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An Experimental Investigation to Create Human Comfort Jacket

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Abstract— "Faster, mightier & smaller" is still a keyword for each and every invention, followed in development also. In this day-to-day world we look for the compactness and efficiency of any product. Keeping this in our mind we have attempted to design and fabricate an economical and reliable unit known as "Thermo Electric air conditioner".This paper aims on conditioning the thermal environment lower or higher than the ambient so as to produce comfort to human body according to the ambient conditions. The paper mainly points on the development of a portable air-conditioning unit that facilitate the on sight comfort of workers or two wheeler drivers by cooling the jacket worn by them. The device has two sides, and when DC current flows through the device, it brings heat from one side to the other, so that one side gets cooler while the other gets hotter. The blower attached to the device will blow off the hot or cold air from either of the sides to the pipe attached to the jacket according to the ambient conditions.

Index Terms—: Peltier effect, Thermo-electric Module, Jacket, Hot side, Cold side, Battery, Heat Exchanger.

1 Introduction

In day-to-day world we are concentrating on the compactness and efficiency of each and every product that we are producing. Keeping this in mind, we thought of designing and fabricating an economical and reliable unit known as "Thermo Electric air conditioner".

Human comfort is that condition of mind, which expresses itself with the thermal environment". This work concentrate on conditioning the thermal environment about 5 degree higher or lower than the ambient so as to produce comfort to human body.

This paper points to concentrate on the development of a portable air-conditioning unit that facilitate the on sight comfort of workers or Two wheeler drivers by cooling the jacket worn by them.The device has two sides, and when DC current flows through the device, it brings heat from one side to the other, so that one side gets cooler while the other gets hotter. The blower attached to the device will blow off the hot or cold air from either of the sides to the pipe attached to the jacket according to the ambient conditions.

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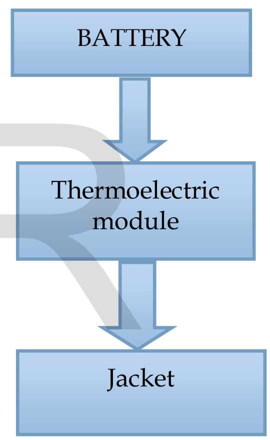

2 Literature Review

As we know that, the physical principles upon which modern thermoelectric coolers are based actually date back to the early 1800's, although commercial thermoelectric (TE) modules were not available until almost 1960. The first important discovery relating to thermoelectricity occurred in 1821 when a German scientist, Thomas See beck, found that an electric current would flow continuously in a closed circuit made up of two dissimilar metals provided that the junctions of the metals were maintained at two different temperatures. Seebeck did not actually

Comprehend the scientific basis for his discovery, however, and falsely assumed that flowing heat produced the same effect as flowing electric current. In 1834, a French watchmaker and part time physicist, Jean Peltier, while investigating the "Seebeck Effect," found that there was an opposite phenomenon whereby thermal energy could be absorbed at one dissimilar metal junction and discharged at the other junction when an electric current flowed within the

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closed circuit. And it is the fundamental principal behind a thermo-electric system.

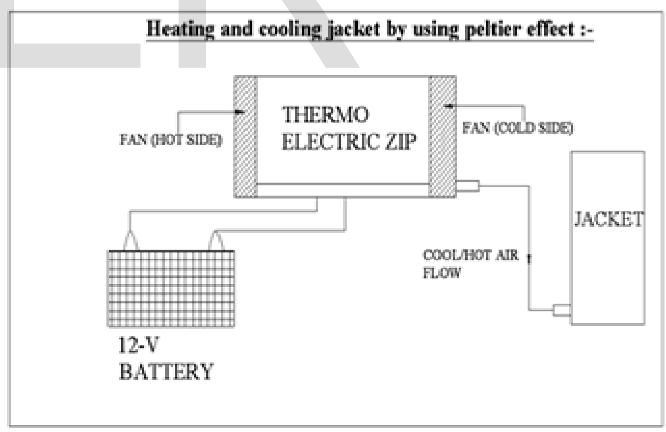
And the theory existed in 1911; the materials available were not suitable for effective cooling. Metals have good electrical conduction but good thermal conductivity as well. This allowed for a very low COP (co-efficient of performance) of 1% due to the thermal conductivity of the metal from the hot side to the cold side of the TEC It was only since the 1950's with the discovery of semiconductors, that the COP was increased. Semiconductors had the same electrical conductivity as metals but much lower thermal conductivity. This provided for a much improved COP of 20%. Typical material composition is alloys of the elements Bi, Cd, Sb, Te, Se and Zn. The standard alloy used today in manufacturing is the type.

As per the study it is found that the human body has a whole radiate energy in the form of heat. Heat energy dissipated accounts about 350000J/h and about 80% of this energy is left of by the frontal upper portion of (body) of human beings. Hence an equivalent cooling source is required to counter act the heating process.

