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Transient Thermal Analysis on Cooling Plate for Battery Module of an EV Vehicle

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Abstract: *Electric vehicles (EVs) are favored Lithium-particle batteries for energy capacity on its specialized elements. The greater expense, low release rate, long life cycle, and restricted energy thickness of the presently accessible in particle battery brings about low effectiveness to defeat these issues at their fullest limit. So modelling of cooling plate has done by Solidwork 2016 software and thermal simulation has performed on ANSYS 19.2 software. Here cooling plate four materials are taking like Al 1100 , AL oxide, Al 96 and Al 92 So Here find out temperature results all four materials are Al 1100 , AL oxide, Al 96 and Al 92 ,33.27 ^{0}C, 33.09 ^{0}C,32.96 ^{0}C and 32.9 ^{0}C Here find out heat flux results all four materials are Al 1100 , AL oxide, Al 96 and Al 92 , 1.52 e^5, 1.71 e^5, 1.52 e^5 and 1.43 e^5 So here it is cleared that exiting material AL 1100 cooling plate has more temperature distribution and more heat flux released these all data find out with help of simulation software by ANSYS workbench 19.2 Thermal transient simulation platform So here find out less value of temperature and heat flux AL 92 Aluminum alloy.*

Keywords: Solid-work, ANSYS 19.2 , Al 1100 , AL oxide, Al 96 and Al 92.

Introduction

Electric vehicles (EVs) are favored Lithium-particle batteries for energy capacity on its specialized elements. The greater expense, low release rate, long life cycle, and restricted energy thickness of the presently accessible li-particle battery brings about low effectiveness to defeat these issues at their fullest limit [1]. The exhibition of EVs is profoundly dependent on the battery limit and its center temperature assumes a significant part in battery execution. Wan et al [2] concentrated on warm execution of a smaller than expected circle heat pipe utilizing water-copper nanofluid. Mochizuki et al (2014) concentrated on Heat pipe-based detached crisis center cooling framework for safe closure of an atomic power reactor. Zhao et al [3] audited the warm exhibition further developing techniques for lithium-particle battery anode adjustment and warm administration framework. The battery temperature strongly affects charging and releasing pace of the battery. This makes the warm administration of an EV battery pack critical, plan of energy-thick packs need to utilize hearty cooling frameworks, regularly utilizing fluid cooling circles with many channels. The intricacy of these frameworks adds to the expense - somewhere near 10-20% of the general expense of the battery pack. Li-particle batteries are especially defenseless to warm flee occasions for one or two reasons, including their high energy content and their inclination to self-heat once the electrolyte arrives at a specific temperature (from 70° to 130° C). Li-Ion cells are normally exposed to crumbling with time because of their working circumstances and condition of charge. Temperature significantly affects the productivity of essentially all batteries [4]. Because of notoriety of fast charging and execution driving, the hotness misfortunes in the cell increments because of high current in the cells [4]. There are two principle wellsprings of hotness age in a battery cell: electrochemical activity and joule warming because of the movement of electrons inside a battery cells. The temperature scope of 25 °C to 40 °C gives the ideal working circumstances to Li-particle batteries and in the event that the temperature is raised over 50 °C it becomes destructive for the life expectancy of the batteries;. Indeed, even a solitary cell's youthful weakening can decrease the exhibition and productivity of the entire battery pack extensively. The primary point of the BTMS is to direct the temperature of the cells of the battery and along these lines increment the life expectancy of the battery. There are two primary kinds of BTMS: dynamic frameworks and aloof frameworks. The dynamic framework principally relies upon constrained dissemination of a particular coolant like water or air.

Direct Refrigerant cooling

Like dynamic fluid frameworks, an immediate refrigerant framework (DRS) comprises of an Air Conditioning circle, yet Direct Refrigerant System utilizes refrigerant straightforwardly as hotness move liquid flowing all through the battery pack.

