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Analysis on BTMS in Ev by Li-Ion 18650 Battery Using Matlab Software

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***Abstract:*-- An investigation is performed in Analysis on BTMS in EV by li-ion 18650 battery using MATLAB software. The EV are very equal to normal IC engine due to evergreen and to avoid pollution the BTMS play an important role in EV mobility to avoid more amount of heat produced by the EV battery system and the BTMS is main for the safety purpose of the vehicle and the passengers, So the electric vehicle needs more cooling to their batteries. Many ways of cooling are processed Our work is to reduce the time duration each vehicle by the amount of power or load act on the vehicle the time will varied the lithium-ion battery is used as it has more efficiency and have more capacity. Our result proved This work is done by the active cooling by liquid cooling process by Direct cooling method the tesla S model 18650 battery is taken for the analysis purpose the BTMS software is developed in a closed loop type as its have a number of subsystem and by saturation level is denoted by the time values where the input is given by a constant temperature of 30℃ by using Simulink and Sims cape in MATLAB simulation software**

Index Terms:- Battery thermal management, closed loop, MATLAB, PID (Proportional Integral Derivatives), Simulink.

I. INTRODUCTION

A Battery Management System is any electronic device that manages the battery (Cell or battery pack) such as by protecting the battery from operating outside its safe operating area, monitoring its state, calculating secondary data, reporting that data, controlling its environment. The BMS continuously monitor parameters such as temperature, voltage and current in and out of the pack to ensure it is being operated in safe conditions the entire time, BMS is responsible for thermal management of the battery and monitors its temperature continuously. BMS can adjust cooling and trigger other safety. Thermal management systems use a wide range of cooling solutions, including heat sinks, heat pipes, heat exchangers, liquid cooling systems, fans, and phase change materials to keep electronics within their operating temperature range. Which generate excess heat and Overheating can damage electronics, which means this heat needs to be dissipated. One of the most challenging issues faced by the automobile industry is providing proper thermal management mechanisms to avert thermal runaways. In a closed environment, there is less chance of uncontrolled heat transmission in batteries when the rate of increase in the battery temperature.

II. RELATERD WORKS

The electric vehicles are popular on the current market the battery thermal management system model for balancing the different cooling and heating circuits within battery pack to fulfill the performance, other factors such as weight, size, reliability etc. Cell in the battery are depends on both temperature and operating voltage. Cell work well when cell operate within limited voltage and temperature. Otherwise, damage will occur to cell and will be irreversible. Excess heat and lack of heat will brings about problems.

a. This thesis shows an advanced battery thermal management system for emerging electric vehicles by developing battery thermal management system is a combination of thermoelectric cooling, forced air and liquid cooling. The liquid coolant has indirect contact with the battery and acts as the medium to remove the heat generated from the battery during operation. Forced air assisted heat removal is performed from the condenser side of the thermoelectric liquid casing. The experiments are carried out on a simulated electric vehicle battery system. The battery surface temperature drops around 43 ℃ (from 55 ℃ to 12 ℃) using TEC-based water cooling system for a single cell with copper holder when 40 V is supplied to the heater and 12 V to the TEC module.

b. The second thesis shows that thermal management improvement of an air cooled high-power lithium-ion battery by embedding metal foam is effect of embedding aluminum porous metal foam inside air cooled battery model to improve its thermal management four different cases of metal foam insert were examined using three-dimensional numerical simulations. Compared to the case of no porous insert, embedding aluminum metal foam in air flow channel

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significantly improved the thermal management of battery cell. The effects of permeability and porosity of the porous medium as well as state of charge were investigated on the standard deviation of the temperature field and maximum temperature inside the battery in all four cases.

c) This thesis shows an Active cooling based battery management using composite PCM differences. Phase change material (PCM) is commonly used in the study of battery thermal management system (BTMS) However, with low thermal conductivity, pure PCM is not sufficient for transferring the heat generated from battery cells. To resolve this problem, the thermal conductivity of PCM was enhanced using cooper foam. Active liquid cooling was also combined with copper foam/paraffin composite phase change material (CPCM) to provide extra cooling ability. The cooling tube is evenly distributed in the copper foam, and a coolant is circulated through the tube.

