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Critique on two-wheeler electric vehicle batteries

Jigar Patel[1], Prof. Bhushan Save[2], Amitkumar Vishwakarma[3], Rohan Gawai[4]

[1, 3, 4] B.E students, Dept. of Electrical, VIVA Institute of Technology, Maharashtra, India
[2]Assistant Prof & HOD, Dept. of Electrical, VIVA Institute of Technology, Maharashtra, India

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Abstract - *In addition to an overview of various battery types and charging procedures, this paper introduces and evaluates other significant parameters. such as Lithium-Ion Batteries, Nickel Metal Hydride Batteries, Lead Acid Batteries, and Nickel Cadmium Batteries used in Electric Vehicles, and it illustrates the advantages that Solid-State Batteries offer over other battery chemistries, particularly Lithium-Ion Batteries, which have a liquid electrolyte.*

***Key Words*: Batteries, Lithium-ion, Lead Acid, Comparison, Electric Vehicles, Nickel Battery.**

1. INTRODUCTION

When the world's pollution levels dramatically increased in the late 20th century and it became clear that climate change was having an impact on the world, the demand for clean energy increased. The immediate need led to the search for a superior substitute. New vehicle CO2 emissions in Europe regulation (which establishes a minimum requirement of 95) grams of CO2 per kilometer for passenger vehicles by 2021) is the extension to 2025 and is currently being worked on. Because EVs have been shown to reduce carbon emissions, electric propulsion in vehicles has become essential. Although many manufacturers began making EVs, Tesla's roadster first gained popularity. The battery is the most important component of an EV because it greatly influences the vehicle's cost, safety, range, and overall performance. Those powered by a battery and propelled by an electric motor are referred to as electric vehicles. You can categorize them into pure electric vehicles, fuel cell vehicles, and hybrid electric vehicles electric ones. When subjected to two pressures from the environment and energy supply and environmental protection, every nation on earth is developing electric vehicles vigorously engineering. China Electric Vehicle Association (CEVA), a national non-governmental organization composed voluntarily of members of the electric vehicle industry, government agencies, and employees, was established in 2004. They are developing electric vehicles vigorously engineering. A citizen of China an independent, non-governmental organization that industry for electric vehicles, voluntarily some essential hybrid and pure electric vehicle technologies have made advancements. Made and pristine small-batch production is now possible to drive an electric car. Japan has also placed a lot of emphasis on the study and creation of electric vehicles.

The battery capacity an EV can use directly affects how the industry develops. Lead acid batteries are preferred for electric vehicles due to their low cost-to-energy ratio. But compared to other batteries, these batteries have a short cycle life. Additionally, using lead-acid batteries in an electric vehicle reduces its range because they are heavy and bulky. The Nickel Cadmium battery was able to overcome these drawbacks. They were much smaller, lighter, and more cost- and space-effective. Additionally, the power-to-weight ratio was favorable. The development of EVs was accelerated by the introduction of nickel metal hydride batteries. Intercalation, a more controlled process than redox reaction, is used by the negative electrode of NiMH supplementary electrochemical cells. NiMH batteries have a higher energy density despite having a higher self-discharge rate. Suitable for electric hybrid cars. Both of the electrodes in lithium-ion batteries are undergoing an intercalation process. Additionally, they are a strong alternative for use in EVs due to their higher energy density, longer lifespan, and lack of memory effect. As a result, battery performance was greatly enhanced. The main benefits of Li-ion batteries were their high energy density, lengthy lifespan, and low self-discharge rate. However, a battery failure could result in significant harm because of the extremely low operating temperature. As the name suggests, lithium-based Solid-State Batteries (SSBs) use a solid electrolyte instead of a liquid electrolyte for ion conduction to overcome these drawbacks of Li-ion batteries. It has a wide operating range and no thermal runaway.

2. TYPES OF BATTERY:-

2.1 Lead acid batteries.

Gaston Plante created the lead acid battery in 1859. Lead oxide serves as the positive plate, heavy metal lead serves as the negative electrode, and sulfuric acid serves as the electrolyte. The charging and discharging process is accomplished by the electrolyte and electrode reaction.

The advantages of lead-acid batteries include their mass production ability and relatively mature technology. The cost of production is low and the cost of the raw materials is low. The fact that the quality and volume are typically high is one of its drawbacks. This makes electric vehicles heavier and uses more energy. Lead-acid batteries also pollute the environment and have a short lifespan. However, lead-acid batteries continue to be widely used by many vehicles

Manufacturers today have a sizable market share in China. Electric vehicles powered by Batteries still couldn't compete with petrol engine vehicles due to short drive range, long recharging time of batteries, and lack of sufficient charging stations. Besides that, Lead Acid and Nickel Cadmium (NiCad) batteries were the only options suitable for EVs during the 1900s.

The chemical reaction equation of lead acid battery.
$Pb(s) + SO4^{2-} \leftrightarrow PbSO4 + 2e^-$ (Anode)
$PbO2 + 4H^+ + SO4^{2-} + 2e^- \leftrightarrow PbSO4 + 2H2O$ (Cathode)

2.2 Nickel Metal Hydride.

Although NiMH batteries are mainly used as an auxiliary power source in hybrid cars, they are not widely used in China's electric vehicle market. Alkaline batteries include Nimh batteries. It has been hailed as "green energy" because of its excellent safety record and lack of pollution. NiMH batteries have high specific and energy capacities. Nickel metal hydride batteries have ten times more power and a volumetric energy density that is three times higher than a lead-acid battery. The nickel metal hydride battery technology used in electric vehicle batteries has some drawbacks. The main factors limiting the development of the Ni-MH battery are the high cost of nickel and the fact that it is a kind of limited resource. Ni-MH batteries' capacity also declines at low temperatures. Nickel metal hydride batteries can store more energy than lead-acid batteries, but over-discharge will permanently harm them. The primary goal of studying NiMH batteries should be to address application-related issues. The function and capacity of the NiMH battery's rapid charge and discharge could be enhanced by increasing the catalyst's activity on the metal hydride electrode surface. Nimh batteries' issues can be resolved by using the right additives, and conductive adhesives, or by improving the battery's design, among other methods. As a result, NiMH batteries are still the go-to source of energy for electric vehicles.

