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Cooling of Intelligent Helmet using Phase Change Materials and Forced Convection with Smart Ignition and Accidental Alarming System

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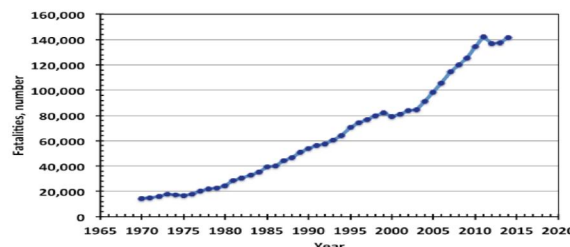
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Abstract: This paper deals with cooling of helmet using phase change material with forced convection accompanied with alarming the accident occurred while riding a bikes. Though it is very obvious, noticed that young people as well as the teenagers do not wear helmet while riding bikes. And according to the National Crime Records Bureau, Ministry of Road Transport & Highway, Law Commissions of India, Global status report safety declared on Dec12, 2016 total percentage of people died during accident was 98.60% who were not wearing helmet. In India 1214 road crashes occur every day whereas two wheelers account for 25% of total road crash death. Over 1, 37,000 people were killed in road accident in 2013 alone. Thus our main objective before this magnum opus is to make the helmet essentiality as it provides cooling sensation to the wearer. It is also equipped with accidental alarming system that will send a message to all the selected personal contacts. In case any severe case accident occurred there are possibilities that helmet may get a sort of jerk and this will activate the accidental damage sensor. Not only this but also no one can ride the bike after consumption because it has alcohol (gas sensor MQ3) sensor which will notify the microcontroller and ignition system will stop working. Hence preventing any individual to ride the bike after alcohol consumption or accident due to some other reason. There is an abort switch provided to discard the process in case of any minor accident.

Keywords: Phase change material, heat exchanger, NdFeB Disc, Vibrational sensor, Alcohol detector (MQ3), RF transmitter and receiver, Arduino programmed micro controller, automatic starter, accelerometer, GPS Module

I. INTRODUCTION

Nowadays we often see people do not wear helmet or only they supposed to wear because of such strict road safety rules implemented by the government and also helmet during hot days becomes too much sophisticated to be wore. Thus we came with an idea of a helmet equipped with such facilities that let the bike rider's necessity to wear helmet. In hot days it becomes difficult to wear helmet and the sweat creates too much problems and uneasiness thereof this COOLING HELMET will let the bike rider's head temperature maintained at specific range of temperature accordingly use of phase change material and forced convection and not only this it will ensure the bike engine to start only when the alcohol detector send a radio signal to the receiver in bike. In case of alcohol consumption the helmet will not send the radio signal to receiver as it already detects alcohol from breath and also bike will start unless the biker has helmet on his head thus helmet becomes necessity for a bike to start. We do, generally observe that most of the accident are caused due to excessive alcohol consumption, in this magnum opus will keep a check over the amount of alcohol consumption and the special sensor will not allow the engine to start therefore unless the bike rider wear the helmet. Once he had helmet over his head the alcohol detector will indicate the controller unit whether the amount of alcohol consumed is under the limit or over and the transmitter sends a RF signal to receiver in bike for ignition to operate .Another special equipped feather is ACCIDENTAL ALARMING SYSTEM which will help in sending a message of emergency help to pre saved contact detail in case of an accident. Thus immediate help may be send to the victim.



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II. HEORETICAL WORKING ANALYSIS OF HELMET AND DIFFERENT SYSTEM

Cooling of Helmet

Free Energy Engine (to run fan for forced convection)

