Experimental analysis on motorcycle helmet using peltier module for human ergonomics.

A Project report submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

MECHANICAL ENGINEERING

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ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (Permanently Affiliated to Andhra University, Approved by AICTE, Accredited by NBA & NAAC with 'A' grade)

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ABSTRACT

Helmet is a mandatory head gear for safety of bike riders and motor cyclist. But, safety of riders by using helmet is influenced by many factors like properties of material, scope of sight, weight, thermal aspects (skin temperature and sweat rate inside).

Parameters like thermal discomfort and warmth perception play important role physically and mentally lowering their support to safety. Hence they are to be monitored and controlled.

The present work focuses on experimental analysis of standard helmet and the modified helmet with peltier module and provisions to air flow. The changes made may effect various aspects like strength and weight. Modeling and static structural analysis are done and suggestion are made to optimise the helmet up to required level to support user's safety focusing on improvement of thermal comfort and ergonomics. The temperatures between the existing standard and modified models are experimentally observed and compared.

The experimental results showed that the helmet with peltier module and heat sink in presence of velocity exibhits good human comfort as it cools effectively in comparison with standard helmet in the normal conditions.

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CHAPTER 01

INTRODUCTION :-

A motorcycle helmet is the head gear used by the motorcycle riders. These are primarily used for the safety of motorcycle riders to protect the head from impact during accidents. According to the latest Statistics from the Insurance Institute for Highway Safety Fatality Facts, majority of bicyclist/ motorcyclist deaths, are due to serious head injuries. Therefore it is important for every motorcyclist to wear a helmet. Most of the accidents include the two wheelers; hence the safety of the motor cycle rider is most essential requirement. The motor cycle riders should sustain serious head injuries during the accidents. The human head is very vulnerable to injury. Helmets could decrease the risk of head and brain injury upto 90% and facial injury to the upper and mid face by 65%, They can lower mortality between 32% and 50%.

India has a national helmet law that makes helmet use mandatory for both motorcycle drivers and pillion riders (co-passengers). “enforcing helmet laws, therefore, the Traffic Police after intercepting a two-wheeler with the main rider or the pillion rider without helmet then both the main rider and the pillion rider shall be subject to Road Safety Education and Counseling for not less than two hours before imposition of fine as prescribed in the Motor Vehicles Act, 1988,” said the statement. it is necessary to focus primarily on design and performance of the motorcycle helmets for the safety and comfort of the riders.

The materials of helmet are likely to increase thermal discomfort.Due to these properties it becomes difficult to travel by wearing a helmet for long distances in hot conditions.

COMPONENTS

The major components required for the fabrication of air conditioned helmet are:

- Helmet
- Thermoelectric module
- Heat sink
- Laser sensor gun

1.1 Helmet:

A helmet is generally made of layers. The outermost layer is usually a hard material. The best helmets today use composite materials which include fibreglass mixed will all manner of high-tech new-age materials ranging from aramids to carbon fibre. In every case, the new-age material is highly regarded for its strength and resistance to decay under abrasion and to penetration. The lower rung helmets can be fibreglass, polycarbonate or even ABS plastic. The shell shall be dome-shaped. There shall not be any metallic component passing through the shell. It shall be provided with a brim with or without a peak. The brim and peak (where provided) shall be integral part of the shell and these shall have no sharp edges.

In this project polycarbonate is the basic material. Inside the hard layer is a softer layer, made almost invariably of polystyrene, technically called EPS, and expanded poly styrene. Polystyrene is a normally a hard white plastic, usually seen in disposable coffee cups and ice boxes. The result is a still hard-ish plastic 'foam' called EPS. In an impact, the EPS liner works more or less on the same principle as an airbag. It absorbs the energy of the impact, using that energy to crack, break, crush, rather than pass it on to your brain.

1.1.1 Types of helmet

There are five type of helmet in the market intended for the motorcyclist. They are:

- Full face.
- Off-road/motocross.
- Modular or “flip-up”.
- Open face or ¾ helmet.
- Half helmet.

1.1.1.1 Full face helmet:

A full face helmet covers the entire head, with a rear that covers the base of the skull, and a protective section over the front of the chin. Such helmets have an open cut-out in a band across the eyes and nose, and often include a clear or tinted transparent plastic face shield, known as a visor, that generally swivels up and down to allow access to the face. Many full face helmets include vents to increase the airflow to the rider. The significant attraction of these helmets is their protectiveness. Some wearers dislike the increased heat, sense of isolation, lack of wind, and reduced hearing of such helmets. Full-face helmets intended for off-road or motocross use sometimes omit the face shield, but extend the visor and chin portions to increase ventilation, since riding off-road is a very strenuous activity. Studies have shown that full face helmets offer the most protection to motorcycle riders because 35% of all crashes showed major impact on the chin-bar area.

1.1.1.2 Off road/motocross:

A motocross helmet showing the elongated sun visor and chin bar. The motocross and offroad helmet has clearly elongated chin and visor portions, a chin bar, and partially open face to give the rider extra protection while wearing goggles and to allow the unhindered flow of air during the physical exertion of this type of riding. The visor is to allow the rider to dip his or her head and provide further protection from flying debris during off road riding. It will also keep the sun out of the eyes of the rider during jumps.

Originally, off-road helmets did not include a chin bar, with riders using helmets very similar to modern open face street helmets, and using a face mask to fend off dirt and debris from the nose and mouth. Modern off-road helmets include a (typically angular, rather than round) chin bar to provide some facial impact protection in addition to protection from flying dirt and debris.

1.1.1.3 Modular or "Flip up":

A hybrid between full face and open face helmets for street use is the modular or "flip-up" helmet, also sometimes termed "convertible" or "flip-face". When fully assembled and closed, they resemble full face helmets by bearing a chin bar for absorbing face impacts. Its chin bar may be pivoted upwards (or, in some cases, may be removed) by a special lever to allow access to most of the face, as in an open face helmet. The rider may thus eat, drink or have a conversation without unfastening the chinstrap and removing the helmet, making them popular among motor officers.

Many modular helmets are designed to be worn only in the closed position for riding, as the movable chin bar is designed as a convenience feature, useful while not actively riding. The curved shape of an open chin bar and face shield section can cause increased wind drag during riding, as air will not flow around an open modular helmet in the same way as a three-quarters helmet. Since thin chin bar section also protrudes further from the forehead than a three-quarters visor, riding with the helmet in the open position may pose increased risk of neck injury in a crash.

1.1.1.4 Open face or ¾ helmet:

The open face, or "three-quarters", helmet covers the ears, cheeks, and back of the head, but lacks the lower chin bar of the full face helmet. Many offer

Snap-on visors that may be used by the rider to reduce sunlight glare. An open face helmet provides the same rear protection as a full face helmet, but little protection to the face, even from non-crash events.

Bugs, dust, or even wind to the face and eyes can cause rider discomfort or injury. As a result, it is not uncommon (and in some U.S. states, is required by law) for riders to wear wraparound sunglasses or goggles to supplement eye protection with these helmets. Alternatively, many open face helmets include, or can be fitted with, a face shield, which is more effective in stopping flying insects from entering the helmet.

1.1.1.5 Half helmet:

The half helmet, also referred to as a "Shorty" in the USA and "Pudding Basin" or TT helmet in the UK and popular with Rockers and road racers of the 1960s in the British Isles. It has essentially the same front design as an open face helmet but without a lowered rear in the shape of a bowl. As with the open face, it is not uncommon to augment this helmet's eye protection through other means such as goggles. Because of their inferiority compared to other helmet styles, some Motorcycle Safety Foundations prohibit the use of half helmets now.

