Utilizing Lithium And Lead Battery In Two Wheelar Electric Vehicles

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ABSTRACT
In today's automobile sector, battery-powered electric vehicles are now starting to take the spotlight. It can be difficult to determine which battery type satisfies all the essential requirements, including energy storage efficiency, constructive qualities, affordability, security, and usage life, given the variety of battery types used in today's electric vehicles. The current research explores the autonomy of an electric vehicle using lead as well as lithium-ion (Li-Ion) batteries, both of which have the same capability to store electric energy. This scientific effort is innovative in that it uses simulation technology to examine the autonomy of the vehicle and the performance of two alternative battery types for electric vehicles on the different model in actual time.

Keywords: lithium battery, lead battery, electric vehicle.

1. INTRODUCTION

In electric vehicles, batteries are among the most crucial parts. For the duration of the charging process, batteries serve as both an import of energy and a storage device for electrical energy. The electric machine is powered by the battery, which provides electric current. Rechargeable secondary batteries, such as the lithium-ion battery, are eco-friendly and capable of being recharged multiple times. This particular type of battery is becoming more and more appealing for usage in electric vehicles because it offers improved energy storage stability and a higher energy density than other secondary battery kinds. The study and development of batteries used in electric and hybrid vehicles is becoming progressively more common as a result of the high demand for fossil fuels on global markets along with the rise of environmental issues brought on by an increase in the number of vehicles with combustion engines. These vehicles provide an economic opportunity for the road transport sector by lowering the production of greenhouse gases and mitigating noise and airborne pollutants [1, 2].

The class of secondary and rechargeable batteries is below that of lead acid batteries. Even though the battery has small ratios between its strength and weight, it may nonetheless provide several surge currents. Therefore, lead acid cells have an abnormal strength to weight ratio. An electrolyte battery that uses lead and sulfuric acid for functionality is called a lead acid battery. To enable a regulated chemical reaction, the lead is immersed in the sulfuric acid. It is because of this chemical reaction that the battery produces power.

For the purpose of to replenish the battery, the reaction is then reversed.

These types of batteries use a sponge motive and lead peroxide to transform chemical electricity into electrical energy. The capacity of a battery refers to its capacity to hold a specific quantity of electrical power or charge. It is an illustration of the total energy or electricity produced by the battery's electrochemical processes. It is known by two different names: battery energy capacity, expressed in Wh, or battery charge capacity, expressed in Ah. It's critical to recognize the difference between the genuine battery capacity and the notional average capacity supplied by the manufacturer. When a new battery is utilized under regulated circumstances, its theoretical capacity is determined. The condition and stage of life of the battery, together with the functional and climatic factors, all impact the actual accessible storage capacity.

As per [3], the automotive industry is a major contributor to global warming, contributing to 23% of greenhouse gas emissions from the earth's atmosphere. Subsequently is ranked second in this group, after the industrial sector. The previously "Paris Declaration on Electro Mobility and Climate Change and Call to Action" was ratified in 2015 as a result. Reducing global warming by more than 2 degrees is the most important objective of this proclamation. If electric vehicles account for 35% of all vehicles sold till 2030, then this target can be accomplished. To achieve this goal, the acquisition cost of electric vehicles must be reduced until it approaches the cost of vehicles with engines that are internal combustion. These days, depending on the technology employed, the battery can account for 25–50% of the cost of an electric car, making it the most expensive component [4, 5, 6].

Furthermore, numerous studies demonstrate that the one way discharges efficiency surpasses the full round-trip efficiency, with the charging efficiency being ignored and set to 1 [8]. Since the operational and ambient circumstances affect the one-way efficiency of both the charging and discharging processes, an inaccuracy in the battery capacity calculation is possible in both scenarios. Additionally, no matter the power rate, a battery cannot achieve 100% charging efficiency.

According to [5, 7, 8], by 2025, battery costs are expected to drop to 225 Euros per kWh. This will result in a significant reduction in the cost of purchasing electric vehicles and allow them approach the cost of vehicles with engines that are gasoline-powered. Li Ion battery production costs dropped by more than 50% between 2020 to 2024 as reported by [4]. According to the size of the battery, Figure 1 shows a comparison of the growing market for a number of electric automobiles:

