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A REVIEW ON FAST CHARGING METHODOLOGIES OF ELECTRIC VEHICLES

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Abstract : The Li-Ion battery is charged using a constant voltage, constant current charging method. The solution, photovoltaic energy, is making its appearance in the EV charging infrastructure. By altering the transformer ratio, the inverter's voltage gain can be adjusted. Instantaneous thermal gradients are altered by fast charging. The grid and electricity quality may be impacted by EV charging.

The goal of this study is to create a comprehensive, current overview of fast charging techniques for battery-electric vehicles (BEVs). The foundational ideas of single battery cell charging as well as existing and upcoming charging standards are covered in this paper. Globally, battery-powered electric vehicles are becoming more and more common. Numerous causes, such as the need to lessen noise and air pollution and our reliance on fossil fuels, are driving this trend. The primary disadvantage of modern electric vehicles is their short range and the length of time needed to charge their batteries. Through research and development, great strides have been achieved recently to use pulse charging, as opposed to continuous current and/or voltage delivery, to shorten the charging period of the batteries in electric vehicles. The portion that needs to be concentrated on estimating the electrical properties of the vehicle's battery is crucial for learning about the potential driving range.

Key Words: Electric Vehicles, Li-Ion battery, Fast charging, Ultra-Fast Charging, Pulse charging.

1.INTRODUCTION:

The rising cost of oil and environmental concerns have led to a noticeable surge in interest in clean car technologies including fuel cell and electric vehicle (EV). The use of electric cars (EVs) in place of conventional vehicles (CVs) is growing in appeal. Electric batteries, which EVs run on, require recharging from the electrical grid. Electric vehicles (EVs) are undoubtedly a suitable link between the transportation and electricity industries. Due to their low energy consumption and zero emissions, EVs can also offer a suitable option to lessen the impact of transportation on the environment and reliance on energy. Electric cars (EVs) have risen quickly recently in response to global need for green energy. The primary cause of air pollution in major cities is CO2 emissions from traditional gasoline-powered automobiles. Current advancements in electrical vehicle technology will provide an alternative to internal combustion engines (ICEs). These developments include Fuel-Cell Electric Vehicles (FCEV), Plug-in Hybrid Electric Vehicles (PHEV), and Battery Electric Vehicles (BEV) in various configurations. Additionally, scientists are developing battery technologies to enable EVs to charge at a fast rate. As a result, in the coming years, more EVs will be used. By 2020, it's anticipated that over 5 million EVs will be in use. Since most EVs have a 100 km range, a charging station is just as necessary as a petrol station. Quick charging (less than 30 minutes), long battery life (minimal temperature rise while charge), and standardisation (all vehicle providers can be utilised) are the three key concerns for a charging station. [3]

For a battery charger, the constant current (CC) and constant voltage (CV) methods are typically employed. Whereas CV delivers a mild temperature rise with a longer charging period, CC offers a higher temperature rise in a shorter amount of time. The 30 minute charging time and low temperature increase requirements from EV users cannot be reached by the CC and CV methods due to the maximum charging current (Imax) and voltage per cell (V/Icell) limitations imposed by battery providers. In conclusion, Li-ion battery degradation at rest and during cycling, charging rate limitations resulting from electrochemical processes, and limited energy density (compared to petroleum) still pose significant obstacles to the widespread adoption of EVs, even with the declining cost and significant performance improvement. [4]

2. BACKROUND:

It is impossible to ignore the effects of the growing number of EVs since the electrical power networks were not intended for this new kind of load, which equates to the battery charging systems of EVs. The task at hand involves reconstructing the electrical power grids in the most expedient, environmentally sustainable, and "smarter" manner feasible. EVs are a novel kind of load that poses new challenges as well as opening up new actuation opportunities. The issues derive from the potential for numerous cars to be charged at the same time, which could overload the electrical grid, as well as from the consequences of the battery charging systems' non-sinusoidal current consumption. Among the opportunities is the fact that, if they cooperate with the electrical power grid to store and distribute the energy from the batteries in parked vehicles, these vehicles have enormous potential to regulate the consumption profile from the grid by smoothing the natural intermittency of the renewable energy sources and ensuring the grid's stability in terms of voltage and frequency. As previously indicated, certain cars permit their batteries to be charged using off-board systems, such as those found at public charging stations, but the majority of cars have on-board battery charging systems. The nominal properties of the vehicle's batteries must be respected in order to extend the life of the charging system, which is an AC-DC power circuit.[1] [6]