Among this full facehelmet is more safety which covers the entire head. So we consider this helmet as project prototype. In this helmet, we include vents to increase the air flow to the rider. One in the front of mouth and other in the upper portion where we keep two tin-funnel.

1.2 Helmet Testing:

The Snell Memorial Foundation has one of the most advanced and busiest helmet testing facilities in the world. Snell's California helmet testing laboratory is the one of the few in the United States accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA). Before a helmet can be Snell-certified, it is tested in Snell's state-of-the-art test facility. Snell technicians conduct a variety of tests to determine the helmet's performance and ability to stay on the head in different environmental conditions - ambient, wet, heat, cold. Depending on the application and the standard, each helmet must pass all or some of the following tests.

- Impact test
- Positional stability (Roll-off) Test
- Dynamic Retention Test
- Chain Bar Test
- Shell penetration test
- Face shield Penetration Test
- Flame Resistance Test

These are the standard tests which are performed for the quality of helmet. But due to lack of whole testing equipment we tested our helmet in Ansys software, by making design and the corresponding thickness and by using the same material polycarbonate.

1.3 Thermo electric module:

Thermoelectric modules are solid state devices that convert an electric current into a temperature gradient. They operate on the principle of Peltier effect. They consist of two sides – a hot side and a cold side. These are also known as Peltier device, Peltier heat pump, Solid state refrigerator, or thermoelectric cooler.

Acting as a solid heat pump, thermoelectric modules produce a heating, cooling or stabilisation effect. The module acts as a heat pump in that it moves heat from the cold side to the hot side. The hot side requires a proper method to remove the heat for the device to function properly. The more efficient the means of removing the heat from the hot side, the colder the cold side will operate.

1.3.1 Principle:

Peltier effect: The peltier effect is the temperature difference created by applying a voltage between to electrodes connected to a sample of a semi conductor material. this phenomenon can be useful when it is necessary to transfer heat from one medium to another medium on a small scale.

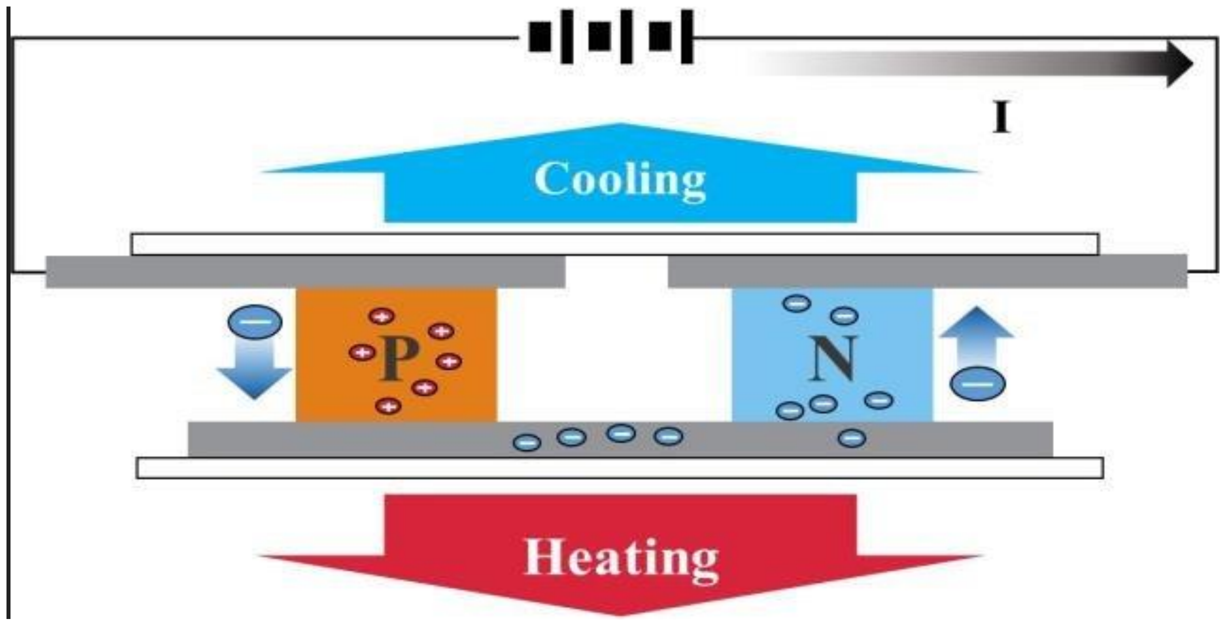

Fig 1.1 Peltier Effect

1.3.2 Types:

Types of Thermoelectric modules:

- Single-Stage
- Multi-Stage

1.3.2.1 Single stage:

These are used for medium to low heat applications including temperature stabilisation in fiber optics and Ink jet printers.

1.3.2.2 Multi stage:

They are used for night vision goggles and imaging systems for the aerospace and defence industries.

1.3.3 Applications:

- Industrial electronics and telecommunications
- Production of semiconductor integrated micro chips
- Laser equipment
- Medical equipment
- Food industry
- Systems of temperature control of the critical parts and components of lathes and machines.

1.4 Heat sink:

A heat sink is an electronic device that incorporates either a fan or a Peltier device to keep a hot component such as a processor cool. There are two heat sink types: active and passive. Active heat sinks utilize power and are usually a fan type or some other Peltier cooling device.

Passive heat sinks are 100% reliable, as they have no mechanical components. Passive heat sinks are made of an aluminium-finned radiator that dissipates heat through convection. For passive heat sinks to work to their full capacity, it is recommended that there is a steady air flow moving across the fins.

Here in this experiment we used a passive heat sink. An aluminium finned radiator is used as a heat sink.

1.5 Laser Sensor Gun Thermometer (Infrared Thermometer):

An infrared thermometer is a thermometer which infers temperature from a portion of the thermal radiation sometimes called black body radiation emitted by the object being measured. They are sometimes called laser thermometers as a laser is used to help aim the thermometer, or non-contact thermometers or temperature guns, to describe the device’s ability to measure temperature from a distance. By knowing the amount of infrared energy emitted by the object and its emissivity, the object’s temperature can often be determined within a certain range of its actual temperature. Infrared thermometers are a subset if devices known as “thermal radiation thermometers”.

The design essentially consists of a lens to focus the infrared thermal radiation on to a detector, which converts the radiant power to an electrical signal that can be displayed in units of temperature after being compensated for ambient measurement from a distance without contact with the object to be measured. A non-contact infrared thermometer is useful for measuring temperature under circumstances where thermocouples or other probe-type sensors cannot be used or do not produce accurate data for a variety of reasons.

Fig 1.2 Laser Sensor Gun Thermometer

CHAPTER 02

LITERATURE REVIEW

2.1 A Review on Ergonomics of Headgear: Thermal effects.

Cornelis P. Bogerd et al[6] (2014) explained why a person with helmet in warm atmosphere feels thermal discomfort or inconvenience. The main heat transfer pathways for headgear are convection evaporation, and radiation. These mechanisms and the interaction with the user are studied using numerical methods, bio-physical models and user trials or combinations of these methods. The heat transfer is a function of the environment, helmet parameters, and the user characteristics. effects have been assessed directly on human participants. These studies have focused on physiology, comfort, thermal sensation, and cognitive effects. Finally they confirmed that a human wearing helmet feels thermal discomfort in certain weather conditions and long hours.

