A STUDY ON RELIABILITY ENHANCEMENT OF ELECTRIC CAR BATTERY

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Abstract: As vehicle emissions are restricted and there is currently a high demand for fossil fuels, global car manufacturers are exploring alternative ways of introducing a new car model which would be a big capture of the market. Electric vehicles (EV) have been developed further to benefit from current global problems in terms of prices of fossil fuels and their environmental impact. Given that car battery play a key part in the overall performance of EV, many scientists have worked on the component improvement. This article aimed to reliably identify failure type, test method, and life prediction method of the EV battery. In concentrating on this, reliability.

1. Introduction

Today, because of the latest environmental issues, electric cars (EV) are booming. Batteries are the most distinguished of the different storage systems of electricity. Although there are other options, including the storing of hydrogen, a Dubus voltage stabilization battery is often needed and other auxiliary or critical fuel cell system devices are turned on. The main challenges with EVs are high capital costs, short life, and poor low-temperature efficiency. The development of efficient storage systems for electromobility is, therefore, an important aspect. Regarding the electromobility of the batteries under scrutiny, lithium processing is illustrated. The most significant and lowest rate of discharge is its basic strength and energy density. Moreover, the cell voltage is higher, and this is the key downside of the poor surplus resistance. For this type of battery, a specially built charging device is required. The material base of this battery is lithium, as lithium ions are transferred by a separator, and vice versa, from cathode to anode (loading). Lithium-ion however (Li-ion) But Within the various groups, batteries can be categorized by certain elements, mostly those which relate to the chemical composition of the cathode.

EV is a description of diversified innovations that include a range of engineering fields such as mechanical engineering, electrical engineering, electronics engineering, and automotive engineering. The total performance of the EVs can be increased by integrating different technologies and reducing fuel consumption. The EVs are composed of three main components, namely electrical motor, power conversion, and energy storage. To drive and use electric power stored in batteries, electric drives employ electric motors. In comparison to traditional cars relying on petrol, during service EVs never consume the emissions that make EVs greener. However, electricity generated from renewable sources such as hydro-electric, wind, solar, or biogas plants is important for charging the EV. In addition to being a road car, EVs are a modern electrical equipment system for our business and therefore have safe and efficient road transport.

EV model has a battery form of its own as a power source for the car to drive, like advanced PB-acid, NiMH, and Li-ion, and it's considered to be a crucial element. Thanks to their use, the future growth of the EV market has led to battery efficiency is improved. The greatest downside of the EV system, which stops car makers from manufacturing EV widely, is the maintenance of system efficiency and durability over a certain time without loss. The limitations of battery-powered EVs have been seen by limited drive range, long charging time, and a reduced passenger and cargo volume. The function of the ideal EV battery must be strong enough to provide steady acceleration and upward control over a long distance with one charge. The high-quality battery, free servicing, and recyclable making it the ultimate customer vehicle. The efficiency of EV batteries is also critical as the automaker determines the EV should be broadly marketed to consumers. The most growing connection with battery technologies is EV technological barrier.

The first step to understanding EV battery reliability is to identify the forms of failures which have occurred. Upon detection and analysis of defect types, the correct methods of monitoring are used to ensure that the output of the batteries is up to standards and to identify any structural faults. It also relates to ensuring that the battery protection meets legally relevant environmental regulations. The model of lifetime estimation is also critical to increase the battery's efficiency.