d) This thesis shows thermoelectric cooling, Material Modeling and applications Thermoelectric cooling systems have advantages over conventional cooling devices, including compact in size, light in weight, high reliability, no mechanical moving parts, no working fluid, being powered by direct current, and easily switching between cooling and heating modes. In this study, historical development of thermoelectric cooling has been briefly introduced first. Next, the development of thermoelectric materials has been given and the achievements in past decade have been summarized. To improve thermoelectric cooling system's performance, the modeling techniques have been described for both the thermo element modeling and thermoelectric cooler (TEC) modeling including standard simplified energy equilibrium model, one-dimensional and three-dimensional models, and numerical compact model. Various coolants are measured air coolant refrigeration coolant etc.

III. METHODOLOGY

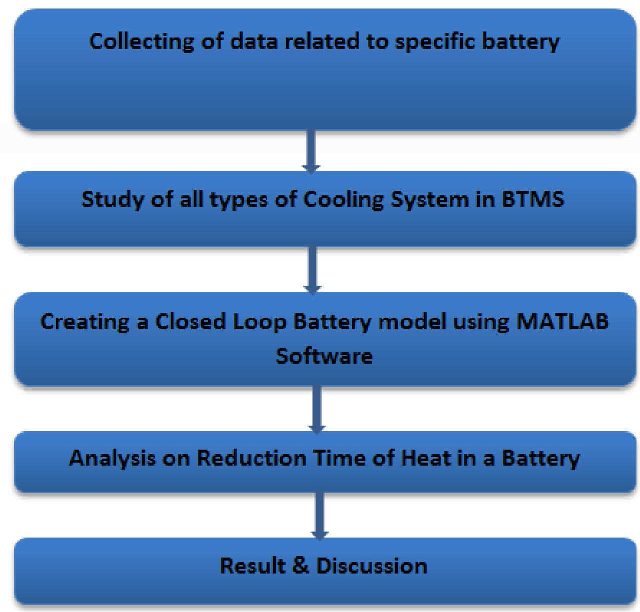

Figure 1: Methodology of project

18650 BATTERY

18650 batteries can have anywhere from 300 to 500 charging cycles, which is insane! It usually takes about 3 hours to charge an 18650 lithium-ion battery fully. Battery is the power source for EV. Choice of cell makes a huge difference in performance. Three main aspects of a good battery design are Mechanical, Thermal, and BMS Designs etc. The average surface temperature of first to last cell of battery is at 42.7℃ to 45.3℃.

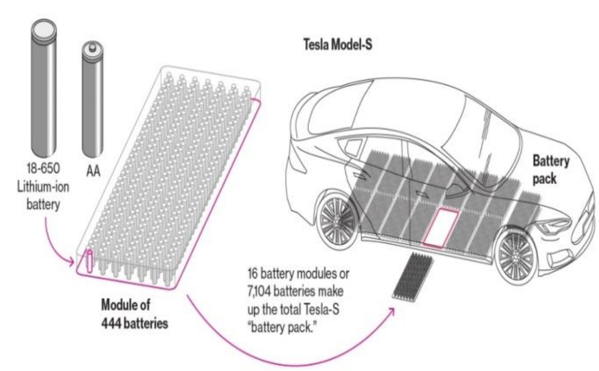

Figure 2: 18650 Battery

Commercial 18650 lithium ion batteries (Panasonic NCR 18650B) were chosen for the experiment due to their large cell capacity. NCR18650B lithium ion battery has chemistry of LiNiCoAlO2, nominal capacity of 3.2Ah and nominal

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voltage of 3.6V. To understand the thermal characteristic of the lithium ion battery, all single cells were discharged at different current rates. The battery was first charged in galvanostatic mode at a 0.5C rate (1.6A) with a voltage cut-off limit of 4.2V, followed by a potentiostatic mode until current drops to 65mA. (1.6A), 1.5C rate (4.8A) and 2C rate (6.4A), respectively, until the voltage drops to 2.5V. Due to a safety consideration, the test will be manually interrupted if the maximum temperature of the battery reaches 60 ℃.

