymes involved in the metabolic pathways within the body such as cellular respiration failed to work effectively at high temperatures, and further increases the can lead them to denature, reducing their ability to catalyze essential chemical reactions. Hyperthermia is also called thermal therapy or thermotherapy. For humans, hyperthermia is defined as a temperature greater than 37.5-38.3degree Celsius, depending on

the reference used, that occurs without a changing the body's temperature set point. [10]

The climate in India keeps changing as per the latitude, altitude and season. Now, coming to Rajasthan, because of its topography the climate here keeps varying. It is the driest region in India. Rajasthan is located in the northwestern part of India and thus, it is more prone to different climatic changes. While the western part of Rajasthan is dry and infertile, the southwestern part is hilly and wet.

The town of Kargil is another place among the coldest places in India. It is situated along the banks of Suru River (Indus) and perched at an altitude of 2,676 m. The temperature here drops to as low as -48°C in winters.

The temperature in the boundary areas of the country mostly changes unpredictably, it results in the effect of the hazard on the human body. As the systems getting used by the military for body temperature maintaining are only for heating or the cooling purpose means they perform a single operation. Also are high in weight which causes the problems like mountain sickness, pain in back, fatigue, etc. Hence we are introducing our economical and lightweight body temperature maintaining system.

## II. MATERIALS AND METHODS

### A. HARDWARE ARCHITECTURE :

Fig.1 shows the block diagram of the smart jacket using TEC plates, this will contain both the cooling and heating system in a single pack and it will be provided using TEC plates which is a Peltier device.

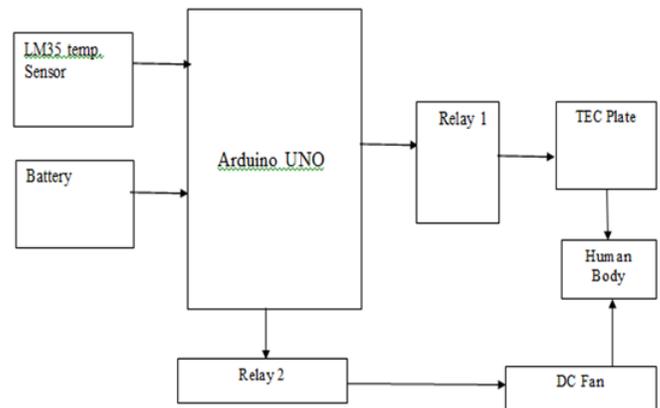


Fig.1: Hardware block diagram of Smart Jacket using TEC Plates.

The purpose of the application is thermoregulation, so the device should be the portable one. It will be achieved by using the Arduino UNO for the automation purpose operated using the battery. The temperature sensed by the temperature sensor LM35 will be compared with the reference temperature and the specified output voltage will give to the TEC plate according to that reference temperature, the temperature of TEC plate transferred to the body which will help the body to cool down or warm according to the external temperature.

The Peltier element itself then consists of two semiconductors, P-type and N-type, and connecting bridges. In the N-type semiconductor electrons are the majority carriers and holes are the minority carriers. These are drawn towards the positive pole, from the cold side to the warm side. In the P-type semiconductor holes are the majority carriers and electrons are the minority carriers. They are taken to the negative pole, from the cold to the hot. The result of the process is the decrease in the number of free charge carriers in the coupling bridge on the cold side and thus the decrease of the thermoelectric voltage between the bridge and the semiconductors. The bridge cools on the cold side while the second junction gets warm. The Peltier elements are then connected in series and conveniently mechanically arranged into thermos batteries. To achieve higher temperature differences, it is possible to create their cascades. All elements

are electrically isolated from the surroundings using ceramics with good thermal conductivity. Resin at the edge of the device is used to avoid moisture.

