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Charging System for Auxilliary Storage in Plug-in Vehicle

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ABSTRACT

Almost all vehicles have their own on-board batteries charging systems, while some do allow the charging of their batteries using off-board batteries charging systems, such as public charging stations. This charging system is an AC-DC power circuit that needs to be managed to respect the nominal characteristics of the vehicle's batteries and prolong their lifespan. It should also keep an eye on the batteries while they run to guard against harm caused by charging or discharging. The ACDC power circuit can be constructed using a variety of topologies depending on the desired system characteristics. There are two different types of architectures—direct and indirect architectures—that can be used to link EVs to the grid. The EV and the grid system operator only have one communication channel to use under the direct architecture. On the other hand, the indirect architecture calls for communication between a grid operator and a middle system.

Keywords: *Battery Charging; Discharging; Grid System; Lifespan; Power Circuit.*

1.0 Introduction

The transportation sector's oil consumption has increased more rapidly than any other sector in recent decades. This growth has mostly resulting from increased consumer demand for personal-use vehicles using standard internal combustion engines (ICEs). Different ground vehicles use the majority of the petroleum[1]. The world Vehicles will grow from 700 million to 2.5 billion in number. Since they use no oil and emit no pollutants locally, battery-powered electric vehicles (BEVs) look like the perfect solution to the energy crisis and the problem of global warming. The drawbacks of these vehicles have been brought to light by aspects including their high initial cost, limited driving range, and lengthy charging times.[2-3] The new topology of the battery combined with the bidirectional ac/dc-dc/dc converters for PHEVs is being studied by researchers. The suggested architecture can be used in four different ways, including bidirectional power transfer between the battery and the dc connection and charging and discharging the battery from/to the grid.

An electric motor that draws electricity from a rechargeable battery propels electric vehicles (EVs). The performance requirements for many EV specs much surpass what traditional battery systems are capable of. Due to the high voltages and currents involved in the system as well as the advanced charging algorithms, however, as battery technology advances, charging these batteries becomes increasingly difficult[4]. There are two different types of architectures—direct and indirect architectures—that can be used to link EVs to the grid. The EV and the grid system operator only have one communication channel to use under the direct architecture. The indirect architecture, on the

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other hand, calls for communication between the grid operator and a middle system[5]. In this essay, we focus on the earlier design. Electric vehicles (EVs) engage in continuous charge-discharge cycles when they connect to the grid to carry out various V2G services. The expense related to the EV batteries' deterioration needs to be examined and assessed, therefore these cycles may be of major concern to the owners of the vehicles[6-7]. In light of this, the battery cycle life (CL) must be taken into account while talking about the battery's deterioration.

2.0 Battery Wear Optimization with Adaptive Cycle Life

The service of V2G is participated in the cycle life of battery for the model optimization by considering the signals of frequency regulation and degradation of battery cost [8].

2.1 Cycle Life

Battery degradation, or the volume and rate of energy lost in batteries, is a factor in CL. The amount of charge-discharge cycles an EV battery can go through before it falls below a given level is also a function of the DOD and cycle frequency. The recommended regime for a Li-ion battery is said to be 80 percent DOD, which is the nominal amount for degradation.

$$CL = (L100)e^{\beta(1-DoD)}$$

where, C_L is the cycle life of a battery, L_{100} is the value of the C_L at 100% DOD and β is the decay coefficient. Decay coefficient is the exponential decrease in the value of the cycle count and its value falls between 3 and 6 for different batteries .

2.2 Frequency regulation price analysis

The services have the price in market which is needed for the ancillary requirements . This need is the regulation price which is in need for up and down of the demand observed by the grid operator[9]

2.3 EVCD optimization model

For the EVCD optimization model, we used it as the basis; for those who are interested, more details are offered. To show how the signal of regulation influences the ideal SOC profile and charge/discharge cycle while accounting for the cost of wear, we incorporate actual regulation pricing into the model in this study.

2.4 The iterative algorithm with dynamic cycle life

The iterative approach that has been suggested for calculating the CL of EV batteries taking part in V2G operation. The initial CL of the EV battery is initialized with the corresponding DOD in accordance with the framework[10]. The electrical vendor is then contacted to receive the electricity and regulation pricing. To acquire the ideal charge/discharge patterns and reduce the battery's wear cost, the EVCD optimization is simulated.

3.0 Battery Modelling

Here, a battery model is provided to satisfy all needs with non-linear charging/discharging characteristics, as well as their dependence on the battery's state of charge. Self-discharge resistance (Rs), a function of open circuit voltage, charge resistance (Rc), and discharge resistance (Rd), which differ for charging/discharging, are the elements for characterisation. Overcharge resistance (Rco) and over discharge resistance (Rdo) greatly rise as a result of the internal chemistry of the battery[11].

