COOLING OF BIKER'S HELMET USING PELTIER MODULE

Deshpande Atish Kishor

Department of Production Engineering, VJTI Mumbai, (India)

ABSTRACT

Human life is so precious and valuable, that it should not be compromised under any cost. The concern over the safety of vehicle drivers has pushed for invention of new equipment that can save lives. According to Statistics from the Insurance Institute for Highway Safety (2010), it is mentioned that nearly 70% of mortality in road accidents occur due to head injury, where the rider has not worn a helmet. It is not that people are very negligent about their lives on road, but that they experience dozens of discomforts by wearing helmets. The most common discomfort is that, heavy sweat occurs due to excessive heat formation. This paper deals with the development of cooling system for biker's helmet using thermoelectric technology. The system consists mainly of a heat sink, aluminum passageway and Peltier module. The prototype is fabricated and mounted onto biker's head. Experiments are conducted on the prototype to analyze the performance of the cooling system.

Keywords: Biker's helmet, coolant, Peltier module

I. INTRODUCTION

The helmet is a critical piece of safety equipment for bike rider. Although there are many varieties of helmet designs available in the market, the product must essentially protect the head against injuries, maintain user comfort, and appeal to the user in terms of cost and aesthetics. It is imperative that the rider is comfortable with wearing the helmet. The conventional biker's helmet has two principle protective components: a thin, hard, outer shell typically made from polycarbonate plastic ,fiber glass, and a soft, thick, inner liner usually made of expanded polystyrene or polypropylene "EPS" foam. The poly-foam liner serves as the shock absorber to support the head during collision. The purpose of the foam liner is to crush during an impact, thereby increasing the distance and period of time over which the head stops and reducing its deceleration. Unfortunately, since the equipment has been made compulsory to be worn, the user must endure uncomforting causes by the device. Indeed, the liner has high heat insulation properties which results in low heat transfer between the head and the outside air. This creates an uncomfortable and dangerous environment to the head, especially for long distance travel. Carpenter (1987) [1] projected that temperature in the helmet during such conditions reaches 38°C. In this temperature, it is very hazardous to travel due to a reduction in the ability to concentrate. Therefore, keeping a bike rider cool during transit has been at the forefront of helmet design considerations. This project is using the famous concept of Peltier discovered in 1834. According to the Peltier Effect, at the junction of two dissimilar metals the energy level of conducting electrons is forced to increase or decrease. A decrease in the energy level emits thermal energy, while an increase will absorb thermal energy from its surroundings. In other words, when current is made to flow through a junction between two conductors A and B, heat may be generated (or removed) at the junction. The Peltier heat generated at the junction per unit time, $\bar{Q}$, is equal to

$$\bar{Q} = (\mu_a - \mu_b) * I$$

Where μ_a and μ_b are the Peltier coefficient of conductor A and B respectively and I is the electric current from A to B. The reasons which made me to use Peltier effect (Thermo-couple module) are of interest. The very important reason is that they possess no moving parts, along with this; they not only have zero maintenance but also have long service life time. A typical Peltier heat pump device involves multiple junctions in series, through which a current is driven. Some of the junctions lose heat due to the Peltier effect, while others gain heat. There are several attempts made in order to enhance the comfort level of the biker's helmet by improved ventilations. But it seems to be non-impressive as most of the solutions revolve around forced convection of the air but unfortunately the respective system does not provide proper circulation of the air to the head of the rider [2]. The phase change material (PCM) cooling helmet utilizes the principles of heat transfer via conduction to cool the rider's head. Tan and Fok [3] have taken a simplified approach to their design with a solution that requires no power supply for operation. What they needed is the PCM which is to be placed in the bag in between head and the inner boundary of the helmet. When the surface temperature of the rider's head is greater than the melting temperature of the PCM, the absorption of heat from the head causes the PCM to melt. The stored heat in the PCM is discharged by immersion in water for a time period ranging from 13-25 minutes which re-solidifies the PCM for further use. As a result they have designed a solution which would be ineffective for riding applications such as touring and would prove difficult to adapt to applications in other areas where a longer operation time is required. The pro remote intake cooler is designed for desert dune buggy racing but with minor adaptations could easily be designed for operation on a motorcycle. Its operation is quite simple. A motor draws large amounts of air in from the environment. The air is filtered and blown at relatively high pressure into the motorcycle helmet. In the case of motorcycle helmet operation, a considerably smaller filter system could be used and a smaller motor with lower compression could also be utilized. The over-riding limitation of this package is the control offered to the rider. If the Ambient temperature is considerably high the cooling effect will be greatly limited. Since the designs suggested above fail to give the satisfactory solution, this paper aims to provide a better solution for the cooling of the helmet.

II. DESIGN

The major components of the air conditioned thermoelectric helmet include: circular cavity as outside/inside air channel, Electric fan as a heat extracting device, the peltier module, cooling chamber, heat sink and water as coolant. The electrical power is supplied by means of a 12 V DC battery. On the very front side of the helmet two circular ducts are facilitated to introduce the atmospheric air in to the helmet. This air is collected in to the cooling chamber above which the assembly of peltier module and heat sink is placed while in between the riders head and the cooling chamber a pouch filled with water is fixed. The pouch of water not only works as coolant but also does service as spreading media for the cooled air on to the head. The heat sink is used to enhance the rate of heat transfer from the hot surface of the thermoelectric module so that the heat will be discarded outside the helmet. In order to maintain the efficiency of the thermal module, a cooling fan is used to reject the heat from the hot side of the module to ambient surroundings.