Alcohol % Detector for Ignition of Bike Engine

Accidental Alarming System

Working Block Diagram of Helmet

Brief description of main components of Helmet

Vibrational sensor

MQ-3 alcohol sensor

Radio frequency transmitter and receiver

Arduino programmed control board

AccelerometerMMA7361

GSM Module

A. Cooling of Helmet

The most often problem with helmet is that in hot days it becomes too much problematic to wear helmet thereof use of phase change material to maintain the temperature. This will not only help the rider from hotness of summer days but also in winter season it will keep the head temperature at such a moderate value which led to feel the comfort ability. For maintaining the head temperature near 22 degrees we used PCM 22 which is a crystalline hydrated salt having a specific nature of absorbing heat when the outside surrounding temperature is more and which results in converting its phase from solid crystalline to liquid while on the other hand when the outside temperature is considerably low (winter season) than the standard range of temperature of HS22(phase change material) act as heat source and release its latent to the head. Though using this inside by putting a layer of PCM HS 22 inside the casing of acrylonitrile butadiene styrene which if a hard fiber protective cover and inside this a sealed pouch of PCM should be placed keeping the utmost care of human comfort and by this the direct contact of head skin and PCM will improve the heat transfer rate fast and attains the specified temperature. During summer season the PCM will act as sink and head temperature will be the source temperature and the whole process of heat transfer will alter during cold weather thus this will be suitable as all-weather helmet.

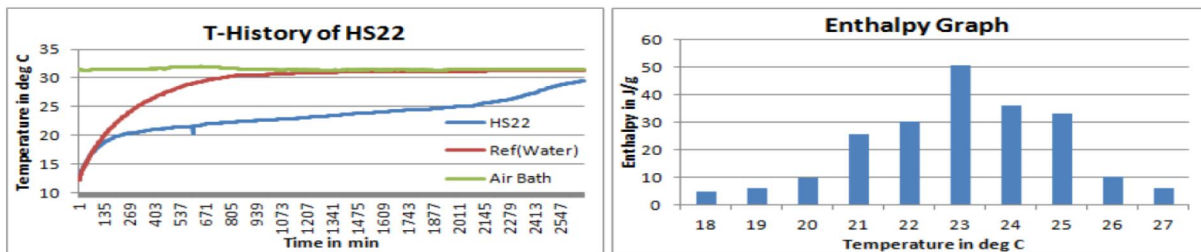
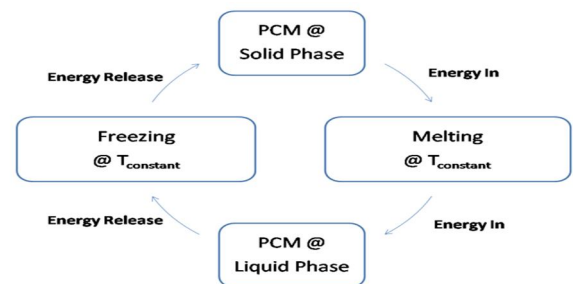


Fig1. (Temperature and Enthalpy Graph)

1) Characteristic of PCM HS 22:

Properties	Values
Melting point	23 degrees
Freezing point	22 degrees
Latent heat (KJ/kg)	185
Liquid density	1540
Solid density	1840
Thermal stability	2000 cycle



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Fig2. Schematic Phase Change of PCM

As the PCM is placed inside the helmet casing and these types of material significantly very much effective in storing the thermal heat because of their ability melting and solidifying over wide range of temperature. Since when the PCMs absorb a certain amount of heat and transform their phase from solid to liquid and hence giving the desired effect of cooling over specific area. While considering our head PCMs absorbs the heat in excess and keeps the head at range of temperature for specific PCM. There are wide range of PCMs are available like fatty acid, organic salts, hydrated salts et cetera.

2) *Cooling Phenomenon:* Working phenomenon includes the heat extraction from head by PCM and gets its phase converted from solid to liquid through heat exchanger thereafter the significant role of forced air convection comes into account and the inlet air increases the net heat transfer rate so that the cooling is done rapidly. The air is passed through a copper pipe as because the copper has high thermal conductivity of 386W/MK at 25°C and thus giving an optimized result of cooling.



Fig3. Helmet with exhaust and inlet fan

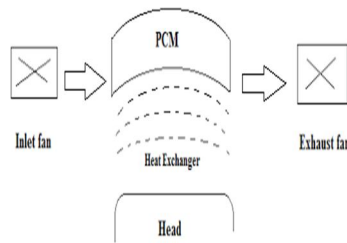


Fig4. Block diagram of cooling of helmet using PCM

B. Free Energy Engine

Forced convection also plays a significant role in maintaining the temperature of phase change material. Two fans are equipped, one inlet and other outlet for air circulation system that enables to extract heat from inside of helmet casing. Fan will run as a free energy engine without any external power source but in place of this we used powerful NdFeB DISC (permanent magnet) which is axially magnetized whose operating temperature is up to 70 degrees.