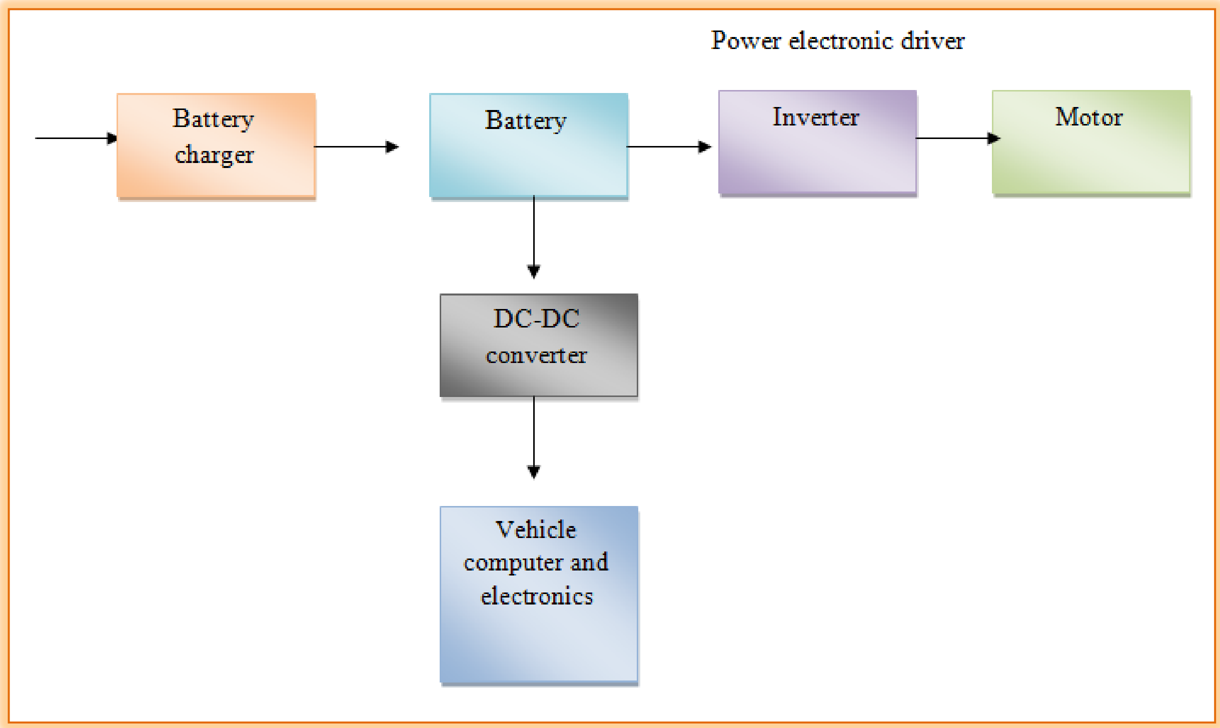

Fig. 1 Key component of an electric vehicle

1.2 BATTERY TESTING METHOD

The goal is to build EVs which are compatible with conventional IC motor vehicles

Execution and size. The standard battery test flow includes the following areas: core battery performance testing, special performance testing, health, abuse testing, and life cycle testing, based on the manual USBC EV battery test procedures. The battery-power test consists of electricity-based tests that are compulsory. Available specific performance monitoring relies on the manufacturer's specifications.

The monitoring of protection and misuse shall ensure that the devices are safe for the consumer and adhere to the legislation of government. This also recognizes some design flaws that could endanger public health.

Common procedures for life cycle evaluation are used to decide how USABC's criteria are fulfilled by the projected operational life of EV batteries. Accelerated aging and normal conditions of use are employed to define electrical output loss as a feature of life and to recognize acceptable mechanisms of failure.

Certain researchers have also proposed approaches for battery monitoring for a particular type of EV battery. Automatic battery control device architecture that has been developed for battery behavioral testing in VRLA with three main battery parameters: noise, current, and temperature. This testing methodology covers battery supplier quality analysis, product management, and performance assessment, battery usage validation, and computer behavior study for researchers designing compliance prediction algorithms. This testing method includes.