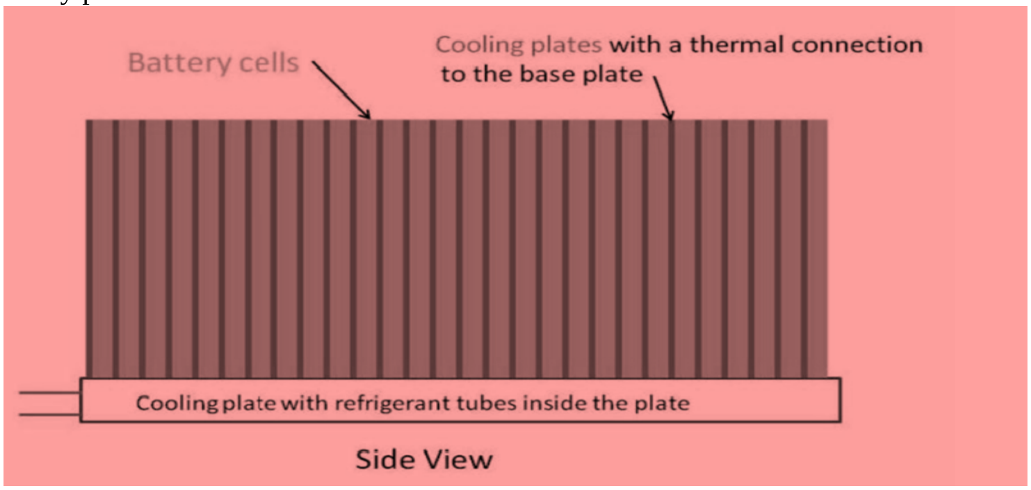

Fig.1.1 Direct Refrigerant Liquid cooling.

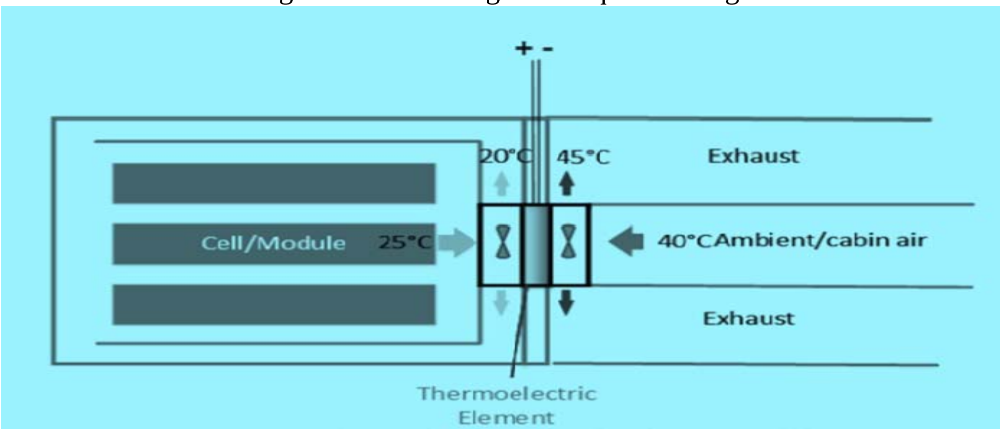

Fig 1.2 Thermoelecrtric cooling / heating system.

II. Research Methodology

With everything taken into account, there are two central fragments that were performed at this moment. The essential fragment is to develop a 3-layered model of the grip circle, followed by performing restricted part examination using business limited part (FE) programming to consider the warm furthest reaches of the business grasp plate as showed up in figure under

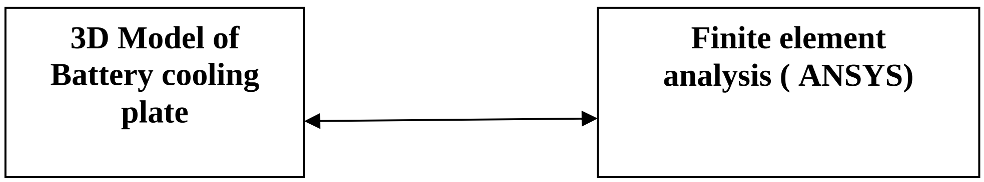

Fig. 2.1: Main Battery cooling plate limited component examination venture.