For the setup of two inlet and exhaust fan on each side of helmet, a casing is used to cover fan (a D.C. fan can appropriately be used) and at each corner of the casing a permanent magnet is to be placed for providing stable magnetic field. Each magnet is so systematically placed that flux lines of magnetic field cuts by the winding of fan and thus a motion is setup in the rotor. Basically the electric fan uses the phenomena of electro-magnetic induction, in which the current carrying conductor wire produces a magnetic field to rotate the rotor of fan. But this unconventional source of energy does not use, any kind of external power source (like battery) to run the fan and hence it is converted into free energy engine. Though the permanent magnet is used near head thus a very genuine question comes, will magnetic field harm to human being? To get rid of such problem we used such a low intensity of magnet which is enough capable to run the fan but do not affect the head and also a crynitrile butadiene styrene polymer cover is used as a protective layer thus it can stop much of the magnetic field effect which might can harm the human being.

1) *Specifications of NdFeB Disc:*

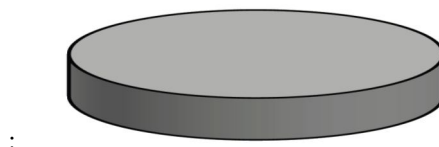


Fig5. Permanent magnet of disc shape

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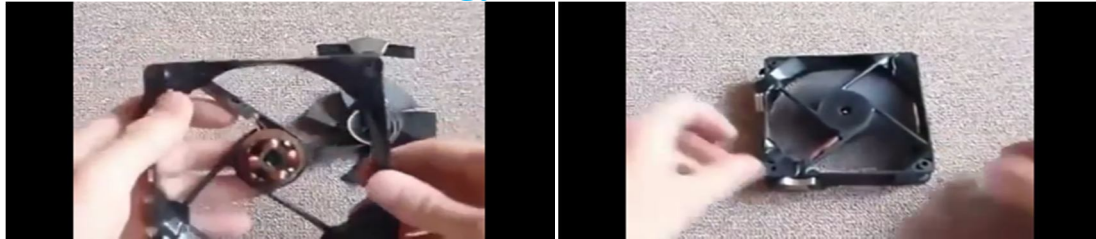


Fig6. Fan running with magnetic force

- 2) *Working Phenomenon of Free Energy Engine:* Though in helmet for forced convection system we are using permanent magnet to run the inlet and exhaust fan. Therefore it is essential to describe the working phenomenon of FREE ENERGY ENGINE. For this four magnet are kept in symmetry with the coil as coils are 90° apart from each other so as the disc are, as soon as all the four magnet are synchronized with each other the rotor start rotating with to the cutting of flux lines by coil. The only problem, is to stop the fan persist therefore to stop the motion of fan one of the disc is to be misplaced and as the disc is mis-aligned from its actual defined place the rotor of fan stops hence the control over the fan can be achieved.

C. Alcohol Detector

Alcohol detector system is a unique system which facilitates the driver to avoid the case of DRINK AND DRIVE. We often see most of the youth used to drink and drive which ultimately results to be loss of self-consciousness and leads to accidents. Helmet will automatically detect whether the individual has cross the drinking limit or not? As the helmet is equipped with a switch and facilitated with a transmitter and bike with a receiver. This whole system is controlled by a microcontroller which is programmed by Arduino UNO board. Though in case of alcohol consumption the breathing (alcohol) sensor will observe the amount of percentage of alcohol in breath and will send a signal to the micro-controller and in case of alcohol consumption, the Arduino board's analog pin will set up at LOW which results no radio frequency transmission to receiver of bike and the engine's spark plug will not ignite, using this technique it will reduce rate of accident caused by drink and drive. Until the bike rider doesn't wear helmet the power supply will not be sent to micro-controller and system will not operate. In case of no alcohol consumption the sensor first of all detects and will immediately sends an encoded message to transmitter and the encoding is done by RF encoder whereas this signal is send using, the aid of radio frequency transmission system. Now on the bike, receiver receives an encoded message which is further decoded by RF decoder and generates an electrical signal which goes to automatic starter and ignites the charge inside the combustion chamber.