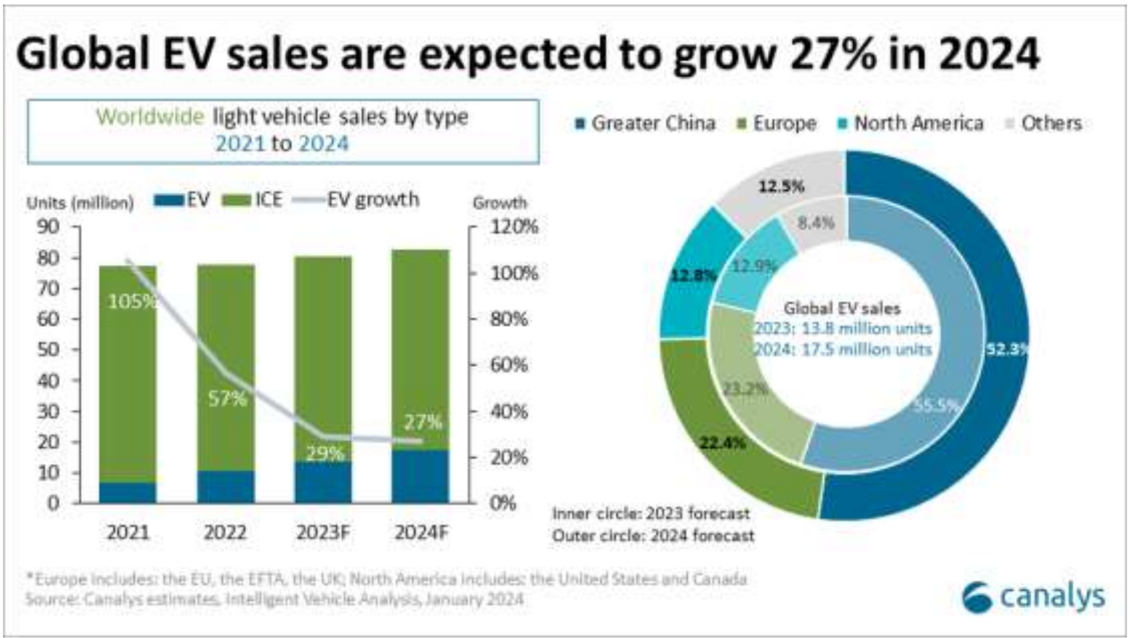

Figure 1. Comparative evaluation of different electric vehicle market growth

Upon examining the aforementioned electric car models, research from [4, 5, 6] indicates that, based on a 25% reduction in battery value from the overall vehicle cost, the approximate cost of one kWh of energy is between 17,000 in India. Due to their high energy density and increased power per mass battery unit, Li-Ion batteries are currently the most widely used technology in electric vehicles, as seen in figure 1. Their popularity has allowed for the creation of certain battery types with lower weight and dimensions at competitive prices. Through research projects completed by [8, 9, 10, 11]. When compared to lead batteries, Li-Ion batteries—which are utilized in the electric vehicle industry—showed enhanced power (800–2000 W/kg) and specific energy (100–250 Wh/kg). According to research [12], this technology offers the best "charge to weight" option, meeting one of the most crucial requirements for a battery utilized in the electric car sector and facilitating the simple replacement of Ni-MH batteries with them.

A further benefit is the absence of memory effect, which causes an extended life cycle by progressively losing maximal energy capacity even in the case of repeated recharges without total exhaustion. The high developed operating temperature of Li-Ion batteries is a drawback that may have an impact on performance in terms of energy, lifespan, and safety during use [13]. To regulate and track the internal cell temperature with this technology, one management battery system is needed. In addition to the negative effects of operating temperature, there are issues with excessive manufacturing costs [14], the ability to recycle spent batteries [15], and the infrastructure for infrastructure recharging [16].

Furthermore, numerous studies demonstrate that the one way discharge efficiency surpasses the full round-trip efficiency, with the charging efficiency being ignored and set to 1 [18]. Since the operational and ambient circumstances affect the one-way efficiency of both charging and discharging, an inaccuracy in the battery capacity calculation is inevitable in both scenarios. Additionally, no matter the power rate, a battery cannot have 100% charging efficiency.

Additionally, propulsion systems with electric engines that run at 180 V DC or 320 V AC can successfully employs these batteries, demonstrating an extended lifespan (up to 80% Depth of Discharge DOD). Additional benefits included the capacity to employ braking-related regenerative energy, the use of materials that are recyclable in their development, outstanding thermal qualities (temperature range of -30 to +70 degrees Celsius), safety during battery charging and discharging, etc. [17, 18]. According to a study between Li-Ion and lead batteries conducted by [19], Li-Ion cells provide a 20% improvement in specific energy. Nevertheless, when the additional mass of the battery is included, the entire battery system must be considered.

One could argue that, in comparison to the Li-Ion battery management system, the Ni-MH battery management system is less complex and heavier. From the perspective of autonomy, Ni-MH batteries seem to be more efficient when compared to Li-Ion batteries, which power the electric Nissan Leaf EV, which has an autonomy of 160 km, while the GM EV1, which has an autonomy of 280 km..