Positive electrode reaction is written as:
$Ni(OH)2 + OH^- \leftrightarrow \beta\text{-}NiOOH + H2O + e^-$
Negative electrode reaction is written as:
$M + H2O + e^- \leftrightarrow MH + OH^-$

2.4 Nickel Cadmium Battery.

Nickel-cadmium was invented in 1989. It is manufactured by depositing active material inside the porous nickel of plated electrode. Nickel-cadmium can absorb gases generated during discharge that offered several advantages over lead acid the nickel-cadmium battery is known for its good battery cycle life and high internal resistance. Nickel cadmium (NiCad) became the most suitable battery for portable electronic equipment to this day. The usage of NiCad batteries in electric vehicles is developed in the 1990s. Society has been using nickel-cadmium batteries extensively, and they are meant to replace lead-acid batteries, particularly in European-made cars. In the 1980s and 1990s, nickel-cadmium batteries were created for use in electric vehicles. Because of its long battery cycle life, nickel-cadmium batteries are well-known.

Nickel-cadmium has a rated capacity of. it has a life cycle of 1000 charging and discharging. Unfortunately, the market for Nickel Cadmium batteries did not expand due to their relatively low range and high prices.

2.3 Lithium-ion batteries.

Lithium ions serve as the charge carrier in Li-ion batteries, which can be thought of generally as energy storage systems that rely on insertion processes from both electrodes. Given this broad definition, the Li-ion battery family is made up of many cell chemistries. The negative electrode used in the majority of Li-ion batteries is typically constructed of carbon (such as graphite) or lithium titanate ($Li4Ti5O12$), while several unique materials, such as Li metal and Li(Si) alloys, are currently being researched and developed. To facilitate ion transfer, the electrolyte is often made up of a combination of lithium salts (such as $LiPF6$) and an organic solvent (such as diethyl carbonate). The transport aspects of the battery, when used as an energy source (i.e., a galvanic device), where the electrons travel from the negative electron. This arrangement uses a separating membrane to allow lithium ions to pass between the electrodes while preventing an internal short circuit. To keep the electrolyte electro-neutral, the positive electrode is through the electrolyte. The electron current and Li^+ ion flow are reversed when the system is run in charge mode, which is equivalent to operating it as an electrolytic device.

Table-1: Comparison Table of Different Types of Batteries

Parameters	Lithium Ion Battery	Lead Acid Battery	Nickel Cadmium Battery	Nickel Metal Hydride Battery
Charging temp (°C)	45 to 0	50 to -20	45 to 0	45 to 0
Discharging temp (°C)	60 to -20	50 to -20	65 to -20	65 to -20
Life (cycle)	3000-600	300-200	1000	600-300
Voltage (volts)	3.7-3.2	2	1.2	1.2
Energy Density (Wh/L)	250-400	90-80	80-50	120-60
Specific Power (W/Kg)	260	285	200	200
Specific Energy (Wh/Kg)	200-150	40-35	70-50	70-50
Energy Efficiency (%)	90	85	140-100	85
Nominal Voltage (V)	350	6	1.2/Cell	343
Rated Capacity (Ah)	158	215	2.5 to 20	77
Rated Capacity (Kwh)	55	1.29	0.024	26.4
Cost	More than lead	Cheap	Expensive	Expensive
Depth of Discharge (Approx)	20% for 300 cycles	20% for 500 cycles	20% for 2500 cycles	20% for 2500 cycles
Energy Density (W.h.Kg-1)	270-100	50-30	80-50	120-60
Power Density (W.Kg-1)	680-250	180	150	1000-250
Self-Discharge Rate (%.Month-1)	10 to 3	5	20	30
Charging Efficiency (%)	90-80	95-50	90-70	65

3. CONCLUSION

Studies and comparisons were conducted on the primary battery types used in EV applications. More reliable electrolyte research is anticipated to enable the replacement of traditional batteries with SSBs. Lithium-Ion batteries are popular due to their safety and high Power and energy densities. By examining the restrictions on space for storing the battery, the potential range for various batteries was calculated in the modified model. SSBs guarantee a greater driving range than other battery chemistries that were covered in the paper. Currently, Solid-State Batteries are expensive, but they're a reduction is anticipated due to mass production. Future EVs will be able to go more than 800 kilometers thanks to modifications to SSBs. superior and modern battery technologies, like zinc, are also feasible for EV applications.

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BIOGRAPHIES

Mr. Jigar Kirit Patel
Student of BE Electrical Eng.,
VIVA Institute of Technology,
Virar, Palghar, Maharashtra, India

Prof. Bhushan Save
Prof & HOD of Electrical Eng.,
VIVA Institute of Technology,
Virar, Palghar, Maharashtra, India

Mr. Amitkumar Subhashchandra Vishwakarma
Student of BE Electrical Eng.,
VIVA Institute of Technology,
Virar, Palghar, Maharashtra, India

Mr. Rohan Anand Gawai
Student of BE Electrical Eng.,
VIVA Institute of Technology,
Virar, Palghar, Maharashtra, India