Battery capacity (Ah) is modelled varying with *SOC and the* expressions for the charging/discharging characteristics of LI-ion are as given -

Maximum power available is also limited to certain parameters; the maximum power limit is obtained by

$$P = V_{bus} \times \frac{V_{oc} - V_{bus}}{R}$$

Where V_{bus} is either $V_{OC}/2$ or minimum battery voltage.

When we combine this power equation with the KVL then it will yield-

$$\frac{P}{I} = V_{OC} - (R \times I)$$

By multiplying with I on both sides the equation becomes-

$$P = (V_{OC} \times I) - RI^2$$

Now the equation is solved in the block diagram-

$$RI^2 - (V_{OC} \times I) + P = 0$$

The lesser requirement of voltage is needed for obtaining equal amount of power and the allowable voltage value is achieved by not exceeding the minimum value of raw current

$$I = \frac{V_{OC} - V_{\max}}{R}$$

In advisor the SOC algorithm determines the residual capacity in Amp-hrs charge unit. The value is approximated by a series of steps, and during this estimation, the columbic efficiency and maximum capacity will remain functions of temperature[12] . For the initial SOC non- zero Ah is used and then it is calculated by-

$$SOC = \frac{C\max - Ah}{C\max}$$

Where, Cmax- Maximum capacity

Ah- Amp-hr used

The SOC is now calculated based on the power bus specifications, and the output has the available power. With the initial SOC value the sate of charge at different time instants (t) is calculated by the following integration-

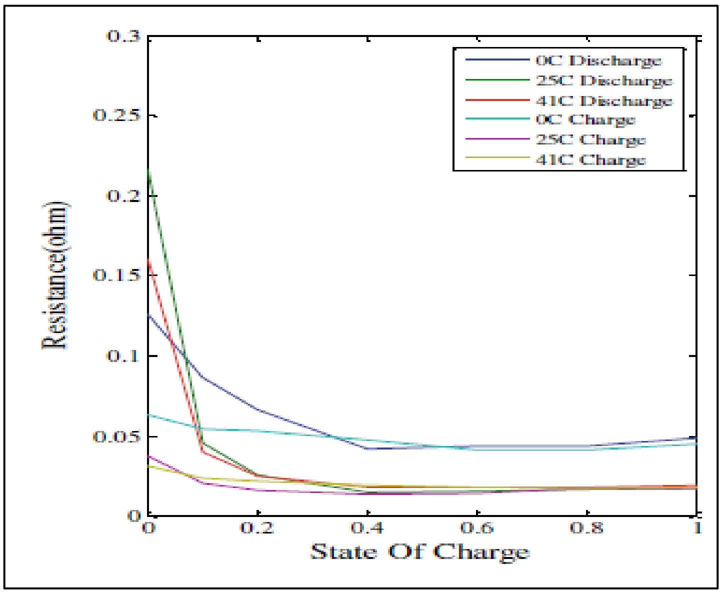
$$SOC(t) = SOCi + \frac{1}{3600}\frac{\eta bat(i(t),T)}{Cap(T)}\int_{t0}^{t} i(t)dt$$

Where, Cap(T) is the capacity and ηbat(i(t),T) is the columbic efficiency of the battery.

4.0 Result & Discussion

Internal resistance decreases during discharge and reaches its lowest value at half charge. After a complete charge and discharge, the resistance reading is greater. When a Li-ion battery is charged from empty to full, its internal resistance value is largely flat. When SOC is between 0 and 70%, the battery power declines, with the biggest drop occurring between 0 and 30% of SOC.

Figure : Charge /Discharge Condition Variation with SOC



Current energy and environmental issues have been effectively addressed by EVs, HEVs, FCHVs, and PHEVs.Electric drive trains completely or largely replace ICEs in these vehicles thanks to the breakthrough power electronics and ESSs. The goal of advanced ESSs is to meet the energy needs of hybrid power trains. At this time, the majority of commercially available EVs and hybrid cars lack hybrid ESSs. Advanced hybrid electric drive trains could not be equipped with just one ESS component, such as batteries, UCs, or FCs. Researchers are looking at hybrid ESSs that have a huge capacity, quick charging and discharging, a long lifespan, and are inexpensive.This article examines several hybridization topologies for EVs, HEVs, FCHVs, and PHEVs. More research should be done to introduce transformative ESSs into future advanced vehicles to lower costs, boost efficiency, and extend electric driving range in order to make HEVs and PHEVs competitive with conventional vehicles on the market.

5.0 Conclusion

The quantity of charge-discharge cycles a battery experience is negatively correlated with battery cycle life. Therefore, when optimizing the V2G operation, the battery cycle life and the cost of degradation should be carefully taken into account. In this study, we create a brand-new iterative technique to forecast how regulation pricing and static and dynamic electricity will affect battery cycle life. By taking into account frequency regulatory signals, day-ahead real-time pricing, and the anticipated cycle life, we optimise the charge-discharge process.

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