III. PELTIER MODULE

A thermoelectric cooling (TEC) module is a semiconductor-based electronic component that functions as a small heat pump. When DC power is applied to a TEC, heat gets transferred from one side of the module to the other. There are 127 couples in single module; 40mm x 40mm x 3.8mm size module is a single stage module which is designed for cooling and heating up to 90°C applications.

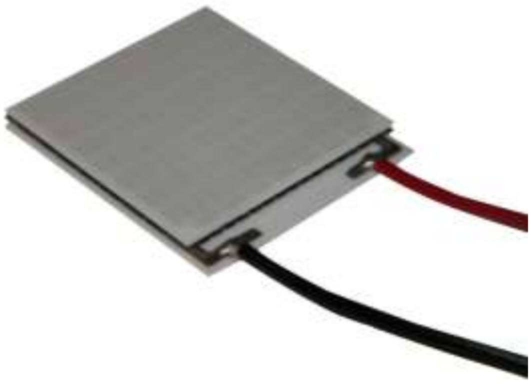

Fig. 1: A typical single stage thermoelectric module.

IV. HEAT SINK

The rectangular fin type heat sink is deemed most suitable to be used on the prototype helmet. The external sink is the focus of preliminary design as it is understood that the effective operation of the cooling system would depend on the ability of the external sink to remove heat energy.

V. AIR CHANNEL

The hollow circular air channel is made in inner foam of helmet for forcing the air in and out of the chamber directly. The passage is able to supply considerable amount of flowing air from outside the helmet during high speed travel. Basically, the air from the outside will push the air in the chamber into the helmet. Thus, a higher cooling rate will be achieved.

VI. COOLING CHAMBER

The chamber is built with a built-in internal fan thermoelectric cooler for cooling purpose. It acts as medium of heat transfer where outside air will be cooled and then directly transferred into the helmet. The chamber is built to provide enough space for air to be cooled and pumped-in using small electric fan. The fan will be installed on the open space of the chamber thus extracted cooled air from the chamber, right into the helmet.

VII. ELECTRIC FAN AS AN AIR PUMP

The use of the fan is very important in this design. The fan works as the pump for transferring cooled air from the cooling chamber into the helmet.

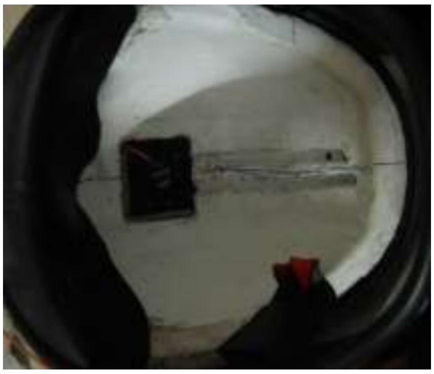

Fig.2 Air passage and cooling chamber

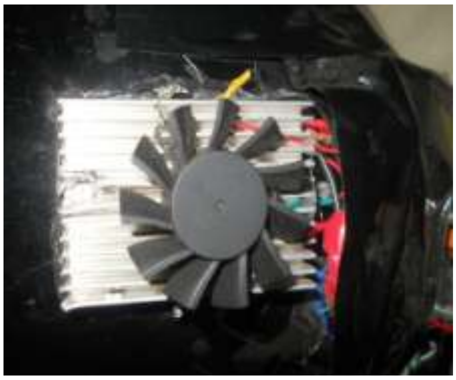

Fig.3 Electric fan

VIII. OVERVIEW OF THE NEWLY DESIGNED HELMET: The design of prototype is shown.

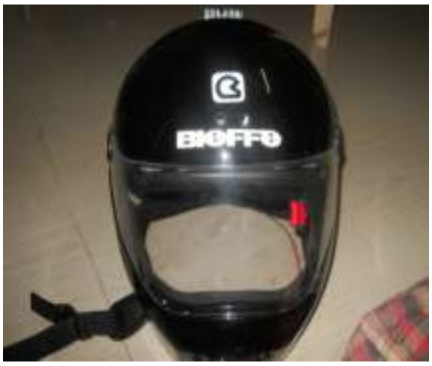

Fig.4 Front view of prototype of helmet

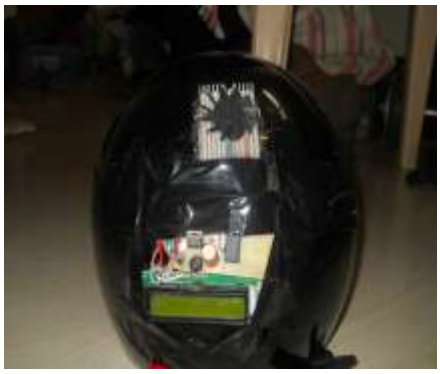

Fig.5. Back view of helmet

IX. RESULTS: The observations for moving conditions recorded by digital temperature display are as follows.

Table1

Reading no.	Time in (min : sec)	Temperature in ^{0}c
1.	Initial condition (00:00)	33.80
2.	00:15	33.80
3.	00:30	33.08
4.	00:45	33.08
5.	01:00	32.80
6.	01:15	32.80
7.	01:30	32.80
8.	01:45	32.50
9.	02:00	32.50
10.	02:15	31.80
11.	02:30	31.30

12.	02:45	30.10
13.	03:00	30.90
14.	03:15	29.90
15.	03:30	29.70
16.	03:45	29.50
17.	04:00	29.10

Thus during 4 minutes of trial, it is found that cooling of 4.7 degrees is achieved when tested on the field.

X. CONCLUSION

The prototyping of a cooling system based on thermoelectricity for a motorcyclist helmet has been done. The targeted cooling performance is achieved and future improvements will be carried out to enhance the cooling performance of the design. This will include the use of higher power thermoelectric. This can be a very effective solution mainly for the people living in high temperature zones like Nagpur and Jaipur.

REFERENCES

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