FINITE ELEMENT ANALYSIS

The restricted part technique is mathematical examination framework for finding unpleasant solutions for a wide combination of planning issues. Because of its various assortment and flexibility as an examination gadget, it is tolerating a great deal of thought in essentially every industry. In progressively planning conditions today, observe that it is essential to gain unpleasant solutions for issue rather than exact shut find course of action. It is incomprehensible to hope to find insightful mathematical solutions for some, building issues. An intelligent courses of action is a mathematical explanation that gives the assessments of the best dark sum at any region in the body, as result it is real for ceaseless number of region in the body. For issues including complex material properties and cutoff conditions, the planner resorts to mathematical procedures that give induced, yet commendable courses of action. The restricted part procedure has turned into an indispensable resource for the mathematical courses of action of a wide extent of building issues. It has been developed meanwhile with the extending use of the fast electronic automated PCs and with the creating complement on mathematical procedures for planning examination. This methodology started as a hypothesis of the helper plan to specific issues of adaptable continuum issue, started with respect to different circumstances.All the above frameworks have been coordinated with usage of a predefined conditions and prerequisites that helps with obtain the suitable and trustworthy result.

Methodology

Stage 1: Aggregation data and information connected with cooling balances of IC motors.

Stage 2: an absolutely parametric model of the motor square with balance is made in ANSYS programming system bundle.

Stage 3: Model got in Step an attempt of is examined utilizing ANSYS 19. (Workbench), to get the hotness or hotness rate, warm inclination and nodal temperatures.

Stage 4: Manual computations are finished.

Stage 5: Finally, we will generally will more often than not check the outcomes acquired from ANSYS and manual calculations for totally unique material, shapes and thickness.

III. Material Properties

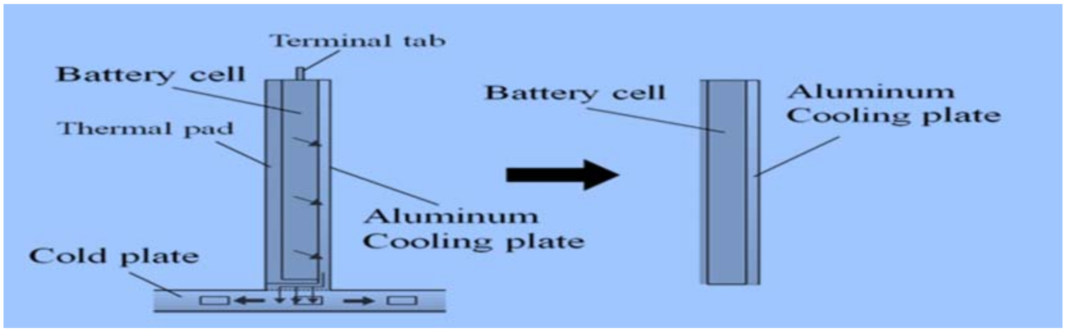

Fig. 3.1 Simplification of 2D battery model.

Table 3.1 The properties and value used in the analysis.

Size of battery cell	11×248×260 mm^3
Size of aluminum cooling plate	t×248×260 mm^3
The type of Al plate	Al-1100
The temperature of coolarnt	25°C
Heat capacity of battery cell	880 J/kg·K
Heat conductivity of battery cell	4 W/m·K
Heat transfer coefficient (b/w Al plate battery)	1000 W/ m^2·°C
Thermal dissipation of the battery	12 W (Average value)