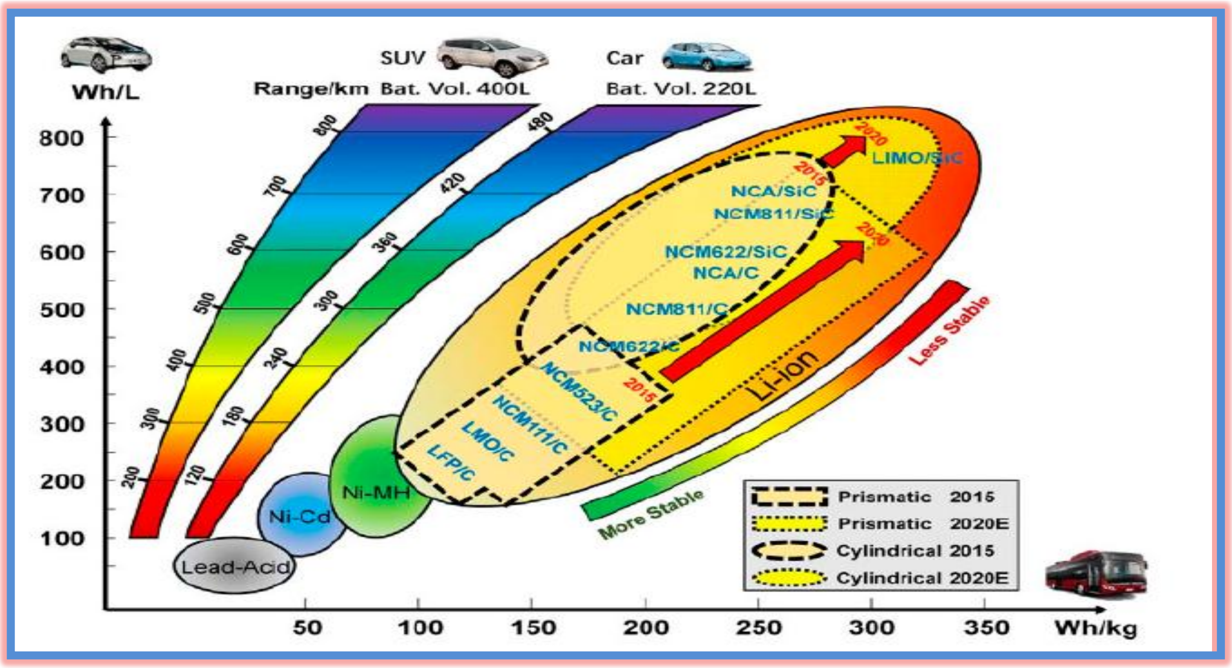

Figure 2. Li-Ion Battery roadmap.

Not only are batteries needed to increase the basic energy needs to solve this inconvenience, but sophisticated control and optimization techniques are also necessary. The use of a robust battery model in this sense is a vital factor in enhancing the system's techno-economic efficacy. The Battery Management System (BMS) controls the energy stored in the batteries and indirectly the protection of vehicle passengers for the correct function of or operation of the required battery model is important. Battery architecture is one of the most common uses. Their analysis, statistical or computational models represent functional results by complex second or greater differential equations. As many parameters are not needed, they are quick enough. Such models do not, therefore, have physical interaction, nor are they appropriate. Abstract simulations use different methods for analyzing battery performances, such as artificial intelligence. At the training level, accuracy primarily depends upon data volume. This is virtually difficult to understand since only preliminary findings are used.

Table :1 Comparison of levels for charging an EV

Prediction capability	Thevenin based/PNGV models (ECM)	Impedance based models	Runtime-combined based models
DC	No	No	Yes
AC	Limited	Yes	No
Transient	Yes	Limited	Limited
Battery run time	No	No	Yes

1.3 BATTERY FAILURE TYPES

The leading cause is grid corrosion in which the battery's life cycle is reduced by the positive grid corrosion. The conductivity of the grid slowly reduces as the battery spins and ages, which corrode the material from the plate and build up in the cell jar. This substance aggregation establishes a leading pathway and reduces the cell's ability. Applying low porosity thicker grids created by bottom-for-coating will reduce the levels of the corrosion grid. The growth in the grid is attributed to cracking the battery container at the most vulnerable point in the terminal posts due to premature battery loss.

Another typical mistake is to unload the negative plate for a while. The negative plate receives the oxygen discharge into a positive plate while load, in which the negative plate is not completely charged. A new battery architecture that recombines oxygen and hydrogen eliminates oxygen diffusion on the negative plate was introduced. In turn, the negative plate is held an incomplete order.

Dry-out happens due to significant battery pressure or overheating, resulting in water from the cell being drained and the separator loses conductivity. This state shortens the battery 's life. With the addition of a catalyst that recombines oxygen with hydrogen, water loss can be recovered and dry out prevented.

Charging schemes

An adapter for charging a battery is the basic part of BEV. Charging is not only a battery charge but a state-of-the-art device to regulate current and voltage. The adapter may be used in a docking station as a separate device. For any battery, it helps to evaluate health, longevity, and efficiency through the charge and discharge cycle. With EVs, different forms of charging include constant electric current, constant voltage, constant voltage mix, and continuous current. With EVs, regenerative braking involves the spontaneous charging of batteries.

Slow charging

Level 1 can handle domestic appliances (120 V-AC). Both vehicles are fitted with on-board loaders with a total power of 2 kW. It is the cheapest way to charge batteries, and will normally charge batteries of the car overnight, and the effect would be four miles an hour battery charging

Semi-fast charging

Load capacity will be 5 times more than level 1 at the level 2 charging stations. It offers a charging 3,4 kWon-board adapter or 35 km for up to 16 kilometers of travel for 1 hour, with a charge of 6,7 kWhonboard. Such chargers are especially used for PEV batteries that can be fully charged in 7 hours.

Fast charging

Tier 3 is used to charge fast DC (DCFC) for 350 km in half an hour. The loader must be offboarding at this point because its charging capacity is considerably higher than other stages, and reaches 100 kW. As a general rule, DCFC charges 85e105 miles in 25e30 minutes. The DCFC converter provides high-power DC directly through the charging inlet of the evs to the EV traction system.