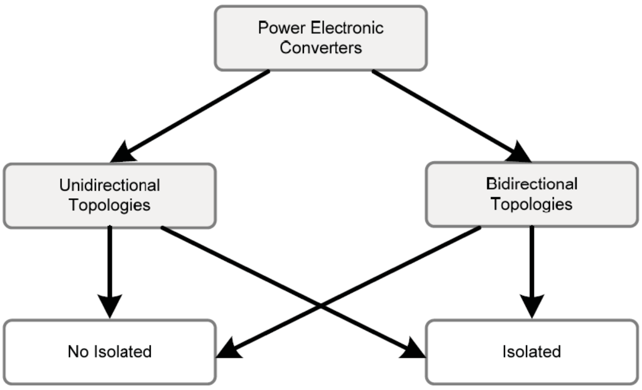

Fig. 1. The primary types of ac-dc power converter topologies utilised in EV battery charging systems

Today's EVs use a variety of Li-ion battery derivatives, several of which are still in development. In an effort to maximise the battery's longevity, safety, and performance, researchers might choose the electrolyte, positive, and negative electrodes. Fig. 1 depicts the normal charging procedure for a single lithium battery cell. There are two steps to it. In the first, the cell is subjected to a constant current (CC stage), which causes the voltage to rise from 3,0 V—which is indicative of a depleted state—to 4,2 V, which is the nominal cell voltage. At this moment, the cell voltage is regulated to stay constant (at the CV stage) until the current approaches zero.[2] By increasing the current used at the CC stage, the battery charging time can be shortened, although high currents might shorten the cell's lifespan or result in permanent damage. A basic analysis using a crude battery model similar to the one in Fig. 2 demonstrates that applying a larger current causes higher losses because of the internal resistance of the battery cell. As a result, proper thermal control is necessary for fast charging in order to keep the battery's temperature within a safe range. [7]

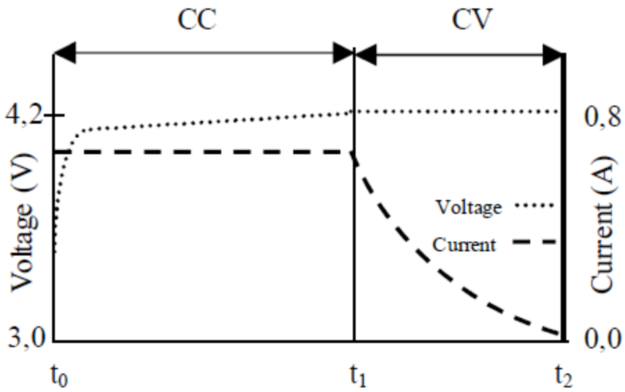

Fig. 2. Single lithium battery cell charging process

3. BATTERY CHARGING METHODOLOGIES:

When recharging EV batteries, many physical implementations and techniques are used. The physical implementation of the battery charging infrastructure refers to the means by which the energy is physically transmitted to the vehicle, whilst the battery charging strategy refers to the forms and magnitudes of the currents/voltages to be used during charging. [8][15]

3.1. Constant Voltage:

A constant voltage charge gradually reduces the charging current as the battery gets closer to its full charge while maintaining the charging voltage at the highest level that is appropriate for a certain kind of battery. When utilising lower voltages, this works well because temperature is typically not a problem, but long charge times are a worry. [16] [18]

3.2 Constant Current:

This charging technique, as its name suggests, builds up the battery voltage to its full charge value by applying a continuous current. Constant current to the battery can quickly lead to overheating and damage, reducing the battery's life, even if it is applied within the rated current. [14] [16]

3.3 Constant Current-Constant Voltage (CC-CV):

Constant current-constant voltage charging, originally known as just "Voltage Controlled Charging," is a popular method of charging batteries in which the charger applies a constant current up until the battery reaches a predetermined voltage potential. At that point, the voltage is held constant and the current keeps decreasing until the battery is fully charged. The conventional approach to battery charging, shown in Figure 4, has limitations when it comes to fast-charging applications because cell polarisation becomes a problem. The CC-CV method has been further refined to incorporate numerous constant current phases, as may be predicted, which improves the pace at which the batteries charge. [15] [16] [17]