2.2 Conceptual Design of Motor Cycle Helmet to meet the Requirement of Thermal Comfort, Ergonomics and Safety.

S.K Mithun et al[2] (2013) done an conceptual design on motor cycle helmet for thermal comforts, safety with adjustable interior and ergonomics. They underwent GEMBA study on the existing helmets based on QFD and PDS. They had made QFD analysis and maximum importance was given to the temperature control facility inside the helmet, adjustable inside foam, visibility, size and shape and materials. they have done the geometric modeling of helmet using CAD V5 where discretization of the geometric modeling, air flow passage inside the helmet. the CFD analysis is used to study the air flow pattern and temperature distribution inside the helmet. The conditions where taken without exhaust fan and with exhaust fan and the variations of pressures, temperatures, and velocity where studied. It was concluded that the condition with exhaust fan has reduces the thermal discomfort and gives proper ventilation.

2.3 Cooling of Motorcyclist Helmet with Thermoelectric Module.

M.Hrari, et al[2](2013)with the development of cooling system for motor cycle helmets using thermoelectric technology. This development has involved peltier effect and the design of this was done using a software. The model was made by using aluminum pipes, electric fan and a cooling chamber where the model has been under went the stimulation results, experimental result and field results and it was concluded that the target is reached and there is a problem of electric fan sound inside which should overcome.

2.4 Experimental Study on Generation of Cooling Inside the Motorcyclist Helmet by Using Peltier Module.

Balineni Venkateswarlu, Dr. A. SudhakaraReddy(2017) have conducted experimental study on generation of cooling inside the motorcyclist helmet by using peltier module. Their experimental setup includes two peltier modules connected in parallel with 12V Dc rechargeable battery provided with heat sink. The experiments have been carried out under different conditions peltier under natural convection, and peltier under forced convection. It is concluded that the helmet inside temperature is decreased. The cop and efficiency of the natural circulation and forced circulation condition is 1.85 and 2.86% respectively. The COP (coefficient of performance) and efficiency of the peltier by using forced circulation of air is found to be better than that under natural convection conditions. They ensured that using of peltier module ensures thermal comfort for driver providing cooling effect.

2.5 Helmet Cooling using Phase Change Material.

Yigit Sezgin, Murrat Celik (2015) have done analysis of the cooling of a motor cycle helmet by phase change material (HS 29) with forced convection .Casing of helmet made with cu for absorbing more heat from wearer means act as heat collector ,using cu pipe inside and outside of the chamber and providing two fans at the back side of the helmet one for suction of air and other act as exhaust. Based on this phenomenon temperature values taken inside the helmet, comparison takes place with or without PCM material and also increases the working time of PCM by selecting suitable material and change of interior design of helmet.

2.6 Design and Experimental Study of a New Thermoelectric Cooling Helmet.

Linlin Cao et al[3](2017) designed a new cooling helmet which is cooled by thermoelectric refrigeration with the combination cooling of air and water, thus achieving the simultaneous cooling of the human head and neck. The cooling helmet is experimentally studied by using the environment simulation device and the self-made thermal manikin to simulate the cooling effect of different environment and human body cooling conditions, such as environmental temperature, input power, fan speed and circulating water velocity, on the helmet. The results show that the environmental temperature has a significant influence on the helmet cooling characteristics. The helmet can meet the cooling requirement under the high temperature environment by adjusting the helmet operation parameters.

2.7 Scope of Work:

A comprehensive study of literature revealed that people feel thermal discomfort and warmth perception when they use motorcycle helmet in hot weather. This lowers the safety and comfort of motorcyclists. Efforts are made by researchers to cool the helmet using different procedures like using thermoelectric module, using phase change material and making vents to air flow.

Based on these observations this work focusses on experimental study of cooling the motor cyclist helmet using peltier module in different conditions and these experimental results are compared to get better cooling and improve human ergonomics.

CHAPTER 03

THEORETICAL CALCULATIONS OF THERMO ELECTRIC MODULE

3.1 Testing of Thermoelectric Module:

1) The thermoelectric module was tested initially by giving power supply of 12V and 4 Amp.
2) The module acting as a heat pump transmits the heat generated to the cold side affecting its temperature and thus affecting the cooling property.
3) While testing with the thermoelectric module, the maximum and minimum temperatures obtained in the module are measured by using a laser sensor gun ans are found as follows.

- Maximum temperature on hot side : 43.6 degree centigrade.
- Minimum temperature on cold side : 24.7 degree centigrade.

3.1.1 Theoretical Calculations

Thermoelectrical module consists two ceramic plates on both sides which is generally aluminium and tin plates. So to find heats based on properties of ceramic plates and the following formulae.

Q1=(A12*i*t1)+(0.5i*i*r)-u(t1-t2),

Q2=(A12*i*t2)-(0.5*I*i*r)-u(t1-t2),

u=(a1K1/L1)+(a2k2/l2),

r=(l1/a1A1)+(l2/a2A2),

(or)

r=(v/i).

where

Q1,Q2 are the heats on hot and cold sides,

1) u is overall thermal conductivity,

r is resistance,

l1,l2 are lengths of the plates,

k1,k2 are coefficient of thermal conductivity of the Al and tin,

a1,a2 are the coefficient of linear expansions of Al and tin respectively,

a12=a1-a2,

A1,A2 are areas of hot and cold plates respectively.

K1=204w/m-c , k2=64w/m-c , a1=22.5e6/c , a2=23.4e6 .

Finally we got values of heats are Q1=26.02 w and Q2=25.379 w.

3.2 Selection of place for removing material.

Some material should be removed over the helmet for attaching thermoelectric module. As it could effect the purpose of the helmet. So the place that is to be removed from the helmet should be chosen properly minimising the effect of removing the material. A survey is done on number of accidents that happened for motor cyclists and deformation of helmets that took place in those accidents.

According to the survey made the area right over head and on the top of the helmet is less likely to directly get an impact during accidents. Other areas are subjected to more impact when compared.

So the area of 4 cm x 4 cm is removed from the helmet taking above survey in to consideration and peltier module is installed in that area.

3.3 Attachment of heat sink:

To minimize the heat transfer a heat sink is placed on the thermoelectric module.While the fan with Al cooler heat sink is placed on the top of the thermoelectric module heat on hot side liberated out. So that heat on hot side decreases and also in cold side. So that we got better results.

As the impact absorbing layer is made of expandable polystyrene material and it melts or soften at high temperature. So to protect it from the heat generated from module, the module is placed in the wooden support and it is attached to the impact absorbent layer with help of tape.

Now a hole is created in the outer shell of the helmet, so that fan with Al heat sink can be attached to the module from outside.

Now 3D printed fan with Al heat sink cooler with dimensions 40mm*40mm*10mm is attached to outer side of the thermoelectric module.

All the parts assembled, firstly impact absorbent layer is placed inside the shell and comfort layer is then base gasket is fixed and visors is using screws.

Fig 4.1 Peltier module with heat sink.

Fig 4.2 Attachment of peltier module in grooves

CHAPTER 04

MODELLING AND ANALYSIS OF HELMET WITH GROOVE:

4.1 Strength is reduced due to material removal so, it is to be compensated and optimized.

When some material is removed automatically strength and weight of any thing will be reduced. The same happened in the case of this helmet. But there is a provision of adding the material and that is removed. And that material is to be added in a proper place and proper manner to obtain the required results.