An increase in weight and outdated technology are the drawbacks of Ni-MH batteries. The development of alternative battery types to the traditional Ni-MH battery has brought about advancements in the field of electric car battery technology in recent years. Certain concept cars and buses used in urban public transit were powered by Na-NiCl2 batteries, commonly referred to as ZEBRA batteries (Zeolite Battery Research Africa) [20]. When compared to other current technologies, these battery types are particularly noteworthy for their cheaper cost and higher energy density (90–120 WH/kg).

Additional benefits include resistance to overcharging and over discharging, longer cycle life, and constructive toughness, which enables them use in abrasive conditions without compromising performance in cold climates. Higher internal operating temperatures (270–350 °C) are indicative of the significant reduction in Na-NiCl2 battery size. This implies that continuous use of the electric car is required to prevent the battery electrolyte from freezing. If the vehicle is not in use, an external heating system (which draws 90 Wh from the battery) can be utilized to keep the system working at the proper temperature.

However, the battery must be allowed to defrost and restored to its original operating settings over a period of 12 to 15 hours [21]. Li-Ion batteries are currently in an advanced development stage, with their theoretical values approaching those found through research [22, 23]. However, these batteries are still unable to meet demands, particularly those related to autonomy, necessitating the development of new technologies that can provide high energy storage capacity along with an extended lifespan [24]. Researchers have also shown a great deal of interest in another type of technology, the Li-S battery, primarily because of its higher theoretical specific energy (2500 Wh/kg) and theoretical specific capacity (1672 mAh/kg). As can be a result, it is regarded as a strong competitor for current technology and a viable option.

Nowadays, there is limited utility for this type of battery because of its lower lifespan and energy retention capability [25, 26].

2. MATERIALS AND METHODS

To highlight autonomous variations and assess the capabilities lithium and lead acid battery types, a virtual automobile based around the constructive specifications of the two wheeler electric vehicles are uses. Different brand of two wheeler electric vehicles, lithium ion battery, lead acid battery.

3. RESULTS AND DISCUSSION

Table 1; Battery technology comparison

S.N.		VRLA lead acid	Lithium-ion (LiNCM)
1.	Energy Density (Wh/L)	100	250
2.	Specific Energy (Wh/kg)	40	150
3.	Regular Maintenance	NO	No
4.	Initial Cost ($/kWh)	120	600
5.	Cycle Life	1.000@ 50%Dod	1.900@80% Dod
6.	Typical state of charge window	50%	80%
7.	Temperature sensitivity	Degrades signtifically Above 25 C	Degrades signtifically Above 45 C
8.	Efficiency	100% @20- hour- rate 80% @ 4- hour rate 60% @ 1 hour- rate	100% @20- hour- rate 99% @ 4- hour rate 92% @ 1 hour- rate
9.	Voltage increments	2V	3.7V

Motorbikes and scooters require two-wheeler batteries in order to start the engine and run numerous electrical systems. These battery packs are a crucial part of these vehicles. Finding the appropriate battery type is a must to guarantee the reliability and effectiveness of your two-wheeler. This post will examine the many kinds of two-wheeler batteries that are on the market and their features.

Two-wheelers have long used conventional lead-acid batteries as their default battery type. Their affordability and dependability make them a popular substitute. In order to store and release electrical energy, these batteries employ a solution of sulfuric acid and water as the electrolyte and lead plates. Better than traditional lead-acid batteries, maintenance-free lead-acid batteries require less upkeep. They don't require routine maintenance, such as replenishing the electrolyte, because they are sealed. They are therefore easier to use and more appropriate for passengers who want a hassle-free ride.

The development of lithium-ion batteries in two-wheeler battery technology is a relatively recent development. When it comes to weight, performance, and longevity, they are significantly superior to lead-acid batteries. Lithium is the main component used in lithium-ion batteries for preserving energy.