IV. Modeling & Simulation

4.1 Modeling of cooling plate

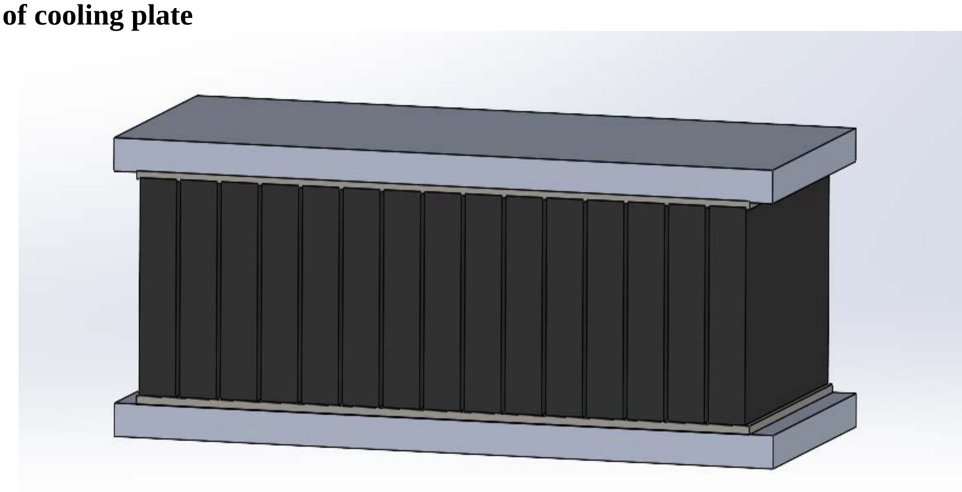

Fig.4.1: 3D model of cooling plate with 15 Lead battery set box.

4.2 AL Oxide

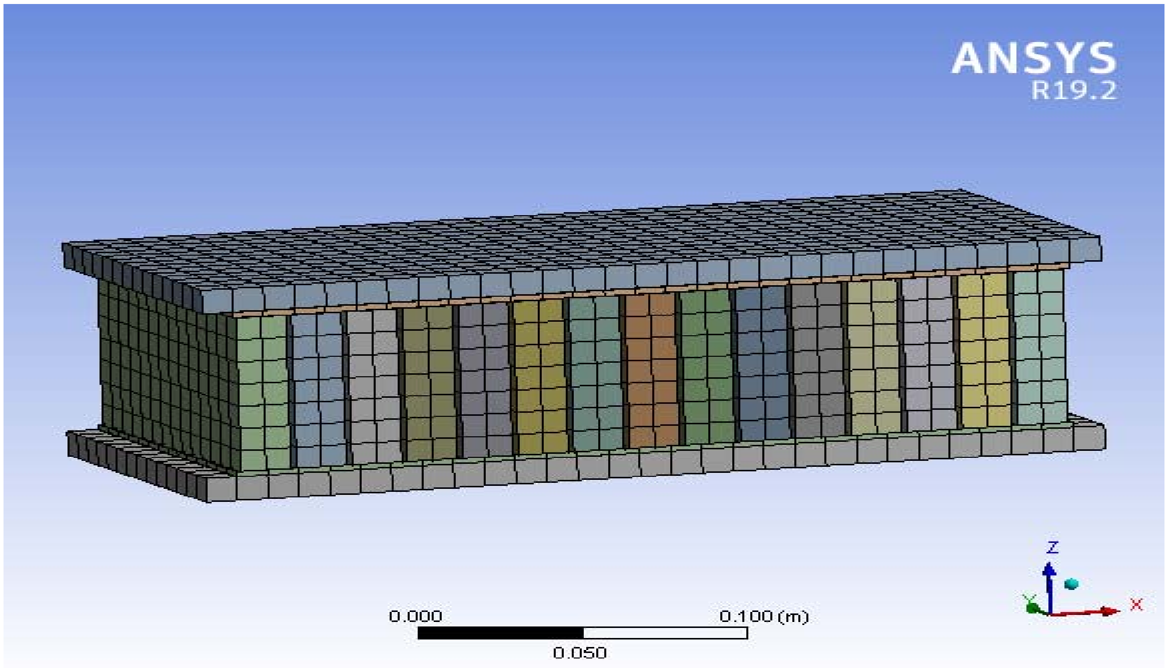

Fig. 4.2: AL 92 Alloy material cooling plate meshing.