To recognise the most effected area due to material removal, a solid model is prepared in 3D-SolidWorks interface and static structural stress analysis is done in AnSys interface.

4.1.1 Introduction to solid works

SolidWorks isa solidmodeling computer aided design (CAD) and computer aided engineering (CAE) computer program that runs on Microsoft Windows. SolidWorks is published by Dassault Systems

SolidWorks is a solid modeler, and utilizes a parametric feature-based approach which was initially developed by PTC (Creo/Pro-Engineer) to create models and assemblies. The software is written on Parasolid-kernel.

Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allows them to capture design intent.

Design intent is how the creator of the part wants it to respond to changes and updates. For example, you would want the hole at the top of a beverage can to stay at the top surface, regardless of the height or size of the can. SolidWorks allows the user to specify that the hole is a feature on the top surface, and will then honor their design intent no matter what height they later assign to the can.

Features refer to the building blocks of the part. They are the shapes and operations that construct the part. Shape-based features typically begin with a 2D or 3D sketch of shapes such as bosses, holes, slots, etc. This shape is then extruded or cut to add or remove material from the part. Operation-based features are not sketch-based, and include features such as fillets, chamfers, shells, applying draft to the faces of a part, etc.

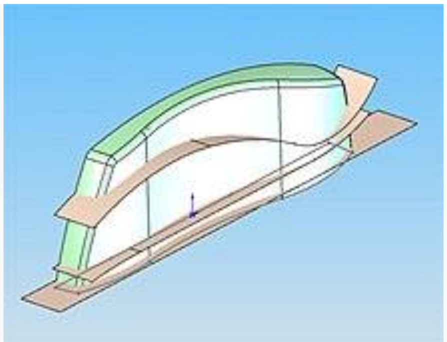

Fig 4.1 screen shot captured from a SolidWorks top-down design approach.

Building a model in SolidWorks usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The parametric nature of SolidWorks means that the dimensions and relations drive the geometry, not the other way around. The dimensions in the sketch can be controlled independently, or by relationships to other parameters inside or outside of the sketch.

In an assembly, the analog to sketch relations are mates. Just as sketch relations define conditions such as tangency, parallelism, and concentricity with respect to sketch geometry, assembly mates define equivalent relations with respect to the individual parts or components, allowing the easy construction of assemblies. SolidWorks also includes additional advanced mating features such as gear and cam follower mates, which allow modeled gear assemblies to accurately reproduce the rotational movement of an actual gear train.

Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed. The drawing module includes most paper sizes and standards (ANSI, ISO, DIN, GOST, JIS, BSI and SAC).

4.1.2 Introduction to Ansys

Ansys Inc. is an American public company based in Canonsburg, Pennsylvania. It develops and markets engineering simulation software. Ansys software is used to design products and semiconductors, as well as to create simulations that test a product's durability, temperature distribution, fluid movements, and electromagnetic properties.

Ansys was founded in 1970 by John Swanson. Swanson sold his interest in the company to venture capitalists in 1993. Ansys went public on NASDAQ in 1996. In the 2000s, Ansys made numerous acquisitions of other engineering design companies, acquiring additional technology for fluid dynamics, electronics design, and other physics analysis.

Ansys develops and markets finite element analysis software used to simulate engineering problems. The software creates simulated computer models of structures, electronics, or machine components to simulate strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes. Ansys is used to determine how a product will function with different specifications, without building test products or conducting crash tests. For example, Ansys software may simulate how a bridge will hold up after years of traffic, how to best process salmon in a cannery to reduce waste, or how to design a slide that uses less material without sacrificing safety.

Most Ansys simulations are performed using the Ansys Workbench software, which is one of the company's main products. Typically Ansys users break down larger structures into small components that are each modeled and tested individually. A user may start by defining the dimensions of an object, and then adding weight, pressure, temperature and other physical properties. Finally, the Ansys software simulates and analyzes movement, fatigue, fractures, fluid flow, temperature distribution, electromagnetic efficiency and other effects over time.

4.2 Modeling of helmet in 3D - solidworks:

Common design parameters of a standard helmet are taken and helmet is designed in solidworks interface using surface modelling.

First the helmet is designed with the standard parameters and next the groove of 4cm x 4cm is made as per the dimensions of thermoelectric peltier module.

