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Original Research Article

EV Battery Comparison Study Systems Using Lithium Ion and Solid State Batteries

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Abstract:

Electric vehicles are currently experiencing a renaissance due to advancements in machinery, a continued emphasis on sustainable energy, and the diminishing impact of transport on ecological change and other common issues. Electric vehicles have been described by Project Drawdown as one of the 100 newest solutions for monitoring climate change. Traction battery special systems are used in newer (or wearable) vehicles, but an electric vehicle battery (EVB) is a type of battery used to control electric vehicle (BEV) incentives. These batteries are usually secondary (battery control) batteries and usually contain lithium ion. Forklifts, electric golf carts, bicycle scrubbers, electric bicycles, electric cars, trucks, vans and other vehicles all use power batteries and have much higher ampere-hour limits.

Keywords: electric vehicle, battery system, new renewable energy energy, lithium ion battery

Introduction

The observable impact of the petroleum-based transportation foundation in the 20th and 21st centuries, together with concern over peak oil, sparked a resurgence in interest in an electric transportation framework. Electric vehicles (EVs) differ from vehicles powered by petroleum derivatives in that the power they use can be produced from a variety of sources, including petroleum products, nuclear power, renewable energy sources like solar and wind power, or any combination of those. Depending on the fuel and technology used for power generation, electric vehicles' carbon footprint and other emissions change. Depending on the vehicle, the power may be stored in a battery, flywheel, or super capacitors. Energy for gasoline-powered vehicles comes from one or more sources, typically non-sustainable petroleum derivatives.

History of Batteries in Electric Vehicle

Inside the flow electric vehicle (EV) development and charge technique towards increasingly green and reasonable vehicle, there are key mechanical obstructions and challenges, which are as often as possible altering according to partners' points of view [1]. 10 years prior, reviews have called attention to this fundamental hindrances of the commercial presentation of EV was rates, existing reach & accessibility of recharging foundation[2]. Nonetheless, the main obstructions had varied radically. Expenses of the battery the most costly part of the EV impetus framework had gone down almost 90% [3,4]. Rate equality will get normal till 2025 most recent. In the times to comes, electric vehicles will be less expensive to purchase contrasted with ordinary vehicles. Realizing going expense &

support value are now less expensive presently, but that implies only aggregate value of possession (TCO) would less expensive before long. The driving reach expanded 100-150 km till 400+ km [5-7]. Many nations, accessibility of recharging foundation taken as yet an issue, particularly to individuals in metropolitan regions and who frequently had no personal stopping point. EVs had demonstrated better to the climate [8,9] also permit greater entrance to sustainable power resources in the power network [10]. At the present time, the structure, cell, anode, and material levels of an electric vehicle battery are taken into account. The projected breakdown for 2025 is based on framework level objectives of 225 Wh/kg. The cathode side is hinted at by anode and material properties. By 2030, this can be enhanced even more, reaching 450 Wh/kg. The battery's energy thickness will increase in the same period from 310 Wh/L in 2010 to 580 Wh/L in the present day to 1100 Wh/L in 2030. Battery prices have dropped from 1000 euros per kWh to 130 euros per kWh, and are expected to further decline to under 80 euros per kWh. An increased driving range or reduced vehicle weight will result from a higher explicit energy, and this will happen at a cheaper battery cost. In 2010, batteries were typically 30 kWh in size; currently, 60 kWh is no longer an exceptional circumstance, and by 2030, the battery limit will exceed 80 kWh [11–13].

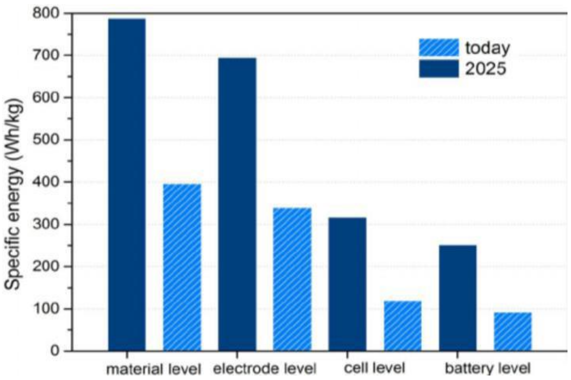

Fig. 1 Specific Energy of Electric Vehicle Battery [1]

The traction inverter power thickness increases from 10 kW/ L in 2010 to 30 kW/L in 2020 and can further be worked on up to 65 kW/L in 2030 depending on the DCinterface voltag e, which results in a volume reduction of up to 40%. In the s ame period, the peak inverter efficiency increased from 92 p ercent in 2010 to 96 percent in 2022 and can be further impr oved to 98 percent in 2030 by integrating wide bandgap tech nology into the drive system. By doing this, the driving rang e will increase by 8%. Comparatively, the battery charger an d DC/DC converters could achieve efficiencies of up to roug hly 100% by 2030, leading to a 20 percent reduction in char ging costs. Additional efficiency improvements result in decrease in the utilization upto 32% [11]. Ecological effect of EV chiefly relies upon how power delivered. In view of the energy blend the Carbon dioxide discharges was around 300 Carbon dioxide g/kWh in 2010.