D. Accidental Alarming System

In this helmet accidental alarming system will help to text a message the pre-saved contact number in case of any accident as well as the emergency need of help message will be send to nearest police station and ambulance service, so the immediate help may be given to the needful. This will work according to the identification of situation of accident. When the individual meets an accident surely he will be subjected to a sort of jerk. Though the helmet is equipped with a vibrational sensor and accelerometer to measure the degree of tilt from ground surface as in case of any accident occurred the bike may surely falls down and this accelerometer will send a message to microcontroller and when any accident occur the vibration sensor gets activated and controller retains a pre-saved alarming message from GPS data using GPS module (pre-defined interface) which is internally integrated to it. Thereof micro-controller plays a significant role in extracting the data and after modulation it will be send to the existing contacts. This additional feature will help to provide instant possible help which may be send to the accident spot. Working of accidental alarming system is solely based on GSM module, the threshold value is already fixed in the micro controller and in case of accident when a sudden shock is subjected to the vibrational sensors it extract the value and compare it with pre-determined value and if the vibration cross the threshold value then the controller activates the alarming system and it sends text message to the family members and with some specific time if no response is noticed then it may be considered as a major accident and ambulance with accordance to police is informed and thus providing the immediate help. The whole system is programmed through the Arduino using delay feature.

E. Working Block Diagram Of Helmet

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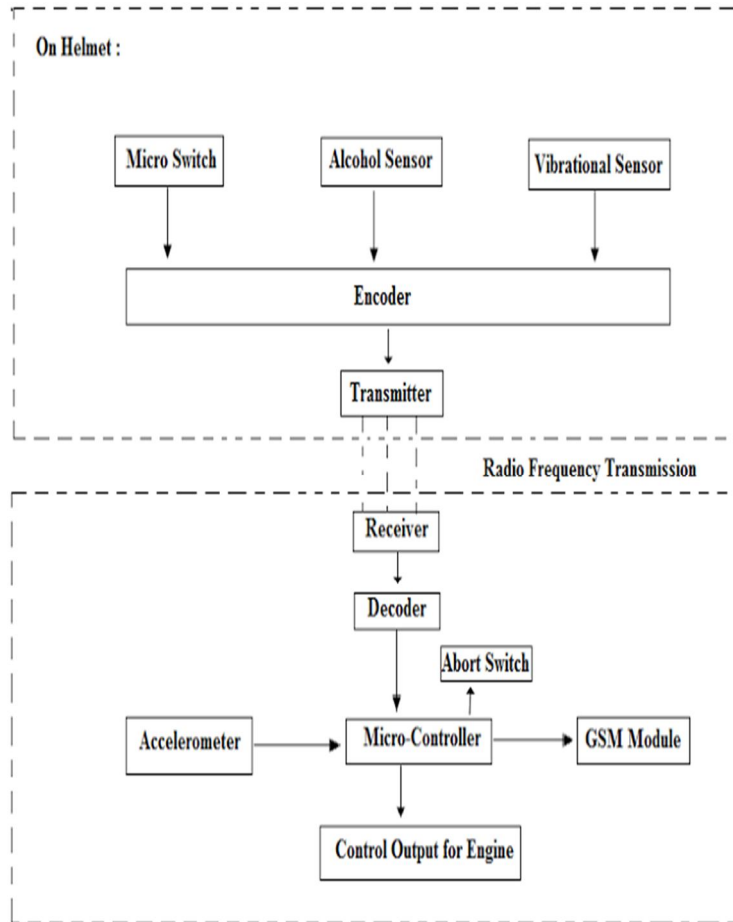


Fig 7. Working Block Diagram of Helmet

F. Brief Description of Main Components of Helmet

This section includes the brief description of all the components used in the cooling of helmet, forced convection's free energy engine, alcohol detector, alarming system:

- 1) **Phase Change Material:** PCM material is a unique material which extract heat from source to sink at expense of its phase transformation and during cold season it releases latent heat to keep the temperature at such an extend to provide the wearer comfort ability. We used HS22 which a mixture of inorganic hydrated salt and maximum operating temperature is 80°C.



Fig 8. PCM pouch

- 2) **Heat Exchanger:** Heat exchanger is the component particular used in this helmet which is in direct contact with the skin of head and physically in contact with PCM as well. It is made by close meshing of copper wire that helps to increase the total surface area and heat transfer rate for instant effect.

