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Thermal Management for Electric Vehicles: Enhancing Heat Dissipation and Efficiency

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Abstract: In this paper we are going to talk about all the researches been done till date on the lithium ion battery. Will you also talk about the heat issue and potential fire hazards occurring in the lithium ion battery electric vehicles which tends to getting hazardous day by day. In this paper an experiment has been performed showing the instability in fluctuation in the temperature of lithium ion battery while they are charging, being used and discharging, This paper also show what happens when lithium ion battery is being charged by a normal charger and a fast charger and how the health regarding the lithium ion battery is affected as well as how the temperature increases to a certain point when it starts heating up and the heat issue occurs giving a proof that high energy density battery have the potential of having an heat issue and fire hazard. We will also see what Indian government have regulated to propose and promote zero emission vehicle. How Indian government is proposing and planning to introduce EV in the cities of India and regulations on building on charging station of different types and the cost reduce the pollution and emission in the country we will review on what has been done till now and also propose what can be done in the future to reduce the issue and also reviewing the issues which has been detected till now.

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I. INTRODUCTION

As the world is moving towards clean energy and electric vehicles are being promoted all over the world india is also working towards its contribution in clean energy and reduction in carbon footprints. Companies like TATA, Morrison garage, mahindra etc are introducing electric cars and two wheelers from OLA and Aether. But the consumption and demand of electric vehicles have also revealed the flaws or gaps comes in the technology flaws like overheating an explosion of batteries. Currently these batteries are being commonly used in all over the worlds from electric vehicles to toys and cellphones. In EVs the issue occurs as high energy density lithium ion battery get highly overheated internally damaged and even in some cases catches fire or explodes(1). This paper talks about from what kind of battery used in cars from how they are functioning in car to what problems are occurring its reason and with the idea how it can be resolved or reduced will be learned and understand in the paper below.

- *Lithium-ion Battery*

These batteries are advanced technology which of course utilizes lithium as its main module in its electrochemistry throughout the cycle of discharge atoms of lithium within the anode are ionized in electrons are separated. Lions then proceed through the anode and flow across the electrolyte till they come to the cathode where ions reunite with their electrons and neutralize electrically. Bing small enough the LIBs Are able to advance a micro permeable separator in between the anode and cathode. Lithium ion battery have the capacity to store a lot of charge and voltage per unit of mass and volume(2).

- *Current Conditions Concerning LIBs*

From past decades LIBS are introduced in hybrid cars and electric vehicles increasing their demand and making them very important for electric vehicles, as the world is moving towards electric vehicles, demand of lithium ion battery is increasing and with more EVs on the road the issue of battery malfunction heat fault lithium ion battery catching flame or exploding is becoming a major concern for battery manufacturers and also to the companies who are selling electric vehicles. To create an environment of trust companies offer different warranties and offers alongside the purchase of vehicle but it only work as a temporary solution to a chronic issue(2).

- *Technology and Battery in a Car.*

Before manufacturing of any battery pack every battery cell have to go through a set of tests and rule. Apart from that It should be built with the rules and regulations stated by the particular Department of government who deal with EV battery pack and system.
Departments-

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- Automotive Research Association of India (ARAI)
- Central electricity authority standards (CEA)
- BIS Standards for electric vehicles charging guide

Different levels of charging station is built across the country, according to the supply and conditions variation. Below table show the different specification of the label with their compatible Chargers(3).

Table 1 Different Specification of the Level with Individual Compatible Chargers (3).

S.no	Charging stations	Voltage(v)	Power(kW)	Type of vehicle	Type of compatible charger
1.	Level 1(AC)	240	<=3.5 kW	4w,3w,2w	Type 1, Bharat AC-001
2.	Level 1 (DC)	>=48	<=15kW	4w,3w.2w	Bharat DC-001
3.	Level 2 (AC)	380-400	<=22kW	4w,3w,2w	Type 1, type 2, GB/T, Bharat AC-001
4.	Level 3 (AC)	200-1000	22 to 4.3 kW	4w	Type 2
5.	Level 3 (DC)	200-1000	Up to 400 kW	4w	Type 2, CHAdeMO, CCS1, CCS2

➢ *Battery Management System (BMS)*

Battery management system works to regulate and also supervise equal charge in every cell of the battery in every single pack. It is always supervising the vehicle. The vehicle is running or during charging which could be fast charging or standard and balancing all the cells in the same charge, This is known as cell balancing. BMS plays very important role in battery and electric vehicle safety(4). The BMS keep track of temperature, voltage, Current, along with charge condition of specific cell in the battery and ensure that they are within safe operating limits. It also balances the cells that helps to expand the lifespan of battery pack. Moreover, BMS Can also communicate with the EV's other systems, such as the charging system to guarantee that the battery is effectively and securely charged and drained with the cooling system, Which is taking care of the whole battery pack to be in the appropriate temperature(1). Overall, the BMS takes part in guaranteeing the safety performance in addition with the longevity of the vehicle.

➢ *Advantage of Battery Management System.*

- Improve battery life, BMS can monitor the battery's health and performance and optimize its charging and discharging which improves its battery life And prevent early failure(5).
- Battery management system can detect and prevent overcharging overheating and over discharging concerning the battery which helps in reducing the risk of fire and explosion.
- It can optimize the charging and discharging rate of the battery which can improve electric vehicles, acceleration range and overall performance.

➢ *Some Potential cons can also be fined in Battery Management System Given below.*

- Battery management system is a very expensive affair including its setup which can increase the overall cost of the vehicle.
- Battery management system is a very complex mechanism in system with the very sophisticated software and hardware components which makes it very hard and requires training to troubleshoot and repair if any problem occurs(6).
- If electric vehicle is standing in heat sometimes battery management system detect that heat from the surrounding outside of vehicle and calculate it as the internal heat of the vehicle and shuts down the system with the response of overheating which is not the case As the surrounding is heat For example, a vehicle is standing in Rajasthan There have been cases where BMS has shut down the vehicle thinking that it has been overheat.
- BMS Components are very fragile and sensitive which if are not quality checked properly, can fail in malfunction, which can compromise the vehicle safety and performance

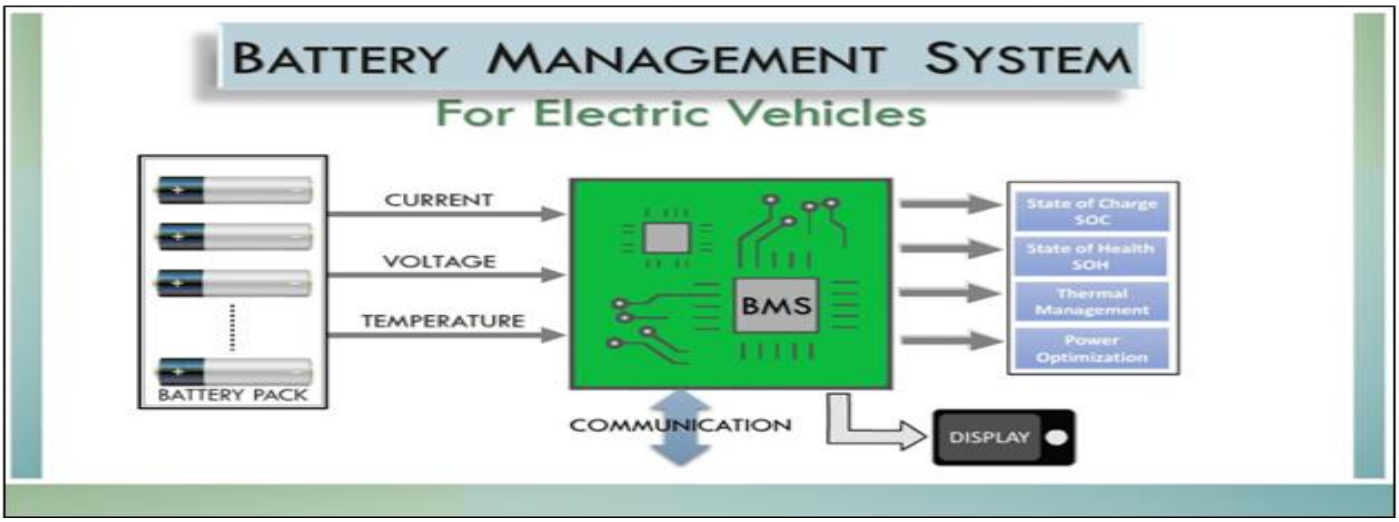

Fig 1 A Diagram for Understanding Battery Management System of EV.

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➢ *Electric Vehicle Battery pack and Module*

The core of an electric vehicle is its battery pack. It contains a set of batteries that work together to store and supply electricity to the car's electric motor. The battery module contains a huge number of individual battery cells connected in series or parallel to produce the required voltage and capacity(2).

Depending on the type of the electric vehicle hatchback sedan or SUV, Different EV battery packs have different numbers and size of battery modules. Generally larger electric vehicles require more battery modules to provide sufficient energy, while small electric vehicles require fewer battery modules. The battery modules are typically designed to be replaceable aligned for easy maintenance and repair of battery pack This means that if one or more battery modules fail, they can be replaced without having to replace the entire battery pack(7).

The most commonly used battery chemistry in electric vehicle battery pack are lithium ion and nickel metal hydride. Due to their high energy density, longer lifespan and less weight compared to other battery types, lithium ion batteries are the most often used option. In general, the ev battery pack and module are essential part of electric vehicle There are an important component in determining the range and performance of electric vehicle since they supply the electricity required to run the vehicle The technology continues to improve and we can Expect advancement and innovation in the battery technology in forthcoming future(8)(9).

Fig 2 Base of EV chassis with battery cells.

➢ *Instability of Lithium-ion Battery*

Due to their high energy density lithium ion batteries are utilized in many electric vehicles and portable electronic devices. However, these batteries can also be prone to instability and safety risk If not designed, manufactured and used correctly. Some common reasons for the instability of LIBs include(9).

- Overcharging: If a lib is overcharged, it can cause the battery to overheat. And in extreme conditions, led to a fire or explosion.
- Overheating: lithium batteries generate heat during use but as the temperature gets too high, it can causeway the battery to fail and malfunction or get very heated.
- Mechanical damage: If the battery is physically damaged, such as by puncturing or crashing, it can causeway the battery to leak or catch fire
- Manufacturing defect: Lithium batteries are complex devices and if in quality assurance any electric vehicle lithium ion battery pack is defected, it can lead to instability and safety risks.

To prevent these risks, manufacture uses various safety features and techniques to prevent instability and reduce the likelihood of safety incidents These safety features may include temperature sensor, and various safety circuits that prevent overcharging and over discharging of the battery. While Lithium ion batteries are being transported It can also get risky as lithium ion batteries cannot be completely discharged They always contain 25 to 30% charge even while being transported to a different place(10).

Additionally, users of lithium ion battery should follow proper charging and storage instructions, such as using the appropriate charger, not leaving the battery in hot environments, and avoiding exposing the battery to excessive physical stress In conclusion, while lithium ion batteries are broadly used in convenient power supply, they can pose safety risk, if not used, and maintain correctly. Manufacturers and users should follow proper safety guidelines to reduce the risk of instability and safety incidents(11).

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Current scenario of lithium ion battery in the company regarding supply and risk of Transportation. The demand of sleet and battery is rapidly increasing as the request of electric vehicles is increasing. It shows the growth of ev market However, the supply of lithium ion battery is currently facing some challenges due to the insufficient supply of raw materials used in their manufacture. The battery require material such as lithium, cobalt, nickel and manganese that are often sourced from countries with limited reserves of these resources. Additionally, there are concerns Above the environment society and the rights of Labor, which are being affected by the mining of all those raw materials specially in developing countries where labor standards in environmental regulations may be weak(12) (13).

To resolve all the concerning issues and addressing the challenges. Some companies and governments are investing in research and development to find alternative to the materials currently used in lithium ion batteries. For example, solid state batteries, which employ a solid electrolyte rather than liquid or gel electrolyte, are gaining popularity compared to conventional lithium ion batteries. Solid state batteries have the potential to provide greater energy density, quicker charging times and increase safety(13). Overall, the market for lithium ion battery for electric vehicle is expanding quickly. And there are challenges regarding the supply of raw materials However, there are also promising developments in battery technology that may help to overcome these challenges in the future.

Risk in transportation of lithium ion batteries is one of the issues which cannot be overlooked As Lithium ion batteries are high energy density batteries they have a tendency and a very prone to heat as little batteries cannot be completely discharged which means there is always an enough charge left in the batteries to get heated get imbalanced or Causeway a phenomena which is known as thermal runaway. This happens when the battery overheats. Setting of a series of events that may result in an overheating issue explosion of fire, because the batteries are exposed to a variety of environmental variables during transit, including variations in temperature, humidity, pressure This danger is increased. To mitigate this risk Lithium ion batteries for electric vehicle are designed with thermal management system and internal safety mechanism being an important safety feature. There is also an risk while transporting batteries is a potential of mechanical damage, as electric vehicle batteries are very large and heavy And their casing semi vulnerable to damage during handling, loading and unloading. Even the minor damage, the battery casing can lead to a short circuit Apart from that if lithium ion batteries are being transported by land There is also a risk of theft due to high value of lithium ion batteries and some materials like cobalt nickel Which can be extracted and sold in the black market(14).

