CCCV Charging Method For Electrical Vehicle

Mrs.Sucheta S Patil.
Assistant professor
Department of Electrical Engineering
Nanasaheb Mahadik College of Engineering,Peth.
Maharshtra,India.

Ms.Mayuri Vijaysingrao Bhosale .
Department of Electrical Engineering
Nanasaheb Mahadik College of Engineering .Peth
Maharashtra,India

Mr.Raviraj Rajiv Patil.
Department of Electrical Engineering
Nanasaheb Mahadik Collge of Engineering,peth.
Maharashtra,India

Ms.Prajkta Sunil Gholap.
Department of Electrical Engineering.
Nanasaheb Mahadik College of Engineering,peth
Maharashtra,India

Mr.Indrajit Sanjay Mali
.Department of Electrical Engineering
Nanasaheb Mahadik College of Engineering,Peth
Maharashtra,India.

***Abstract*— Recent development in high density lithium- ion battery technologies expanding the electrical vehicle market structure. New technologies used to help for solving problem regarding to the battery cell of electrical vehicles. Issues like charging time, battery life, temperature rising at charging process. These issues can be solving by using CCCV method complicating factors include safety, durability thermal breakdown and cost of Li-Ion batteries should be used within safe temperature and voltage ranges in the operate safely and efficient. This paper present smart new technology CCCV method for improving the charging process for the electrical vehicle. The electrical are expanding rapidly therefore it need to simplicity. Development and availability of fast charging technologies is lead to expanding the electrical vehicle use for large community of India to compare with the petroleum vehicles.**

Keywords*— *fast charging, cccv method, battery storage.

I. INTRODUCTION

In recent years electrical vehicle is growing fast. With the advantages of zero pollution, high energy sources, electrical vehicle has been the new development point of electro motor industrial. Li-Ion battery has been widely used in electrical vehicle its high energy density, high long-life cycle and high safety level. Charging electrical vehicles batteries at rates comparable to gasoline vehicle, gasoline vehicle gives pollution to the environment.

Rapid charging process is the CCCV (constant current constant voltage) method. To reduce the charging times, it involves the charging the battery with high constant current in a low state of charge region through the decreasing charge current increase with the aim of minimizing cell degradation.

Rapid charging pattern is related to balance between the charging time and cell life cycle. This charging pattern gives the less charging time.

II. GENERAL ASPECT OF ELECTRICAL VEHICLE

- Improvement of air quality.
- Improvement of transportation sector.
- Less maintenance.

.

III. CCCV METHOD:

Constant current constant voltage charging method is commonly approach to battery charging where the charger applies a constant current until the battery reaches a predefined voltage potential, at which point voltage is held constant and the current continuous to decrease until a full charge is reached. This is given in below diagram.

Different batteries have different characteristics when it comes to charging. The constant current constant voltage strategy which includes CC stage and CV stage has become very popular method to charging Li-Ion battery. When constant current is giving to the battery and then terminal voltage increase maximum safe voltage. Then battery starts to charge at constant voltage till the battery meets the target. Open problem is to select the correct current at constant current stage. High current cause energy loss.

Initially ,the battery is charged at constant current.when the battery is nearly full, its voltage reaches the constant voltage setting of the charger ,and the current decays expontially as the battery gets a finishing charge.

IV. EXPERIMENT:

1.Battery and equipment:

The battery uses is 18650 cylindrical Li-ion battery with normal capacity of 1.37 Ah, a normal voltage of 3.7 V, and a cut-off voltage of 4.25 V. The maximum charging and discharging rates are 1C and 2C Respectively. The positive

electrode material is $LiFePO_4$ and negative electrode material is LiC. the battery tester is LD battery tester with 8 test channels and the test process can be programming and monitor by computer. The battery was tested in a temperature chamber to ensure the temperature parameter to be constant. The detail parameters of battery tester and temperature chamber.

Using CCCV increases the charging speed and charging efficiency also increased. Most effective method for charging time decrease and battery life cycle increase.