Table 2: Capacity, range and prize of different type of electrical vehicles are as follows:

S.N.	MODEL NAME	BATTERY	CAPACITY	RANGE	PRIZE
1.	Ultraviolette F77	Lithium battery	10.3 Kwh	323 km/charge	2.99-3.99 LAKH
2.	S1 PRO	Li-ion (NMC)	4	195	129999
3.	S1 AIR	Li-ion (NMC)	3	151	14999
4.	S1 X+	Li-ion (NMC)	3	151	84999
5.	S1 X(4KW)	Li-ion (NMC)	4	190	195000
6.	S1 X (3KW)	Li-ion (NMC)	3	143	849999
7.	PHOTON LP	Li-ion (NMC)	1.876	95	699999
8.	OPTIMA CX2.0	Li-ion (NMC)	2	90	118910
9.	OPTIMA CX 5.0	Li-ion (NMC)	3	90	98300
10.	RIZTA	Li-ion (NMC)	2.9	135	124360
11.	APEX	Li-ion (NMC)	3.7	160	109999
12.	450X(3.7KW)	Li-ion (NMC)	3.7	157	194999
13.	450X(2.9KW)	Li-ion (NMC)	2.9	150	138746
14.	450S	Li-ion (NMC)	2.9	111	128146
15.	PRAISE PRO	Li-ion (NMC)	2.9	115	102989
16.	I- PRAISE PRO	Li-ion (NMC)	2.08	81	84443
17.	OKHI-90	Li-ion (NMC)	3.6	137	122955
18.	DUAL 100	Li-ion (NMC)	3.12	161	186000
19.	R30	Li-ion (NMC)	1.25	129	119085
20.	LITE	Li-ion (NMC)	1.25	60	61998
21.	RIDGE+	Li-ion (NMC)	1.7	60	69093
22.	RIDGE 100	Li-ion (NMC)	3.12	81	84606
23.	INSPIRER	VRLA	1.35	149	115311
24.	JAUNTY	VRLA	1.68	60	53951
25.	FIESTY	VRLA	1.68	80	62964
26.	JAUNTY PLUS	Li-ion (NMC)	2.4	108	70025
27.	JAUNTY PRO	VRLA	2	95	107734
28.	JAUNTY i- PRO	Li-ion (NMC)	2.52	120	77228
29.	BRISK	VRLA	1.92	80	106344
30.	RUBE	VRLA	1.92	70	65625
31.	NEU	VRLA	1.92	70	47000
32.	VIRAJ	VRLA	1.92	70	50000
33.	AMBER	VRLA	1.92	70	53000
34.	UTILITY	VRLA	1.92	70	54000
35.	DELTA	VRLA	1.92	70	53000
36.	NOVA 93	VRLA	2.3	70	55000
37.	CYCLONE	VRLA	1.92	70	57000
38.	SPARROW	VRLA	1.92	70	57000
39.	NEBULA	VRLA	1.92	70	27000
40.	SHOPHIE	VRLA	1.92	70	58000
41.	ARTOPASS	VRLA	2	70	60500
42.	AQABA	VRLA	2	70	62000
43.	MOUNTAIN	VRLA	2	70	67000
44.	PARINDA	VRLA	2	70	62500
45.	UNIQUE MANO	VRLA	2	70	64000
46.	SPARROW PLUS	VRLA	2	70	62000
47.	SHAYARA	VRLA	2	70	75000

VRLA= valve regulated lead acid battery.

4. Choosing the Right Battery

It is up to you to decide what kind of two-wheeler battery best suits your needs and interests. The following considerations should be made when making a decision.

Budget: Ascertain the maximum amount you are prepared to spend on a battery. Although they cost more, lithium-ion batteries have superior lifetime and performance.

Type of Vehicle: Your battery selection may be influenced by the kind of two-wheeler you own. While traditional lead-acid batteries are sufficient for daily commuters, AGM or lithium-ion batteries may be beneficial for outstanding performance motorcycles.

Maintenance Preferences: Free of maintenance batteries, such as MF lead-acid or AGM batteries, are great options if you'd rather not to deal with any hassles.
Climate: Take into account the local climate. Certain battery types, such as lithium-ion, could be more susceptible to high temperatures.

CONCLUSION

To start and run the electrical systems on your motorbike or scooter, you will need two-wheeler batteries. Knowing the many battery kinds on the market will enable you to choose wisely depending on your unique needs. Selecting the appropriate battery type guarantees a trouble-free and seamless journey, regardless of whether you choose the performance of lithium-ion batteries, the dependability of AGM batteries, or the cost of lead-acid batteries. Above data show that lithium ions battery is so environmentally with high capacity in comparison to lead acid battery.
High capacity lithium battery have high range with high prize while lead acid battery have low potential but used in two wheeler vehicles mostly.