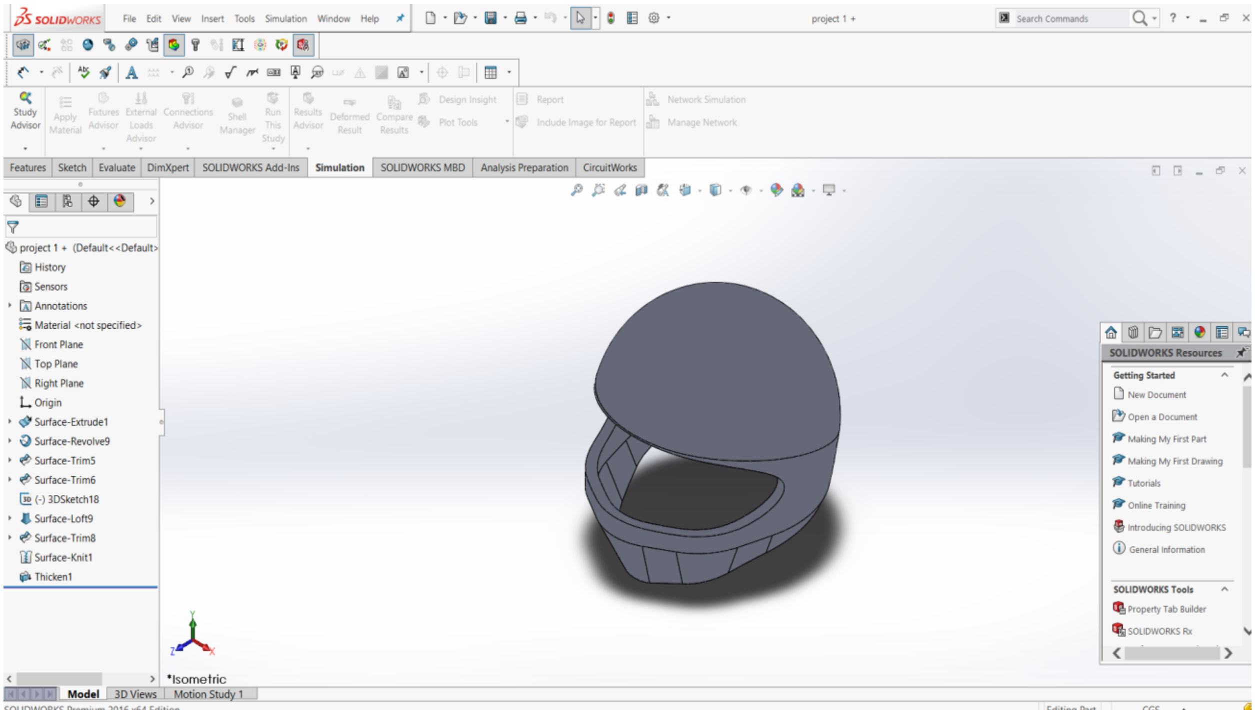

Fig 4.2 Modeling of helmet

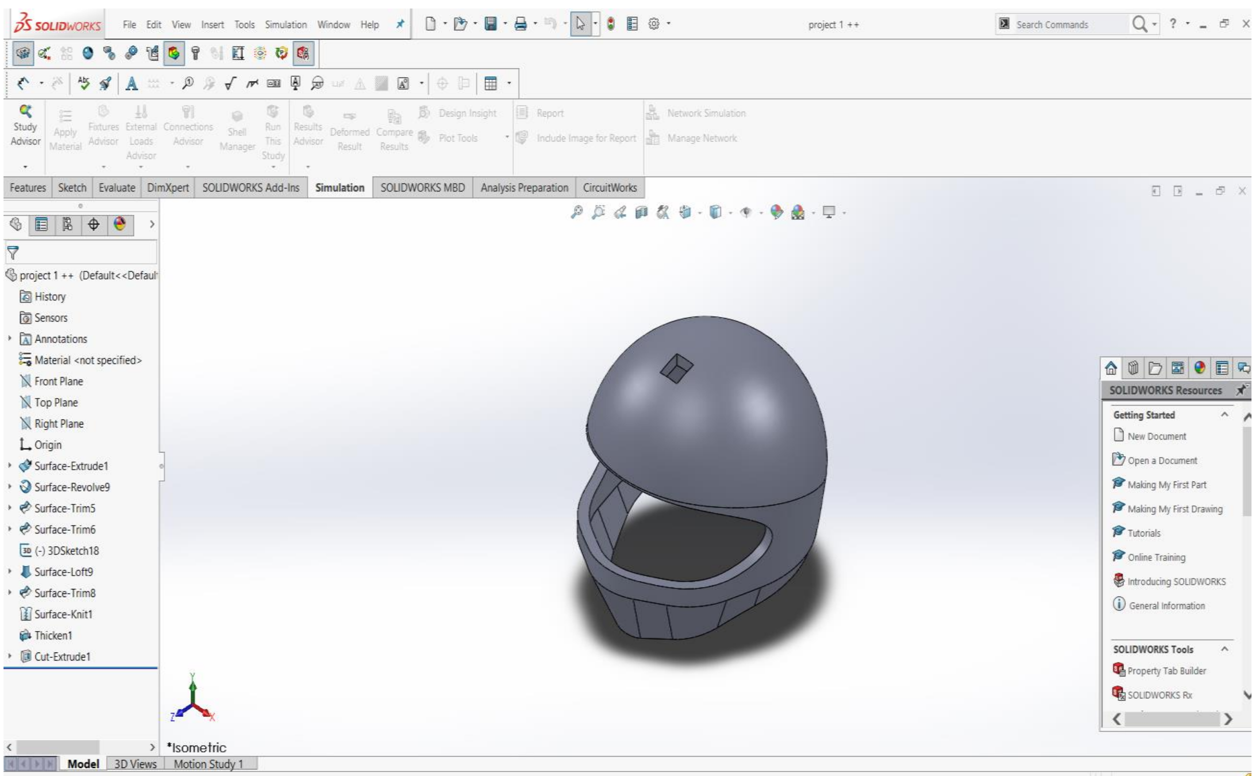

Fig 4.3 Modeling of Helmet with groove

4.4 Static structural stress analysis on helmet with groove

Material : polycarbonate.

Density :1500 kg/m^3.

Tensile yield strength : 63Mpa.

Ultimate tensile strength :70MPa.

Compression yield strength :80Mpa.

Ultimate compression strength:120Mpa.

