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# Cfd Analysis of Battery Management System for Electrical Vehicle using Nano-Fluids

**A. Srinath, J. Venugopal, R. Harish**

***Abstract: All automobile sectors looking at new technologies like electrical vehicles because to control the pollution and decreasing fuel consumption. In the present study, we analyze the flow and heat transfer performance of tesla model battery system and using Nano particles in base fluid. We consider water and ethylene glycol as the base fluid and aluminum oxide and copper oxide particles are dispersed into the primary phase. The investigation is performed by varying the heat source intensity of the battery and flow rate of the nanofluid is also varied. The results are compared by plotting the stream line contours, isotherms, pressure distribution inside the battery. The results show a significant reduction in the temperature distribution inside the battery system using nanofluids.***

***Keywords: battery modules, copper coil, Nano particles,* CFD *fluid flow and heat transfer***

## I. INTRODUCTION

The nanofluids are widely used to remove the heat dissipated from the batteries. The nanofluid consists of a base fluid and water or ethylene glycol is widely used as base fluids and different nanoparticles are dispersed into the base fluid to enhance the heat absorbing capability of nanofluid. Cosley and Garcia[1] discusses the different techniques that are available for removing heat from the battery using nanofluids as the working fluid. Wei and Agelin [2] investigated the performance of different nanofluids which remove heat from batteries and they found that the heat absorbing capability of nanofluids is higher than the base fluids. It is also found that the thermal conductivity of the nanofluid shows a drastic increase when the nanoparticles are added into the base fluid. This property of the nanofluid improves its thermal performance. Khodadadi et al. [3] used the conventional air cooling strategy to remove heat from batteries. In this technique, air is forced at a higher velocity over the battery and the inertial force of air extracts heat from the battery packs. It was also found that the air cooling and nanofluid cooling methods are widely used for removing heat from batteries. Chein and Chuang [4] used nanofluids by dispersing the carbon nanoparticle into the base fluid. They estimated the heat transfer rate of the nanofluid and found that this nanofluid with carbon nanoparticles has higher heat extraction capability compared to conventional nanofluids.

Huminic [5] conducted a similar study using paraffin and the results indicated a huge decrease in the temperature distribution of the lithium ion battery system which was considered for the study. Etacheri et al.
[6] We subsequently summarize the characteristic parameters for the analysis of various battery thermal management system designs. Park et al. [7] This paper presents the air-cooling system for the lithium-ion battery and how effectively the heat is transferred form battery. Routbort et al [8] The experimental test shows that the how effectively battery surface temperature reduced when we use different types of nano-fluids and study of different nano-fluids. Malekshah et al. [9] in their study used CuO nanofluid and found a significant improvement in the heat transfer rate and their numerical investigation is based on lattice Boltzmann method. In the present study, we vary the strength of the heat source and the inlet velocity of the nanofluid.

## II. DESIGN OF BATTERY PACK

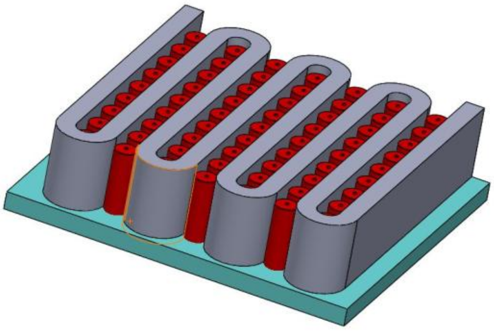

**Figure 1. Schematic diagram of battery**

## III. IV. MESHING AND PREPROCESSING

The battery pack and cooling coil is been designed using Solid works 2019 software before being imported to ANSYS Fluent for Pre-processing and meshing. Using ANSYS workbench design modeler an interface is created between the contacting fluid region and boundary conditions were created. To discretize the domain into smaller region mesh is generated where by the computer numerical calculation the conservation of equations is approximated. The two main zones which are batteries and cooling coil is to be meshed as it is modelled as a separate interacting fluid domain.