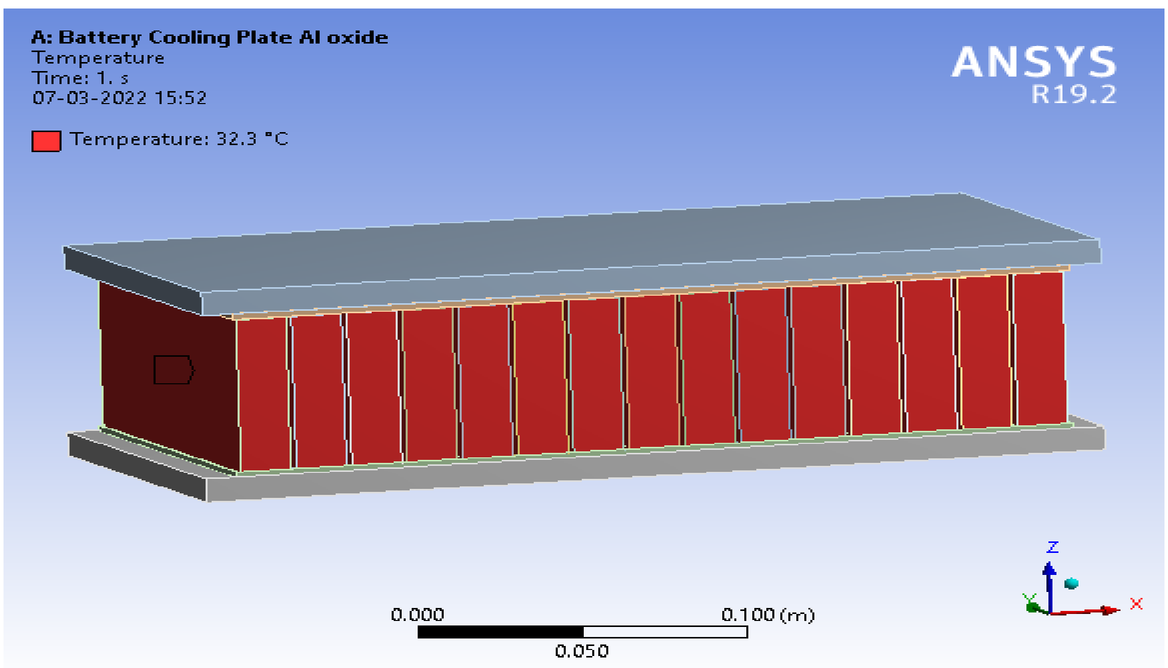

Fig 4.3: AL 92 Alloy material cooling plate thermal boundary condition applied at battery 32.3 ^{0}C.