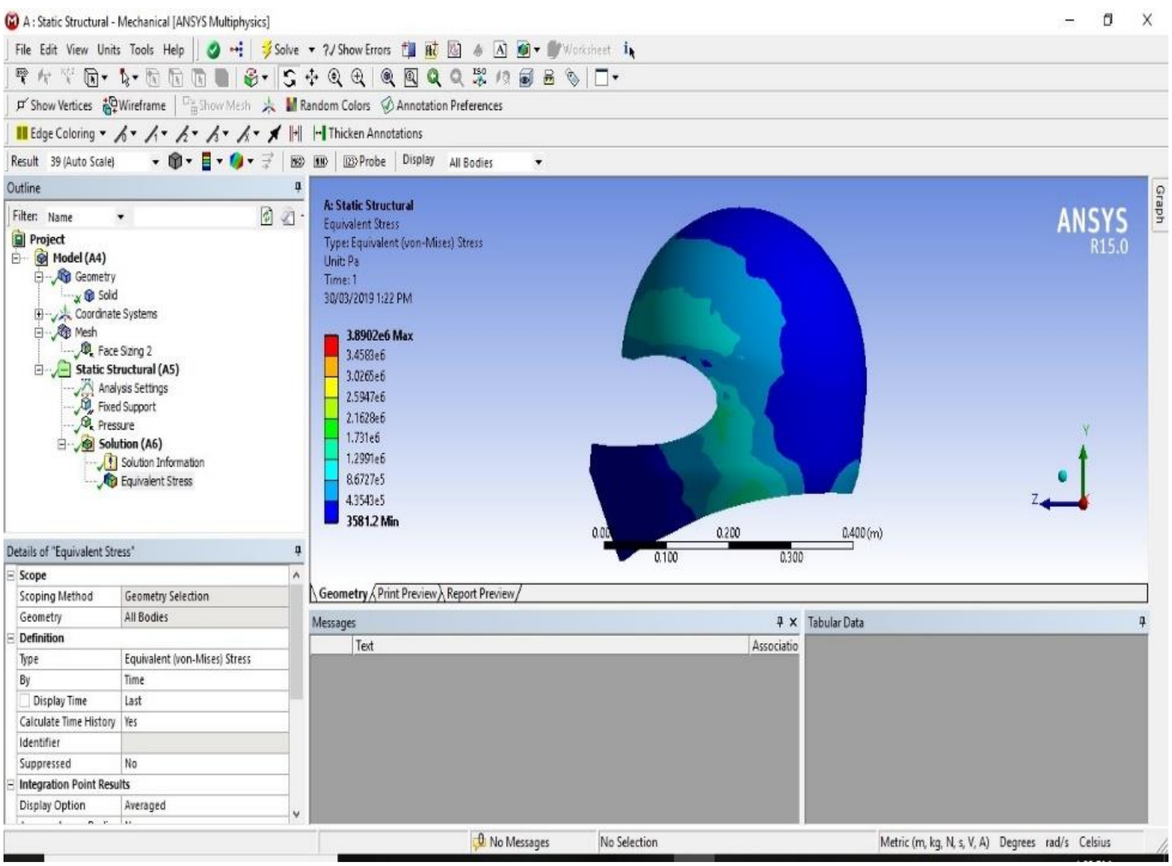

Fig 4.4 structural analysis side view

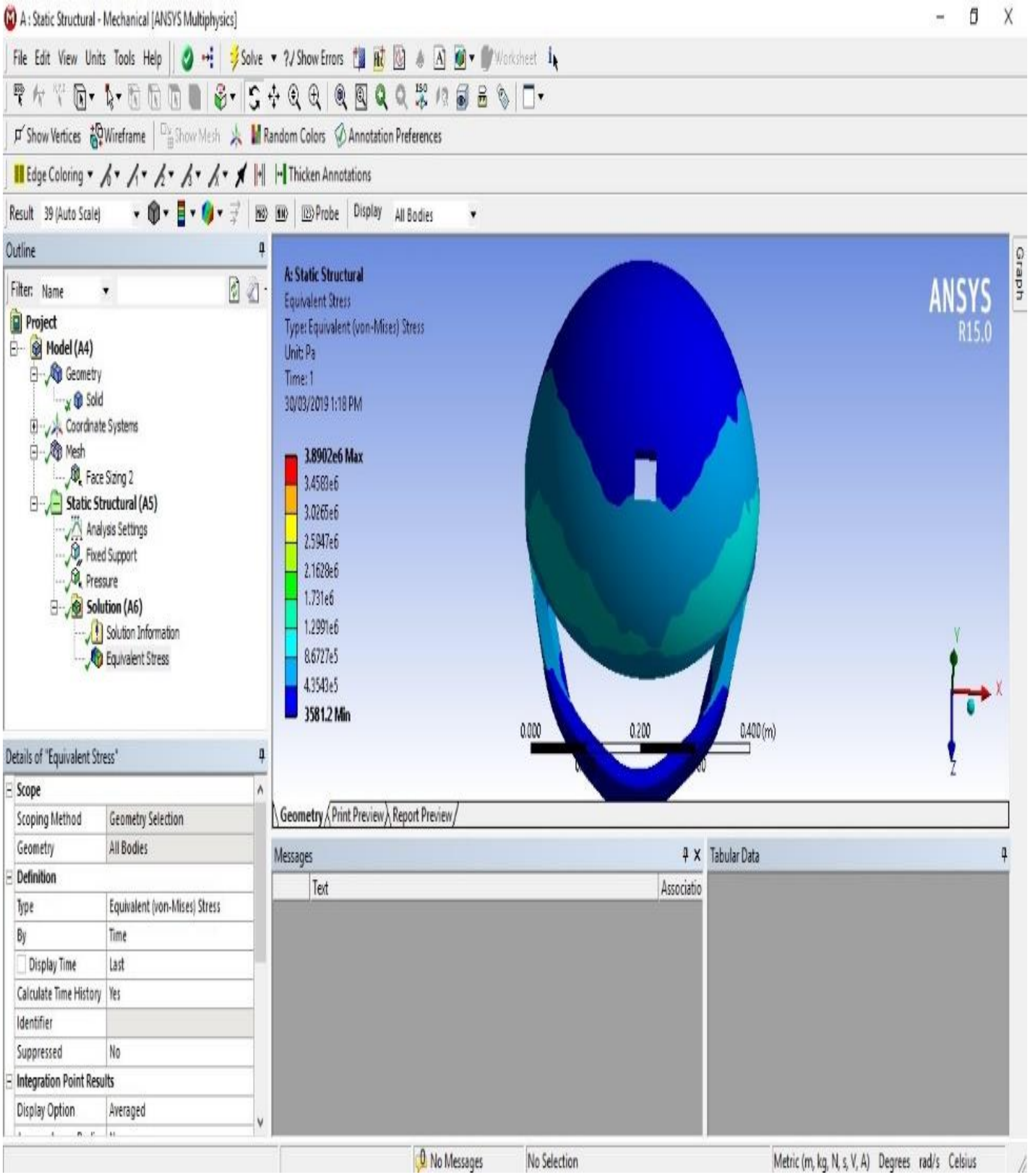

Fig 4.5 Static structural analysis of helmet with groove

The light blue area from the egde is the place where some material could be added to optimise the strength. With this provision we can make some area to attach peltier module.

Therefore strength optimization could be done by changing some design parameters like thickness and material properites in the effected area.

CHAPTER 05

MODIFICATION TO STANDARD HELMET

By making a standard helmet and attaching the components required to produce the cooling effect, a themoelectrically cooled helmet is fabricated. The detailed procedure of fabrication is as follows.

5.1 Disassembling the Helmet:

Initially a standard helmet is taken and all the parts are separated so that cooling components can be attached and redesigned. The main components of a helmet are :

- Visor.
- Outer shell.
- Comfort liner.
- Screws to attach visor.
- Base gasket.
- Impact absorbent liner.

Generally the impact absorbent layer in helmet is foamed polymer liner made of expanded polystyrene (thermocol).

This impact absorbing layer is moulded in such a way that the head is totally surrounded by it and comfort liner is placed on it for the convenience of the rider

.

Fig 5.1 Disassemble of Helmet

5.2 Making a groove in inner shell:

For the proper circulation of the cooled air around the head, grooves are made in the impact absorbing layer. Now to place the thermoelectric module(12V, 5A) and wires in the impact absorbing layer a hole of required dimension.

Fig 5.2 Making of Groove in inner shell

5.3 Installing Thermoelectric Module:

Now to place the thermoelectrica lmodule(12V,4A) and wires in the impact absorbing layer a hole of required dimension.

As the impact absorbing layer is made of expandable polystyrene material, it melts or soften at high temperature. So to protect it from the heat generated from module, the module is placed in the wooden support and it is attached to the impact absorbent layer with the help of tape.

Fig 5.3 Installing Thermoelectric Module in grooves

5.4 Making a groove in the outer helmet :

Now a hole is created in the outer shell of the helmet , so that fan with Al heat sink can be attached to the module from outside.

Fig 5.4 Making a groove in outer shell of the helmet

5.5 Attachment of heat sink:

Now 3D printed fan with Al heat sink cooler with dimensions 40mm*40mm*10mm is attached to the outer side of the peltiermodule on the helmet.

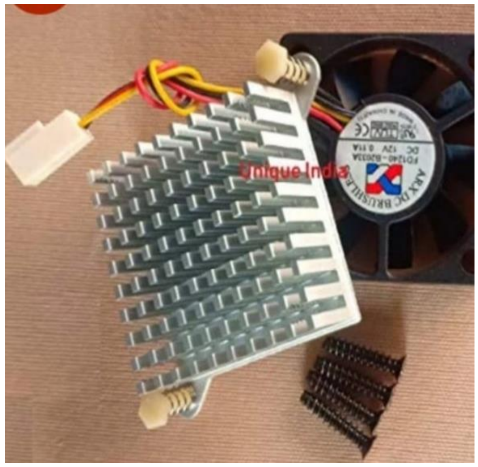

Fig 5.5 Heat sink

5.6 Assemble of helmet:

All the parts assembled, firstly impact absorbent layer is placed insidethe shell and comfort layer is attached then base gasket is fixed and visors is attached using screws.

Fig 5.6 Assemble of thermoeletric module and heat sink

CHAPTER 06

EXPERIMENTAL ANALYSIS

The experiment using peltier module, heat sink is done in various cases under various temperatures. the experiment is done in four different cases they are as follows:

- Peltier module in the absence of velocity
- Peltier module with heat sink in absence of velocity
- Peltier module in the presence of velocity
- Peltier module with heat sink in presence of velocity

6.1 Peltier module in absence of velocity:

Table 6.1 Only peltier module in absence of velocity (trail 01)

TIME (minutes)	HOT SIDE TEMPERATURE T1 (Celsius)	COLD SIDE TEMPERATURE T2(Celsius)	OUTSIDE TEMPERATURE T3(Celsius)
10	34	29	32
12	34.6	30	32
14	34.7	31.3	32
16	35	32	32

Explanation:

It is inferred from the above table that with increase in time the temperature difference between hot and cold ends of peltier module three degree Celsius. The cold side the temperature is initially low and with increase in time it is attaining equilibrium with outside temperature and the hot end of the peltier module remains at higher temperature that developed due to peltier effect.