**B. SYSTEM ARCHITECTURE:**

Fig.2: Shows System Architecture of Smart Jacket using TEC Plates. It shows the flow of operation of the system. The

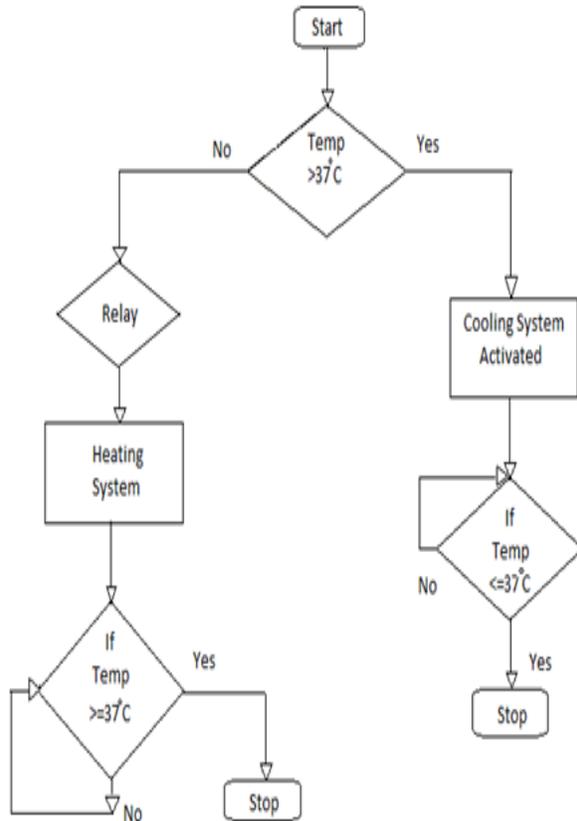


Fig.2: the flow of operation of Smart Jacket Using TEC Plate

**III.RESULT:**

it is observed that Un-compensable Heat Stress (UHS) is a dangerous and potentially fatal physiological state that occurs when the cooling required to maintain a steady thermal state is greater than the cooling capability of the environment.[11] Which requires additional support to cool the body until comfortable temperature.

This additional support can be given using the TEC plate, the ideal result of the TEC plate for cooling operation is shown in Fig.3 but practically its not so linear. There are some fluctuations due to the other side of TEC which is warming at the same time.

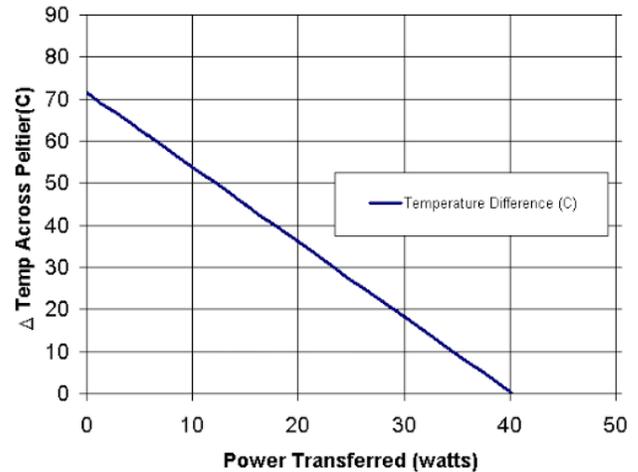


Fig.3: Graph showing temperature response of TEC plate for cooling operation.

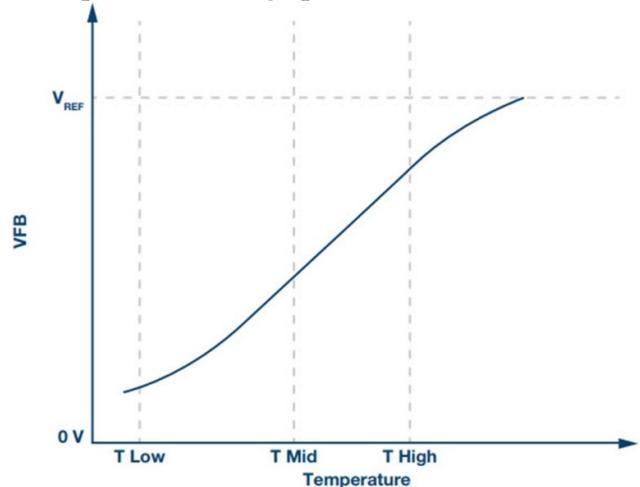


Fig.4: Relation between temperature and voltage for Heating operation of the TEC plate.