Table : 2 Comparison of levels for charging an EV

Quantity	Level 1	Level 2	Level 3
Voltage (V)	120	208/240	200-450
Current (A)	15	40	125
Useful power (kW)	1.4	7.2	50
Maximum output (kW)	1.9	19.2	150
Charging time (h)	12.00	3.00	0.33
connector	J1772	J1772	J1772 combo

1.4 Types of electric vehicles

The new transport technology, i.e. EV, is often defined by the electric propulsion system as an automotive vehicle. As a result, hybrid electric vehicles may be used (HEVs), electronic battery vehicles (BEVs) and PHEVs. The use of EV battery is a big improvement in contrast to traditional vehicles. EVs are silent in service, help to eliminate gas pollutant from conventional vehicles, and the main aspect is the three-fold lower running cost of EV. Unfortunately, some drawbacks are often caused by batteries such as large weight , high battery costs and volumes that enforce substantial restricting of battery coverage and increasing output in compliance with the weather conditions Electric vehicle battery (BEV)

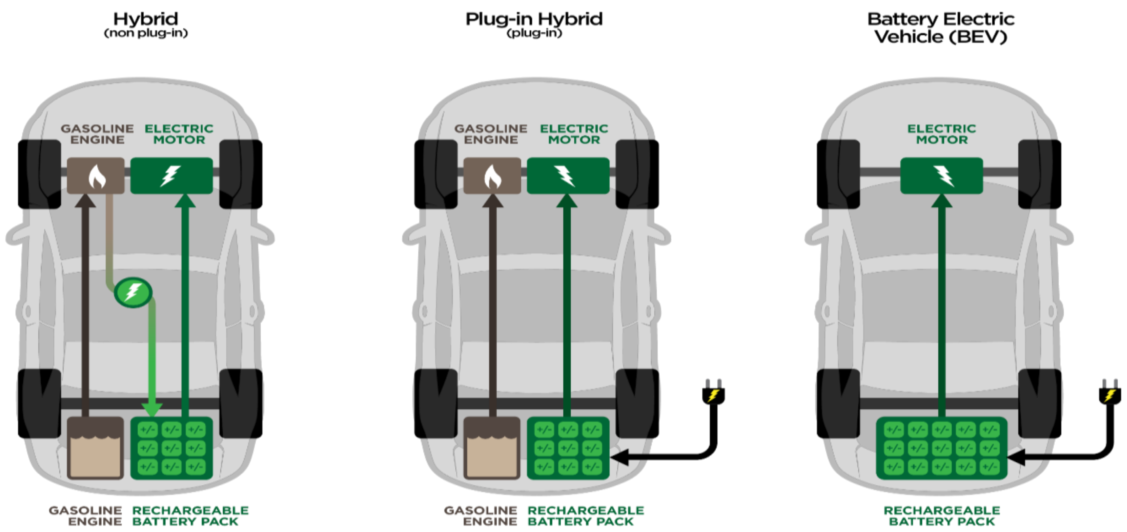

Figure: 3 Types of electric vehicles

Factors affecting the EV

BEV operates with an electric motor and a generator, running only with high-capacity power circulated in a cell. BEV from the grid can also be powered. Batteries are one of the leading factors according to the automotive industry, especially in the field of electric cars. Thus, prices, atmospheric conditions, energy efficiency and power capacity are the key target factors for the batteries, which make them distinct. Accordingly, batteries are substantially reduced greenhouse gas emissions used to supply high energy efficiency electricity from various renewable sources including wind , solar , geothermal and other alternative energy sources for varied power grid applications.

Hybrid electric vehicle (HEV)

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Plug-in hybrid electric vehicles (PHEV)

PHEVs are electrically or gasoline-capable of driving. These are battery powered systems that can be attached to the power grid. The car usually makes a medium battery capacity. It leads to a range of several hundred kilometres, with outstanding pace and top speeds relative to other diesel engines. Various forms of PHEVs of different sizes exist.

1.5 Battery pack design of EV

A battery pack is a series-connected and parallel mix of cells to the desired working voltage and current values. Such kits include a range of electrochemical, hydraulic, test and thermodynamic features. In EV implementations, several individual cells have been stacked in a specific order to connect the power flow battery. Therefore, because of large numbers of calls, different forms of chemical dependent on lithium, multiple safety loops, battery packs for EV applications are very costly. The design of the pack consists of multiple phases, such as (1) choosing battery cell technologies and battery size specifications; (2) design of the device (electric, controller and structural); and (3) battery pack protection and monitoring. Battery pack construction.

