

**PROCEEDINGS**  
**4<sup>th</sup> International Conference on Technical  
and Vocational Education and Training (TVET)**

**Theme:**  
**Technical and Vocational Education and Training  
for Sustainable Societies**

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## **4<sup>th</sup> International Conference on Technical and Vocational Education and Training (TVET)**

**Theme: Technical and Vocational Education and Training for Sustainable Societies**

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## FOREWORD

Welcome for all respected scholars, researchers, post graduate students and especially Keynote Speakers to the 4 ICTVET. The theme of the conference focus on Technical and Vocational Education and Training for sustainable societies and consist of six subthemes. i.e Development of learning model on TVET, Workplace Learning and entrepreneurship, Innovation on applied engineering and information technology, Management and Leadership on TVET, Vocational and Technical Teachers education, and Assessment and Evaluation on TVET.

Sustainable society should be followed by the improvement of various factors that have impacts to the quality of vocational and technical education and training, particularly to overcome the competitiveness of the world business. As we have already known the rapid change of technology as well as the change of demography, having a great effects to the life of peoples in this world, The competitiveness need a collaborativeness to survive the life of millions peoples who lost their jobs. Young peoples as a productive generation have to be creative and innovative to face the competitiveness. So this proceeding contents consist of various findings of research in the field of vocational and technical education as well as applied technology and mainly based on the subthemes of the conference.

Finally, we would like to thank a million for all participants of this conference and all parties who support the success of this conference. Hopefully the seminars and scientific work of this seminar can be a reference material for basic education and elementary school teacher education in Indonesia.

Padang, July 2, 2018

Tim Editor

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## CELL ROTATION TO RESOLVE THE WEAKEST CELL DAMAGE IN THE BATTERY PACK IN DISCHARGING PROCESS

Irwanto Zarma Putra<sup>1</sup>, Citra Dewi<sup>2</sup>

<sup>1,2</sup>Department of Electrical Engineering Faculty of Engineering  
Universitas Negeri Padang Jl. Prof Hamka, Air Tawar, Padang, Indonesia

**ABSTRACT:** This paper discusses the use of batteries in battery packs that will explore the tendency of weakness in some battery cells. In the battery pack, there will be a battery cell that becomes the biggest damage target caused by undervoltage in the discharging process. Undervoltage occurs because of the difference in voltage values on each cell in the battery pack. The circuit becomes one of the factors causing a difference in cell voltage value in the battery pack. Therefore the cell rotation method is offered. This method will attempt to repair the difference in voltage values in the battery pack. The repair is focused on battery cells that will be under voltage in every discharging cycle that is conducted to keep the battery condition to be maintained. The displacement of the cell with the lowest value to the cell with the highest value successfully eliminated the weakest cell which constantly experiences greater stress than other cells in the circuit in the discharging process.

*Keyword: Battery, Battery pack, Cells Rotation, Discharging.*

### 1. INTRODUCTION

The battery is one of the main components in the use of portable devices and electric vehicles which is developing better. The use of battery in portable devices and electric vehicles uses more than one cell batteries to supply the energy needs. The existence of batteries in electric vehicles has a high economic value compared with other devices [1] so a research about maintaining the condition of battery cells to be in good condition and work optimally is needed to be conducted. This paper is proposed a new method to maintain the cell battery on the battery pack to be optimal.

### 2. BATTERY

The battery is a device used to save energy through an electrochemical process. Electrical chemical occurs when charging of electric energy is converted to chemical and when discharging of chemical energy is converted to electric energy [2].

A battery consists of several cells that are connected in series or parallel to obtain the required voltage value of electronic devices. Battery capacity is affected by several factors [3] such as a number of active materials, material type, temperature, battery life, operational usage, and maintenance.

The battery used in this study is Lithium-ion battery. The lithium-ion battery is commonly found in electronic devices. The lithium-ion battery was

first discovered by Whittingham in 1960. This battery is one of the most popular rechargeable battery types today. Some of the advantages of a lithium-ion battery are having high energy specifications [4], no memory effect, long charging and discharging cycles [5], and easy maintenance [6]. In addition, to use in electronic devices, lithium-ion battery is also widely used by industry, military equipment, electric vehicles [7].

### 3. BATTERY CELL ROTATION AND THE MECHANISM OF CELL DISPLACEMENT

The new method applied in this study is cell rotation. The method is based on the explanation stated [1] that there is a cell that will be the weakest cell or in other words, the cell will be damaged firstly compared to other cells caused by the imbalance of the cell.