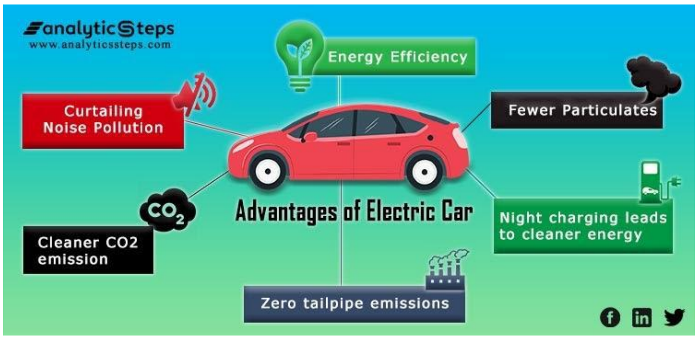

Fig.2 The Environmental Impact of Electric Vehicles

Normally, through an expanded portion environmentally friendly power resources & taking gradually eliminating thermal energy stations, that by 2030 the CO2 discharges would lessen underneath no less than 200 CO2 g/kWh, the EV utilization & emanations that create the power, the carbon dioxide outflows each vehicle would diminish from 66 CO2 g/km in 2010 to under 30 CO2 g/km in 2030. Lithium ions flow from the negative electrode via an electrolyte to the positive electrode during discharge and back again during charging in a lithium ion battery, also known asa Liion battery. The positive electrode in lithium ion batteries is made of an intercalated lithium compound, while the negative electrode is commonly made of graphite. With the exception of LFP cells, lithium ion batteries have a high energy density, little memory effect, and a low selfdischarge rate. It is possible to construct cells that emphasise power density or energy. However, because they contain flammable electrolytes and can catch fire or explode if damaged, they can pose a safety risk. Alternatives to electrolytes, such the lithium polymer battery, have also been crucial. Polymer electrolytes show promise in reducing lithium dendrite development. The purpose of polymers is to maintain conductivity and prevent short circuits[12].