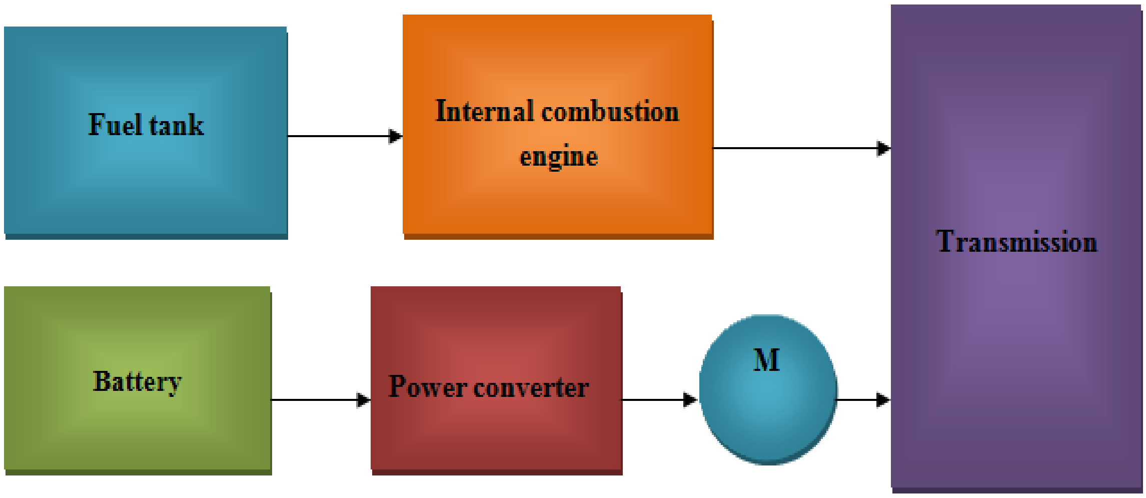

Fig: 4 Parallel hybrid electric vehicle

External considerations Other characteristics such as the travel range and charging time and cost of an electric car make them less practical in today's world. The introduction of EVs is more expensive than modern hybrid cars, compared with many new passenger vehicles.

Citizens were unable to pay a high cost as demanded by electric cars EVs were to buy prices of electric cars that could compete with internal combustion engine vehicles (ICEV) in Germany by 2025, and could progressively and efficiently reduce their purchasing costs to the same degree as those needed by electric cars. The accelerated decline in the price of electrical cars is a result of the continuing studies on different factors such as travel rates, purchase prices and costs for possession of electric vehicles. Further work is needed to offset the expense of the performance of the car. The driving range of EVs is one of the big obstacles that are narrower than other cars.

Figure: 5 The development of EV battery testing

1.6 Testing for EVs

Various battery tests are performed to determine the operating parameters of the battery to be stable and resilient to failure. The set is continuously tested using ETA-TP004 and SAE J227 research benches. In range checking, the battery pack temperature will be between the range 60 ° F and 120 ° F. There are other requirements beyond that must be followed.

i. Wind speed at the test location recorded during a test should not exceed ten mph.

ii. EV accessories should not be used during the test activities.

iii. Range related tests should always commence with batteries, initially charged to the standard point by using rapid charging.

1.7 Factors affecting the EV

Internal factors

There are features that make an electric car less convenient in today, such as its travel range, charging times and prices. EVs are more expensive than traditional motor vehicles, as compared to another traditional vehicles the cost of EVs is more prevalent. It also concluded that the people were not willing, as requested by EVs, to pay the high costs. That over 63% of purchasers rejected EV adoption due to the high price. The purchase costs of EVs should decline rapidly and rapidly in line with studies of the purchase price for EVs which, by 2025, can be competitive with internal combustion engine vehicles (ICEV) in Germany by hybrid EV (PHEV) plug-in and battery operated (BEV).