In conclusion implementing proper safety measures and strict guidelines and extra sensitivity towards the components can somehow prevent this type of loss in batteries and they can be delivered safely.

- *Charging Infrastructure:*

Regulation by Govt of India These regulations were directed by the government of India (2022) to the secretaries of all ministries, department and Chief Secretary of state and Union territories. These charging regulations of electric vehicle were revised because of the demand and consumption which has been increased in the past few years because of many different automobile companies have introduced electric vehicles. Objective of those charging infrastructure for electric vehicles and regulations has several objectives, such as to permit quicker adoption of electric vehicle in India By safeguarding affordable charging infrastructure as well as ecosystem with a safe and reliable accessibility. These regulations will also help to generate employment opportunities and also opportunities for the new startups, small businesses and small entrepreneur decorating an industry basing their work in the growing field of electric vehicles(3).

Public Charging stations (PCS), The station will be installed in the common public places in public parking lot where the user can charge a EV with the charging cost regulated by the government.

Battery charging station (BCS), In this station, the batteries of electric vehicle will be charged, To be precise the difference is that electric vehicle is not the one will be plugged in, but it will be the battery which is charging into the charging station which means The battery will be easily detachable.

Captive charging station (CCS), Charging station placed Will be owned by privately running body, like corporate houses, government dept, bus depot and hotels.

Battery swapping station (BSS), Station where your Discharge battery will be swapped with a fully or partially charged battery in the station. You will be able to swap your batteries according to your need It will take minimal time to swap the battery and get your vehicle running. Cost of swapping battery will be more than recharging a car. And also, there are less chances that swap battery is fully charged(3).

The regulations were made regarding electric vehicles, not just 4 Wheeler, but two wheel electric vehicle, and also heavy duty electric vehicles such as commute bus and EV trucks The guideline showed the plan till 2025 for charges, supplies and station will be constructed, how much cost and what guidelines should be followed for the running the mall. This guideline were created to commence in initial phase of introducing electric vehicle in India And let the citizens of the country get habitual and can slowly adapt to the changing market of electric vehicles in their country. The document of guidelines on electric vehicle and infrastructure consists of 64 pages, which was issued within approval by Honorable Minister of power New and renewable energy, Suman Majumdar. The guidelines and regulations were sent to all the government bodies which have anything to do with renewable energy consumption of power and electric vehicle Also in city infrastructure(3).

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This issues with the approval of Hon'ble Minister of Power, New & Renewable Energy.

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Copy to:

1. Prime Minister's Office/Cabinet Secretariat
2. CEO, NITI Aayog
3. The Secretaries of the CERC/State Commissions/JERCs
4. Chairperson, CEA
5. DG, BEE

(S. Majumdar)
Under Secretary to the Govt. of India
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Fig 3 First copy Sent to the Highest Authority of India then the sub Bodies, after Approval (3)

➢ *Cause of Overheat and Potential Fire Hazard in EV Battery.*

The Lithium-ion battery used in EV car are very high energy density. So they possess different kind of instabilities like overheating phenomena, electrochemical ageing, cell degradation and variations in electrolyte properties, which can causeway thermal runaway. Different phenomena sometime combined creates enough heat to overcome the cooling system And the gas Smoke created leak from the back, which is highly flammable. And also have a tendency to self ignite due to low ignition temperature Due to those occurring system gets heated or gets a potential hazard for fire

These phenomena occur due to load unload of battery, as in when ev is charged, it goes into a state which is known as active balancing. And when battery is being used, it turns to passive balancing. So that what happens in active and passive balancing is given below(15).

Active balancing the cell in battery pack is attached in series in every cell possess some amount of individual behavior. So, when the battery is charged, all the cell balances themselves onto a higher degree of charged cell(16).

Passive balancing at the cells are attached in series And when they are not charging that mean vehicle is being used or standing in an idle position or the system is in rest The cell go into the passive balancing. Passive balancing is a process in which all the cell achieve the lowest Percentage of charge and balance themselves to the rower charge And the charge in lost in the cell is known as thermal runaway(16).

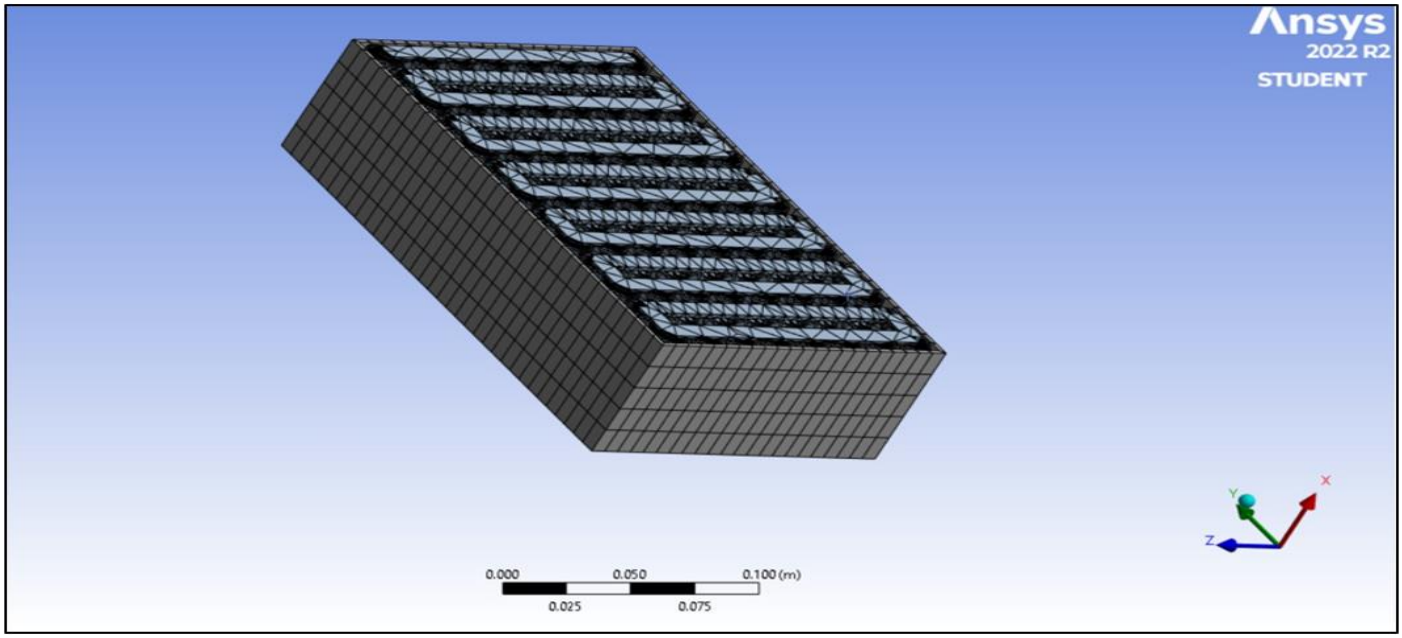

Fig 4 EV battery pack showing series connection between cells.

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Battery pack design showing the series connection between cells, because of which active and passive balancing occurs, affecting each cell. In thermal runaway the charge is lost in the cells are converted into gas, which Releases in the battery pack This gas is highly sensitive and easily combustible And we think it in any way Thermal runaway cannot be prevented as it is at chemical phenomena which occurs in the battery. As the gas is released in the battery after a duration of time the system starts getting heated up An overpower the cooling system of the battery pack and increases the temperature of the system above the Goldilocks zone which is the temperature should be more than 15 degrees Celsius and less than 45 degrees Celsius And in some cases, 35 degree Celsius to maintain the proper functioning of the battery pack This temperature is increased(6).

Thermal runaway is caused because of not maintaining the regulations of battery pack which is abusing or exceeding the set charging and discharging limits being exposed to high temperature And consecutively charging of the battery pack with a fast charger which creates the imbalance in the cells. Operating the lithium ion battery outside of the stability window generate heat That trigger heat activated exothermic processes inside the battery which in terms generate a large quantity of extra heat. The rise in temperature then occurs as a result of exothermic reaction. Speeds up the kinetics of the reaction which consecutively increases the temperature And the cooling system becomes useless(17).

Most electric vehicles have thermal management system that control the battery's temperature using liquid or air cooling to keep the battery pack within the Goldilocks zone. By keeping the battery within the optimal temperature range this mechanism helps to keep it from getting excessively hot or cold Battery pack are designed for temperature regulation so that the temperature can be maintained But due to some phenomena the Goldilocks zone and the thermal management system of the battery pack cannot defend against the heat generated from the chemical reaction happening inside the pack. Now we will see the experiment and proof of the above discussed issue(18).

➢ *Experimentation*

Below data represents the experiment done on two identical cells showing different behaviour, while being charged resting and discharging at the same time. Equipment used in the experiment were provided by Indian institute of technology Ropar in their lab, equipment are as follows

II. DAQ970 A DATA ACQUISITION SYSTEM

It is used to measure the inside temperature of the cells. The temperature of the cell is measured using thermocouples that are fastened to it at the top, middle, and bottom when it is being charged, discharged, and resting. Other end of the thermocouple attached inside the DQ with the time interval set on 10 seconds for each reading till the whole process of charging resting and discharging happens.

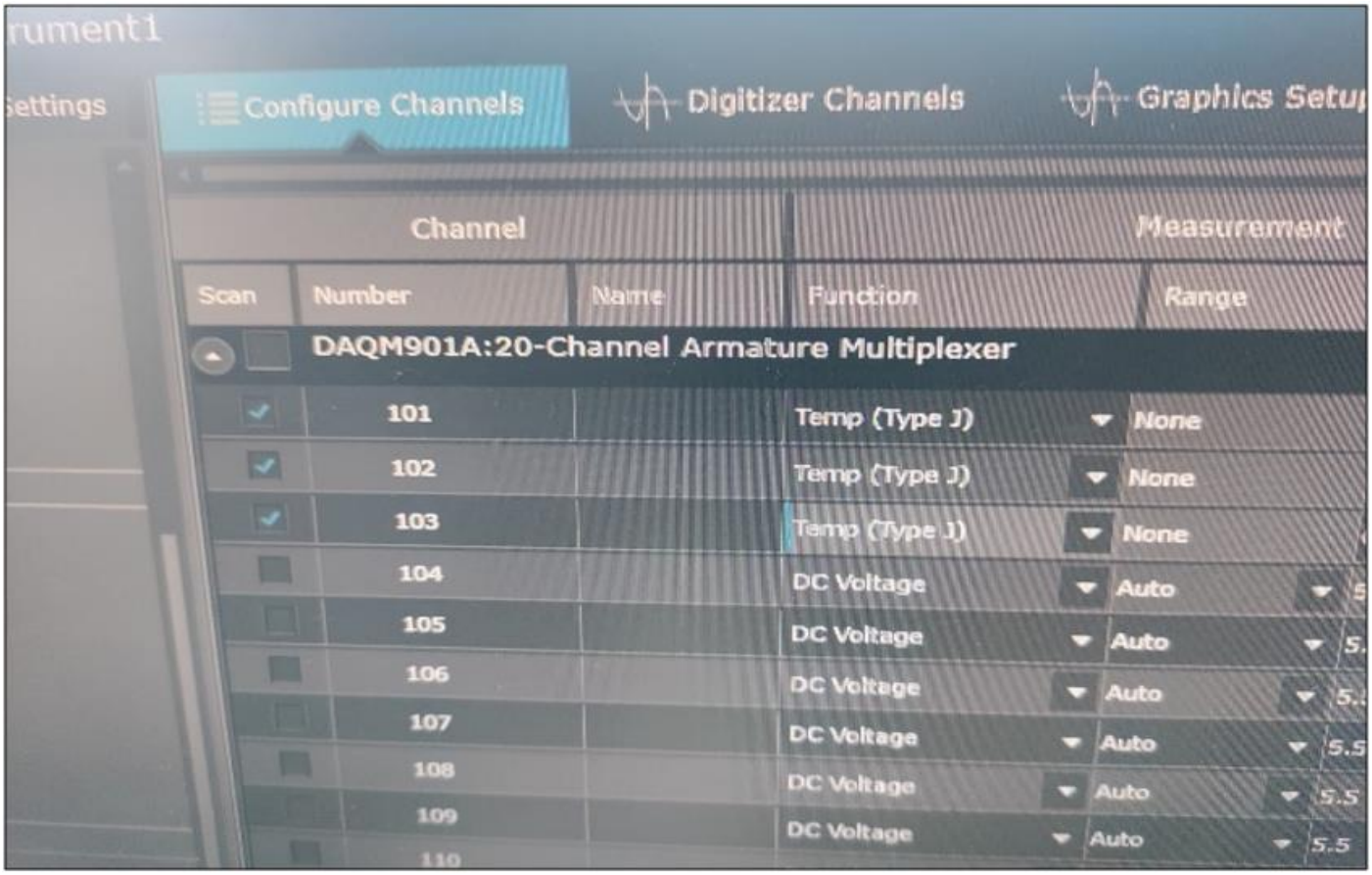

Fig 5 Screenshot of DAQ970A Showing Battery Channels being used for Battery Testing their Charging, idle Drain, and Discharge.