The circuit becomes one of the factors causing the different value of cell voltage in the battery pack, therefore the cell rotation method is proposed. This method will attempt to repair the difference value in the battery pack. The repair is focused on battery cells that will undergo under voltage in charging and discharging cycle that is conducted to keep the battery condition maintained.

The application of the cell rotation method is also limited to batteries that have not experienced many charging and discharging cycles. The limitations are made on the basis of internal custody

owned by each cell that has not undergone many changes.

The process of charging and discharging performed as much as 9 early cycles to determine the pattern of voltage value changes for 6 lithium-ion battery cells that are arranged series. 9 cycles of charging and discharging which selected based on changes in internal resistivity and battery capacity that will occur in every cycle are not too significant [8]. The charging and discharging process is done to detect which cell becomes the weakest cells and the strongest cell in the battery pack. From 9 cycles of charging and discharging, the result showed that cell 3 is the weakest cell in the battery pack and cell 4 is the strongest cell in the battery pack. The weakest and strongest battery cell position changes were performed that is from cell 3 to cell 4 and vice versa then the experiment for 9 charging and discharging cycle was done again to determine the changes and improvements that occur in the battery pack.

#### 4. RESULT AND DISCUSSION

The method was applied in the charging and discharging process, but the significant effect only occurred on the change of voltage value in the discharging process. The experiment was conducted in 9 cycles of discharging with the battery voltage value of 24 V and each cell voltage of 4V. The discharging process was conducted with a load value of 50 W with constant load discharging technique. The experiment occurred averagely on 85 minutes with a limit of loading stopped when one cell reached its minimum voltage of 2,7 V.

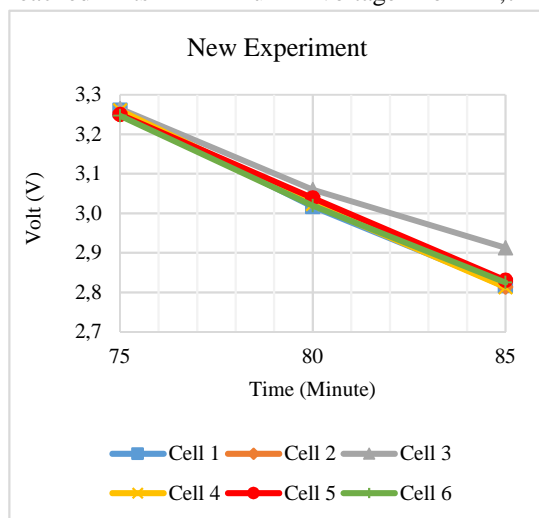


Figure 1 : Detail of Initial Discharging Experiment Data

In the preliminary experiment, the battery was given a load of 50 W with an average time of

experiment of 85 minutes. The experiment was stopped when cell 3 of the battery pack reached a voltage of 2.7 V. From the beginning of the experiment until the 70<sup>th</sup> minute, the changes of voltage value on each cell was relatively balanced, there is no noticeable difference in voltage values, the decline in voltage value that is very sharp and voltage differences on each cell was begun from minute to 75 until the end of the experiment. Cell 4 became the cell with the highest voltage value from the other cell at the end of the experiment. The experimental data showed that cell 3 became the weakest cell and cell 4 became the strongest cell in battery pack. Based on these data and previously described mechanism, the change of battery composition on the battery pack was done, where the weakest cell is placed in the strongest cell position and otherwise and repeat new experiment to determine the result of the change of voltage value in the battery pack.