Specification of 18650 battery	
Input parameters	**Range**
Nominal Capacity	3.2 A h
Nominal Voltage	3.6 V
Thickness	0.5 mm
Cut of limit	4.2 V
Heat generate rate cell	1.44 W
Height	65 mm
Diameter	18mm
SOC	0.5 – 1 C
Heat Flow Rate	300℃

Table 1: Specification of 18650 Battery

MATLAB

MATLAB is a high performance language for technical computing and it is a programming and numeric computing platform used by millions of engineers and scientist to analyze data, develop algorithm and to create model. Simulink is a normal mathematical tools to solve or analysis any mathematical model by using MATLAB Software and these include script to generate code for a particular functions and these guide to modeling a dynamic system. Sims cape is a same as Simulink but it is a physical system where it has electrical tools these both libraries are used to calculate both electrical values by the mathematical term through by having the relevant formulas.

IV PROJECT MODEL

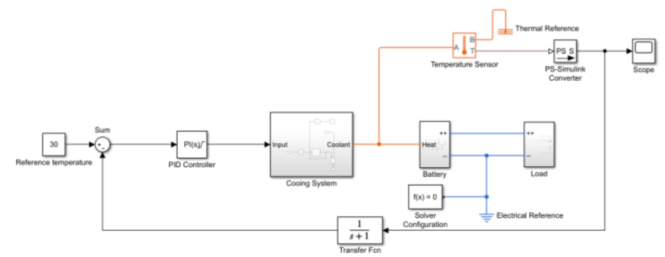

Figure 3: Project model

The above work are focused on the safety of the electric vehicle to avoid accident and damage to vehicle while travelling, So by using Simulink and Sims cape a closed loop model in battery thermal management system (BTMS) is analyzed. With a reference temperature of 30℃ -45℃ denoted as maximum temperature and heat flow rate of 300℃ by the sample time of 1000 a DC source is applied on the battery by connecting the load and the cooling process. To avoid mechanical vibration we placed a solver configuration the load conduct variable resistor and inductor. As the cooling process cannot be done only by pure PCM so the work is done by active cooling methods.

COOLING SYSTEM

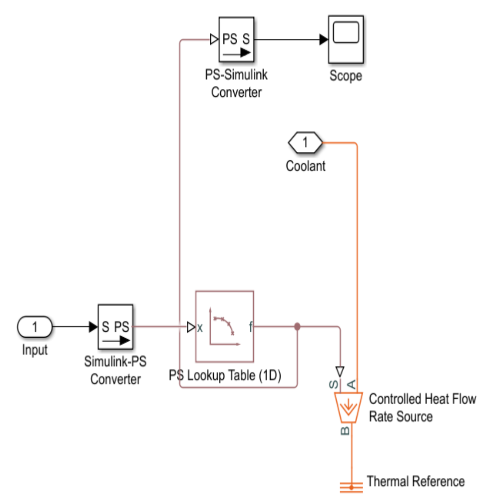

Figure 4: Cooling system

The above work is done in direct cooling method a cooling is to reduce the temperature are alternatively increases when load consumed the battery get discharge and decreases that the heat, where the lookup table is to denote the “x” and “y”

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where the both input and output are given as temperature and time. Cooling system enable load consumed the battery get discharge, when high voltage consumed the system get enable the power consume when cooling is not enable, to know the amount of heat consume in the battery the reference temperature is needed.

PID

PID (Proportional Integral Derivative) and it shows the present past and future values PID is based on Simulink we need power but we can't take Simulink so we took Sims cape by PS-Simulink convertor as lookup tables. The range of temperature from 100℃-120℃ by cooling in expected value based on the cooling down in PID to predict referred room temperature by reference temperature the heat get reduced. PID gives only signal.

$$u(t) = kpe(t) + ki \int e(t)\,dt + kp\frac{de}{dt}$$

BATTERY MODEL

DC Voltage source it maintain an amount of heat transfers by using simscape product by calculating total heat to be transfer to thermal mass, by controlled heat flow rate source the heat is consider a node at joining point near thermal mass a time in variant (constant) voltage across its output terminals independent of the current through the source the AC parameters are not supported.