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Fig 6 As Shown in the Image Above Interval is of 10 secs, so data is Sweeped from the Cells in Every 10 sec and Channel is set on Measuring Temperature.

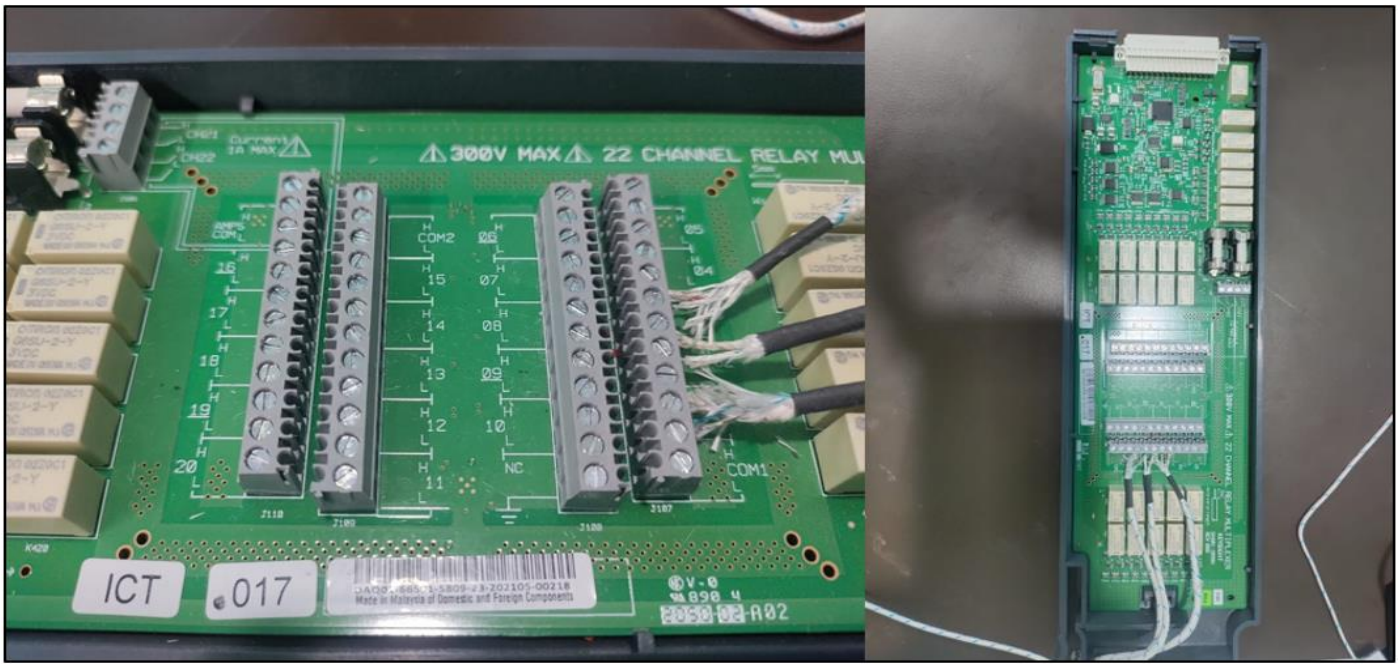

Fig 7 Shows that the ends of Thermocouples are in Channel 1,2,3. Channel 1 is set for top part of cell and Channel 2 to middle and Channel 3 to Bottom.

III. NEWARE BATTERY TESTING SYSTEM (BTS)

This equipment consists of 10 channel to attach cells, BTS work is to charge the battery and discharge it while measuring and keeping record of time, voltage, current, and charge discharge efficiency. User can input his required command in the system, for charging, rest and discharge, by setting time all the 3 process and the system will create a graph for the process. Screen on which the required data is set, visual appearance is in below image.

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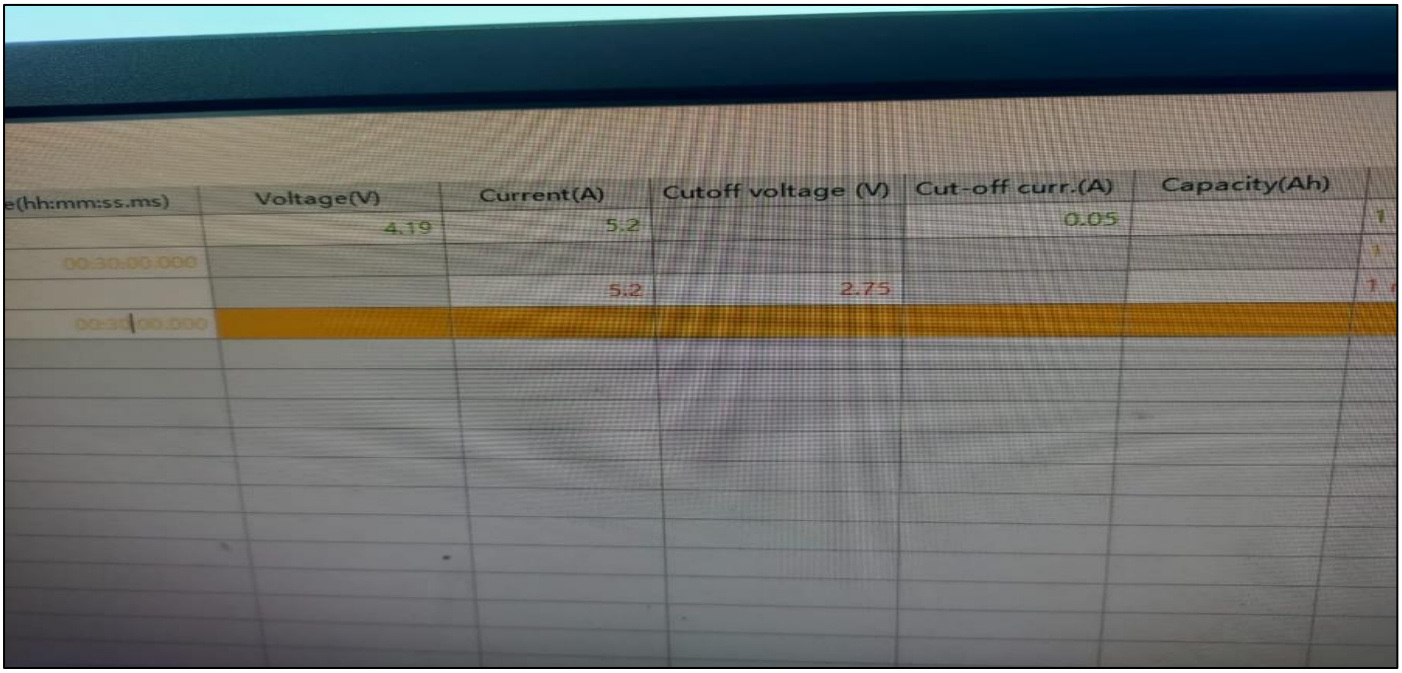

Fig 8 Voltage in the Image is 4.19 Which is the Highest the cell could Reach, Current can be set from Range of 0.5 C to 2 C

Table 2 C value with the current ampere

C Value	Current in Ampere
0.5	1.3
1	2.6
1.5	3.9
2	5.2

Green line in image shows the charging time which can set in time or set to till full charge of cell, red line shows the discharge which can be set exactly like charging, i.e for time or till full discharge, between green and red is resting time in which cell sits ideal.

