© February 2025 | IJIRT | Volume 11 Issue 9 | ISSN: 2349-6002

Simulation of Cooling Helmet

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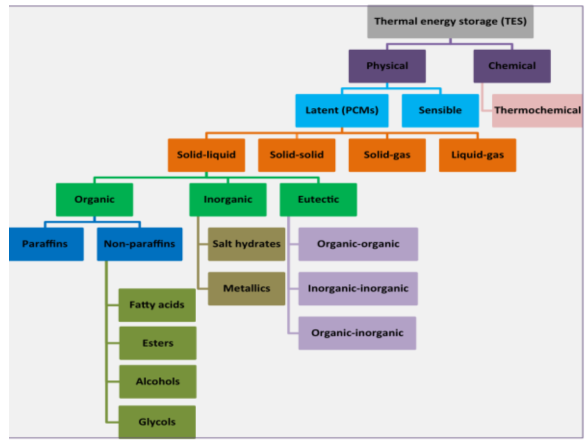
***Abstract*—The most important resource for every country to maintain its wealth and progress is its people. It is vital to keep people safe from accidents while they participate in a variety of risky activities, including industrial labuor, sports, military service, and daily living. Furthermore, wearing it can induce discomfort from the heat, rashes from perspiration, and blurred vision. There are four typical approaches to get around this problem. The first way uses a fiber layer to optimize breathability; the second uses an active technique, the third uses a passive technique; and the fourth uses a combination strategy. The design of a helmet has a major impact on the efficiency of both active and passive techniques. It affects the modes of heat transfer: conduction, convection, and radiation. The goal of the Computational Fluid Dynamics (CFD) simulation is to improve a military helmet's cooling capabilities. The study analyzes the heat transfer processes and airflow patterns inside the helmet using a comprehensive 3D model. Through the optimization of cooling efficiency under various environmental circumstances, the simulation seeks to improve rider comfort and performance by offering insights for the development of cutting-edge helmet cooling systems by using PCM, which is ones of the passive techniques.**

***Index Terms*—Phase changing material (PCM), Active techniques, Passive techniques.**

I. INTRODUCTION

PCMs are classified into eutectic, inorganic, and organic compounds. Organic PCMs, such as fatty acids and paraffin, are known for their non-corrosiveness and chemical stability. Inorganic PCMs, including metals and salt hydrates, offer higher storage capacity and heat conductivity. Eutectic PCMs are mixtures of two or more materials with melting points lower than their individual components, allowing for customized melting points for specific applications.



A. PCM Selection

The selection process of the PCM should contains these processes,

- Physical properties
- Chemical properties
- Melting temperature
- Non-toxic
- Non-flammable
- Economic properties
- Low cost and

II. EXPERIMENT AND METHODOLOGY

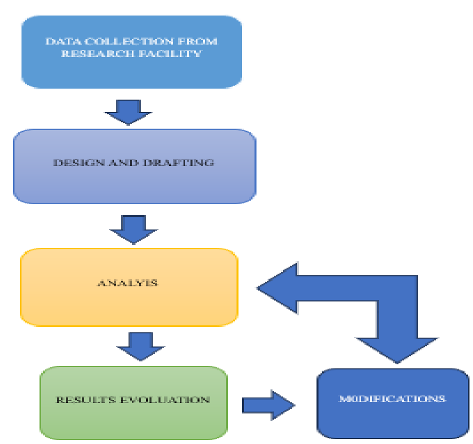


Fig.3.1: Flow Chart of Methodology

A. Assumptions

1.Phase changing material is homogeneous and isotropic throughout the process.

