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# Review on Types of Cooling System in Electric Vehicles

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**Abstract A major factor is the increase in temperature Affects the performance of lithium-ion batteries (LiIon). The heat performance of the battery is to be refined Various methods of heat dissipation. Choosing the right one Cooling techniques for Li-ion battery modules of electric vehicle (EVs) and determining an ideal cooling control 5□ C to temperature maintenance approach 45°C is required. is to maintain the optimum temperature Essential because it increases safety, reduces maintenance costs, and extends the service life of the battery pack. When Various trade-offs are made by choosing the cooling technique In various parameters like weight, cooling effect Temperature compatibility, and cost. Four in this paper Lithium-ion battery cooling methods: liquid cooling, phase Replacement material cooling, dielectric oil cooling, and Thermoelectric cooling is discussed in the paper as well A detailed study on the advantages, disadvantages and more Applications of these four types of cooling systems.**

***Keywords —BTMS, TEC, PCMs,* nH2O.**

## I. INTRODUCTION

Electric vehicles offer many advantages a A conventional IC engine automobile. These benefits Are energy efficient, no noise, not fossil dependent Electric motors are more efficient than fuel IC engines By converting more energy to drive the vehicle. Various Other features make the EV lime-light like With regenerative braking, the EV has smoother acceleration and braking system, more economical. however, There are many challenges related to Battery module. The battery emits a lot of heat Which needs to be kept most effectively and efficiently Battery cooling. It only helps to grow Battery performance but also its health. High May increase temperature (> 50□C). Solid electrolyte interface and internal growth This increase in resistance will decrease the power Distribution significant. In extreme cases, the The separator will melt and the thermal will run away Battery temperature plays a big role in the cell Charging and discharging power, cell availability Balance, and acceptance of charges during reincarnation Not taking into account the growth of the braking battery Temperatures can cause thermal runaway Battery rupture, explosion or fire. This is not Not only endangers life but also property

DAMAGE This paper discusses various methods Can be used to cool Li-Ion batteries.

## II. COOLING SYSTEM IN ELECTRIC VEHICLES

The Basic types of Air Cooling System.

### *A. Lithium-ion battery Lithium:*

A very light metal and falls under the alkaline group of the periodic table. It has three electrons and an electronic configuration of 1s2,2s1. Lithium has the highest tendency to lose an electron, and this property makes lithium highly unstable. Whereas lithium metal oxides are a more stable form of lithium. Individual lithium-ion cells can achieve a very high voltage due to the very high reactivity of the metal [1] . A lithium-ion battery contains several modules connected in series and each module comprises individual cells connected in series and parallel [2]. A lithium-ion battery comprises three major parts: 1. Lithium Metal oxide, 2. Electrolyte, 3. Graphite. Electrolyte separates the lithium metal oxide from graphite. Lithium-ion batteries work in two stages: Charging and Discharging. During the charging stage, it connects the cell to a power source. It connects lithium Metal Oxide to the positive terminal (anode) and it connects graphite to the negative terminal (cathode). Electron in the valence shell of lithium gets attracted to the positive terminal of the power source. Electrolyte acts as a guard and does not allow electrons to pass. Electrons pass through the external supply and reach the graphite layer.

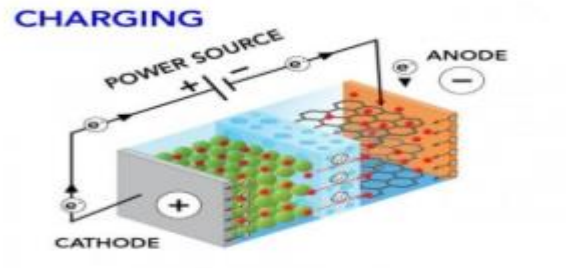


**Fig-1**: Charging Phase

### *B. Liquid cooling*

has higher heat conductivity and heat capacity and so performs very effectively. It has its own advantage like ease of arrangement and compact structure. Liquid cooling helps in maintaining correct temperature of the battery pack [6] . According to researchers conducted, liquid cooling is almost one of the most promising cooling methods

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compared to any other. The microchannel liquid cold and warmth model of single-layer type liquid ion battery was established by Zhao. Tong devised a liquid coolingbased BTMS (battery thermal management system) for primary bipolar Lithium-Ion battery pack. Average temperature and temperature uniformity can be improved by increasing coolant flow rate or the plate thickness. The cooling performance of any fluid will depend on its thermal conductivity and its viscosity [7] . The main consideration for any cooling fluid is the specific heat. Plain water has the highest specific heat though it cannot be used alone so is therefore mixed with glycol. Glycol is the substance in the alcohol family. It is used with water to basically prevent it from freezing ad boiling. Glycol and water mix is inexpensive and is a very well-established cooling fluid. This mixture carries 50% of glycol, 45% of water and 5% of additives, which may include antifreeze, corrosion inhibitor, dye and antioxidant. Glycol has good specific heat capacity and also has good heat transfer properties [8] . Water-glycol systems are considered as indirect cooling.