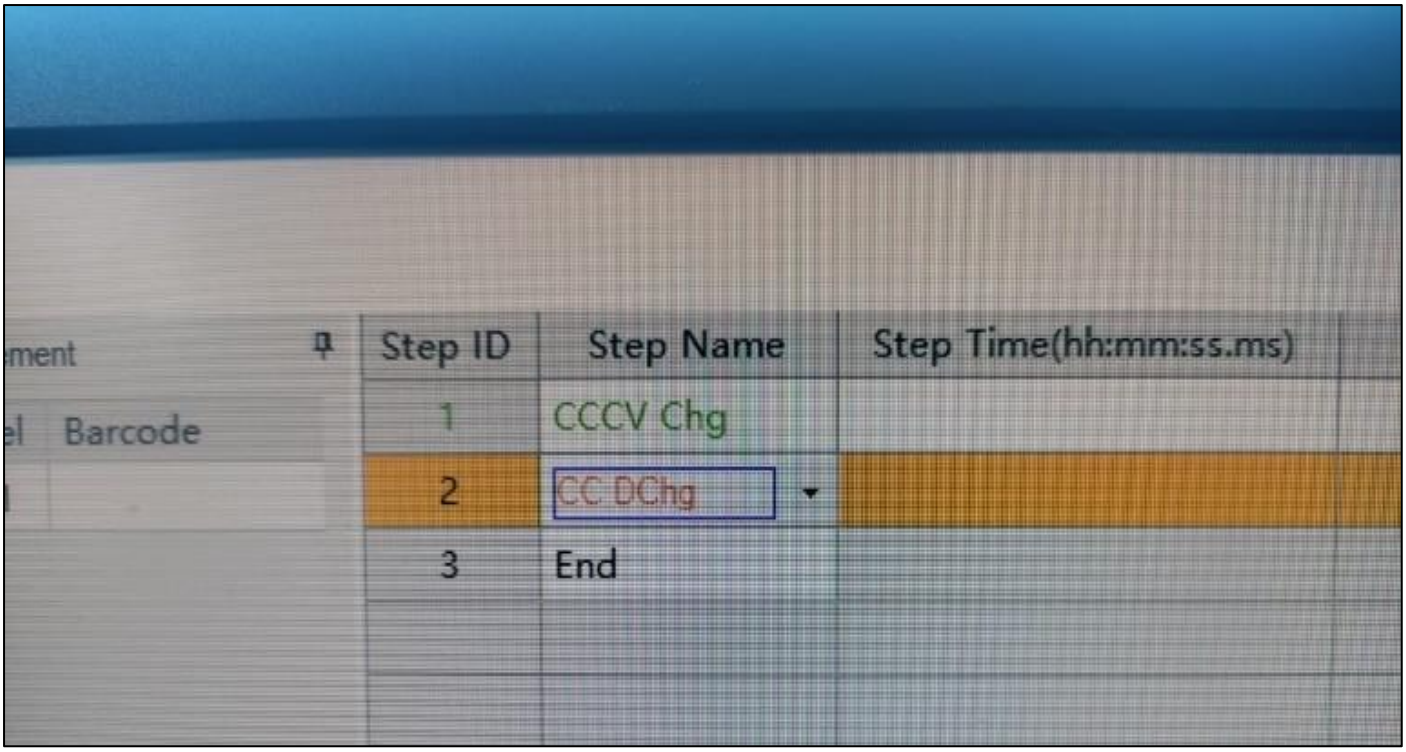

Fig 9 Green CCCV Chg Shows the Charging of Battery, CC D Chg

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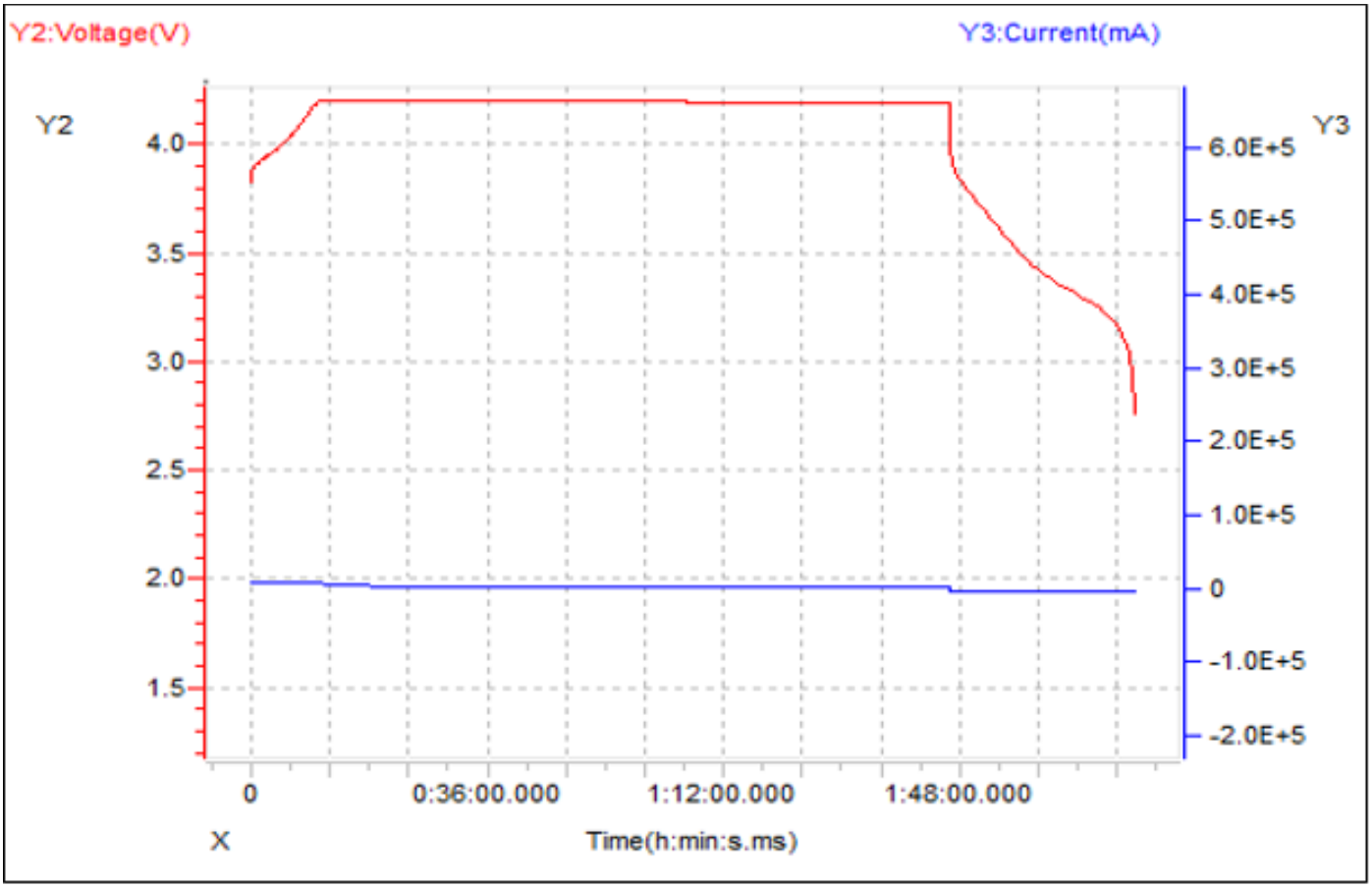

Fig 10 Time Voltage Current Graph Shown in BTS

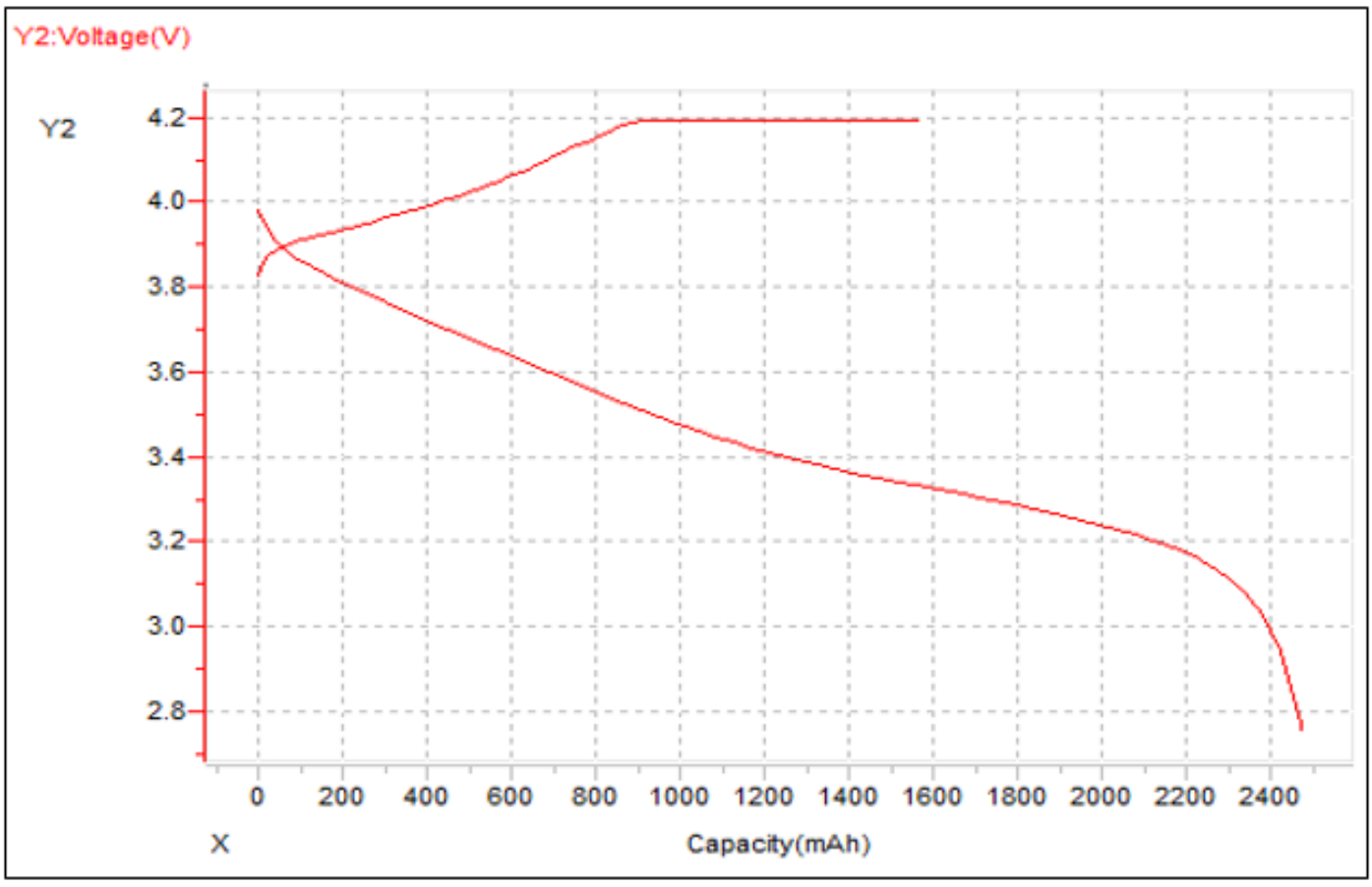

Fig 11 Voltage and Capacity Graph Shown in BTS

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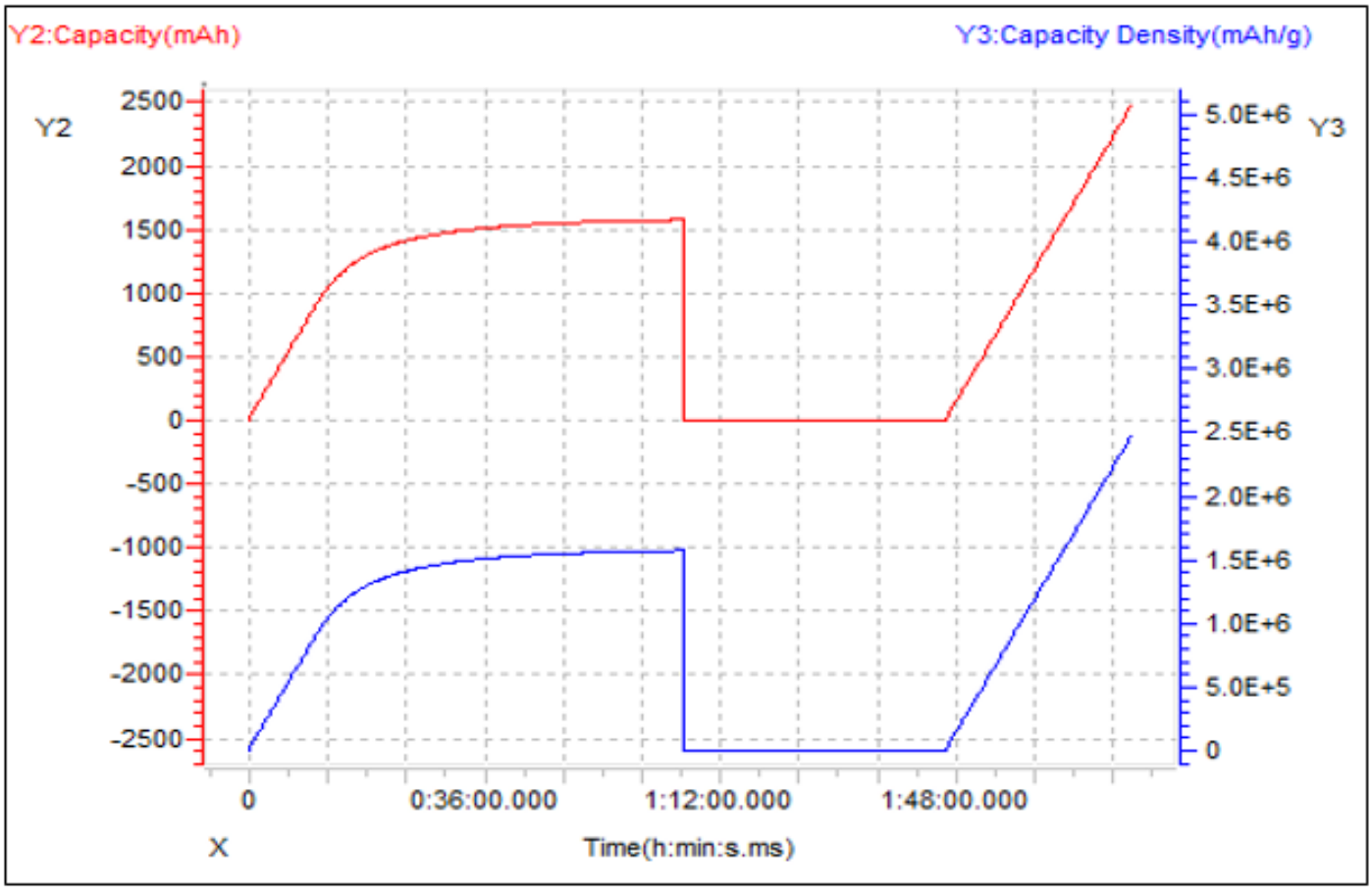

Fig 12 Capacity, Density time Graph Shown in BTS

➢ *Capacity, Density Capacity Time Graph Shown in BTS.*

Experimentation done on the equipment were to determine how much heat does a cell emits on its own while full charge rest and discharge and on what current of charging.

Fig 13 Battery Testing System

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Fig 14 Image of Battery Testing System