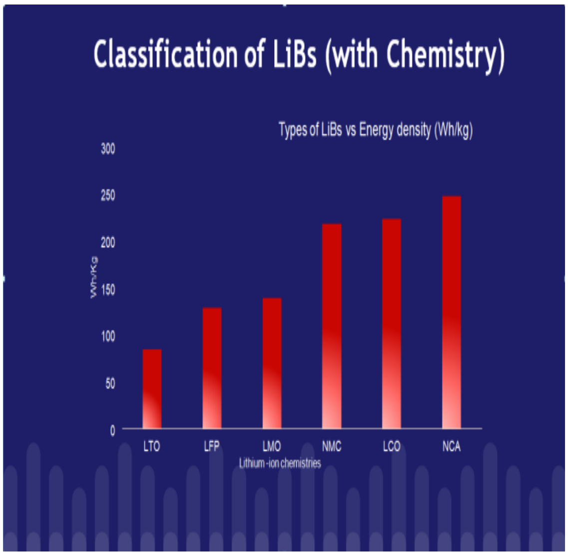

Fig.3 Li-Bs Vs Energy Density Plot

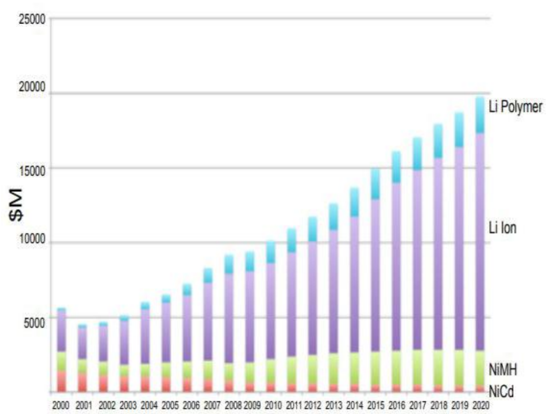

Fig.4 Lithium Battery Market Plot

Because of slight variations in the electrolyte concentration, the ions in the electrolyte disperse. Here, only linear diffusio n is taken into account. As a function of time t and distance x, the concentration change, c, is VII. SELECTION CRITERIA FOR SOLID POLYMER ELECTROLYTES The electrolyte determines how well a battery performs, and there are currently more than 25 different types of solid-state electrolytes available, including oxides, sulphides, phosphates, polyether's, polyesters, nitrile based, polysiloxane, and polyurethane. In solid state batteries, polyether and Lithium Phosphorus Oxynitride (LiPON)based electrolytes are frequently utilized[18]. Table.3 SSB Electrolyte Properties for Selection Criteria Property Why? Dissolution property Lithium salts must be dissolved in order for polymer salt complexes to form, and this re quires sequential polar groups like - O, C=O, and C=N. Electrochemical stability The voltage window and the distance betwe en the onset potentials ought to be substanti al. High iconic conductivity For improved performance and to reduce sel f discharge for a longer storage life. Chemical & thermal stability Neither a chemical reaction within the batte ry nor between the electrodes, current collec tors, or packaging components should occur when the battery is in use. Mechanical strength Positive and negative electrode separation a nd processing viability are both assured by s trong dimensional stability. Low cost To help in achieving cost efficiently & commercialization of the concept. Sustainability & toxicity Harmful effects on the environment should be minimum.

Advantages and Challenges in Solidstate Batteries

Due to the fact that they don't contain any combustible components, solid state batteries are available in smaller sizes than liquid lithium-ion batteries, improving operating safety. In the case of solid state batteries, Solid Electrolyte Interfacial Layer (SEI) is present, which leads in extremely low self-discharge rates and permits multiyear power storage with little loss. The operational life of the currently available solid-state batteries, which is only three years, presents a problem Research and development efforts will undoubtedly contribute to extending the working life of solid state batteries for electric vehicles to over three years[19]. Table.4 Comparison between Li-ion & SSB Batteries Liquid Lithium-ion Batteries Solid-state Lithium-ion Batteries Low processing cost. Excellent thermal stability. Flexible separators can withstand high mechanical stress. Comparatively less selfdischarge. Only at room temperature does it have a high ionic conductivity. Temperature variation range over high ionic range. Life of battery discharge to recycling. Electrolyte taken is nonvolatile. Combustion cause due to flammable electrolyte. Electrolytes are non-flammable, and thus safe Life cycle is affected by SEI degradation. High energy density. Material of cathode have limited choices. High tolerances. Bad thermal stability. Ceramic separator used its rigid and it may break with additional stress. Sensitive to overcharge. No SEI layer formation, and thus, a longer life cycle. IX. UPTAKE OF ELECTRIC VEHICLES By 2030, electric car sales are anticipated to account for 10 to 12 percent of all auto sales. the product innovations made by significant OEMs like Honda and Volkswagen; and battery technology breakthroughs. By 2025, electric car prices will rise to a point where more people may choose to drive them, predicts Goldman Sachs[20]. The results of an industry poll indicate that lithium ion battery prices will probably continue to be high. New technologies, such metal-air, solid-state batteries, are anticipated to gain substantial market share in the upcoming years in order to address this. Factors affecting the uptake of electric vehicles: The adoption of electric vehicles has various restraining factors, which include: [21]

Challenges Advantages

Comparative Study of Electric Vehicle Battery Systems with Lithium-Ion and Solid State Batteries 6 Published By: Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) © Copyright: All rights reserved. Retrieval Number: 100.1/ijese.I254009101022 DOI: 10.35940/ijese.I2540.09101022 Journal Website: www.ijese.org i. Long time in charging: Current lithium batteries need longer charging times to get fully charged. ii. Few EV charging stations and short driving range: As the energy density of the current batteries, including lithium-ion batteries is less, it cannot offer large driving range, which demands for the need for frequent charging and more EV charging stations. iii. Expensive: The cost investment in electric vehicles is higher as compared to the internal combustion engine-based vehicles. iv. Safety concerns: Batteries are the major component in electric vehicles, which are assigned with passive and active safeguards battery structure, but still there is a significant risk in terms of safety, including thermal stability of active materials at high temperature and occurrence of internal short-circuits resulting in thermal runaway. X. CONCLUSION According to polls conducted, standard lithium-ion batteries are gradually reaching a technological saturation point. There is a critical need to create an alternate strategy that addresses every obstacle to the adoption of electric automobiles. Solid state batteries are preferable to traditional liquid lithium ion batteries because they have a higher energy density and are safer. It is anticipated that solid state battery technology would lead to better products with lower production costs and better performance. Major OEMs and MNCs including Toyota, BMW, Honda, and Hyundai are collaborating with R&D organizations, battery material makers, and battery manufacturers to advance technology. Fully marketed solid state battery based electric vehicles are anticipated to go on the market by 2025.

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