International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 6 Issue 5 Ver. I ǁ 2018 ǁ PP. 49-52

A Sampling Method on Lithium-Ion 18650 Charging Graph

Imam Saukani[1], Bambang Siswojo[2], Wijono[3]
(Department of Electrical Engineering, University of Brawijaya, Malang, Indonesia)
Corresponding Author: Imam Saukani

Abstract : *Lithium-Ion is the most widely used battery, compared to the other rechargeable batteries type such as Nickel-Cadmium (Ni-Cd) and Nickel Metal-Hydride (Ni-MH). The 18650 battery is commonly used in various portable electronic equipment manufacturer such as Samsung, LG, Sanyo, and Sony. The conventional method for Lithium-ion battery charging use a constant current (CC / constant current), where a constant value of current is selected according to a certain upper limit of voltage (U_f / upper voltage) and a constant voltage (CV / constant voltage). The drawback is unknown charging duration. In this paper, a mathematical model graph of lithium ion battery is presented. By using the proposed mathematical model, the charging duration with various value of initial battery capacity can be estimated. The current value is sampled every 30 seconds on 180 minutes of duration. The resulting mathematical model is presented in a graph by using Visio Software.*

Keywords - *battery, sampling, lithium-ion, voltage, current.*

Date of Submission: 13-06-2018 Date of acceptance: 28-06-2018

I. INTRODUCTION

Rechargeable battery has an advantages of re-cycle capabilities compared to the non-rechargeable battery [1]. The re-charging process can be done easily by applying certain amount of direct current to its terminal. Research on battery subject is often associated with the design of suitable battery charger [2]. Most of the rechargeable battery use chemical material such as Nickel-Cadmium (Ni-Cd), Nickel Metal-Hydride (Ni-MH), and Lithium-Ion (Li-Ion) (National Semiconductor, SNVA533). The Lithium-Ion battery has the lightest weight among the rechargeable battery, at the same value of energy density. It is also has smallest value of energy losses. A combination between constant current and constant voltage control is used as a charging plan for Lithium-ion battery.

Based on its capability of energy storage, construction of battery is often associated with the combination of series and parallel connection. Hence a specific amount of energy, voltage and current can be achieved. Battery cells is defined as the smallest unit of a electrochemical process, which is consist of electrodes, electrolyte, separator, and terminal. The most important component is anode, cathode, and its ion conductor.

According to Linden (2002), a suitable material for anode and cathode must be carefully selected, so that the voltages can be as high as possible. Not only ion-conductive but also high value of electron conductivity is needed during building a battery cells. This cells has a different characteristic compared to the ion transfer media. This cells only have ion conductivity properties. This properties is needed to avoid such a short circuit problem that may occurred bet anode and cathode in battery cells. Hence, an additional losses in the form of heat can be minimized.

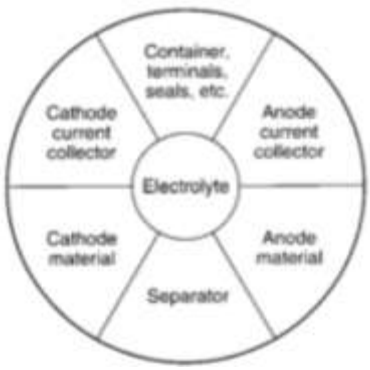

Fig.1. Battery cells component [1]

Battery is divided into two types of categories, primary and secondary battery. Primary battery is one-time usage. In other words, after its energy is completely depleted, should be thrown away. On other hand, a secondary battery can be used in many cycles of charge and discharge. The charging process can be done easily by inject a direct current into the battery pole. A lot of application uses secondary battery as the main energy storage. The example are handphone, smartphone, and UPS. Secondary battery has a separated connection with its electrolyte parts.

Fig. 2. Reserve Battery

According to Mariej Jozef Swierczynski [4] Fast charging method is used to speed up the charging duration. But it also has some serious drawback such as an overheating process that can trigger some explosion. Beside overheating problem, the amount of lifetime is also reduced if there is an excessive amount of heat losses. A lot of battery manufacturer create a reference graph as a guide to charge or discharge the battery product. In this paper Lithium-ion 18650 is chosen as the main research subject.

Sugiarto (2004) [7] stated that recharging batteries can be done by the use of the voltage is constant , the current value depends on the difference between voltage source and battery voltage. At the beginning of the charging, the current value is high, because the battery is still on low capacity. The current flows will be small if the battery voltage source approach full load condition. The most notorious weakness of this method is cannot predict the charging duration. In addition recharging batteries can be done by a source of of the current which is constant, where a source of a current does affected by voltage change which is with the battery.

Mariej Jozef Swierczynski (2015) stated that battery charging can be done by constant current method, where the current magnitude is remain constant regardless of battery voltage. A fast charging method also can be used as charging method, but has a high chance of reduced battery lifetime due to unknown charging duration.

The most commonly used term of battery charging method, is controlled and uncontrolled. The controlled method consist of constant current method, constant voltage and smart charging. Uncontrolled methods is done with a large potential difference with high current flow. The purpose of this method is to achieve short amount of charging time. The drawback of this method is lack of actual time controlling devices. Thus, this method can make the battery quickly damaged. In this method, voltmeter or hydrometer is used to determine the battery capacity when the predicted charging duration is complete.

Based on previous description, a sampling method to generate charging graph is carried out in this paper. A mathematical model and charging circuit based on the manufacture reference is presented. The charging method use a comparison between actual measured current and factory reference model. The output current is measured corresponding to the changes of battery voltage based on factory reference. The output current is adaptively changed in accordance to the voltage value. The proposed method is digitally implemented. The hardware implementation is carried out in Electrical Engineering Department Laboratory

A Lithium-Ion LIR 18650 6800 mAh is used in this research. The charging duration is 180 minutes with 30 seconds of sampling time. The experimental results served in a voltage and current graph as a function of charging time.