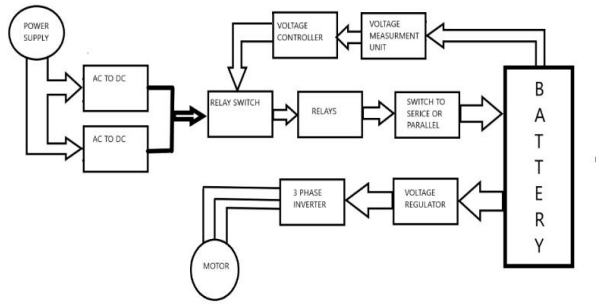

Figure 2. experimental setup.

2) EXPERIMENTAL PROCESS:

- Battery charging process.

As AC convert DC. Voltage is sense by sensors. As charger is connected to the vehicle for charging process. Then battery is start giving output. all the batteries in series switch their position to parallel. The series voltage of batteries measured. If series voltage is not below 15V.then notification blink on users mobile i.e maintenance is required – go to care center. If the series voltage is below 15V then charging process is start.

On the other hand, LCD is displaying some information about temperature, charging percentage. Voltage is checking along way and displaying. Then if battery is full or 100%. battery charging process is automatically stop.

In case of temperature raised above 45C, then automatically charging process stop and also if we disconnect the charger from EV's charging port charging process is stop.

- Battery Management System:

BMS is system which is manage rechargeable battery to insure it operates safely and efficiently. It ensures that battery is operate safe limit. BMS is responsible to the temperature management of battery. It also mange cooling and trigging and other safety mechanism to minimize the risk.

Overheating of the battery pack detected by BMS. Due to overcharging of lithium-ion lead to overheating and explosion. BMS continuously monitor volage of battery pack. Also, BMS does the

1. SOC determination: it providing user indication state of charge (SOC)it indicates the capacity left in the battery.
2. SOH determination: it measures batteries capabilities.
3. Cell balancing: in case of multi cell battery compensating for weaker cells by equally charge on all cells in the chain.

A typical CCCV pattern is use to target charging time. Cycle life span performed between 3.0 and 4.25V using this method.

The Constant current constant voltage charging method widely adapted due to their simplicity and easy implementation.

- Switching of batteries (Series, parallel):

At starting battery is in series position when we start charging battery switch its position series to parallel because in the parallel position overall resistance decreases so current is increases. At the discharge battery switch their position to series.

When the batteries connected in the parallel the current flowing through the circuit increases with no of batteries in the circuit so total current of circuit is increases.

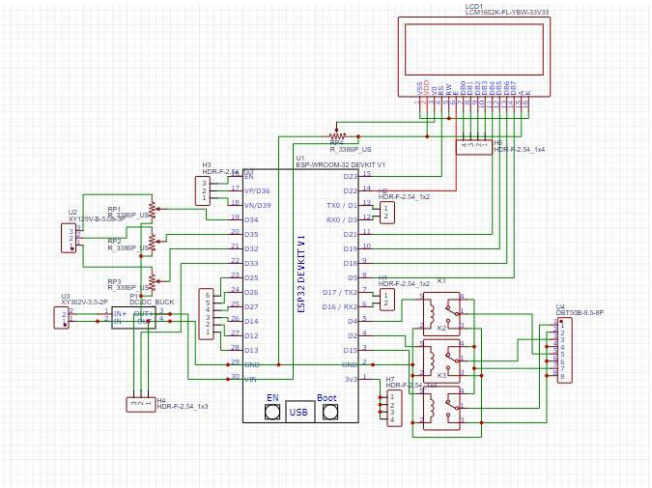

Figure 3. Conceptional design of CCCV method.

Batteries required a constant current to charge the battery until the battery voltage achieves a predefined safe limit .at which constant voltage begins. Then charging voltage kept maximum charging voltage. charging current is exponentially reduces. Constant voltage is used to limit the current and thus prevent battery from overcharge.

Different batteries have different characteristics when it comes to charging time. Here is some tesla model batteries and their charging time. Below table shows the list of tesla batteries used for the real-world data collection.