2. The temperature is considered only during summer season.that is 40 degrees.

3. The solidification of phase changing material is not considered.

4. The effect of heat from the head is considered.

5. The effect of radiation and humidity on the system performance is neglected

6. Flow of air is 0.5kg/s

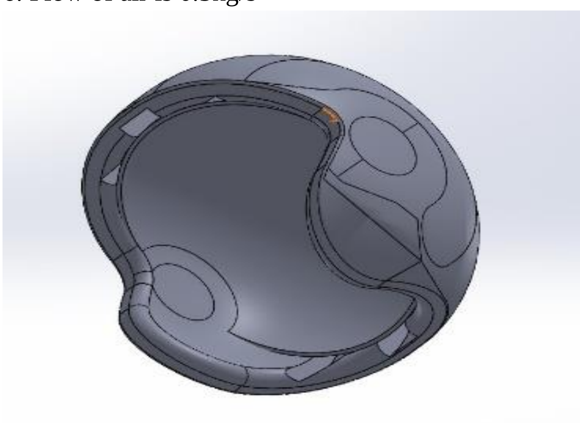


Fig: HELMET CAD

B. Boundary conditions

1. At the interface the amount of heat transfer by the conduction is equal the amount of heat transfer by the convection.
2. The outer walls of the helmet are adiabatic.
3. No slip condition is considered on the wall's computational domain.

C. Material and its properties

Outer layer made of thermosetting plastic. PCM (RUBITHREM -RT27) is pouched in copper box with thickness 0.5cm and height 1cm.and other with thickness 1cm and height 1cm. its properties are density in solid phase 880 (kg/m^3), in liquid phase 790 (kg/m^3), specific heat in solid phase 1800 (J/kg K), in liquid phase 2400 (J/kg K), thermal conductivity in solid phase 0.15 (W/m K), in liquid phase 0.24 (W/m K), latent heat 175 (kJ/kg) and cooling temperature 18 (◦C). Total volume of PCM 7.2x10^{-3} m^3

Hot air carrying in a duct, its properties are density 1.225 (kg/m^3), specific heat 1006(J/kg K), thermal conductivity 0.024 and temperature 40 (◦C), which is flow in a Collector plate made of copper plate whose thickness, height 0.5 cm and conductivity of copper 398 w/m K.

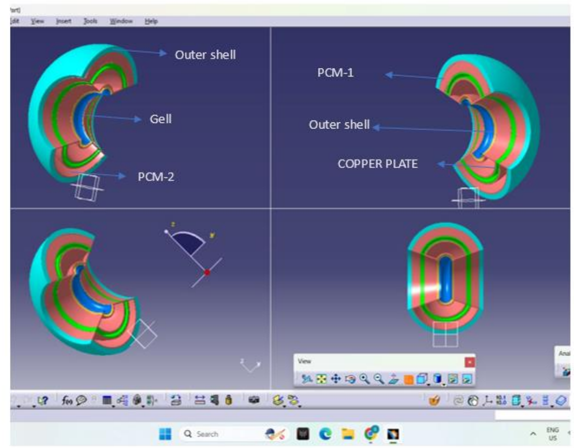


Fig: LAYERS OF HELMET

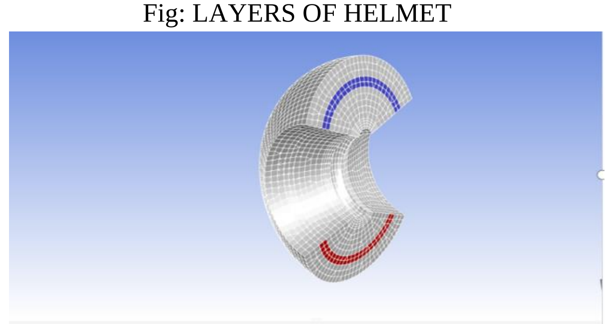


Fig: HEXA MODELING

III. RESULTS AND DISCUSSION

The results are calculated in two parameters such as temperature and pressure

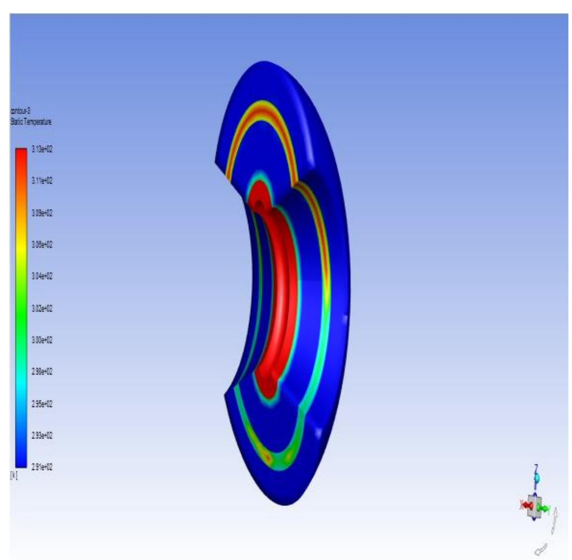


Fig:RATE OF TEMPERATURE OF HOT AIR DECRESES FROM INITIAL TO FINAL STATE.