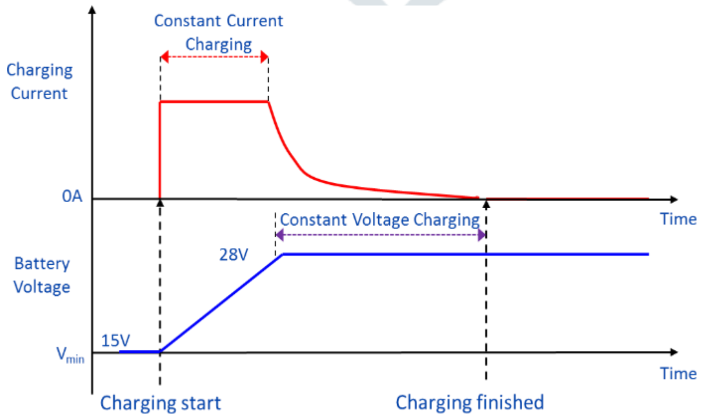

Fig. 4. Constant current-constant voltage battery charging

3.4. Pulse charging:

With pulse charging, the battery receives current pulses that are designed to maximise the charging duration while taking polarisation, battery temperature, SoC, and changeable battery impedance into account. The ions are able to permeate through the electrode materials during the rest interval of each pulse cycle, improving the charging process' efficiency. [13] [15]

3.5 Negative Pulse Charging:

Small discharges are imposed on the battery during the pulse charging rest period via negative pulse charging techniques, which were first designed to improve the efficiency of charging converters for lead acid batteries but have now been extended to lithium ion batteries. The negative impulse serves to minimise the cell's temperature rise and reduces tensions inside the cell. Circuit topologies that recuperate the energy extracted from the battery have been developed since the negative pulse draws a little amount of energy from it. High currents can be continuously fed into the battery, allowing for a greater charge rate and shorter charge time, by periodically depolarizing the cell. This technique can greatly extend the battery's life and aid in its internal chemical reactions. [18]

4. ULTRA- FAST CHARGING AND FUTURE SCOPE:

A lot of upcoming technologies could make owning and operating an emission-free car simpler. With battery packs delivering over 500 miles of range between charges that just take a few seconds and electricity available to you over the air, the problems of "range anxiety" and "long charging times" will soon be history.

We are about to witness a revolution in batteries. Electric vehicle manufacturers are aware that Americans want more range and faster charging times in order for EVs to be in every garage. They are fully aware of the drawbacks of the lithium-ion batteries used to power modern electric vehicles. Battery packs have been the weak link in the continued advancement of power-saving computer circuits and operating systems. Using carbon fiber as the negative electrode while the positive is a lithium iron phosphate, these batteries would be extremely stiff and rigid for structural components. [8] [9] [17]

A business by the name of Graphenano is creating a Graphene battery that it claims will have a 500-mile projected range and only require a few minutes to recharge. According to the manufacturer, these batteries would charge and discharge 33 times quicker than lithium-ion batteries. [9]

Recently, a single battery charge allowed an experimental car to go 1,100 kilometres. This was made possible by aluminum-air battery technology, which fills the cathode of an electric car with oxygen from the surrounding air, making it significantly lighter than liquid-filled lithium ion batteries and increasing range. [4] [17] [18]

5. CONCLUSIONS:

This paper reviewed current fast-charging technologies, discussed problems with fast-charging, such as restrictions and effects on battery systems' ability to handle heat, offered remedies, and suggested new directions for future research. The world will not be able to survive on petroleum-based transportation in the coming decades, so cutting-edge technologies are required to transition to electric transportation that is sustainable. One of the main issues with EVs is their slow charging times. Recharge timings must be comparable to the time it takes to fill up an ICEV's petrol tank in order to be widely accepted by consumers, improved and standards created, encouraging a greater uptake of electric vehicles and paving the way for a more sustainable energy future. Future developments in electric vehicle charging will primarily focus on fast charging, contactless charging, charging from renewable or sustainable energies, and vehicle to home or grid to vehicle research. Fast pulse charging is a critical issue in the commercialization of electric vehicles in order to reduce charge time to a reasonable amount. A fast-charged battery can overheat, weaken performance, and cause damage to the battery; deep discharge, on the other hand, is the root cause of permanent damage. The Battery Management System (BMS) helps to improve battery life, lower damage rate, and optimize capacity, efficacy, durability, and reliability in battery stacks.

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