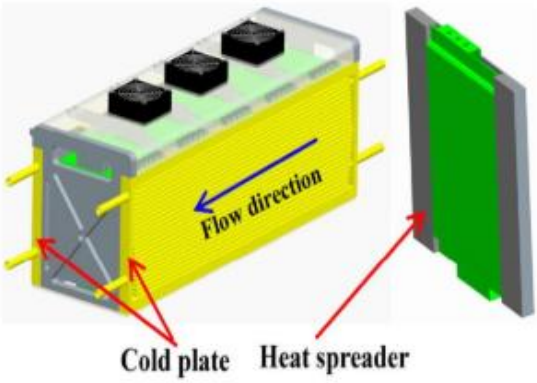


**Fig -3**: Conceptual design of indirect-contact liquid cooling system for battery pack of electric vehicle.

*C. A phase-changing:*

material is a material that releases or absorbs adequate energy at phase transformation to supply useful heating or cooling effect. PCM has such an application due to its property of having high latent heat. Commonly used PCM's are RT35, RT15 (Rubi Therma 15), EG5 (expanded graphite 5), and EG26. The working temperature of PCM ranges from -40C to 150C. PCM is the premier solution for a functional thermal management system of an electric vehicle by maintaining a constant temperature distribution even in any temperature condition [14] . Zhao et al epitomized different methods of thermal management systems, of which he concluded that PCM is a very effective technology for battery thermal management system [15] . Karimi et al experimented on a cylinder lithium-ion battery thermal management system using a composite PCM, which resulted in a decrease in the maximum temperature between the battery surface and composite PCM up to 70% [16] . Azizi and Sadrame Ali suggested a thermal management system for a LiFePO4 battery module with composite PCM and aluminum wire mesh. They found that the maximum temperature of the battery surface was reduced to 19%, 21%, and 26% at 1C, 2C, and 3C discharge rates respectively [17] .

*D. Air cooling*

The lower layer which is hotter becomes less dense. We know that colder part is denser. Due to buoyancy, the less dense, hotter part rises up and the colder dense replaces it. This process is repeated and hence the convection process is carried and the heat transfer s carried out. Convection is carried out by two types. 1. Natural Convection 2. Forced convection [26] . 1. Natural convection: When the convection takes place due to the buoyant force because of the difference in densities caused by the difference in temperature is called as natural convection. Example of this may be natural air. 2. Forced convection: When there are external sources used for creating convection is called as forced convection. These sources maybe fans or pumps. These similar types of process are also used in the cooling of electric vehicles where the vehicles maybe cooled with the help of natural air or with the help of fan. Advantages: Air cooling system is less complicated and has low cost. Disadvantages: Air cooling process cannot be used for most new high-performance applications due to the power density required and the wide range of ambient temperatures it needs to face. It is not possible to extract sufficient heat from the battery with the help of just the cooling system.

*E. Thermoelectric cooling:*

The main issue with the air and water cooling method is the cooling effect can be very limited under certain circumstances [29] . A thermoelectric module is a solid-state energy converter that consists of a bunch of thermocouples connected in series and thermally in parallel [30] . Working: A thermoelectric cooler (TEC) is based on the conversion of voltage to temperature difference. It refers to all of the transformation processes from heat to electricity and vice-versa. It operates according to the Peltier effect. The effect creates a temperature variance by carrying heat between two electrical junctions. A voltage is applied across joined conductor to create an electric current. When the current flows through the two conductors, heat is removed at one of the junction and cooling occurs. Heat is deposited at the opposite junction. The foremost relevance of the Peltier effect is to cool. The Peltier effect can also be used for heating or control of temperature [31] . Thermoelectric cooling has several advantages over other cooling methods like static device, no internal chemical reaction, noise-free, longer operation, no emission of hazardous gases, and minimum maintenance cost [32,34,35] . Disadvantages of TEC are low efficiency and additional power requirement which limits their commercial application [33].

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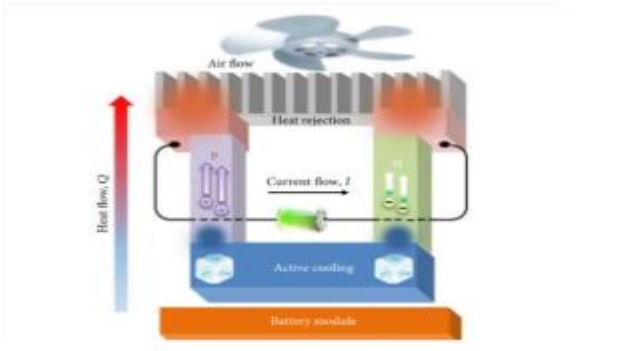


Fig 4: Thermoelectric cooling setup

## III. APPLICATION:

The thermoelectric cooler converts heat to electricity and vice-versa. TECs application revolves around two main aspects i.e. converting heat to electricity and electricity to heat [36] . There are numerous application of TEC. The main application of TECs is its use in cooling Li-Ion batteries, microprocessor of high configured computer and for building air conditioning system [37,38] . TECs have been also used recently in portable refrigerators, portable air conditioners and automobile cooling [39,40] . The most promising application of TECs is integrating it with PCMs for BTMSs to make a passive system into semi-passive system and thus increasing the efficiency of the BTMS

## IV. CONCLUSION

The paper proposes various battery cooling Technology of electric vehicles. Battery thermal Management System (BTMS) is the most important component of EV. During the charging/discharging mode of Electric vehicles are a major focus area for research To maintain the optimum working temperature range of Reduce both battery and maximum temperature and temperature difference. Appropriate and effective The cooling method will significantly reduce the adverse effects A result of the high surface temperature of the battery cells and Efficiently increases the thermal performance of the battery. That It also improves vehicle safety and so on Extends the life of the vehicle. Among all the things mentioned above Battery cooling technique is liquid cooling technique One of the most reliable and promising cooling Technology will be mentioned technique Significantly helps in improving battery performance Under high charging/discharging rates and attention Cheap price should be given to the compact design.

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