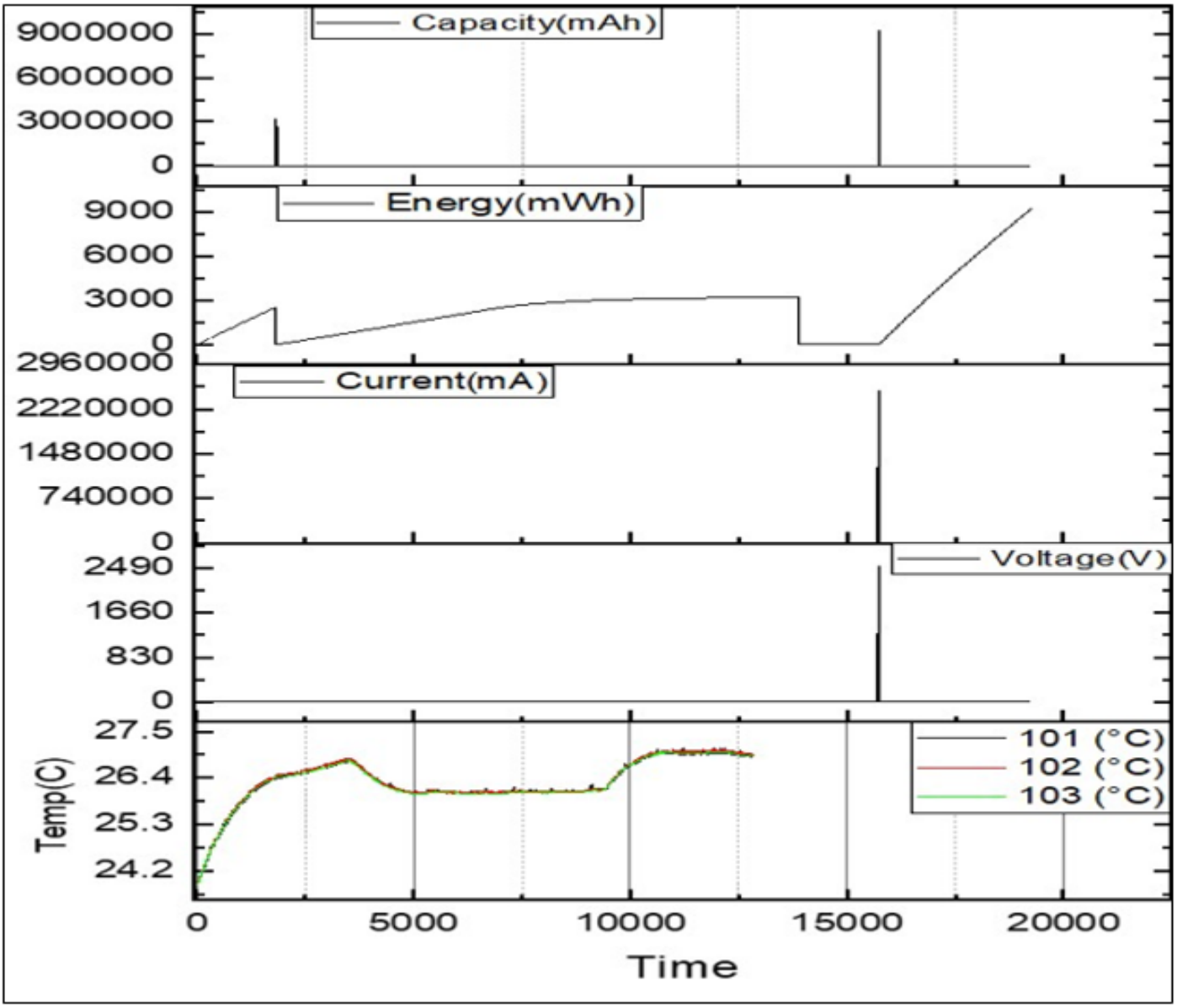

Fig 15 Image: Full Charge, 1-hour rest, full Discharge 3.9 A cell 1

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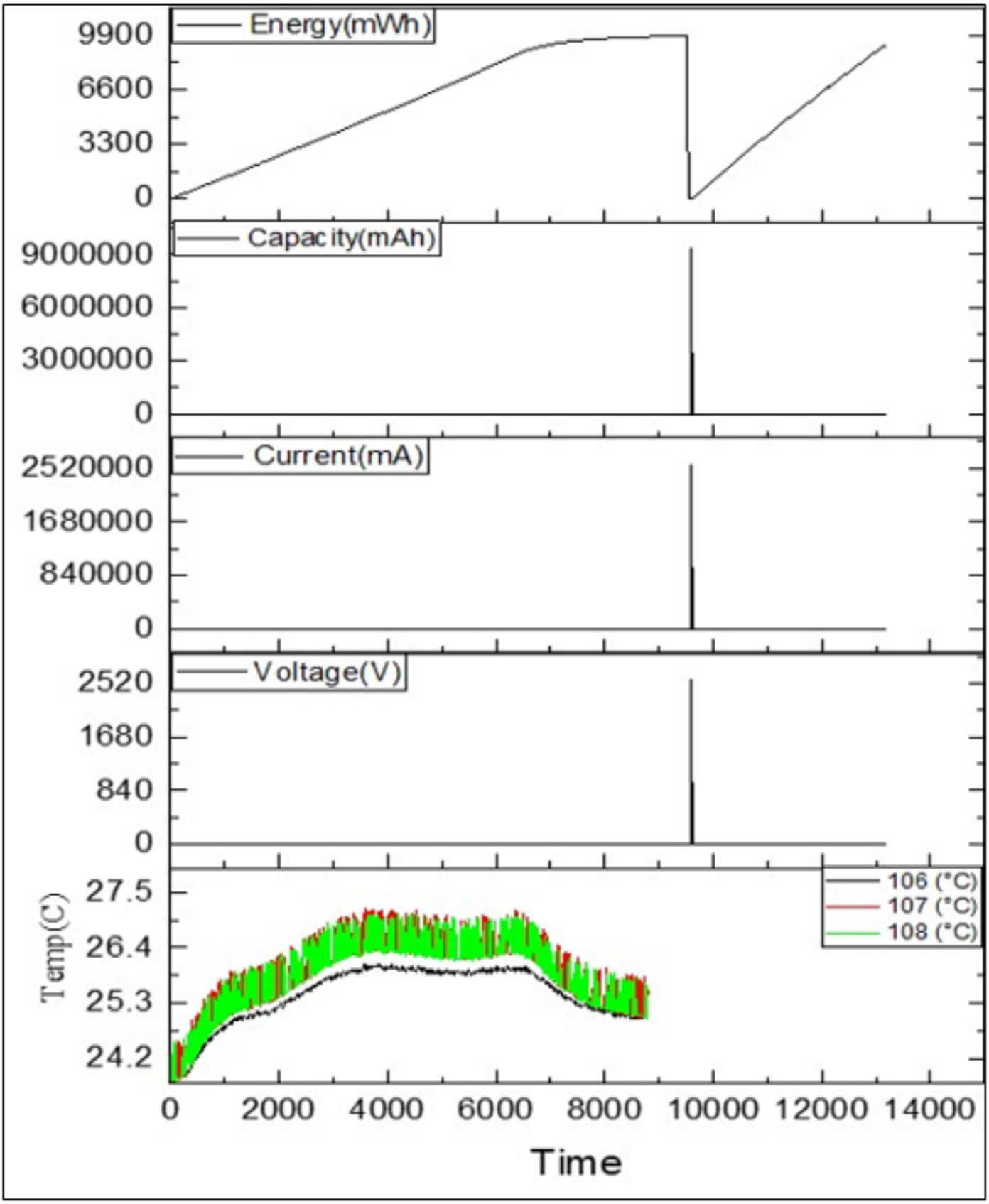

Fig 16 Image: Full Charge, 1-hour Rest Full Discharge 3.9A cell 2

Now in the below data you will see increment in temperature as current for charge and discharge is increases from 3.9A to 5.2A

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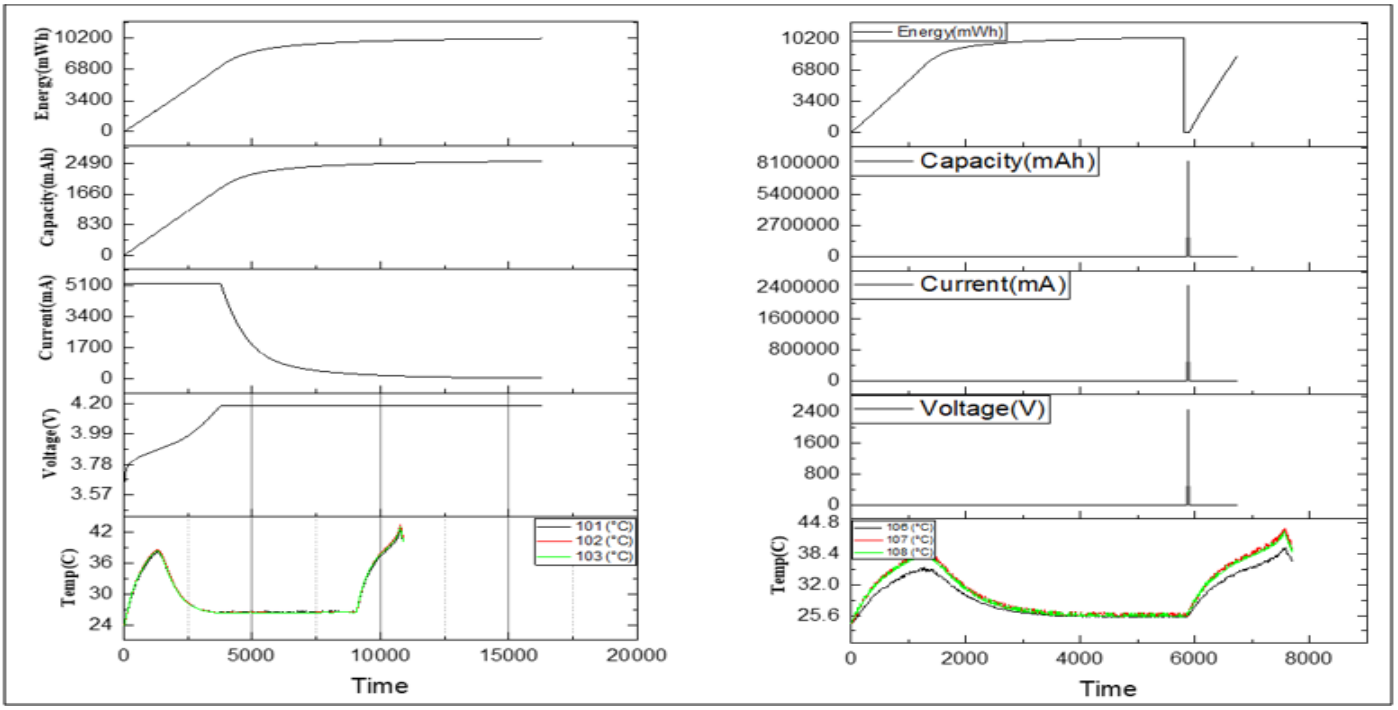
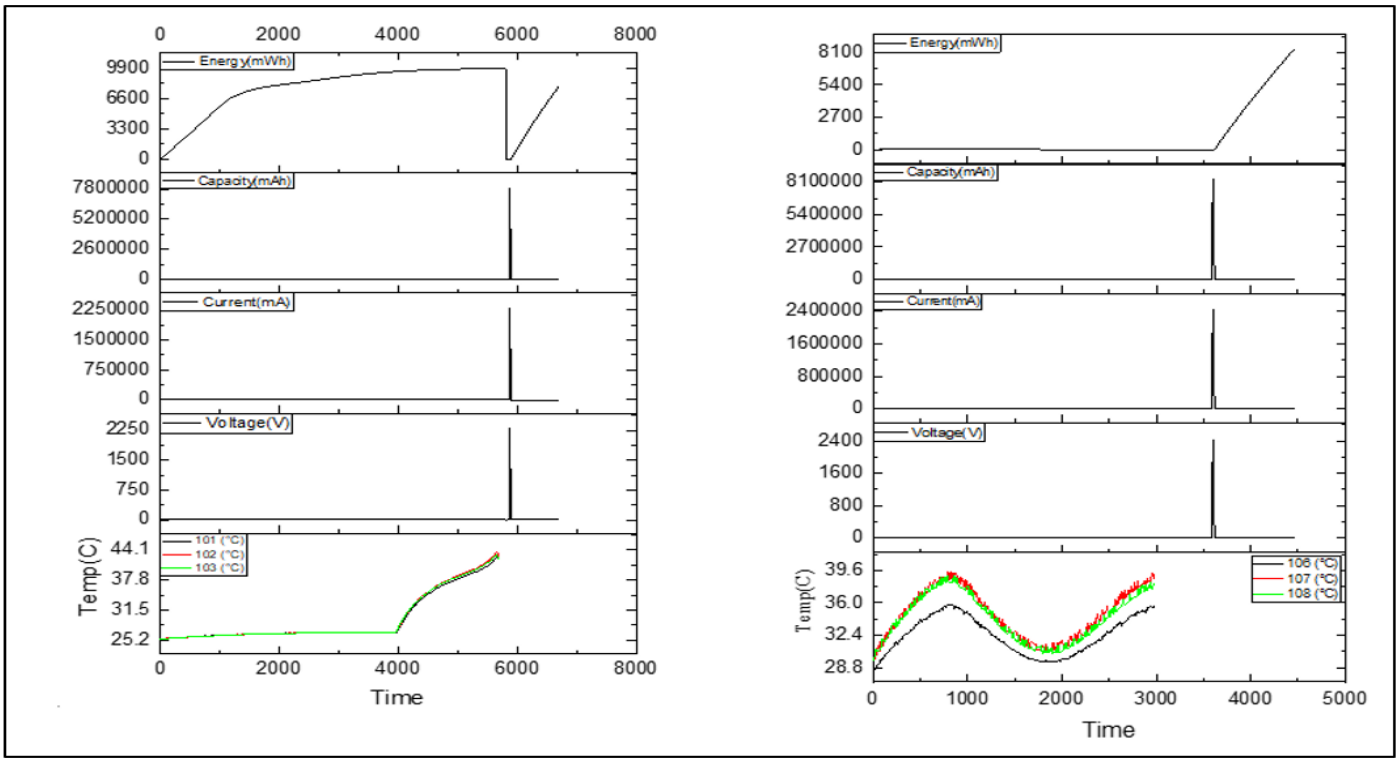


Fig 17 Image: Charge and Discharge is Increases from 3.9A to 5.2A

The mp. in this graph is visibly increasing to 42 degree Celsius(cell 1), which is very harmful and proves the theory of batter heating which affects the pack. The temp. in this graph is visibly increasing to 44 degree Celsius (Cell 2), the temperature in the cell increased at the point when charging resting and discharging process is already complete and cell is in idol position.

The data above was observed after 22 tests done on the cells, loading and unloading them by charge with different value of C, but as the value increased and then decreased the temperature of cell started fluctuating which shows the nature of instability because of which cell starts heating up even sitting in idol position. This shows when EV uses fast or hyper charging station, it affects the cells temperature. The fluctuation, different uses of charging type, passive balancing, and a add on which accelerates this harmful phenomenon is outside environment. As vehicle is made of steel of different types, it resists but do get heated up by outside temperature especially when standing in sun or hot region, like Rajasthan. Below are the data which will show the fluctuation in temperature.