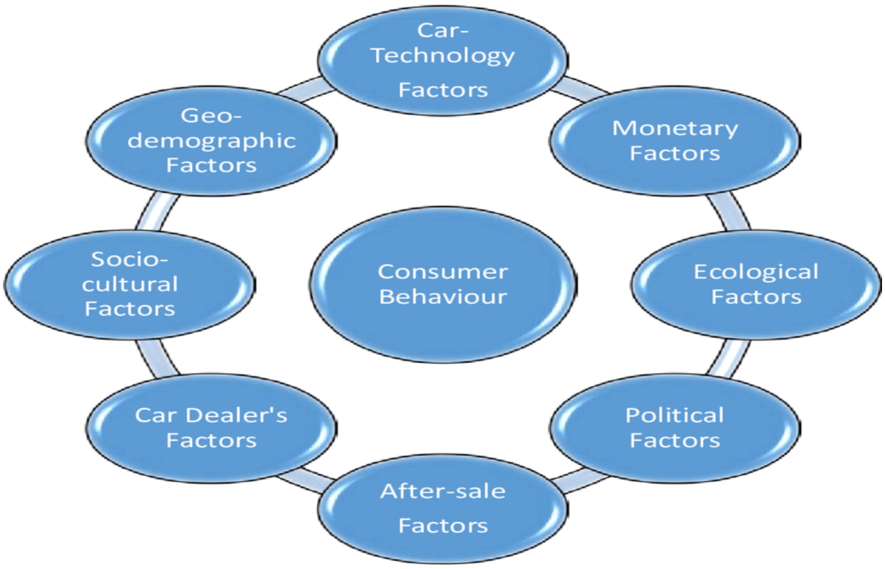

Figure : 6 Classification of factors influencing EV buying intentions

External factors

Many external factors may also influence the acceptance of electric vehicles such as customer specifications, fuel costs and the availability of charge stations. The petrol price spikes are due to the combustion engine burning of fossil fuel. Fuel price is a very significant factor in HEV adoption as customers have different kind of interest and the approval of an EV depends on specific consumer resources, such as employment , wages, the degree of environmentalism, the number and/or kind of car owned and the love of technology .. Vehicles surveyed in 30 countries and found that fuel prices are not important analyzers of electricity market share.

Table: 3 Lists of tests in USABC test procedures manual

Core Battery Performance Test	Constant current discharge	To determine the sustained (30s) discharge power capability of a battery at 2/3 of its open circuit voltage at each of various depths of Discharge.
	Peak power	To perform a sequence of constant power discharge/ charge cycles that define the voltage versus power behaviour of a battery As a function of depth of discharge.
	Variable power discharge	To produce the effects of electric vehicle driving behaviour (including regenerative braking) on the performance and life of a Battery.

	Federal Urban Driving Schedule (FUDS) regime	It is a demanding profile with respect to the frequency of occurrence of high power peaks and ratio of maximum regenerative charging to discharge power.
	Dynamic stress test regime	Can effectively simulate dynamic discharging and can be implemented with equipment at most test laboratories and developers.
Special Performance Test	Partial discharge, Stand loss, Sustained hill-climb power, Thermal performance, Battery vibration, fast charging	
Safety and Abuse Test	Safety testing	To address conditions associated with government regulations or expected accident related exposures
	Abuse testing	Based on mechanical, electrical and environmental exposure for worse-case scenarios
Life Cycle Test	Accelerated aging	To accelerate relevant failure modes and degradation mechanisms to permit rationally precise aging factors to be determined.
	Actual-use simulation	To simulate the conditions that EV battery may experience in the actual operation and the result from these tests will validate the accelerated life-cycle test performed.
	Baseline life test	To determine the battery life achieved under a 'reference' or baseline set of test conditions, for comparison with the results of accelerated life testing under any other set of test conditions.

1.8 LIFE PREDICTION METHOD

Studies around the globe addresses the lifespan estimation of batteries. Several of the prediction model for battery life suggested by the study, based on battery size and parameters. Analytical language to measure battery life for specific loads by considering the variations in the electroactive substance composition into account. 3 specific lifespan prediction methods for VRLA batteries: physical-chemical ageing model, weight of the Ah ageing trend and event-oriented ageing trend. These three methods are then evaluated to define conditions, complexity and speed of measurement. We employed numerous lifespan prediction methods for the Li-ion battery, efficiency models and weighted Ah output models. Leistungs-based simulations measure changes in battery output values. A partly linear input-output configuration for lead-acid batteries based on nonchemical basis. If the parameters are properly tuned, this pattern can be generalized to various battery types.

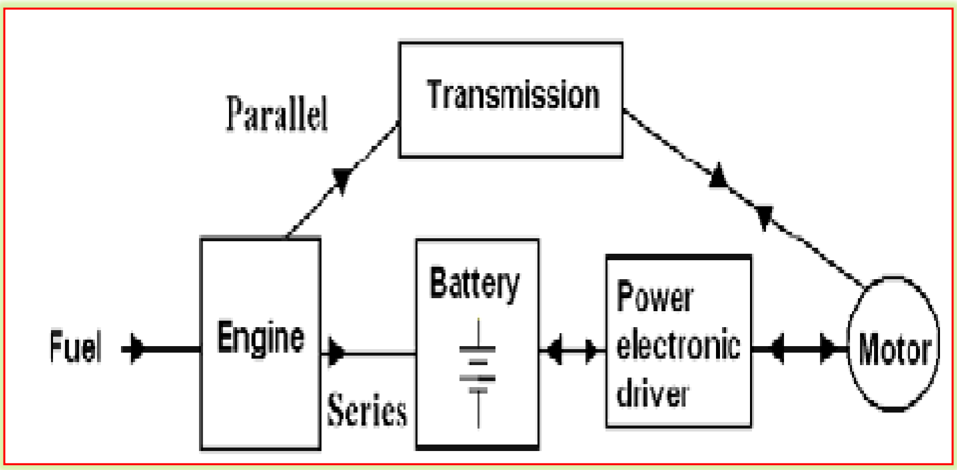

Figure : 7 The key components of electric vehicle

1.9 Components of EVs

EVs are energy systems-based; there is no internal combustion engine. The key components of the electric car are motors, mechanical controls, energy storage and charging mechanisms and a DC-DC converter. It is based on electric power.