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As the mesh which is produced is very finite as the results will be as accurate for the computation to take place

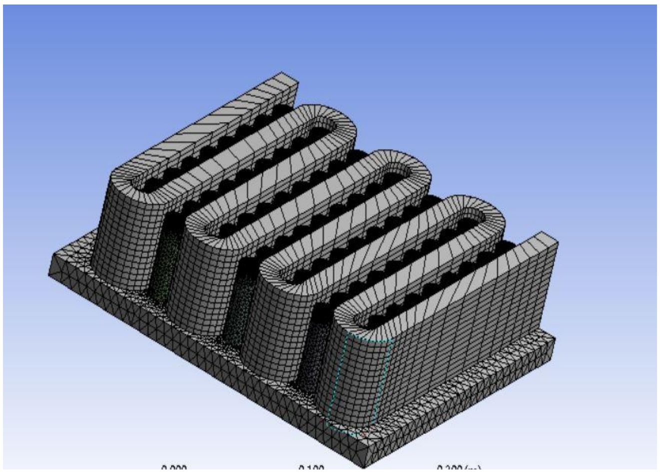

**Figure 2. Schematic diagram of mesh**

## V. RESULTS AND DISCUSSION

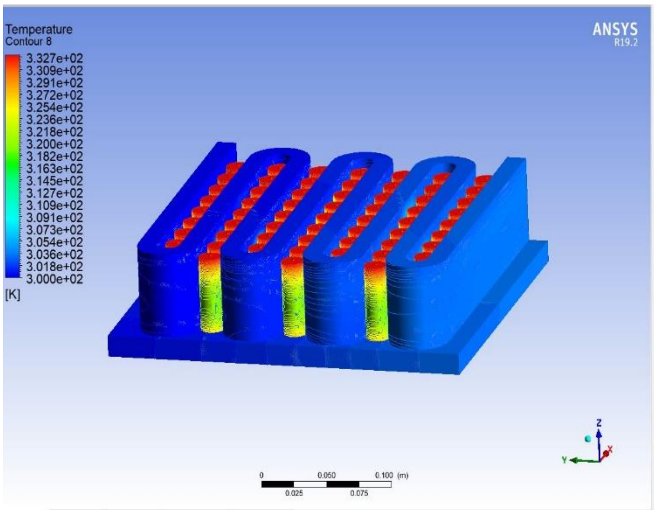

**Figure 3. Temperature contour for water**

The figure 3 is represent the temperature distribution and we observe a higher temperature values on the upper surface of the batteries and as the nanofluid flows at a high velocity though the ducts the heat is reduced further and temperature drop is visualized in the mid-section of the battery.

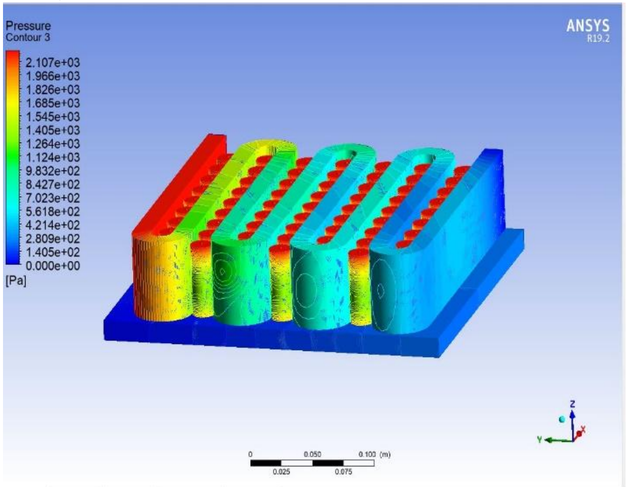

**Figure 4. Pressure contour for water**

The figure 4 is represent to the Pressure contour of the cooling tube. the pressure increases in inlet to outlet because of path of flow is zigzag.