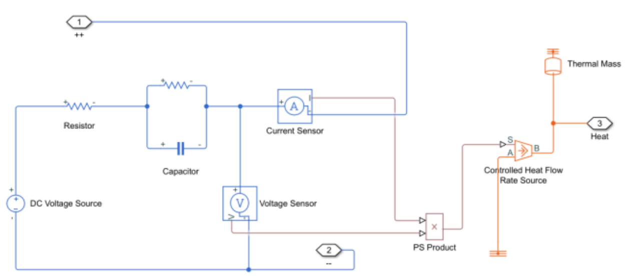

Figure 5: Battery model

A resistor with optional tolerance, operational limits fault and thermal noise modeling. To model temperature effect, the thermal variant of this block by right clicking on block selecting Sims cape block choices and show thermal port. A capacitor is with optimal tolerance, operational limits and fault modeling. The ideal current sensor a device convert current measured in electrical into a physical signal proportional to current connection "+ and –" conserving electrical ports through which sensor is inserted into the circuit "I" is a physical port output current value. Same the ideal voltage sensor, a device that converts voltage between any electrical connections into physical proportion to the voltage "+ and –" conserving electrical ports through which sensor is connected to circuit connection "V" is a physical signal port that output voltage value.

V RESULT

The "Y" axis as the heat flow temperature and the "X" axis as time domain the amount of heat reduced by the increases of temperature due to power consumed in battery. And the heat reduced by the given reference temperature. Heat reduced to 270℃, 230℃, 180℃.

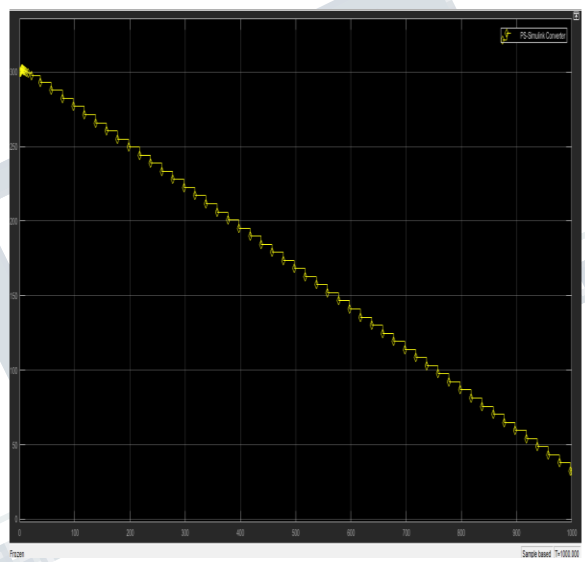

Figure 6: Result

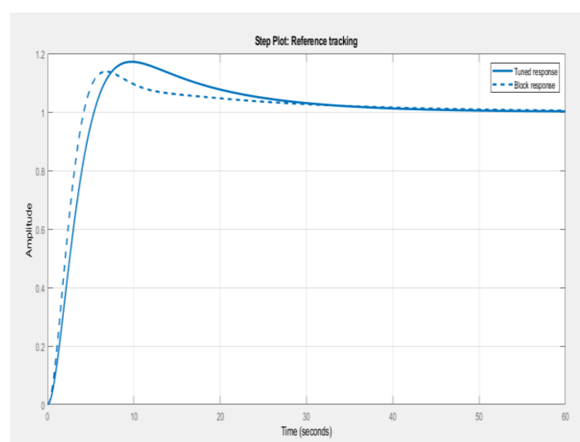

Figure 7: PID Result

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VI CONCLUSION

In this project "Analysis on BTMS in EV by li-ion 18650 battery using MATLAB Software" above result the amount of heat produced in the battery has been reduced, we collect data's on specific battery and analyzed the cooling has done with particular period of time get reduced. In future a prototype new battery model to be done with batteries like (Tata Nexon, MG ZS, Hyundai KONA EV) etc. Analysis their difference of heat consumed in various battery in both hot and cold climate, and same experimental work taken in passive system by using PCM collecting motor data's.

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