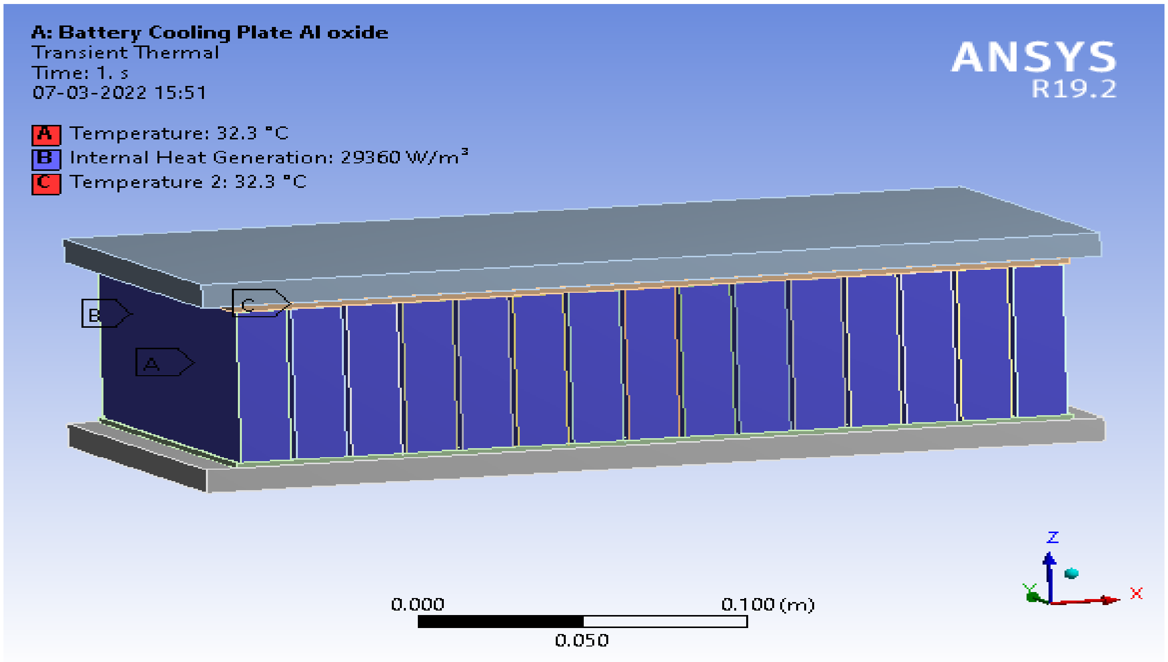

Fig. 4.4 : AL 92 Alloy material cooling plate thermal boundary condition applied.

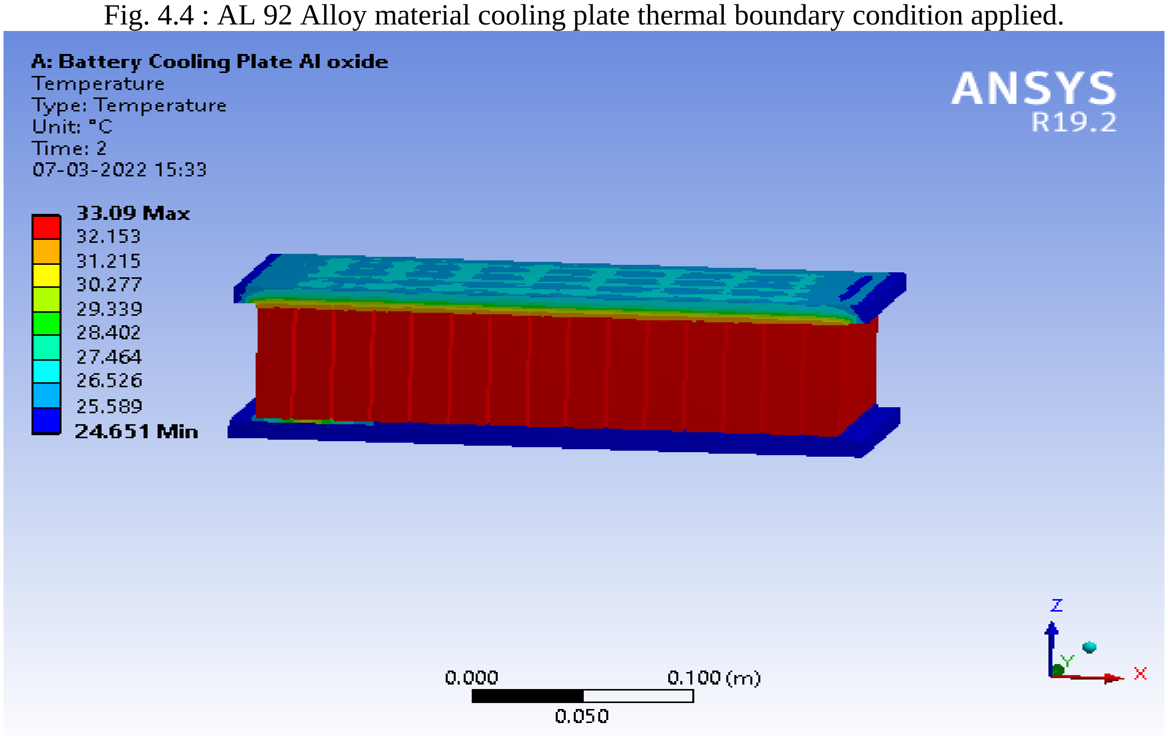

Fig. 4.5: AL Oxide Alloy material cooling plate temperature results.