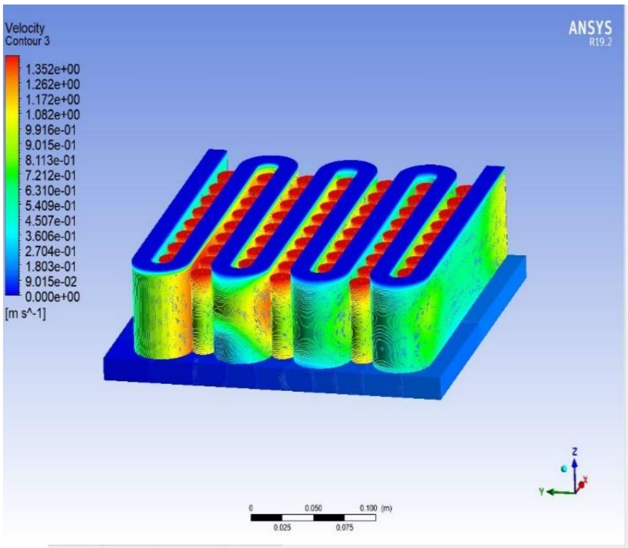

**Figure 5. Velocity contour for water**

The figure 6 represent the velocity contour of the battery pack the velocity which is developing due to the speed of the pump and induces the high velocity at the region of curved surface of the coil

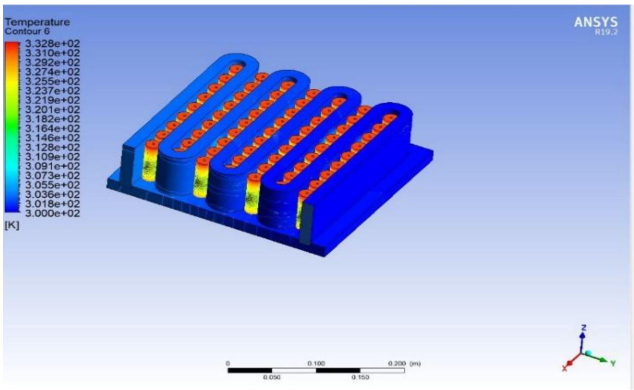

**Figure 6. Temperature contour for copper-oxide**

This figure shows the temperature reduction of the battery due to the flow of copper-oxide mixed with ethylene glycol.

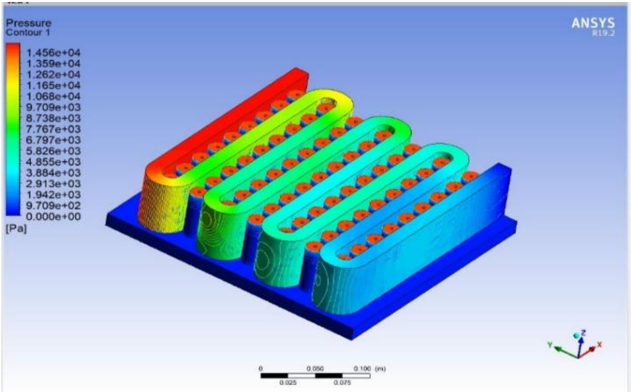

**Figure 7. Pressure contour for copper-oxide**

The figure 8 is represent to the Pressure contour of the battery pack when the copper-oxide is used as the working fluid. Here the pressure distribution is high at the outlet and low ate inlet

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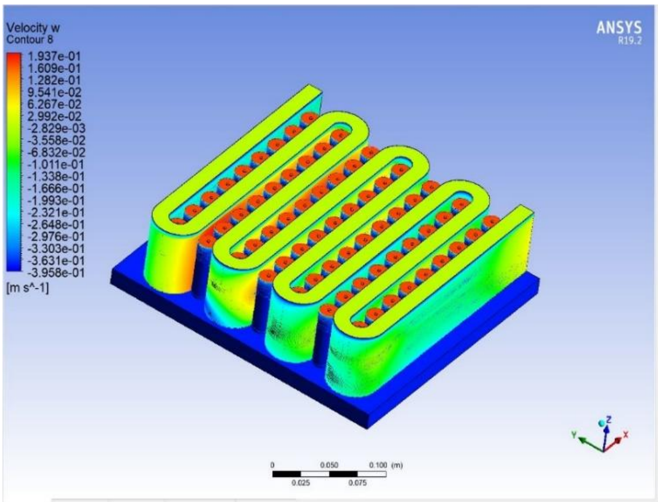