Battery code	Tesla model	Capacity (kwh)	Charge time
BT37	3 Long range	72.8	23
BT70	S70	65.8	33
BT85	S85	73.4	27
BTX4	S/X90	79.6	23
BTX5	S/X75	71.6	27
BTX6	S/X100	95.7	20
BTX8	RareS/X75		25

Table 1. Tesla batteries

At starting development of the cv step charging pattern, which is rapid charging method that allows self-charge control to reflect cell degradation and reduces cycle life degradation.

On the development of a charging pattern that controls charging rate according to capacity degradation of battery cycle ultimately adjust the charging.

3) CHARGING CHEMICAL REACTION:

In charging process, the electrons move from the positive electrode to the negative through the external circuit, and Li+ moves the positive electrode to the negative electrode through separator in electrolyte.

When the lithium-ion battery is discharging it provides current to the external circuit. Internally the anode releases the lithium ion in the oxidation process which pass to the cathode. The electron from the ions starts flowing to opposite direction, flowing out in electrical circuit that is being energized.

During the charging process the reaction occurs in the reverse direction with the lithium ion passing from the cathode through the anode the electrons provide by external circuit combine with the lithium ions to provide the stored electrical energy.

Charging process at low temperature shows main model consist of polarization and impedance increases. The fast-charging process is divided in to two stages. The first stage is charging battery with the maximum charging rate until the cut off voltage reached. The second stage is charging current was decreased to half of the maximum charging rate, and the terminal voltage can be decreased.

4) Result of experiment:

According to the CCCV charging process once the cut off voltage is rapidly reached at a low temperature; the terminal voltage can be decreased with charging current decreased from the maximum rate.

- Charging at 25 C:

The terminal voltage at temperature 25C of two stage CCCV strategy increases near about 4.25V with state of charging 75%. With current decreasing, the terminal voltage of two stages CCCV strategy decreases to voltage 3. 42V.The increasing in the terminal voltage indicates that the normal CCCV charging process has been changed by the increase in the internal resistance at low temperature.

The first charging stage of CCCV strategy which is charging battery at maximum charging rate until cut off voltage reached does not last long before the cutoff voltage is reached is reached in internal resistance and high charging rate.

The second charging stage decreases the charging current and the terminal voltage is increases until the cut off voltage.

Variation in charge time and avaiable capacity relative to the cycle no. for the 18650 battery .as the no of cycle is incresed at high rated charging and discharging is rapidaly done.when the battery charging process is start then the battery manegement system is monitoring process.maintain the voltage at the dischaging process.

The charging period of CCCV two stage are 180min.it has maximun capacity and minimum charging time .when the charging process is start then the battery temprature increse ifvtemprature goes above 45C then the charging process is stop beacause the ultimate range of the temprature is predefine. So the safe opration within a limit is continued.

The charging period was decreased and capacity of battery increasedwith CCCV method .CCCV also increase some percentage of of charging capacity and some percentge battery life.

The overall result is the CCCV method is having great impact in theworld electrical vehicle. As the battery charging field is improve then the electrical vehicle is the most intersting and more convinient to user. Now days user is more comfortable to use these vehicles therefor this field is incresing rapidaly.Many more stretegies are avilable to rebuilt the electrical vehicle.the battery problem issuse are solve then after electrical vehicle have their great market.

- Calculation for current :

Its challenge for this method to providing constant current for the circuit. Current provide the balance between the charging performance and battery life.

Normal range of voltage ,

I= V/(R+nr/m)
= 48/(1+1*12/4)
= 48/4
=12A

Experiment range

I=24/ (1+1*3/4)
= 20.2102A

5) CONCLUSION:

Here we proposed the CCCV method which is rapid charging method for the electrical vehicles. Based on result of experiment CCCV method has several advantages on the other type of charging. This method id simple and convenient to the user.

Using Li-Ion battery for constant current constant voltage method is really worth. Charging and discharging is

dependent on reaction of anode and cathode.in the charging process of battery controlling undesirable changes. This method decreasing the charging time and increasing the battery cell capacity.

