Journal of Electronics, Computer Networking and Applied Mathematics
ISSN: 2799-1156
Vol: 03, No. 04, June-July 2023
http://journal.hmjournals.com/index.php/JECNAM
DOI: https://doi.org/10.55529/jecnam.34.1.6

An Overview and Future Reflection of Battery Management Systems in Electric Vehicles

Vicky kumar Mandal[1*], Rajeev Ranjan[2], Partha Sarathi Bose[3], chandi Das Pal[4], Rituraj Yadav[5]

[1,4,5]Student, Department of Mechanical Engineering, Dr. B. C. Roy Engineering College, Durgapur- 713206, India*
[2,3]Assistant Professor, Department of Mechanical Engineering, Dr. B. C. Roy Engineering College, Durgapur- 713206, India

Email: [2]rajeevranjan.br@gmail.com, [3]parthasarathi.bose@bcrec.ac.in, [4]cpal12567@gmail.com , [5]riturajyadav369@gmail.com
Corresponding Email: [1]vickymandal432@gmail.com*

Received: 27 February 2023 **Accepted:** 22 April 2023 **Published:** 01 June 2023

Abstract: Researchers are becoming more interested in electric vehicle (EV) because it assist to minimise greenhouse impacts, reduce noise and air pollution, and provide freedom from fossil fuels. Electric vehicles depend on their batteries to safely supply the necessary power. The duration of time needed to charge the electric batteries is the biggest drawback of modern electric vehicles. Significant progress has been achieved in recent years to manage energy storage and speed up the charging process for electric vehicle batteries. In order to reduce energy consumption, boost system efficiency, lengthen battery life, and create a clean, efficient transportation system, it is crucial to build a battery management system that ensures long product life and a safe driving experience. This article attempts to provide a concise overview of various important battery management system features, including battery charging optimization, temperature control, and cell voltage balancing. The conclusion and recommendation of the article highlight the potential for further study in the area of electric vehicles.

Keywords: Battery-Management System (BMS), Battery Charging Optimization, Managing Thermal Temperature, Cell Voltage Balance.

1. INTRODUCTION

A Battery Management System (BMS) in a electric vehicles which manages every rechargeable parts in the vehicles, so for this reason it becomes one of the very critical parts in the vehicles in terms of managing the safety in EV. The main aim of battery management

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system in a EV is to keep the battery within the safety region in terms of voltage, current, charge, discharge etc. There might be no doubt that in the very coming years EV'S will going to replace petrol vehicles in a very large extent. The rechargeable batteries are the core component in EVs which requires high maintenance [1]. To introduce EVs in the market becomes so important as petrol and diesel fuel vehicles causes a large amount of carbon dioxide emission which put serious effects on global warming [2]. Yang and Sun [3] presented an electric vehicles swap location routine system where it determines the location of battery swap station. Use of EVs in a large extent can have significant impact on urban air qualities [4]. However, Sierra Research, Inc.(1994) [5] and Dixon (1996) have argued on the matter of indirect economic effects of an EV. Meanwhile International Energy Agency [6] clearly states that current trend of energy is not sustainable environmentally, economically as well as socially [7]. The National Renewable Energy Laboratory which is also known as NERL [8] is developed ADVISOR program which is a type of simulation that reflects steady – state behavior of an electric vehicle. It is highly reported that many batteries are characterized by operating system [9,10]. Even though the concept of temperature or thermal modelling of Lithium- ion batteries has been discussed broadly, many researchers have also studied the efficacy of ambient temperature over a large range and majority of them are limited to only 23 degree centigrade temperature. In references [11,12], cannot provide sufficient data regarding power , ambient conditions etc. A 2D thermal model is developed by Samba et al. [13] considering radial effects as well as detailed tab heat generation. For EV applications high density batteries are required as they help to extend EV driving ranges [14]. Xiang et al [15] found that recycling and re- manufacturing of EV can reduce greenhouse effect up to 6.62% compared to other raw material. Due to rapid demand or growth of EV machines the annual growth of Li-On batteries will grow by 36% from 2015 to 2020 [16]. Also, the recycling of EV batteries has been studied from different points of views such as Georgimaschler et al [17] reviewed the consumed batteries manufactured before 2012. It is also noted that in present more and more EV manufacturers appreciated recycling EV batteries. Recycled Li- on batteries can provide can provide more valuable secondary source of energy [18] .Now a study which is carried out by Oxford University [19] and University of Washington [20] shows that the ageing of battery occurs with its operation but can be detected on a long period of time. With the development of technologies in recent few years, many idea were developed to reduce battery ageing by using optimization scheduling methods [21, 22]. The introduction of grid – connected electric vehicles (GEVs) can bring a bright prospect towards Renewable energy. In [23] and [24] an intelligent optimization is developed for charging/ discharging of electric vehicles battery. The broad learning system (BLS) and extreme learning machine (ELM) [26] are both have strong generalization ability. Most researchers normally engrossed on the energy efficiency and mileage of an EV [27], while battery decadence during vehicles operation is not focused. It is also noted that energy consumptions or releasing of greenhouse Gases because of battery decadence while vehicle operation [28]. In the literature of EV, EMS mainly considered the concept of energy consummation and battery decadence was not taken into consideration [29, 30, 31, 32].