**Figure 8. Velocity contour for copper-oxide**

This figure represents the velocity flow of copper-oxide with ethylene glycol. Since nano particles is added to it the velocity is high in order to pass nano fluid in proper ratio

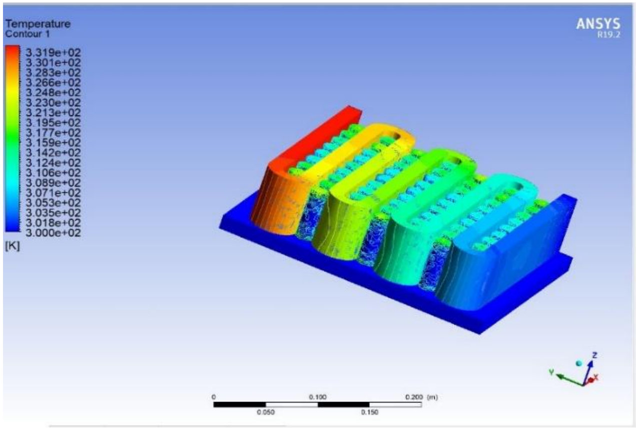

**Figure 9. Temperature contour for aluminum-oxide**

Tis figure shows the temperature distribution of the battery when aluminum oxide is used as the nano fluid with mixture of ethylene glycol.

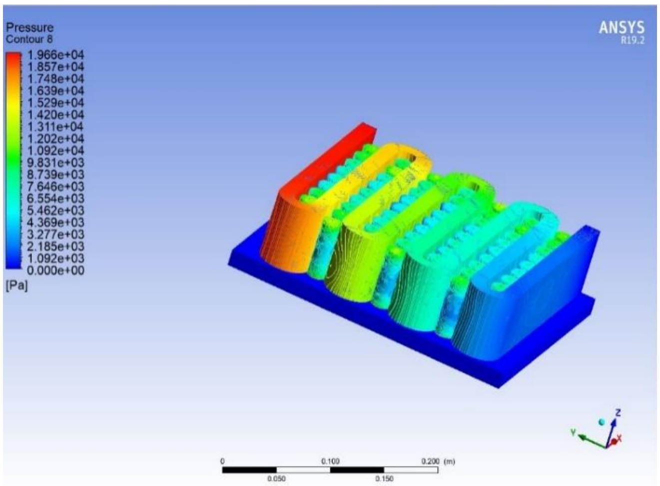

**Figure 10. Pressure contour for aluminum-oxide**

The figure 10 shows the pressure variation pattern visualized for the battery pack and we observe an increase in the pressure distribution at the mid –section of the battery pack considered.

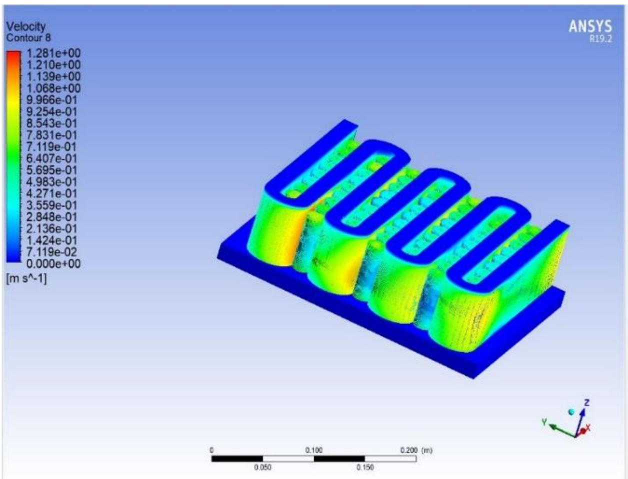

**Figure 11. Velocity contour for aluminum**

This figure 11 represents the velocity flow of aluminum oxide and ethaline glycol. Since the density of fluid is high velocity of fluid is also high in order to increase the heat transfer from battery