References

1. J. Brady, M. O'Mahony, 2011, Travel to work in Dublin. The potential impacts of electric vehicles (Elsevier: Transportation Research Part D: Transport and environment, vol 16, issue 2) p. 188.
2. T.R. Hawkins, B. Singh, 2012, Comparative Environmental Life Cycle Assessment of Conventional and Electric Vehicles (Journal of Industrial Ecology, vol 17, issue 1) p 53.
3. International Energy Agency, 2015, Energy and climate change (IEA Publishing).
4. B. Nykvist, M. Nilsson, 2015, Rapidly falling costs of battery packs for electric vehicles (Nature Climate Change, vol 5) p 329.
5. B. Propfe, M. Redelbach, D.J. Santini, H. Friedric, 2012, Cost analysis of Plug-in Hybrid Electric Vehicles including Maintenance & Repair Costs and Resale Values (Conference EVS26).
6. Z. Chen, N. Guo, X. Li, J. Shen, R. Xiao, S. Li, 2017, Battery Pack Grouping and Capacity Improvement for Electric Vehicles Based on a Genetic Algorithm (Energies, vol 10, issue 4).
7. G.J. Offer, M. Contestabile, D.A. Howey, R. Clague, N.P. Brandon, 2011, Techno-economic and behavioral analysis of battery electric, hydrogen fuel cell and hybrid vehicles in a future sustainable road transport system in the UK (Energy Policy, vol 39, issue 4) p. 1939.
8. A. Sakti, J.J. Michalek, 2015, A techno-economic analysis and optimization of Li-ion batteries for light-duty passenger vehicle electrification (Journal of Power Sources, vol 273) p. 966.
9. C. Alaoui, 2013, Solid-State Thermal Management for Lithium-Ion EV Batteries (IEEE Transactions on Vehicular Technology, Vol 62, issue 1) p. 98.
10. L. Lu, X. Han, J. Li, J. Hua, M. Ouyang, 2012, A review on the key issues for lithium-ion battery management in electric vehicles (Journal of Power Sources, vol 226) p. 272.
11. S. J. Gerssen-Gondelach, A. P.C. Faaij, 2012, Performance of batteries for electric vehicles on short and longer term (Journal of Power Sources, vol 212) p. 111.
12. T. G. Goonan, 2012, Lithium use in batteries (U.S. Geological Survey, Circular 1371)
13. D. Doughty, E.P. Roth, 2012, A General Discussion of Li Ion Battery Safety (The Electrochemical Society Interface, vol 21, no 2) p. 37
14. A, Lajunen, J. Suomela, 2012, Evaluation of Energy Storage System Requirements for Hybrid Mining Loaders (IEEE Transactions on Vehicular Technology vol 61, issue 8) p. 3387.
15. L. Gaines, 2011, The future of automotive lithium-ion battery recycling: Charting a sustainable course (Sustainable Materials and Technologies, vol 1–2) p. 2.
16. O. Veneri, L. Ferraro, C. Capasso, D. Iannuzzi, 2012, Charging infrastructures for EV: Overview of technologies and issues (IEEE ESARS) p.1.
17. D. Linden, T.B. Reddy, 2002, Handbook of batteries, third edition (McGraw Hill).
18. D. Linden, T.B. Reddy, 2010, Linden's Handbook of batteries, fourth edition (McGraw Hill).
19. K. Young, C. Wang, L.Y. Wang, K. Strunz, 2013, Electric Vehicle Battery Technologies (Chapter: Electric Vehicle Integration into Modern Power Networks, Springer) p. 15.
20. T.M. O'Sullivan, C.M. Bingham, R.E. Clark, 2006, Zebra battery technologies for all electric smart car (SPEEDAM 2006) p. 6.
21. Meridian, 2005, The Sodium Nickel Chloride "Zebra" Battery (Meridian International Research).
22. H. Wang, L.F. Cui, Y. Yang, H.S. Casalongue, J.T. Robinson, Y. Liang, Y. Cui, H. Dai, 2010, - Graphene Hybrid as a High-Capacity Anode Material for Lithium Ion Batteries (Journal of the American Chemical Society, vol 132, issue 40) p. 13978.

23. A.D.W. Todd, P.P. Ferguson, M.D. Fleischauer, J.R. Dahn, 2010, Tin-based materials as negative electrodes for Li-ion batteries: Combinatorial approaches and mechanical methods (International Journal of Energy Research, vol 34) p. 535.
24. A.F. Burke, 2007, Batteries and Ultracapacitors for Electric, Hybrid, and Fuel Cell Vehicles (Proceedings of the IEEE vol 95, issue 4) p. 806.
25. D. Aurbach, E. Pollak, R. Elazari, G. Salitra, C.S. Kelley, J. Affinito, 2009, On the Surface Chemical Aspects of Very High Energy Density, Rechargeable Li–Sulfur Batteries (Journal of the Electrochemical Society, vol 156, issue 8) p. A694.
26. L. Chen, L.L. Shaw, 2014, Recent advances in lithium-sulfur batteries (Journal of Power Sources, Vol 267) p. 770.