The experimental activity begins with defining the charging plan and the load type. The corresponding battery voltage and current are measured. The measurement result is used as mathematical model to generate the output signal. The generated voltage and current is always compared with the previous mathematical model. If the battery charging current is still the same after the charging process occurred, then the battery is declared as failure. On other hand, if there's any change as a response due to charging current, the charging process will continue with estimated charging time of 180 minutes. During charging process, the measured parameter is compared with the mathematical model. Hence, the amount of the deviation can be calculated.

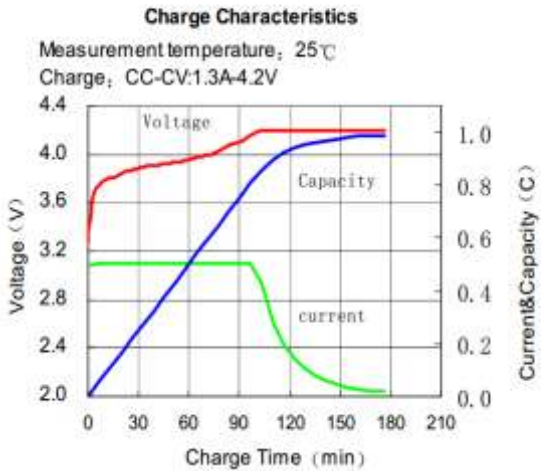

Fig. 3. Factory reference model

The measured parameter is compared with the generated mathematical model. Thus, the amount of the deviation can be calculated. The charging circuit is consist of power supply, voltage sensor, current sensor, and a microcontroller. The output voltage is generated by PWM controller.

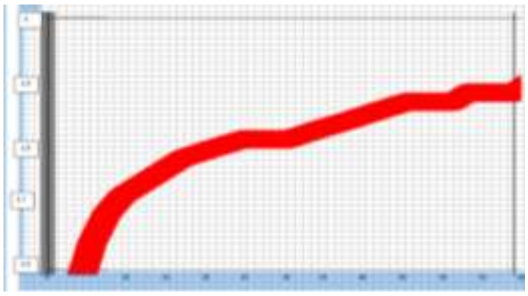

Fig. 4. Captured charging graph with 180 minutes of duration @ 30 seonds of time division

No	Time (minutes)	Current (A)	Voltage (V)	Capacity (%)
1	1	0,473684	3,377778	0
2	1,5	0,473684	3,411111	0,5263
3	2	0,473684	3,444444	1,0526
4	2,5	0,473684	3,522222	1,57895
5	3	0,473684	3,6	2,1053
6	3,5	0,473684	3,6333335	3,1579
7	4	0,473684	3,666667	4,2105
8	4,5	0,473684	3,688889	4,73685
9	5	0,473684	3,711111	5,2632
10	5,5	0,473684	3,722222	5,7895
11	6	0,473684	3,733333	6,3158
12	6,5	0,473684	3,733333	6,8421
13	7	0,473684	3,733333	7,3684
14	7,5	0,473684	3,733333	7,89475
15	8	0,473684	3,733333	8,4211
16	8,5	0,473684	3,7555555	8,9474
17	9	0,473684	3,777778	9,4737
18	9,5	0,473684	3,777778	10
19	10	0,473684	3,788889	11,0526
20	10,5	0,473684	3,8	12,10525
21	100,5	0,426316	4,177778	95,7895
22	101	0,421053	4,177778	95,7895
23	101,5	0,4157895	4,188889	96,3158
24	102	0,410526	4,2	96,8421
25	102,5	0,405263	4,2	96,8421

II. CONCLUSION

In this paper, a sampling method to generate the Lithium-Ion battery charging graph is presented. By using Visio method, a charging graph with 180 minutes of duration and 30 seconds time division is constructed.

The proposed charging graph is verified with the experimental result. The results shown that sampling method can used as a potential alternative to conventional charging method.

REFERENCES

[1]. Linden, D. (2002). Handbook of Batteries. McGraw-Hill.

[2]. Triwibowo, J. (2011). Rekayasa Bahan Katoda Lix TIMnFe dan Pengaruhnya Terhadap Performa Solid Plimer Batterai Lithium. Jakarta: Tesis.Universitas Indonnesia.

[3]. Noh, M. (2016). Ast-charging of Lithium Iron Phosphate Batteray with Ohmic-drop Compensation Method. Elsevier Ltd.

[4]. Mariej Jozef Swierczynski., A. I. (2015). Suggested Operation Grid-Connected Lithium-Ion Battery Energy Storage System for Primary Frequency Regulation: Lifetime Perspective. IEEE Energy Conversion Congress and Exposition (ECCE) - Montreal, Canada.

[5]. J.Lopez., M. V. (2004). Fast-charge in Lithium-ion Batteries for portable applications. IEEE.

[6]. Hao Chen, Julia Shen, (2017) A.degradation-based sorting method for lithium-ion battery reuse

[7]. Sugiarto.I, d. L. (2004). Smart Cahrger NiCd dan NiMh dengan Teknik Pengisian Pulsa. Proceedings Komputer dan Sistem Intelijen (KOMMIT2004).

Imam Saukani " A Sampling Method on Lithium-Ion 18650 Charging Graph." International Journal of Research in Engineering and Science (IJRES), vol. 06, no. 05, 2018, pp. 49–52.