Table 6.2 Peltier module in absence of velocity

TIME (minutes)	HOTSIDE TEMPERATURE T1(Celsius)	COLD SIDE TEMPERATURE T2(Celsius)	OUTSIDE TEMPERATURE T3(Celsius)
10	32	28	29
12	33.5	29.6	29
14	33.7	31.9	29
16	34	33.4	29

6.2 Peltier module with heat sink in the absence of velocity:

Table 6.3 Peltier module with heat sink in absence of velocity

TIME (minutes)	HOTSIDE TEMPERATURE T1(Celsius)	COLDSIDE TEMPERATURE T2(Celsius)	OUTSIDE TEMPERATURE T3(Celsius)
5	32	30	37
7	33	31	37
9	34	32.4	37
11	35	33	37
13	36	34.7	37
15	37	35	37
17	38	36	37
20	39	37	37
25	41	37.8	37
27	41	38	37

Explanation:

It is inferred from the above table that by using peltier module with heat sink and no velocity the difference between the temperatures of hot end and cold end is three where as the cooling temperature is initially low. With increase in time the hot end temperature and the cold end temperature of peltier module are equal and on continuing the cold end attains more temperature than the outside temperature, where the hot side temperature goes on increasing with time when compared to the cold side and outside temperatures.

6.3 Only peltier module in presence of velocity:

Table 6.4 Only peltier module in presence of velocity

TIME (minutes)	HOT SIDE TEMPERTARURE T1(Celsius)	COLD SIDE TEMPERATURE T2(Celsius)	OUTSIDE TEMPERATURE T3(Celsius)
10	30.3	28	34
12	32	29	34
14	33.6	30.5	34
16	35	32.8	34

Explanation:

It is inferred from above table that by using peltier module under velocity the temperature difference between the hot side cold side temperature is three degrees, where as the cold side temperature is low when compared to the outside temperature where as the hot side temperature increases with increase in time and there is only a slight high when compared to the outside temperature.

6.4 Peltier module with heat sink in presence of velocity:

Table 6.5 Peltier module with heat sink in presence of velocity

TIME (minutes)	HOT SIDE TEMPERATURE T1(Celsius)	COLD SIDE TEMPERATURE T2(Celsius)	OUTSIDE TEMPERATURE T3(Celsius)
5	30	29	37
7	31.3	30	37
9	32	31.2	37
11	33	31.9	37
13	33.9	32.6	37
15	34.7	33.3	37
17	35.8	34.1	37
20	36.6	35	37
25	38	36.1	37
27	39	36.7	37

Explanation:

It is inferred from the above table that by using peltier module with heat sink under velocity the temperature difference between the hot side and cold side is three degrees and the cold side temperature is initially low and on increasing the time it is less than the outside temperature but at a point it becomes equal and coming to hot side temperature it is increasing with respect to time.

6.5 Comparing the results

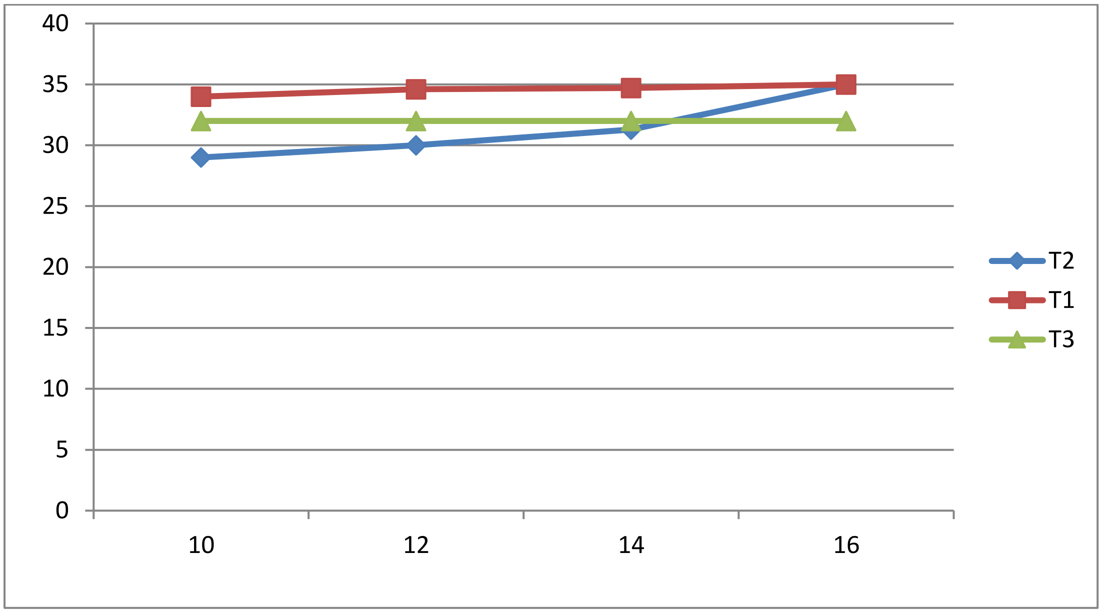

Fig 6.1 Variation of Time vs Temperature for Peltier module in absence of velocity:

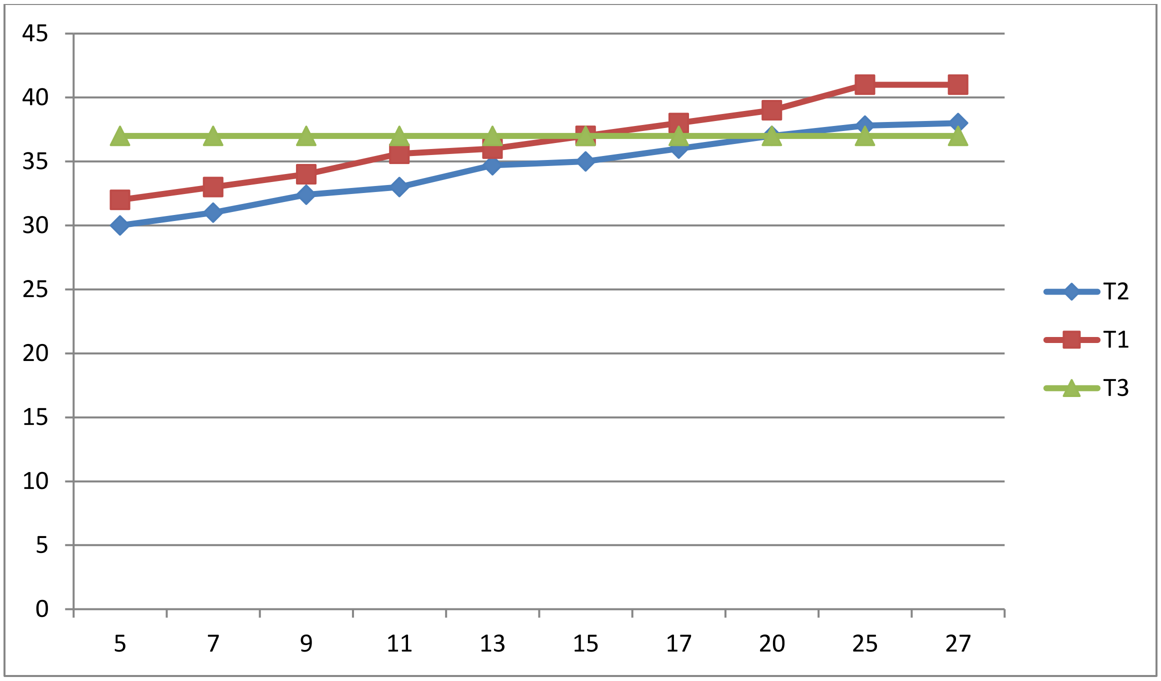

Fig 6.2 Variation of Time vs Temperature for Peltier module with heat sink in absence of velocity