This paper explaining the fast-charging system that do not damage the batteries.

References:

1) **H. J. Ruan, J. C. Jiang, B. X. Sun, N. N. Wu, W. Shi, and Y. Zhang**, "Stepwise segmented charging techn lithium-ion battery to induce thermal management by low temperature. internal heating," *in Proceedings of the IEEE Transportation Electrification Conference and Expo (ITEC '14), Beijing, China, September 2014.*

2) **H. Zhang and J. Wang**, "Vehicle lateral dynamics control through AFS/DYC and robust gain-scheduling approach*," IEEE Transactions on Vehicular Technology, no. 19, 2015.*

3) **Zhang, S.S**. "The effect of the charging protocol on the cycle life of a Li-ion battery" *J. Power Sources* ***2006****, 161, 1385–1391.*

4) **Mohammed, F.H.; Chen, C.F.; Christian, E.S.; Partha, P.M. "**Analysis of the implications of rapid charging on lithium-ion battery performance".

5) **Notten, P.H.L.; Op Het Veld, J.H.G.; Van Beek, J.R.G.** "Boost charging Li-ion batteries: A challenging new charging concept." *J. Power Sources* 2005, *145*

6) **Han, X.; Ouyang, M.; Lu, L.; Li, J.; Zheng, Y.; Li, Z.** "A comparative study of commercial lithium-ion battery cycle life in electrical vehicle". *J. Power Sources* 2014.

7) **Anseán, D.**"Fast charging technique for high power LiFePO4 batteries: A mechanistic analysis of aging". *J. Power Sources* ***2016***

8) **Abdel-Monem, M.; Trad, K**.; **Omar, N.; Hegazy, O.; Van den Bossche, P.; Van Mierlo, J**." Inflfluence analysis of static and dynamic fast-charging current profifiles on ageingperformance of commercial lithium-ion batteries". *Energy* **2017.**

9)**S. J. Huang, B. G. Huang, and F. S. Pai**, "Fast charge strategy based on the characterization and evaluation of $LiFePO_4$ batteries," *IEEE Transactions on Power Electronics*, vol. 28, no. 4, pp. 1555–1562, 2013

10) **Dubarry, M.; Liaw, B.Y**. "Identify capacity fading mechanism in a commercial LiFePO4 cell". *J. Power Sources* ***2009***

11) **J. Fan and S. Tan**, "Studies on charging lithium-ion cells at low temperatures," *Journal of the Electrochemical Society*, A1081–A1092, 2006.

12) **H.-S. Song, J.-B. Jeong, B.-H. Lee et al.,** "Experimental study on the effects of pre-heating a battery in a low-temperature environment," in *Proceedings of the IEEE Vehicle Power and Propulsion Conference (VPPC'12)*, pp. 1198–1201, *IEEE, Seoul, Republic of Korea, October 2012.*

13) **D. J. Docimo and H. K. Fathy**, ''Analysis and control of charge and temperature imbalance within a lithium-ion battery pack,'' *IEEE Trans. Control. Syst. Technol.*, to be published.

14) **L. Patnaik, A. V. J. S. Praneeth, and S. S. Williamson**, ''A closed loop constant-temperature constant-voltage charging technique to reduce charge time of lithium-ion batteries,'' *IEEE Trans. Ind. Electron.*, vol. 66, no. 2, pp. 1059–1067, Feb. 2019

15) **T. T. Vo, X. Chen, W. Shen, and A. Kapoor**, ''New charging strategy for lithium-ion batteries based on the integration of Taguchi method and state of charge estimation,'' *J. Power Sources*, vol. 273, pp. 413–422, Jan. 2015.

16) **T. T. Vo, X. Chen, W. Shen, and A. Kapoor**, ''New charging strategy for lithium-ion batteries based on the integration of Taguchi method and state of charge estimation,'' *J. Power Sources*, vol. 273, pp. 413–422, Jan. 2015.