Motors

Each engine has its own characteristics and benefits. Relevant specifications for EVs, including high power density, fast torque response , high speed and torque performance , high robustness and good reliability for multiple vehicles and at affordable prices. The direct current (DC) vector drives were generated on both EVs. DC drives have a turn, which ensures operating costs are smaller than conventional drives. We also realize, though, that the DC motor is designed for low power levels of up to 4 kW. It is also suitable for limited control uses, such as electric wheelchairs, mini cars etc. Therefore, we are heading towards AC engines with the introduction of more favorable alternating current (AC) motors. Now a new century has introduced less engines to turn, resulting in many benefits such as maximum performance and high power density, reduced running costs, better confidence and less DC engine maintenance. Therefore, AC motors of different types such as induction motors, brushless DC motors, synchronous permanent magnet motors, switched reticence motors. This has a very common AC motor, a variable speed driving mechanism for more than 5 kW of electricity such as air-conditioning, lifting or escalator. The IM and Synchronous motors are typically used to feed sinew supplies without the use of an electronic controller and provide a continuous instantaneous torque. The synchronous motor will then become PM synchronous motor (PMSM) after a field winding has been replaced by a permanent magnet (PM). The high kW rate and current specifications for PM Rotor were chosen that give superior torque speed coupled with light commercial availability and compact size. PM rotor is graded in two different forms, mounted on the surface and mounted internally.

Power electronic driver

The most critical part of the electric propulsion system is control equipment. This system requires a power transfer, and a control and locking mechanism for the closed loop. Becoming productive our system. In the last 25 years , power semi-conductor devices are used in electronic networks, according to the literature review. As a power semiconductor transition in EV controllers, thyristors are used. But now one day, a thyristor was replaced by modern control products, including bipolar junction transistor (BJT), the transistor of metal oxide field effect semiconductores (MOSFET), the thyristor turning gate (GTO), and several others by the insulated bipolar gate (ISGBT) tools. Nonetheless, it must be important to choose an suitable power unit and selection relies on the specifications of the EV and semiconductor parameters. For electrical propulsion vehicles three types of semiconductor systems are primarily used.

Electrochemical energy storage system (EESS)

The energy storage system which controls and regulates the energy flow is given the highest importance in EV. The primary focus at present is on energy storage and its core characteristics, such as storage capacity , energy storage density and many more. The required type of energy conversion process for primary batteries, secondary batteries, super condensers, fuel cells, and hybrid power storage systems. This kind of classifications can be rendered in various fields and analyzes by method can be abstracted. Electrochemical ESS, including batteries, super condensers and fuel cells, is of the utmost importance according to electric vehicle applications. A device electrochemistry, i.e., by means of chemical reactions at the interface of the electrode and the electrolyte transfer of electrons. Several other electrical energy storage devices, which are called primary and secondary batteries, super capacitors, fuel cells, electrolyzers and many others, have been made.

Primary battery.

More than 100 years ago the first main battery was introduced, the other one being zinc oxide. 1940 used pump. Afterwards, many advancements are made with respect to primary cells, their capacities, working temperature, the life cycle, etc., and many primary cells are constructed using various anodecathodium combinations.

Zinc-Carbon and alkaline manganese dioxide batteries

For more than 100 years Zinc-Carbon batteries (zn-C or Zn-MnO2) were the most common. The dry battery is sometimes named. Zn is anode in this, while MnO2 and carbon are being used as a cathode. The material for cathode is made of electrolytic MnO2 which offers long life and high strength. Primary battery theoretical power, i.e. Zn-C is 225 A. h / kg, and this value is based on condensed cells, synthesis on both forms of cathode materials. The maximum capacity of the battery, as standard, is 97 A. h / kg, and this is the highest specific capacity for a cell up to now. The main battery's working voltage / current is 0.16-44 A in prismatic battery configuration and 25-60 mA in keys.

Zinc-air battery

For this process, O_2 is used from the air as an active cathode, and because of that Zn-air 's capacities are double those of the main battery, as is the case with the aerodyne zinc air battery: catalytic cathode, aqueous lcaline electrolyte and zinc powder anode. The cell size is very small gravimetrically and volumetrically. The efficiency range is 40-600 mA.h for construction of the button cell.