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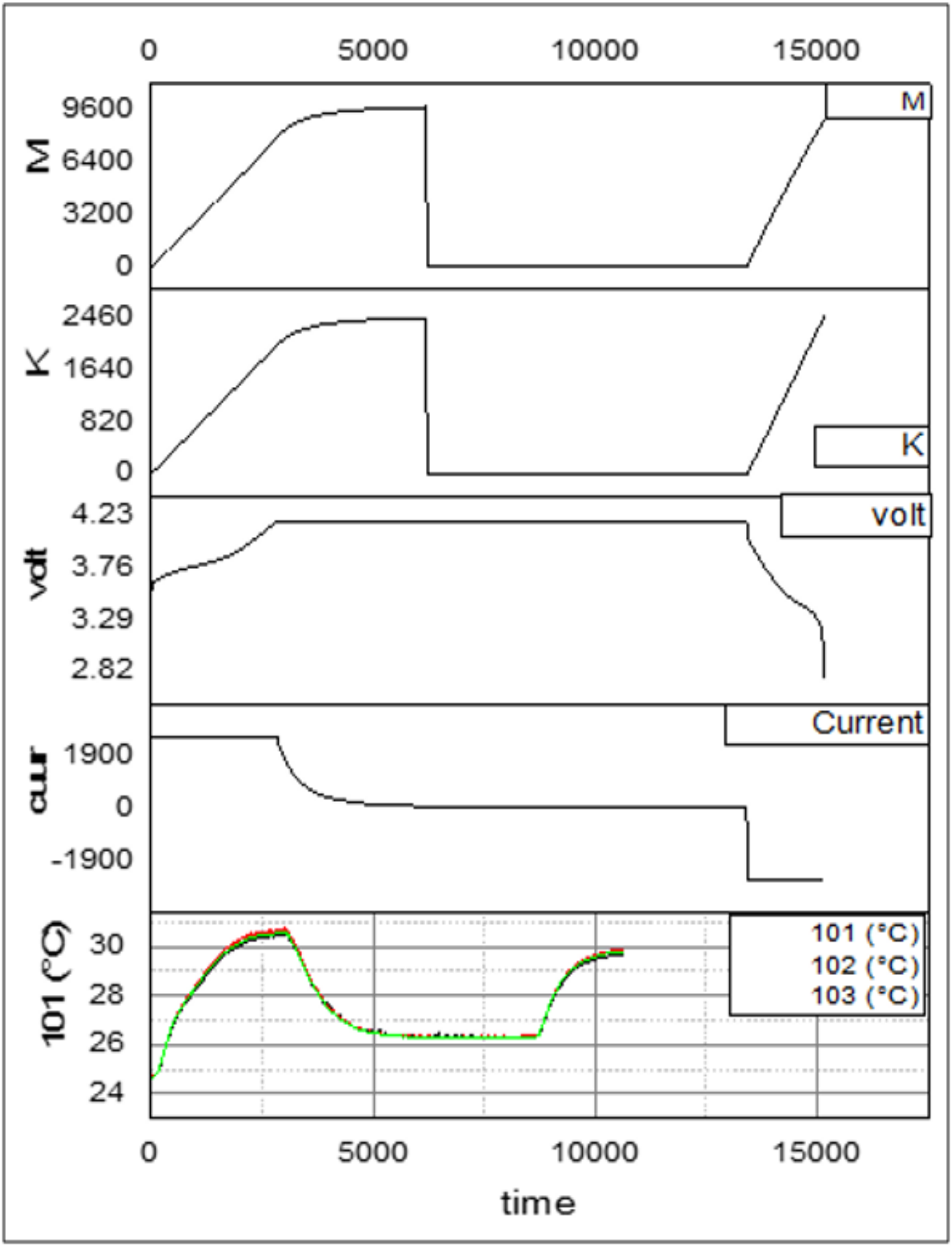

Fig 18 The above-Mentioned data show the Fluctuation of Temperature Every time a Discharged cell is Charged and Charged. Loading and Unloading of cell Creates Instability.

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IV. DESIGN AND IDEATION

Automobile companies use different type of designs in their EVs, design we will be looking into which can help reduce the above issue, will reduce the probability of the cause.

The idea is to create a frame which fitted inside the chassis which is detachable and the frame/case and chassis design will have a passage, very small, which will be used to eject the gas into the environment, this type of chassis design is known as skateboard concept chassis. The passage will only open in a period of time, for e.g. once every month when EV has consumed a lot of charge and discharge cycle the passage will be small enough which merely affect the temperature of battery pack. After a while, the battery pack heats up owing to the gases within and the cooling system is unable to control the temperature. This is because the gases become trapped in the pack and cannot find a route to escape. The leaked gas is highly flammable and also self-igniting at certain point. A very small passage can help in releasing off as the ga emitting from a small passage which means its capable of travelling through small passage which not only prevent the whole design change and machine change in making but also a technically small solution to the issue.

Altering the exiting chassis of EV, with small changes as battery pack will get attached to the chassis and chassis will work as a box and battery pack with its system will be inserted in it, aligning with the passage (small holes) in chassis and the battery and its frame by which its being attached. It's a simple design which can help in creating a change in the heating scenario of the EVs.

➢ *Design*

The two-software used in developing the design are Solid works and ANSYS. Chassis idea was designed on Solid works and ANSYS was used to perform simulation.

➢ *First let's Describe What Skate Board Concept Chassis is.*

- Chassis Structure: The skateboard chassis typically consists of a flat platform with the battery and other components mounted underneath. The structure should be lightweight yet sturdy, usually constructed from materials like aluminum, carbon fiber composites or default material used in car structure to ensure strength and durability.
- Battery Placement: An electric vehicle's battery pack is a critical part. To maximize stability and weight distribution within the chassis, it must to be positioned carefully. Placing it low and centered on the platform can help lower the vehicle's center of gravity, enhancing handling and stability.
- Enclosures and Covers: The chassis design should include enclosures and covers to protect the electrical components from the elements and ensure a clean aesthetic. These enclosures should be designed for easy access to the battery, motor(s), and other internal components for maintenance and repairs.
- Cabin Space and Ergonomics: The skateboard chassis should provide sufficient space for passengers and cargo. Consider ergonomic design principles for seating, legroom, and driver controls to maximize comfort and usability.

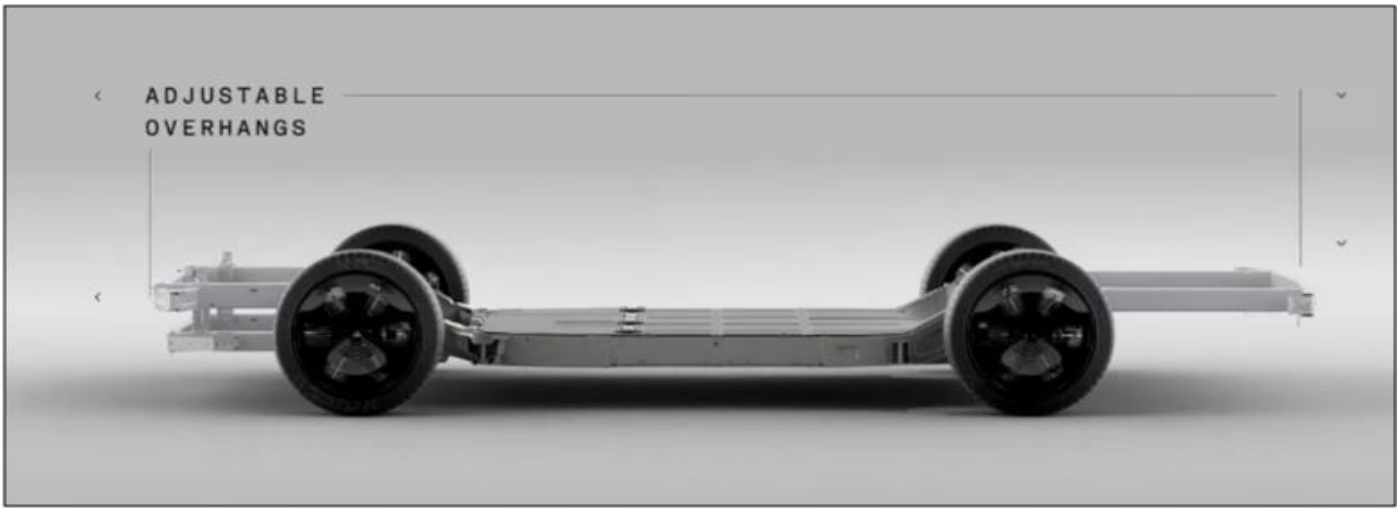

Fig 19 Image: Chassis concept motivated with skateboard concept

➢ *Dimensions, designs and parts*

A battery pack and battery cell will be created here to simulate in ANSYS, designed in SolidWorks. We will create battery frame and battery pack with a frame cap and environment enclosures.

- *Frame- a Frame with Dimensions of a Hatchback is Created, Dimensions are Written Below*

✓ Outer width- 1671 mm
✓ inner width- 1655 mm
✓ Outer length- 3026 mm
✓ Inner length- 1655 mm
✓ Which gives 8 mm thickness to the sides of the frame
✓ Outer height- 180 mm
✓ Inner height- 170 mm
✓ Which gives 10 mm thickness to the bottom of the frame

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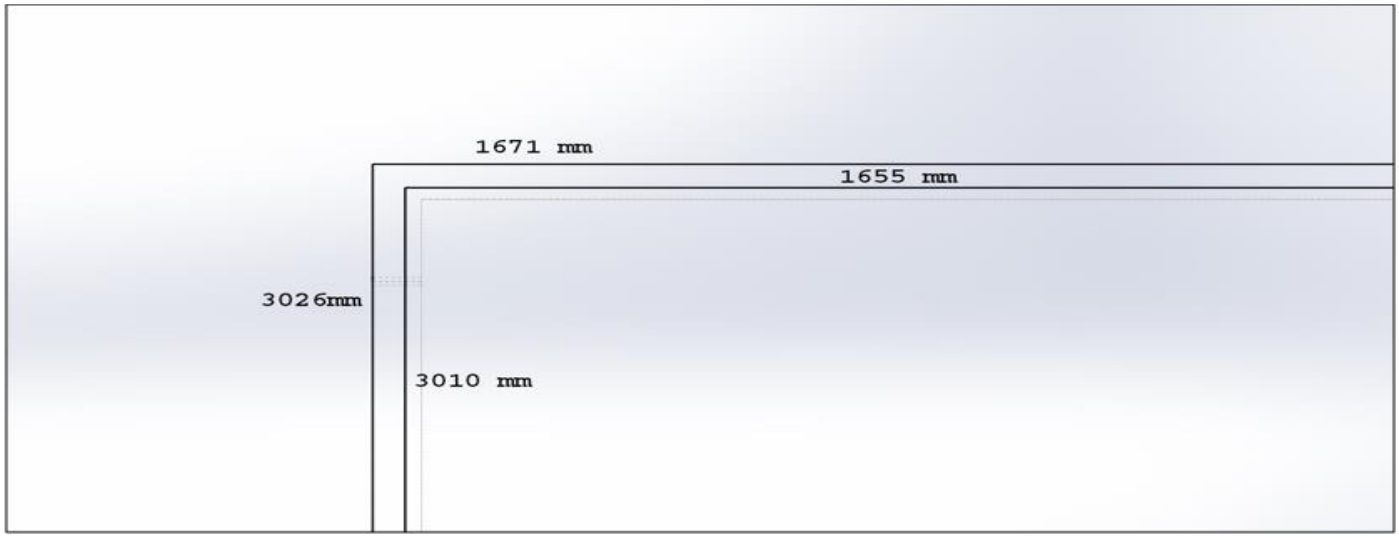

Fig 20 Image: Showcasing Dimensions of Inner and outer Frame of Hatchback Chassis

- ✓ Battery pack-
- ✓ Outer length- 827.5 mm
- ✓ Inner length- 817.5 mm
- ✓ Outer width- 501.6 mm
- ✓ Inner width- 491.6 mm
- ✓ Outer height- 150 mm
- ✓ Inner height- 145 mm
- ✓ Which gives the thickness of 5 mm