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Battery charging optimization

Optimized battery is a type of feature which keeps the battery in check and prevents it from ageing. But a simple question is arise here i.e. why is preventing the ageing of battery is important? Also is it good to turn off the optimized battery charging? Well to answers these questions simply, when a battery is gets too old, it can't hold the charges properly for a long time. Thus, resulting in reducing battery life. Secondly, when you turn off the optimized battery charging, the IPhone will charge direct to 100% without pausing it in 80% , but apple always recommends you to keep the switched on to slow down the battery ageing process. A battery management system in a electric vehicles is that which manages the every electronics part of a electric vehicles. Now, there might be possibilities that we can charge the battery to only 80%, above 80% may lead some losses in the battery. So there are two reasons for what we have to charge our EV battery below 100%: Charging performance and battery longevity. Most of the time you should only charge your battery below 100% because high charging rates can slow down the battery performances and health of the battery pack will improve if you're charging rates is below 100%. Besides these all there are also some methods using which you can improve your battery performance and protect your battery from degradation. When we parked batteries around the sun or outside the room anywhere, try to minimize exposure to the temperature, as discussed above also try to assuage the batteries at 100% and aside fast charging.

Cell Voltage Balance

Cell balancing is a system of working which improves the battery life by increases the capacity of a battery packwith the help of multiple cells in series. There might be a question arise that what will happen if cells are not balanced? So the simple answer of this question is that cell imbalance can cause over charging as well as over dis- charging. These two are common negative effects of voltage imbalance in batteries, when cells are not balanced, they can catch fire immediately or even explode as a thermal runaway. Again, there might be a question that does batteries in series need balancing? The cells in a battery stack are "balanced" when every cell in the stack possess the same state of charge. Now, what is active BMS? so, the term active means current charge in the battery and the work of the BMS is it deliver some of the charging current from higher voltage cells to whole packs or from a whole packs to a lower voltage cells , which is known as active balancing in a cells . The main benefits of improved balance in cells can be improve cells agebility; can also improve battery quality as well as charging and discharging. The battery part of a electric vehicles is said to be balanced, when all the cells are at the same SOC, otherwise the battery imbalance may cause to some harm and heating effects. The EV packs contains series of multiple cells batteries in order to acquire higher functional voltages. This implies that the higher number of cells in a battery, chances of its failure is more. Thus, if n is the number of cells in a battery, then the failure is equal to n times of the battery.