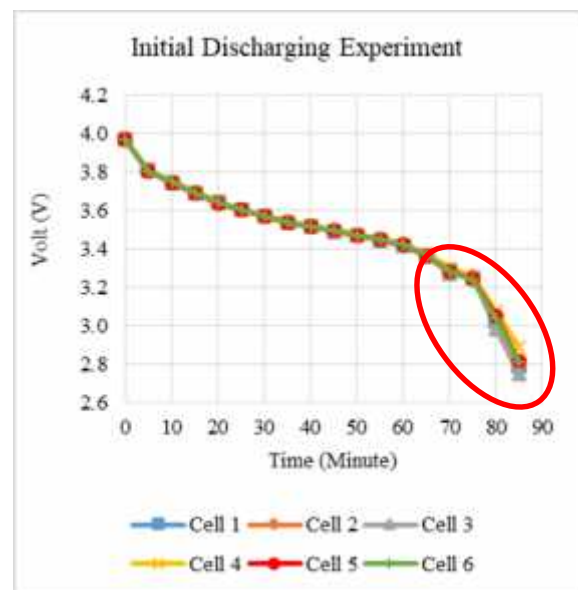


Figure 2 : Initial Discharging Experiment Data



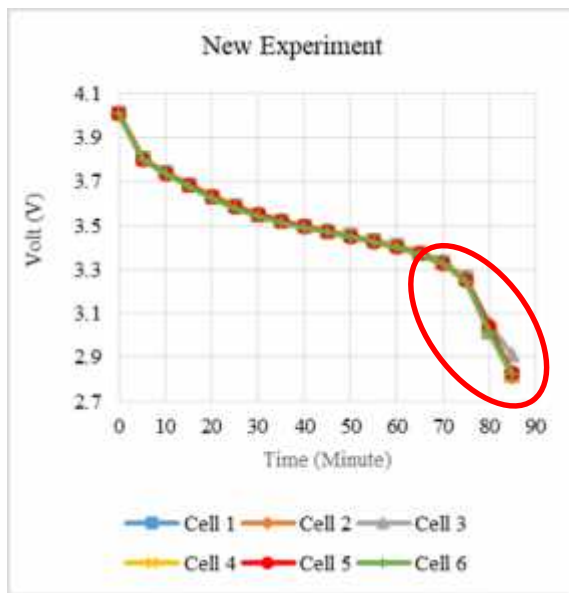


Figure 4 : New Discharging Experiment

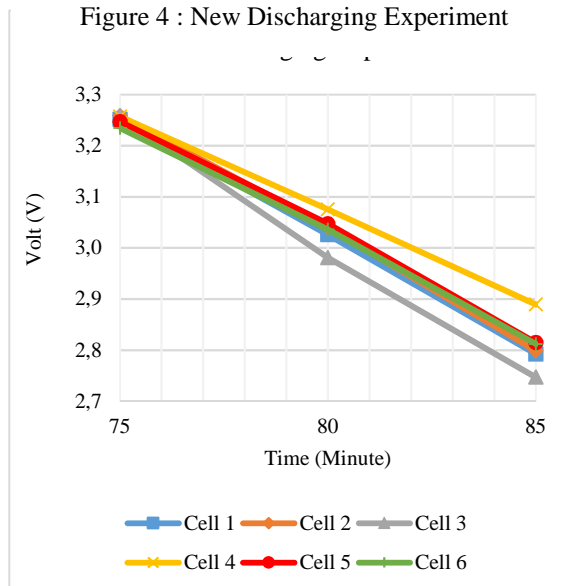


Figure 5 : Detail of New Discharging Experiment

The new experiments performed after the changes in the battery sequence, data showed that the decreasing in volatage value is fairly drastic occurs only at the beginning and at the end of usage. No more cells are found to have lower values than other cells but still get the cells with higher voltage values than other cells. Cell 3 became a cell with a higher value than the other cells at the end of the experiment.

The variety in the standard value of deviation was occurred in the preliminary experiment, cell 3 had higher deviation than other cells that was 0,289

and cell 4 had lower deviation than other cells that

	N	Minimum	Maximum	Mean	Std. Deviation
<b>Initial Experiment</b>					
Cell 3	18	2.747	3.971	3.47628	.289234
Cell 4	18	2.889	3.971	3.49267	.258304
<b>New Experiment</b>					
Cell 03	18	2.913	4.010	3.48767	.257305
Cell 04	18	2.813	4.011	3.47850	.274842

was 0,258. In new experiment, only 1 variety of

**TABLE 1** : Descriptive Statistic

standard deviation value that was on the cell 3 which was smaller than other cells that was 0,257. The higher the deviation value of data means the higher the variety of the data. With the average value of each cell which was almost same, so the preliminary experiment could be stated to have a larger variety of change values than new experiments.

The method proposed in this study is only applicable for the change on batteries that have not yet experienced the cycle. This method successfully resolved a difference in battery cell voltage which will adversely effect on the cell in discharging process. The repair resulted was eliminating the lowest cell by placing the cell in the highest voltage cell position. At the end of this study, It can be concluded that the cell rotation method proposed has a more effective role in the discharging process.

## 5. CONCLUSION

The displacement of the cell from the lowest to the highest successfully eliminated the weakest cell which constantly experiences greater stress than other cells in the circuit in the discharging process. The repair is only applied to the battery which has not much charging and discharging cycle because of other undefined factors due to the effect of this study.

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