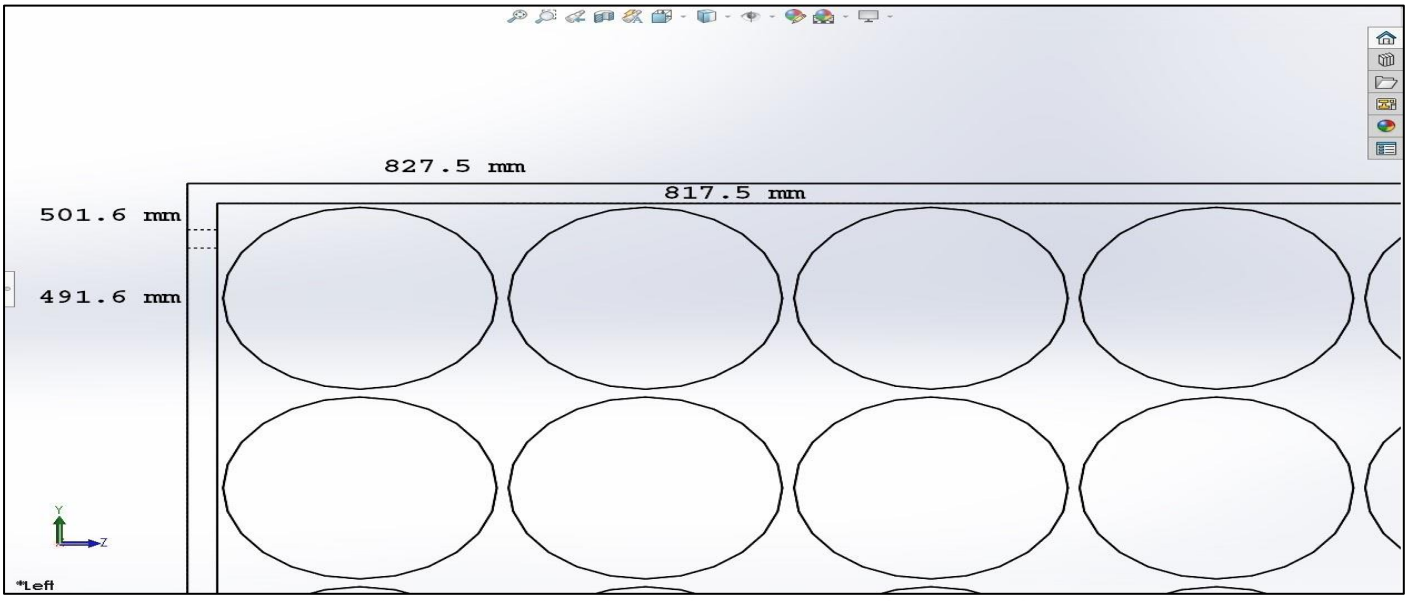

Fig 21 Image: Dimensions and Representation of Battery Pack

➢ *Environment Enclosure*

It is designed to observe the dissipation of gas from the holes to proof that the system is functional.

- Dimension of cuboid of enclosure
- Length- 80 mm
- Breadth- 80 mm
- Thickness- 200 mm
- Interface diameter- 5 mm
- Depth- 10 mm

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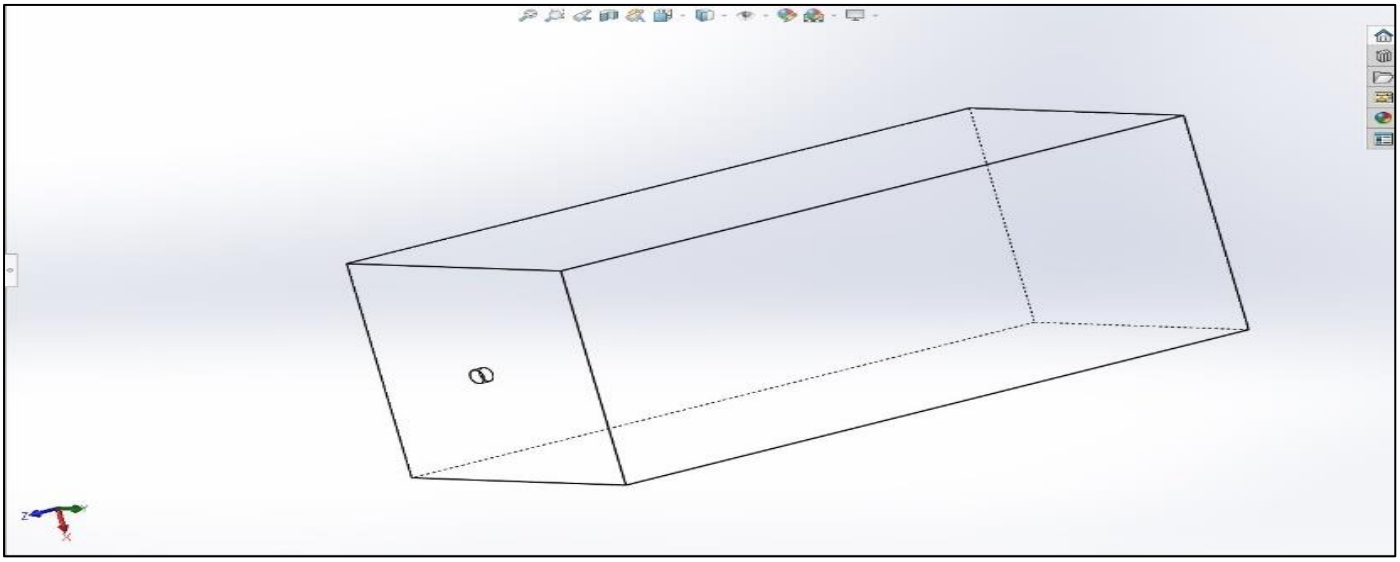

Fig 22 Image: Environmental Enclosure to record and Observe Heat Dissipation

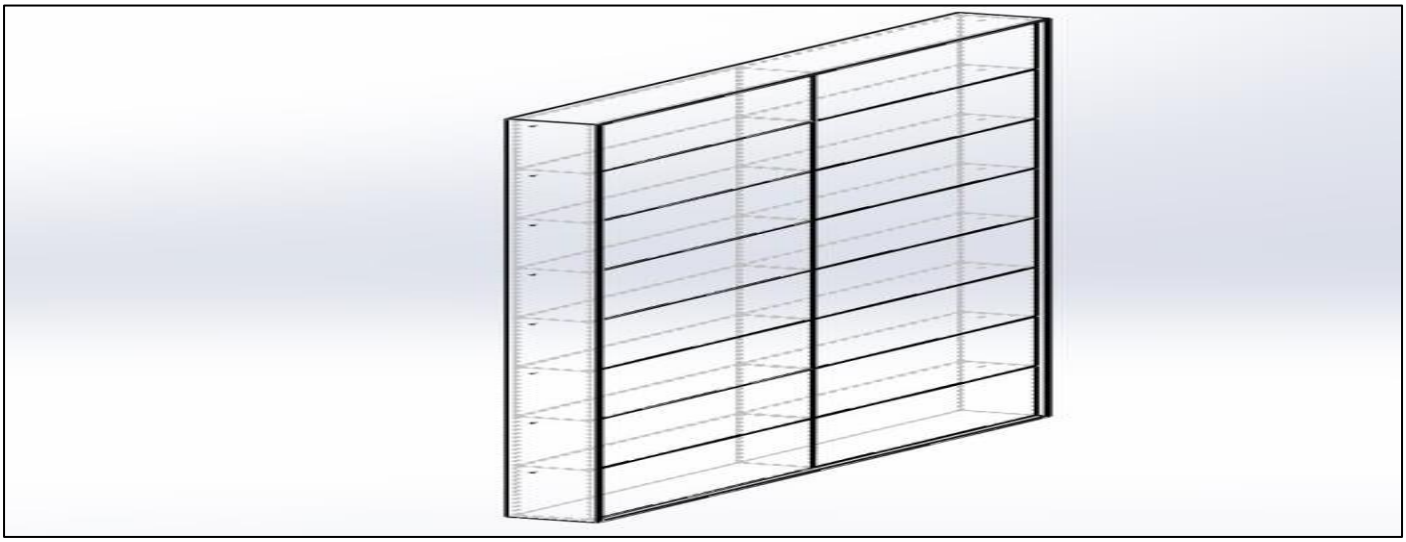

Fig 23 Image: After the Assembly of Battery pack and Frame, the Wireframe Visual looks like Shown Below.

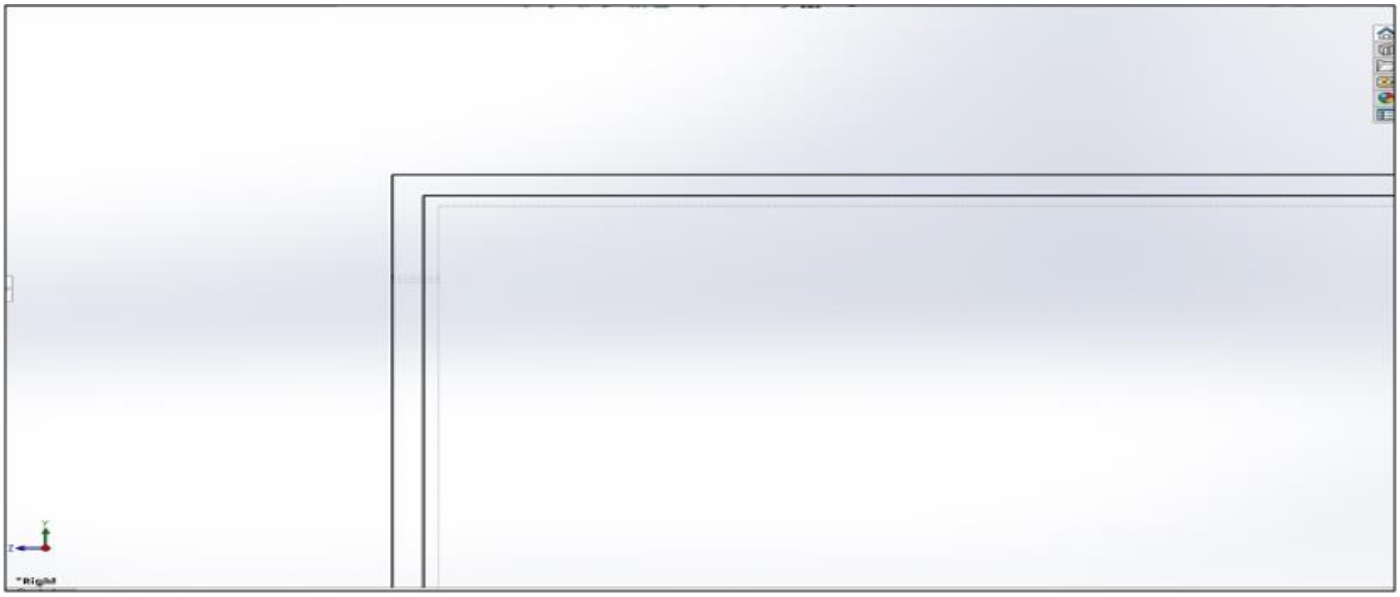

Fig 24 Image: The Battery pack and the Holes that the Battery Pack and frame Share Are Indicated in the Diagram by a Dotted Line. Fully Assembled System Picture is below

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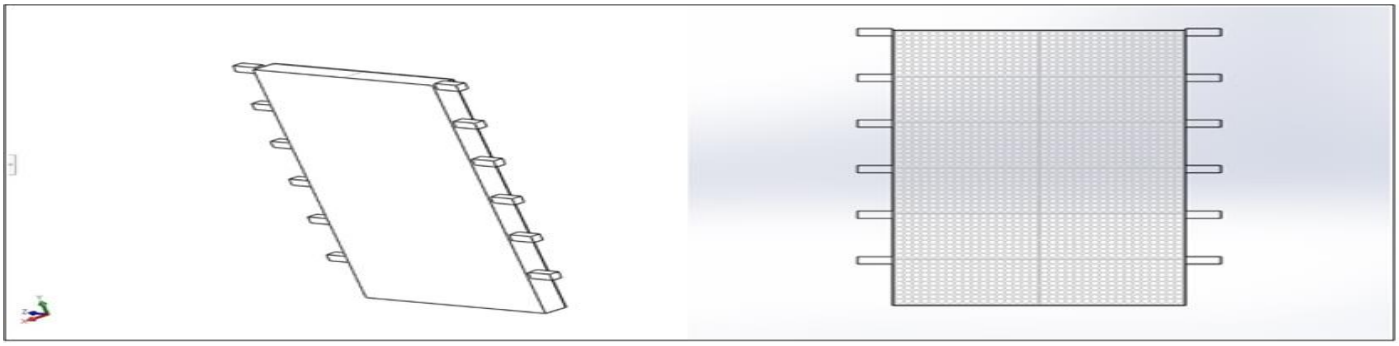

Fig 25 Image: Frame+ Battery Pack +Frame cap + Environment Enclosure, with Sketch and Wireframe view

➢ *ANSYS Simulation.*

Two types of analysis conducted to determine the effectiveness of the design. One is transient thermal and other is computational fluid dynamics.

Anxious transient thermal it allows to study the behavior of the system under time, wearing thermal conditions It corporates the principles of heat conduction, conduction and radiation to stimulate the transient response of system To changing temperature distributions. In this we can define boundary conditions, transient heat source or sink according to the models dynamic and its thermal behavior It helps to stimulate and predict the temperature profile, heat transfer and thermal rate stress.

Competition fluid dynamics This tool is used to determine any kind of error in the models dynamics and how a fluid or a gas will react in With also inputting heat so that we can see the simulation occurring in the model before putting it into our physical form.