4.2 AL 92 material

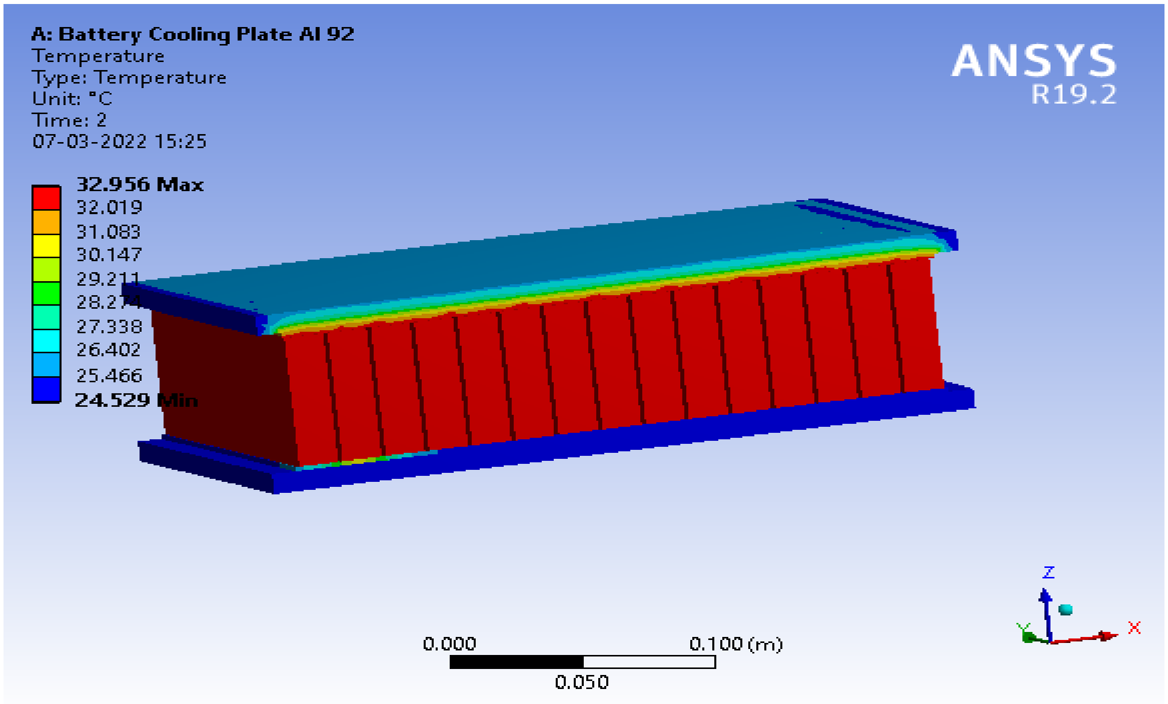

Fig 4.6: AL 92 Alloy material cooling plate temperature results.