3 PRINCIPLE OF OPERATION

Thermoelectric coolers operate by the Peltier effect (which also goes by the more general name thermoelectric effect). The device has two sides, and when DC current flows through the device, it brings heat from one side to the other, so that one side gets cooler while the other gets hotter. The "hot" side is attached to a heat sink so that it remains at ambient temperature, while the cool side goes below room temperature. That cold air is sent through the pipe to jacket. Likewise the connections varies the cold and hot sides.
As the electron moves from minority **p**-region to n-region of a semiconductor it absorbs energy making the region cool there by liberating the equivalent energy in the form of heat while moving from majority region **n** to **p** region.
Thermoelectric modules are solid-state heat pumps that operate on the Peltier effect (see definitions). A thermoelectric module consists of an array of p- and n-type semiconductor elements that are heavily doped with electrical carriers. The elements are arranged into array that is electrically connected in series but thermally connected in parallel. This array is then affixed to two ceramic substrates, one on each side of the elements
The p-type semiconductor is doped with certain atoms that have fewer electrons than necessary to complete the atomic bonds within the crystal lattice. When a voltage is applied, there is a tendency for conduction electrons to complete the atomic bonds. When conduction electrons do this, they leave “holes” which essentially are atoms within the crystal lattice that now have local positive charges. Electrons are then continually dropping in and being bumped out of the holes and moving on to the next available hole. In effect, it is the holes that are acting as the electrical carriers.Now, electrons move much more easily in the copper conductors but not so easily in the semiconductors. When electrons leave the p-type and enter into the copper on the cold-side, holes are created in the p-type as the electrons jump out to a higher energy level to match the energy level of the electrons already moving in the copper. The extra energy to create these holes comes by absorbing heat. Meanwhile, the newly created holes travel downwards to the copper on the hot side. Electrons from the hot-side copper move into the p-type and drop into the holes, releasing the excess energy in the form of heat.
The n-type semiconductor is doped with atoms that provide more electrons than necessary to complete the atomic bonds within the crystal lattice. When a voltage is applied, these extra electrons are easily moved into the conduction band. However, additional energy is required to get the n-type electrons to match the energy level of the incoming electrons from the cold-side copper. The extra energy comes by absorbing heat. Finally, when the electrons leave the hot-side of the n-type, they once again can move freely in the copper. They drop down to a lower energy level, and release heat in the process.

4 EXPERIMENTAL SETUP



Experimental setup consist of a TEC1 -12710 thermoelectric module with a maximum current rating of 10 A and maximum voltage of 16 V. The TEC is attached with suitable heat exchangers to effectively transfer the heating or cooling to the air .The battery used to operate the apparatus is Lead acid type with a rating of 12 V and 7.5 Ah
The entire module and heat exchanger is installed in a casing to protect from external environment as shown in the above figure.The casing is mad of MS steel to facilitate the ease of fabrication and alteration. The cold air from the module is taken through an hose to the jacket where air ventilation's are

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provided for easy flow of air and circulation that induce effective heat transfer.

5 COP OF THERMOELECTRIC MODULE

The COP depends on the heat load, input power, and the required temperature differential. Typically, the COP is between 0.3 and 0.7 for single-stage applications. However, COPs greater than 1.0 can be achieved especially when the module is pumping against a positive temperature difference (that is, when the module is removing heat from an object that is warmer than the ambient).

6 HEAT DISSIPATED BY HUMAN BODY

The average human consumes approximately 2000 Kilocalories per day. This means that the average person expends ~8.37 x10^6 joules of energy per day, since most of us are in some sort of equilibrium with our surroundings. Assuming most of this energy leaves us in the form of heat
On average we radiate ~350,000 J of energy per hour.

Energy radiated / h = 350000J

One hour = 3600 s

Energy radiated / s = 350000/3600 ~ 100W

7 RESULTS

The Peltier jacket is designed and fabricated .We have chosen a sunny day and evening of 28/**02/2016** to conduct the preliminary phase of testing the cooling rate show by the apparatus. Experimental result as per test conducted on 28/02/2016. Table 1. Shows the cooling test results and Table 2. shows heating test results.

TABLE 1. COOLING TEST RESULTS

Test Time	Normal Ambient Temperature	Jacket Temperature
5.00am	24°C	28°C
7.00am	26°C	30°C
7.00pm	28°C	31°C
8.00pm	28°C	31°C
9.00pm	27°C	31°C

TABLE 2.HEATING TEST RESULTS

Test Time	Normal Ambient Temperature	Jacket Temperature
8.00 am	26°C	24°C
10.00 am	30°C	25°C
12.00 pm	33°C	27°C
02.00pm	35°C	27°C
04.00pm	32°C	27°C

8 CONCLUSION

The paper was able to furnish the principle of Peltier cooling as an effecting and adaptable means to promote cooling by eliminating complex refrigeration and cooling systems like vapor compression and vapor absorption refrigeration systems. However the efficiency of the system in terms of energy consumption for a specified cooling is low.
The future of thermoelectric cooling is of no doubt because it will replace the present system as it is simple, cheap and least polluting. Hence our paper is a breakthrough towards the adaptability of Peltier cooling for various aspects of day today life.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper

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