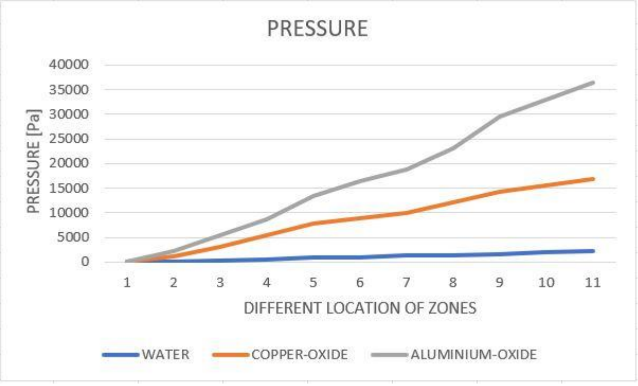

**Figure 12. Variation of pressure for different zones**

Figure 12 represents the pressure variation for different nanofluids and the results are plotted at different zones and it is seen that the pressure increases linearly along the lateral direction.

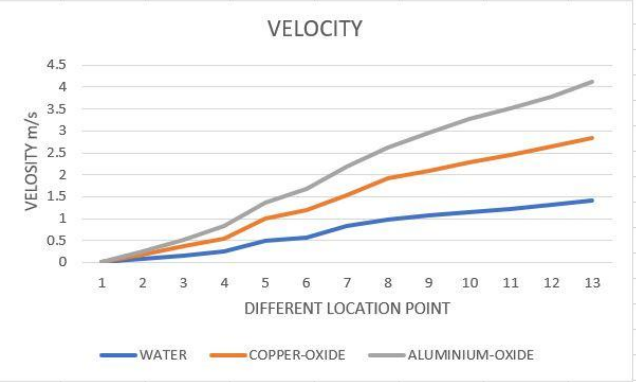

**Figure 14 Normal velocity component**

The normal velocity plot shows a linear increase in the velocity distribution of the nanofluid and it increases in the normal direction.

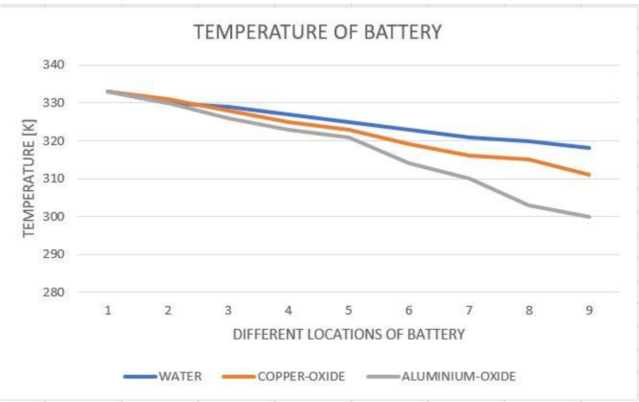

**Figure 13. Distribution of temperature**

Figure 13 indicates the temperature variation along the battery for different nanofluids considered and it seen that the temperature decreases linearly.

## IV. CONCLUSION

The present numerical study is performed to understand the heat transfer behavior of different nanofluids. The battery is considered as constant heat flux source and nanofluids are accelerated through the surrounding ducts and the heat transfer phenomena such as conduction and forced convection are investigated, We also analyze temperature distribution and mass flow rate comparison among ethylene glycol and different types of Nano fluids (CuO, Al2O3) it was concluded that the aluminum oxide having high rate of heat transfer and it is providing better way of cooling effect in the batteries.

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