Silver-oxide battery

Silver-oxide battery was synthesized for the first time in the early 1960's for different uses, including a pocket calculator, watches, etc. Named for its high size, decent storage holding capacity and constant voltage. Zn-Ag_2O has a capacity of 231 A for potential computing space. h / kg, which displays a steady voltage pattern at low and high discharge levels between 1.5 and 1.6 V. The main advantage is that it is kept long at room temperature for up to one year and that its capacity deteriorates up to 35% with normal capacity at low temperatures of (-20 ^oC).

Magnesium/manganese dioxide battery

Magnesium is now known as an anode element as in most batteries. The weight of the air is low and the capacity is high. Mg battery's biggest advantage over the other is the low temperature, i.e., – 20 ^oC and below. The low temperature also influences the heat output of the discharge and depends on the discharge intensity, battery set-up, battery size and several other factors.

Lithium primary battery

The first lithium battery was introduced for military devices in the 1970s, relying on lithium as an anode. With high-energy batteries in the 1960s Despite of long operating times, intense temperature and high voltage the lithium battery was the best. There are also various types of primary lithium batteries,

1.10 WAYS OF IMPROVEMENT

Thermal protection

The battery is held within the required operating temperature range from +20 ° C and +30 ° C, and can be balanced for the charging power and life cycle. The machine will also require heating and cooling components to reach optimum efficiency and sustain the temperature within this range. It can lead to poor performance and subsequent battery loss if the temperature is too big or too small.

SoC, SoH, monitoring

The exact estimation of the length of time a battery would continue to operate before charging is required will allow the customer to know the available amount of electricity to accurately schedule it. The status calculation (SOC) is also known as "Gas Gauge" function which has the same function as a gasoline tank in a vehicle. Fuel gauge function. The correct battery pack SOC calculation is the key consideration for effective power control. State of Safety (SOH) is battery calculations for the preservation of strong currents, source and sink and for maintaining charges over long periods of time. Such knowledge is useful for ensuring that the battery works within the appropriate reasonable limits and that any defective component for placements other than routine maintenance is detected.

Cell equalization (balancing) on cell

In order to reach a higher voltage, EV batteries consist of long cell strings in sequence. Pairing is used instead of minor short-term variations to avoid large-long-term unbalances. It tends to avoid undue tension in the cell too. When utilizing the balance method, the cells of over strength may be raising when transferring charges from one or more high cells to lower charge cells.

1.11 Tolerance setting

Premature battery loss can occur due to unequal temperature distribution and aging difference due to stress of individual cells in a sequence. The best way to pick cells is to reduce the heterogeneity of the characteristics in a single production set. There is a temptation to charge the battery if other depleted cells in the chain with reduced power are present. With close tolerance and rigid process monitoring the efficiency of a battery can be improved.

Specific changes to the EV grid, related to power control technologies, were also illuminated. For the optimal usage of battery capital, i.e. awareness of the real SOC, power efficiency, and the quantification of the battery output deterioration as an input for energy management, more technological development is required in the EV battery and procedures. Battery management systems allow battery operating strategies to be more flexible and reliable, thereby improving EV's battery efficiency.

Conclusion

The advancement of battery architecture and control methods will make EVs one of the most used technologies among many innovations in the near future. A detailed review on all aspects of EVs, with a focus on the design and production of EV batteries is discussed in this article. In the article, the issues of EVs at a mass level will also be illustrated. The cost, longevity, stability, efficiency, durability and usability of the battery, as well as power or energy, are the big issues in solving EVs. Throughout this report, the most important developments were illustrated throughout order to design and create new technologies for batteries. The battery design cycle for EV can also be complemented with advances in other areas, such as nanotechnology, recycling, production process, battery pack construction and processing. The mobility device like HEV and PHEv were able to meet its goals because of the advancements in Li-ion and NiMH battery technologies. The BEV will work as predicted with new solutions, such as high-power metal oxide catode products, a large-capacity anode and a new electrolyte with an incredibly powerful oxidation potential. To increase the escalating rate with a greater charge capacity, new quick charging schemes must be created.

By learning the defects, types of checks carried out and estimation process for life, the efficiency of the EV battery can be increased. The durability of battery systems or devices will, by the suggested solutions, ful fill the requirements and even increase the battery life if the configuration of the battery is dependent on the application criteria. Further enhancing the efficiency of an EV system, however, are the field results, use and the environmental profiles. Sadly, EV vehicle makers will not think about the latest issues related to battery efficiency.

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