4.3 AL 96 Alloy material

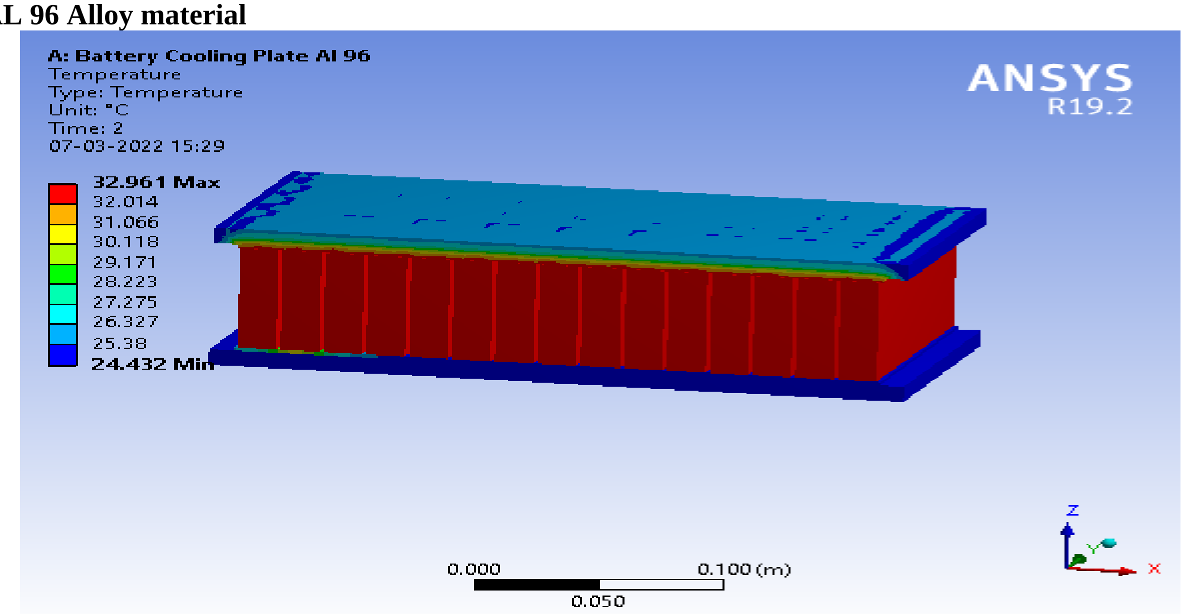

Fig. 4.7: AL 96 Alloy material cooling plate temperature results.

4.4 Al 1100 Alloy

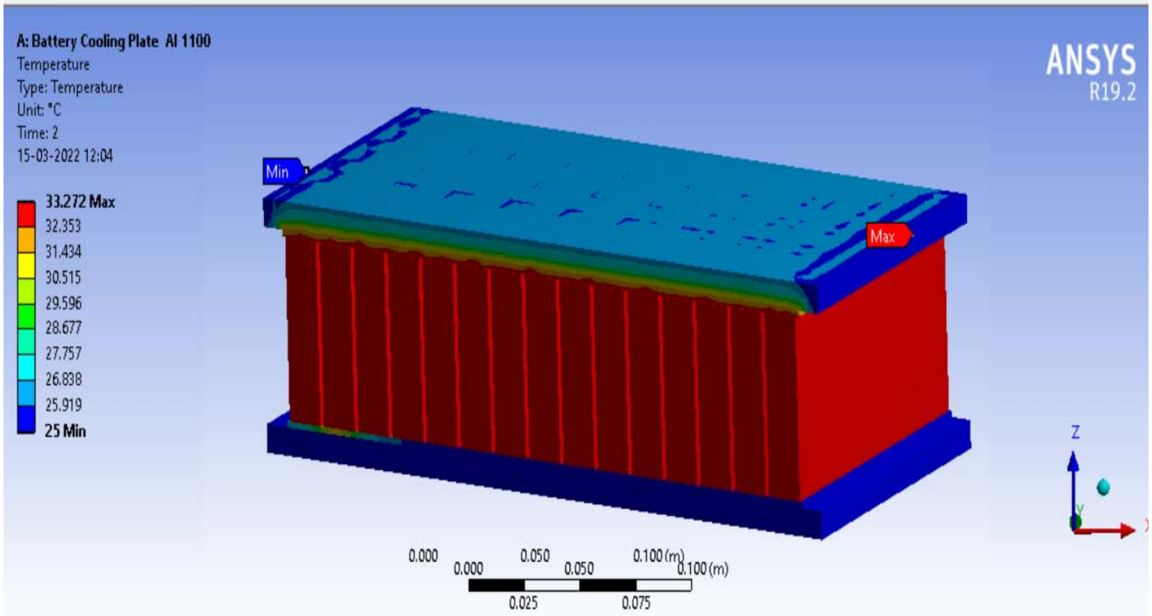

Fig.4.8: AL 1100 Alloy material cooling plate temperature results.

VI. CONCLUSION

Here cooling plate four materials are taking like Al 1100 , AL oxide, Al 96 and Al 92 So
Here find out temperature results all four materials are Al 1100 , AL oxide, Al 96 and Al 92 ,33.27 ^{0}C, 33.09 ^{0}C,32.96 ^{0}C and 32.9 ^{0}C. Here find out heat flux results all four materials are Al 1100 , AL oxide, Al 96 and Al 92 , 1.52 e^5, 1.71 e^5, 1.52 e^5 and 1.43 e^5.
So here it is cleared that exiting material AL 1100 cooling plate has more temperature distribution and more heat flux released these all data find out with help of simulation software by ANSYS workbench 19.2 Thermal transient simulation platform So here find out less value of temperature and heat flux AL 92 Aluminum alloy.

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