➢ *Steps Performed in CFD*

- Putting fluid flow (fluent) on workbench of ansys and importing the design saved in STEP format
- Editing geometry in design modular and adding a inlet in frame cap to simulate air flow in the system
- After editing the design and labelling every part of design accordingly the model is meshed in coarse.
- After meshing the setup is opened, and where in general the gravity of the axis Y is set to -9.81 m/s
- After that you select K-epsilon in viscous model, which is defined for air flow
- Click on boundary conditions choose inlet and set the velocity magnitude to 0.8 m/s
- Click on mesh interface select everything in the left box and create a mesh interface.

Then you click on initialization and choose standard initialization, and select inlet in it, click on initialize. Click on run calculation and put iterations to atleast 2000 to get detailed data.

Comparing two designs with and without holes we can observe the pressure and it affect.
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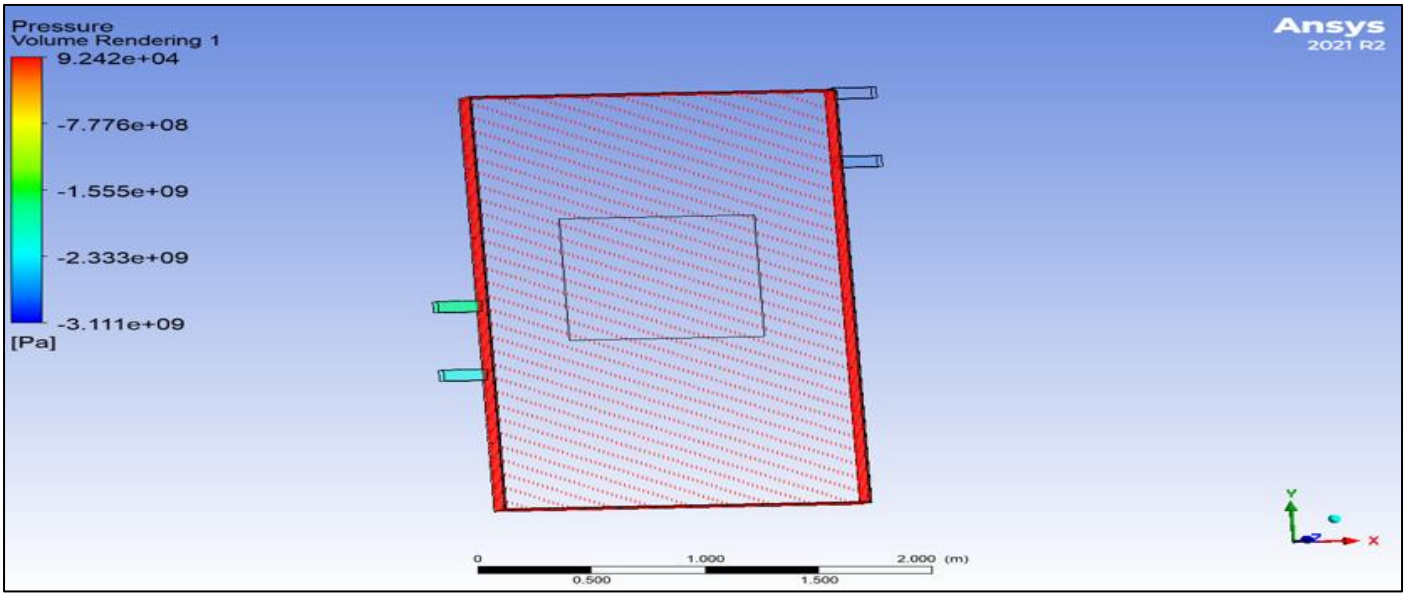

Fig 26 Image: Environment Enclosure Shows the Dissipation of air Outside the Frame, Releasing the Inner Unwanted gas.

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Table 3 Showing 3 axis in meter, and properties of simulation

Bounding Box	
Length X	2.077 m
Length Y	3.044 m
Length Z	0.185 m
Properties	
Volume	9.3697e-002 m³
Mass	735.52 kg
Scale Factor Value	1.

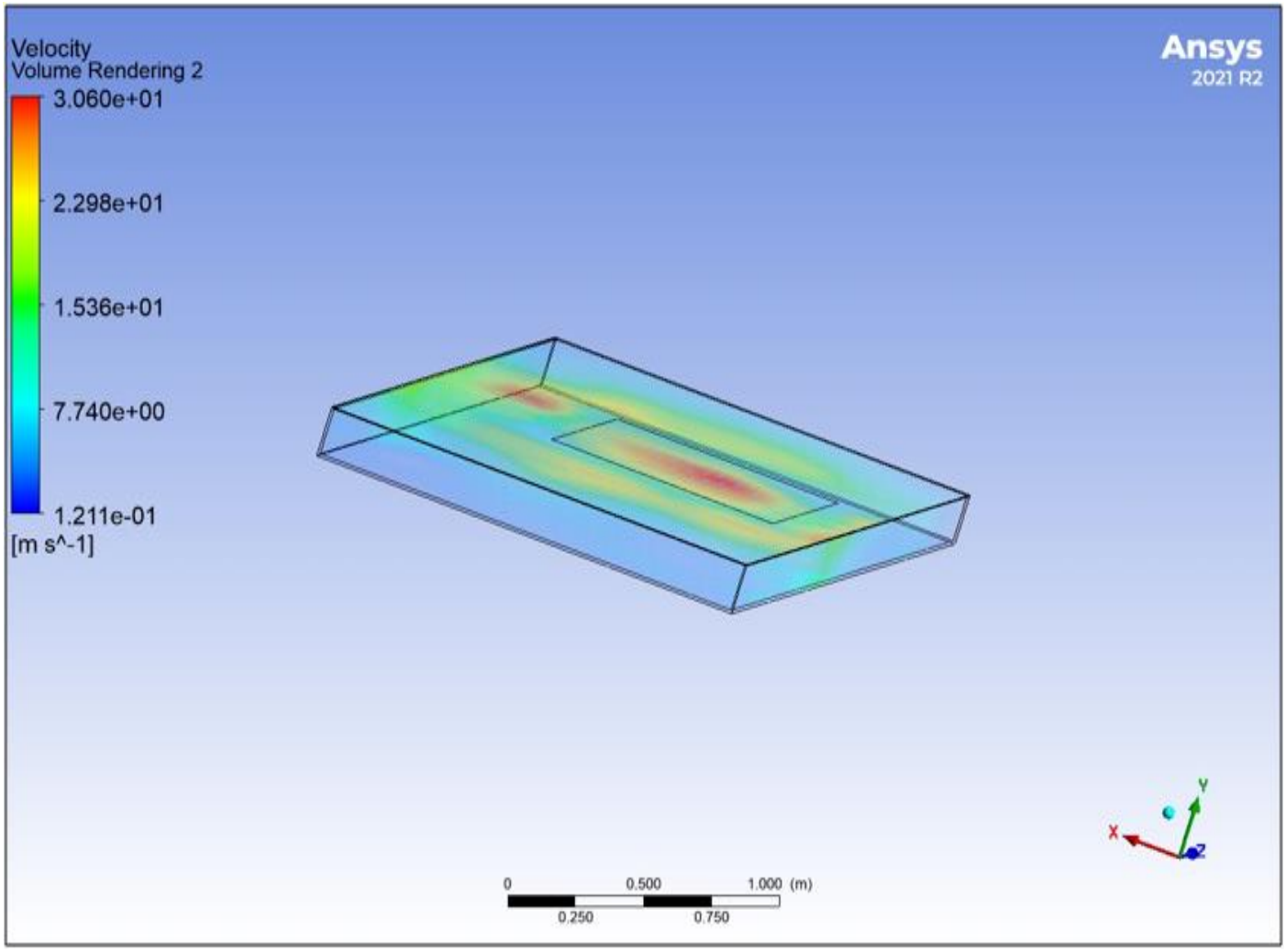

Fig 27 Image: In this Frame there are no Holes, Because of Which the air is hold Inside, which will Become Harmful.

- Material Properties
- Material: air (fluid) Property Units Method Value(s)
- Density kg/m^3 constant 1.225 Cp (Specific Heat) J/(kg K) constant 1006.43
- Material: structural steel

Statistics	
Nodes	9543
Elements	3989

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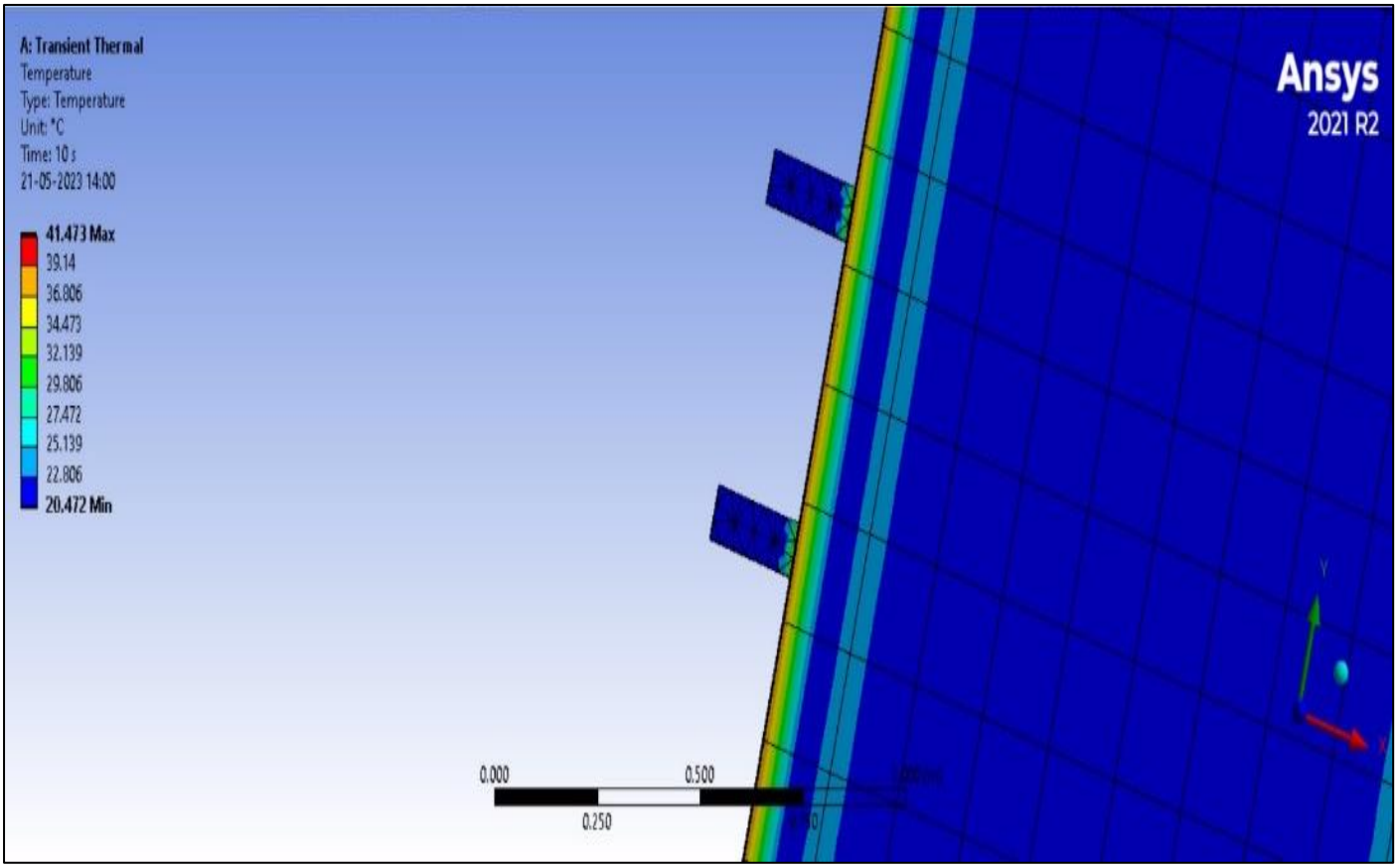

Fig 28 Image: Temperature dissipates from body shown in figure above.

➢ *Conclude research*

After finding the high temperature variant, we designed a skateboard concept design chassis and experimented and found result in which temperature is reducing and gas and temperature is dissipating from the holes of the chassis. This design can be used in future EVs as it give much more space in vehicle both electrically and ergonomically.


Fig 29 Image: showcasing Skateboard concept design.

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V. CONCLUSION

In this review paper we have compiled all the necessary data and information given till date about electric vehicle conditions From their system their heat issues their advantages, their disadvantages The current scenarios and the future with also putting the regulations and rules being created by the government of India to boost and motivate the citizens to buy electric vehicle so that carbon footprint can be reduced And the country can move towards more healthy and less emission and less pollution creating society. After that, we technically discussed all the phenomena which are causing heat dissipation and malfunctioning of electric vehicle and their battery packs with respect to the cooling system. Thermal management system and battery management system After giving all the problems we have also proposed an idea which can be used in future or can be experimented physically to create a better design for an electric vehicle so that the Heat generated in the vehicle can be dissipated easily without affecting the inner cooling system of the vehicle, which will, in the end increase the performance maintenance in life of electric vehicle as well as the battery pack in the system.

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