Future scope

There are various challenges faced by the automotive sector, specifically on the development of electric vehicles. One of the restrictions faced by this sector is the consumer outlook which restricts the uses in less in comparison to ordinary vehicles. As the basis of industry 4.0, the

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future scope of digitally technology may bring revolution in testing of smart vehicles. Not only this technology reduces the expenses but this technology but will also make it safer and more efficient. With the further development of AI technology, the performance may not be evaluated with only current scenarios but can predict the future performance of the EV. Looking to the future towards industry 5.0, would represent the human thoughts into the control in the machines. According to a research by 2025, there will be a great move from conventional to electric in automotive sector. According to some experts the promotion of electric vehicles will rise 3 percent in the worldwide in 2025.

2. CONCLUSION

As per discussed in this article, it is very clear that this system in electric vehicles is very vital in terms of improves batteries conditions as it monitors the temperature, voltage across the packs. The battery management system in electric vehicles is the device which is responsible for managing the heat generation during the operations. In this article we mainly focused on three main topics under battery management system in electric vehicles. It also very important that battery-management system should be well maintained with the battery safety because the safety of the whole cells is depends on the BMS. This paper mainly focused on the study of detailed BMS where we also discussed about the thermal managing in EV, how it actually works. There are also we discuss about the coolants in battery which is also very helpful for managing the thermal changes in the battery. So in this way, we are developing a model for battery management system and based on three parameters voltage, current and temperature.

3. REFERENCES

1. C. Capasso and O. Veneri " Experimental analysis on the performance of lithium – based batteries for road full electric and hybrid vehicles" , applied energy , vol. 136 , PP . 9231-930, 2014.
2. R.J. Huang et al. , "High Secondary aerosol contribution to particulate pollution during haze events in China, " Nature, vol. 514, no 7521, P.218,2014.
3. Yang , J ; Sun , H . Battery swap station location on – routing problem with capacitated electric vehicles compute .operation . Res. 2015, 55,217-232.
4. General Motors Electric Vehicles Progress Report (2017).
5. Kalhammer , F.R ., Kozana ,A., Moyer , C.B., Owens B.B., Owens 2021 . performance and ability of batteries for electric vehicles : a report of the battery technical advisory .
6. International Energy Agency, OECD (2018) World Energy Outlook . International Energy Agency OECD.[2018].
7. United States Environmental Protection Agency (EPA) , Joint technical support documents , 2010.
8. K.B. Wipke, M.R. Cuddy , S.D. Burch , " ADVISOR 2.1: a user – friendly advanced powertrain simulation using a combined backward / forward approach " , IEEE Trans. Vehicular Tech. Vol. 48, no.6 , PP . 1751-1761, November 1999.