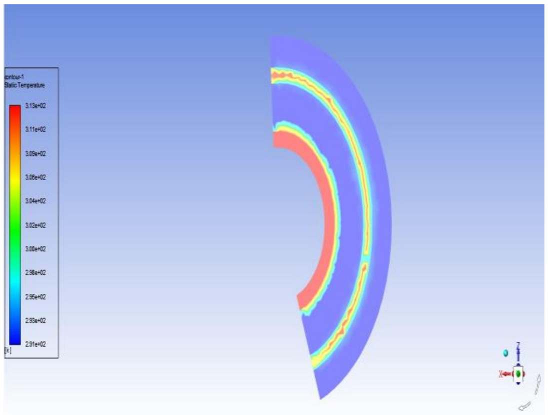


FIG : SHOW THE SECTIONED HELMET, RATE OF TEMPERATURE OF HOT AIR DECRESES FROM 313K TO FINAL 306.4K.

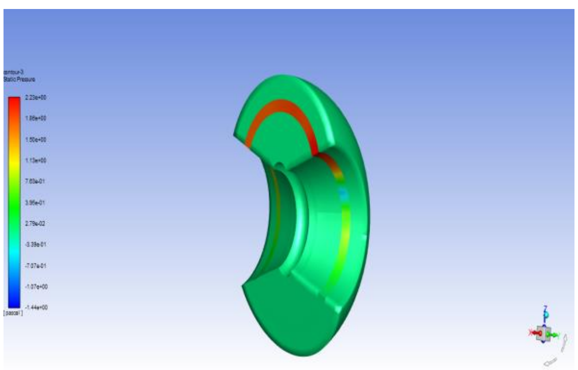


Fig: RATE OF PRESUURE OF HOT AIR DECRESES FROM 2.23 BAR TO 0.02 BAR STATE.

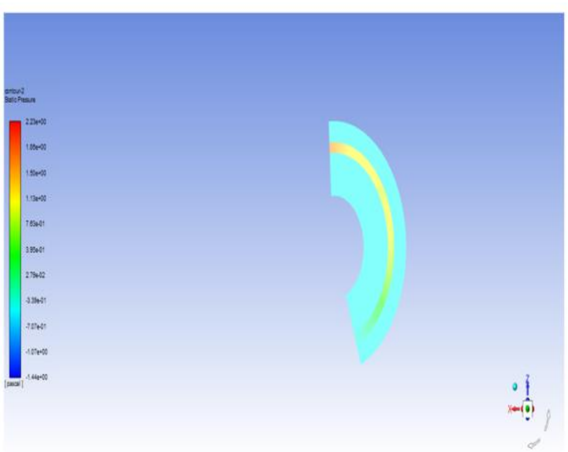


Fig :SHOW THE SECTIONED HELMET, RATE OF PRESSURE OF HOT AIR DECRESES FROM INITIAL TO FINAL STATE.

IV. CONCLUSIONS

Using passive techniques and the phase change material Rubitherm (RT27), along with conduction and convection heat transfer, the air temperature was reduced from 40°C to 33.4°C at the PCM walls, creating a comfortable feeling. The average temperature drop was 6.6°Cover a 2-hour period. As time increased, the PCM reached saturation, ceasing further cooling. To restart the next cycle, the PCM pack is cooled by air when set aside or, for immediate reuse, by immersion in water or cold water.

A. Future Scope

The future scope is want to know the behaviour solid to solid phase changing material and these passive techniques is used in the fallowing

1. In casting and forging operations to protect the workers from the heat.
2. Electronic gadgets
3. Medical fields

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