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Fig9. Copper Plate Heat Exchanger

G. Vibrational Sensor

vibrational sensor are basically used to detect the amount of jerk subjected at the time of accident and these sensors after detection of jerk activate the alarming system by sending a pulsed signal to controller unit. This is used to trigger out the effect of vibration subjected such as earthquake alarm, motorcycle alarm, etc. In case of no vibration jerk the output terminal's output is at LOW and whenever any sudden jerk is subjected to the biker then sensor turn to HIGH and signifying the case of accident. The output from the sensor is directly connected to the micro controller through single chip micro-computer to detect the HIGH and LOW level, thus detect the accident through the vibrational environment.



Fig10 Vibrational sensor module SW-420

- 1) **Mq-3 Alcohol Sensor:** This Alcohol sensor is suitable to detect the presence of alcohol concentration in the breath just like common breathalyzer, it has high sensitivity and fast response time to provide an analog resistive output based on alcohol concentration and its design circuit is very simple as it sends the signal to Arduino board and if amount of alcohol is detected the value at output pin will be LOW and the signal which is send by transmitter to receiver in bike to start the engine will not be send and thus no can start bike after consumption of alcohol. Whereas if alcohol presence is considerable then a signal is send to micro-controller and through transmitter RF signal is received to start engine

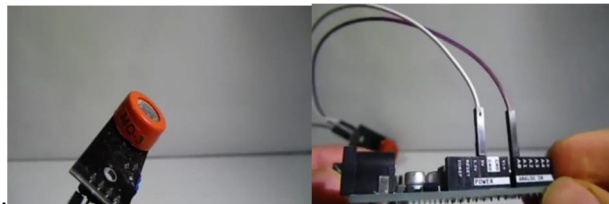


Fig11. MQ-3 alcohol sensor

H. Radio Frequency Transmitter and Receiver

Since this system works over the radio frequency i.e., it works wirelessly. Though to communicate transmitter and receiver both the required. To ignite the engine micro-controller after detection of alcohol limit sends an electric pulse to start the automatic starter.



Fig12. RF transmitter and receiver

- 1) **Arduino Programmed Control Board:** Arduino is used to provide a proper interface between sensors and other electronic equipment. It is much easier to program the vibrational sensor and accelerometer. Hence Arduino board is the main control unit which is connected with transmitter for sending the radio frequency signal to receiver to ignite the spark plug. Very commonly Arduino UNO board is used.

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Fig13. Arduino controller unit (UNO Board)

- 2) *Accelerometermma7361*: Accelerometer basically determines the total degree of tilt from horizontal surface. In case of proper running condition of bike it will create angle nearly 90° that is the safe working mode and if the angle decreases and reaches near the horizontal referential surface that it will inform to control unit and there after process of decision making is done by checking the angle of tilt and signal from vibrational sensor. To activate the alarming system through control unit.



Fig14. Accelerometer

I. GSM Module

In case of accident occurred micro-controller will notify the signal to the GSM module to send a message of emergency help at the accident spot. Since GSM module can accept any network operators SIM card and act as a mobile phone. Though SIM has a number through which a SMS can be send very easily. The modem can connect to micro controller directly and can send a message of emergency help either voice or text to ambulance, family members and police as well.

III. CONCLUSION

This helmet ensures the complete safety of rider and provides the facility to start the engine only when the rider has worn the helmet and not consumed alcohol. If any rules are violated such as consumption case of not wearing helmet then the bike will not start and accidental alarming system will help in informing the case of accident. The perfect interface of sensors will let the biking to a very safest zone. No individual will become a victim of drink and drive and if one accidentally met with an accident then individual should get immediate medical aid.

IV. ACKNOWLEDGEMENT

We are thankful to our Institute "Rajarshi Rananjay Sinh Institute of Management & Technology, Amethi" for encouraging us to explore ourselves. The Incubation Centre of the Institute. Is a beehive of intellectual and innovative activities? Under the excellent & effective guidance of our Head of Department from Mechanical Engineering Department, Mr. Pravesh Kumar Srivastava Sir, we have completed the "Cooling of Intelligent Helmet Using Phase Change Materials and Forced Convection with Smart Ignition and Accidental Alarm System". Our Institute has always focused on providing us a framework for better future for mankind. Also in shaping us to become effective, skilled professionals in coming future. I am very thankful to the Institute's Management & our Director Sir for his leadership.

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