There is no natural acclimatization for men against cold. However, all men require protective clothing, shelters or artificial sources of warmth when exposed to near zero or subzero temperatures [12]. the results of the TEC plate for heating operation are shown in Fig.4.

## II. CONCLUSIONS

This paper concludes that using TEC plates along with LM35 temperature sensors and Arduino UNO for controlling body temperature:

1. It's possible to control the body temperature of personal.
2. Warming efficiency of the system is very good
3. But their some limitations occurred for cooling operation, initially TEC plate cools but as time passes the other side which is worm start transferring heat towards the cool side which result in slowly increasing temperature of cool side, by using dc fan this heating of another side is controlled up to some extent.
4. The weight of the system as compared to traditional systems using bulky compressors for cooling is very low.
5. It saves more power as compared to the existing systems.

Overall this paper contributes towards proposing and generalizing the low weight, low power consumption system at low cost using the TEC plate. This proposed work can be further extended towards observing and controlling more parameters other than body temperature and also towards health care and commercial use.

## REFERENCES

- [1] Zdenek Slanina Martin Uhlik Vaclav Sladeczek, "Cooling Device with Peltier Element for Medical Application", IFAC PapersOnLine 51- 6 (2018) 54–59
- [2] The University of California, "Wearable cooling and heating patch could serve as a personal thermostat and save energy", news release, 17-MAY-2019
- [3] Sahngki Hong<sup>1,2</sup>, Yue Gu<sup>1,3</sup>, Joon Kyo Seo<sup>1,3</sup>, Joseph Wang<sup>1,3</sup>, Ping SSSSSSLiu<sup>1,3</sup>, Y. Shirley Meng<sup>1,3,4</sup>, Sheng Xu<sup>1,3,\*</sup>, and Renkun Chen<sup>1,2,4,\*</sup> "Wearable thermoelectric for personalized thermoregulation", Science Advances Research Article (17 May 2019)
- [4] Ravi Anant Kishore, Amin Nozariasbmarz, Bed Poudel, Mohan Sanghadasa & Shashank Priya, "Ultra-high performance wearable thermoelectric coolers with fewer materials", Nature Communications volume 10, Article number: 1765 (2019)
- [5] A Thesis Presented to The Academic Faculty By Timothy C. Ernst, Georgia Institute of Technology, "Design Fabrication and Testing of a Wearable Cooling System", February 2005.
- [6] ADH & Senior Advisor (PSM) HQ 2 Corps, PIN 908502, C/o 56 APO.(2008)[online]:<https://www.ncbi.nlm.nih.gov/pubmed/27408227>
- [7] Minnich, A., Dresselhaus, M., Ren, Z. & Chen, G. Bulk "Nanostructured Thermoelectric materials: current research and prospects. Energy Environ. Sci. 2, 466–479(2009)
- [8] Abhinaya .M, Silambarasan.P, Sowmiya A.P, "Wearable Hyperthermia Device": IJARnD Paper.
- [9] Elena Gaura, Member, John Kemp, and James Brusey, IEEE Member, "Leveraging Knowledge from Physiological data: IEEE Transactions on Biomedical Circuits and Systems", vol.7, no.6, December 2013.
- [10] +Lt Gen R Jayaswal PVSNI, A VS:AI, PHS (Retd), SurgCmdeP Sivasdas, Wg CdrSS Mishra#, "Health and performance of military personals in the cold climatic environment the western Himalayas".