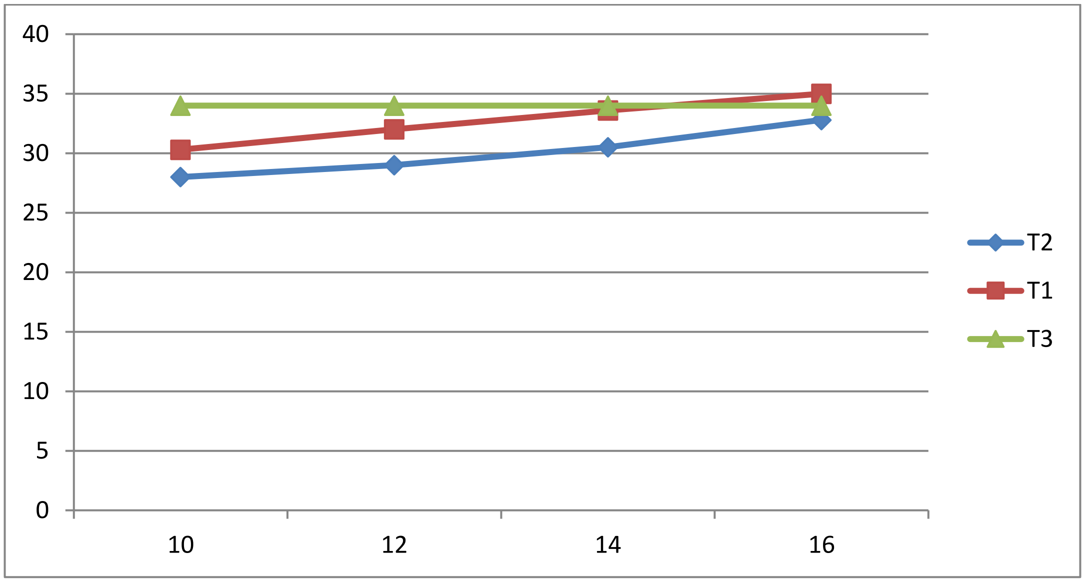

Fig 6.3 Variation of Time vs Temperature for Peltier module in presence of velocity

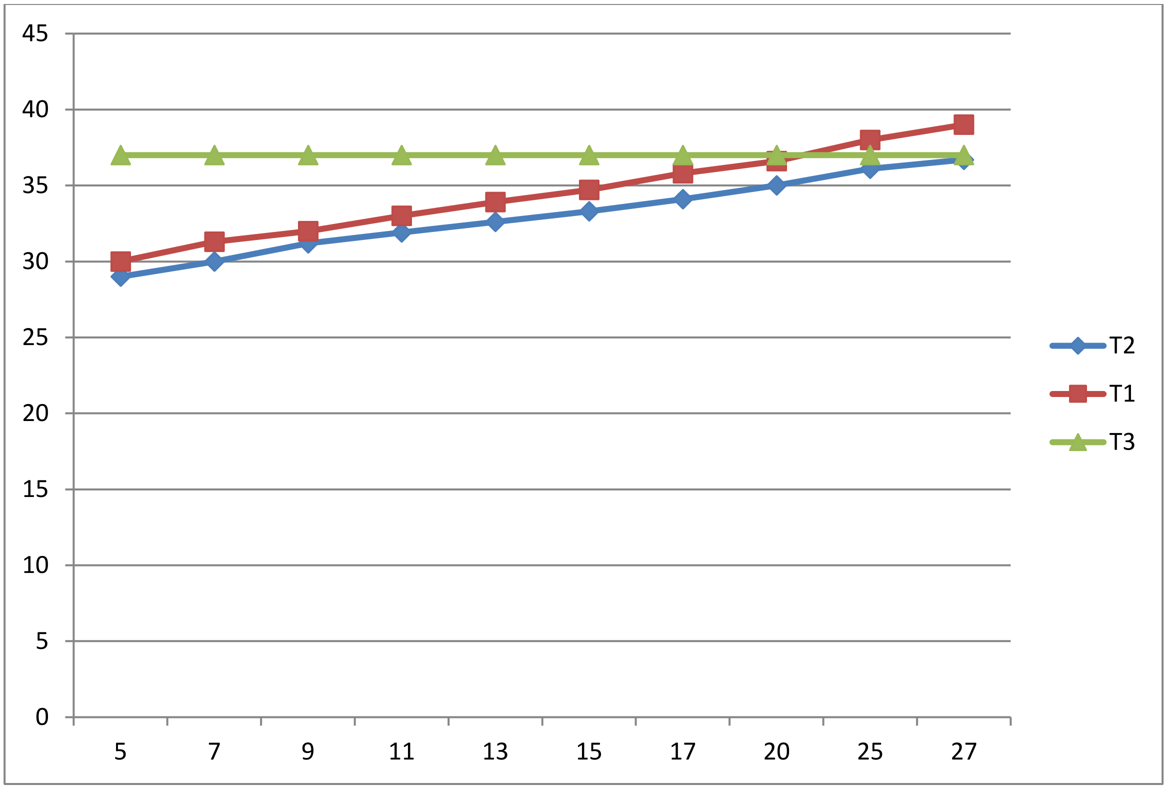

Fig 6.4 Variation of Time vs Temperature for peltier module with heat sink in presence of velocity

Therefore, from the above graphs we can say that using peltier module we can cool put a certain limit. When peltier module is used in the absence of velocity the cooling was minimal and doesn’t last more than sixteen minutes and the hot side temperature is more when compared to bothand its increasing with time

When the peltier module is used with the heat sink in the absence of velocity the cooling was low initially and that effect was reduced and reaches more than the outside temperature and the hot side temperature is also more when compared to both.

When the peltier module is used under the presence of velocity the cooling was low and it lasts more than sixteen minutes when compared to the peltier module in the absence of velocity and the hot side temperature is also near to the outside temperature but not with much difference.

When the peltier module is used with heat sink under the presence of velocity the cooling lasts for more time and even the hot temperature reaches the outside temperature after a long period with a slight difference but the cold side temperature is less when compare to outside temperature.

CHAPTER 08

RESULT:

Hence from the above experiment we noticed that using a peltier module in the absence of velocity, the cooling was low and it attains more temperature at the end, to overcome this the peltier module is attached to the heat sink and the experiment is done under absence of velocity, the cooling improved here when compared to the last case. The experiment is carried out using only peltier module under the presence of velocity where we noticed a good result, the cold side and hot side temperatures are far better than the above two experiments. On further experimentation the peltier module with heat sink in the presence of velocity gave better results when compared to the above three experiments, where the temperatures are less when compared to the outside temperature and the cooling lasts around twenty seven minutes and the hot side temperature is slightly higher with one degree of the outside temperature.

CHAPTER 09

CONCLUSION:

The standard helmet is modified by considering peltier module and heat sink. It is successfully designed in 3D-solidworks to suit the needs of human comfort and taking human safety measurements into considerations.

The static stress analysis is carried out on modified helmet using Ansys interface.

The experimental analysis is carried out for four different cases by considering peltier module, by considering peltier module with heat sink, by the presence of peltier module with velocity, by the presence of peltier module and heat sink with velocity.

The results showed that the helmet with peltier module and heat sink in the presence of velocity gives more human comfort as it exhibits more cooling, safety and human ergonomics.

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