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9. M.A. Kiani , M.F. Mousavi, M.S. Rahmanifar, synthesis of nano – and micro – particles of Li- Mn 204 : electrochemical investigation and assessment as a cathode in Li battery , Int. J Electrochemistry . science 6(2011)2581-2595.
10. L.H. Saw , Y.ye , A.A.O Tay , W.T. Chong , S.H. Kuan, M.C. Yew , Computational fluid dynamic and thermal analysis of lithium – ion battery pack with air cooling , Appl. Energy 177 (2016) 783-792.
11. S. Wijewardana, R. Vepa , M.H. Shaheed , dynamic battery cell model and state of charge estimation , J. power sources 308 (2016) 109 – 120.
12. T. Yuksel , S. lither , V, Viswanthan , J.J. Michalek, Plug – in hybrid electric vehicles LiFePo4 battery life implications of thermal management , driving conditions and regional climate, J. power sources 338 (2017) 49-64.
13. A. Samba , N . Omar , H. Gualous , Y. Firouz , P.Van Den Bossche, J. Van Mierlo , T.I. Boubekeur, development of an advanced two – dimensional thermal model for large size lithium – ion pouch cells, electrochemistry . Act 117 (2014) 246-257.
14. E. Hosseinzaadeh , A. Barai, J . Marco , p.Jemings, A comparative study on different cooling strategies for lithium- ion battery cells, the European battery hybrid and fuel cell electric vehicle congress (EEVC 2017), (2017), PP . 1-9 .
15. Xiong S, Ji J ,Max . Environmental and economic evaluation of remanufacturing lithium – ion batteries from electric vehicles waste manage 2020 ; 102 : 579 -586.
16. Chung D ,Elgqvist E, Sanathanagopalan S. automotive lithium – ion cell manufacturing chain considerations (No. NREL/TP – 6A20 – 66086). NREL National Renewable Energy Laboratory , Golden , Co (united states); 2016.
17. Voelcker J. Reusing electric – car batteries; great idea , lots of practical challenges green car report 2016.
18. VikstromH ,Davidson S, Hook M .Lithium availability and future production outlooks. Apply energy 2013; 110: 252-266.
19. J.M. Reniers , G. Mulder , S ober – Blobaum , and D.A. Howey , "improving optimal control of grid – connected lithium – ion batteries through more accurate battery and degradation modelling , " journal of power sources, vol. 379, PP. 91-102, 2018.
20. Y. Shi , B. Xu , Y . Tan , D . Kirschan , and B . Zhang , " optimal battery control under cycle aging mechanisms in pay for performance settings", IEEE Transactions on automatic control , Vol. 64 , no. 6, PP . 2324 – 2339, 2019.
21. M. Jafari , A. Gauchia , S. Zhao , K. Zhang , and L.J.I.T.O.T.E Gauchia , "Electric vehicle battery cycle aging evaluation in real – world driving and vehicle – to – grid services , " vol. 4, no.1, PP.122-134, 2017.
22. S. Guo , R . Yang , W . Shen , Y. Liu , and method for lithium – ion batteries at high state of charge operated from low temperature , " energy , vol. 238 , P . 121809, 2022/01/2022.
23. X. Shi , Q .Kang , J . An , and M. Zhou , " Novel L1 Regularized extreme learning machine for soft – sensing of an industrial process, " IEEE transactions on industrial informatics , vol . 18 , no . 2. PP . 1009 – 1017, 20-22.
24. K. Xu ,H.D.Yang , C. Zhu , X . Jin , B. Fan , and L. Hu, " deep extreme learning machines based two – phase spatiotemporal modeling for distributed parameters system , "IEEE transactions on industrial informatics, PP. 1-1,2022.

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25. D. Liu, S. Baladi, W.Yu, and C.L.P. Chen, "A hybrid recursive implementation of broad learning with incremental features", IEEE transactions on neural networks and learning system , vol. 33 , no. 4, PP. 1650- 1662, 2022.
26. G.B. Huang , Q.-Y . Zhu , and C.-K . Siew , "extreme learning machine : theory and applications , Neuro computing, vol. 70 , no . 1-3, PP. 489-501,2006
27. W. Vaz , AKR . Nandi RG. Landers, and Uo. Koylu. Electric vehicle range prediction for constant speed trip using multi objective optimization .J power sources 2015; 275: 435-46, 2015.
28. F. Yang , Y. Xie , Y. Deng , and C .yuan " predictive modeling of battery degradation and greenhouse gas emission from U.S. state – level electric vehicle operation", nature communication, vol. 9 P.2429 , 2018.
29. A.U. Rahman , I. Ahmad , and A.S. Malik, " variable structure- based control of fuel cell – supercapacitor – battery based hybrid electric vehicle ," journal of energy storage, vol. 29, P 101365, 2020 .
30. B. Yang , J. Wang , X. Zhang , J .Wang ,H . Shu, S. Li , T. He , C. Lan , and T. Yu ," application of battery / supercapacitor hybrid energy storage system for electric vehicles using perturbation observer based robust control, " journal of power sources , vol. 448, P. 227444, 2020.
31. Y. Kim , M .Figueroa – Santos , N . Prakash, S. Back , J.B. Siegel , and D.M. Rizzo . " co- optimization of speed trajectory and power management for a fuel – cell / battery electric vehicles., " applied energy , vol. 260 , P.114254, 2020.
32. Y. Xie , Y. Li , Z. Zhao , H . Dong , S. Wang, J . Liu , J. Guan , and X , Duan , " micro simulation of electric vehicle energy consumptions and driving range " , applied energy , vol. 267, P.115081, 2020.