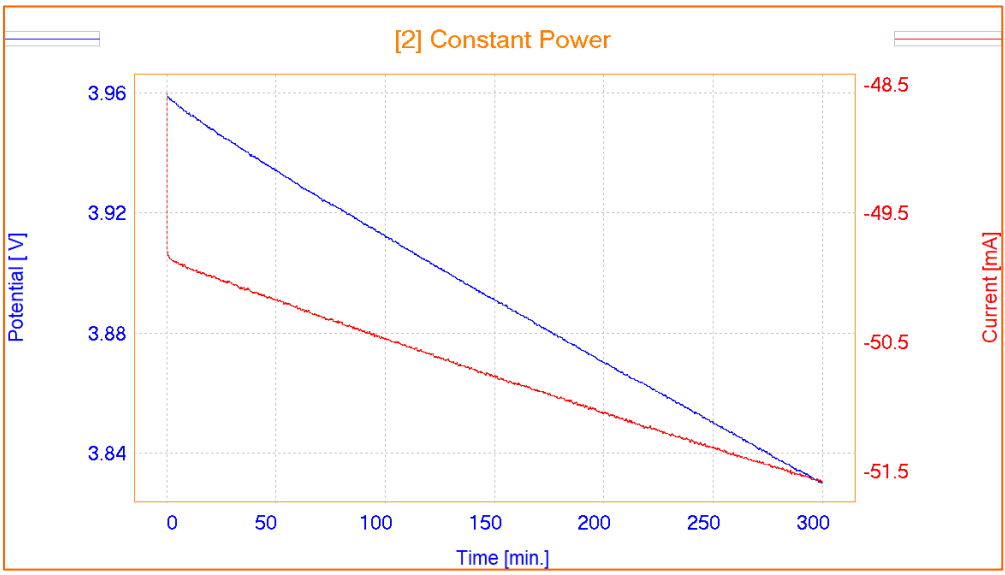
Application Note

Battery AP-B03

Constant Power



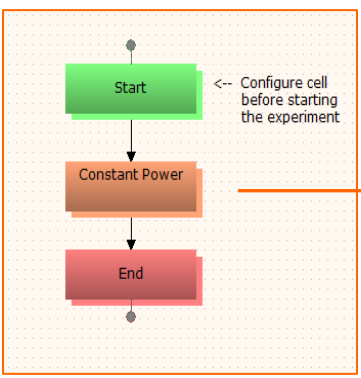
This Application Note describes about a very useful method for testing batteries in long or short term. The power of battery will be kept constant by imposing current and measuring potential during time. Changing the potential and current of the battery, will be investigated.

Introduction

A Constant Power method consists of imposing a charging or discharging current in order to maintain the power of the battery constant. It means that the absolute current imposed to the battery increases or decreases upon time as the measured potential changes to keep the power of the battery, constant. This is one of the method through which the quality of different energy suppliers like battery, supercapacitor, fuel cell could be tested and analyzed.

Parameters

This experiment was performed by OrigaMaster software. The parameters are shown in figure 1.



Constant Power	
Power	200, mW
Duration	10, hour
With current	<0
Keep |current| <	400, mA
Limit potential (mV)	3000
|Charge variation|	0, mA.h
Record every dE (mV)	10
Meas. period (sec.)	1
Record every dQ	0, mA.h
Analog Filter	Auto
Open circuit at end	Yes
Ordinate Y2	Current

Figure 1: Parameters of Constant Power method

In this example, we perform a discharge (with current < 0) at 200 mW until we reach the duration (10 h) or the limits in current or potential, set as below:

- ✓ Current < -400 mA (or absolute current > 400 mA)
- ✓ Potential < 3,000 mV

TIPS: By setting the « With current » parameter, you perform a charge or a discharge:

<0 = Discharge
>0 = Charge

MOST IMPORTANT PARAMETERS

The most important parameters of this method that must be known are as below:

- **Power:** Sets the power that must be maintained constant throughout the overall experiment.
- **Duration:** The duration of keeping the power of battery in constant value.
- **With Current:** If it is defined as >0 it means the instrument performs a charge. If it is defined as <0, it means it is discharging.
- **Keep Current:** In the "Keep current" the maximum current limitation must be defined. The system will stop if the current reaches this limit.
- **Limit Potential (mV):** In the "Limit Potential" part, the maximum limit of potential must be defined, which means the system will stop if the potential reaches this limit.
- **Ordinate Y2:** It is possible to select the displayed data on ordinate Y2: Current, Coulomb, Temperature or Vs (Auxiliary potential). If the current is selected in this box, by looking at the current on Y2 axis, you can easily understand it is a charge (positive polarity) or discharge (negative polarity) process.

NOTE: OrigaMaster software calculates the I current to be imposed to the battery in order to maintain a constant Power as :

I (A) = Power (W) / E measured (V)

So, it is important to always consider this equation and define the values of the three parameters of the method based on this equation. For example, if the Maximum current (Keep current) is defined as 100 mA and the Power fixed at 1 W so the potential must not be more than 10,000 mV. These parameters must be defined correctly on the OrigaMaster.

Results

Figure 2 shows the curve of potential versus time and current. The imposed current is negative, and the battery is being discharged.

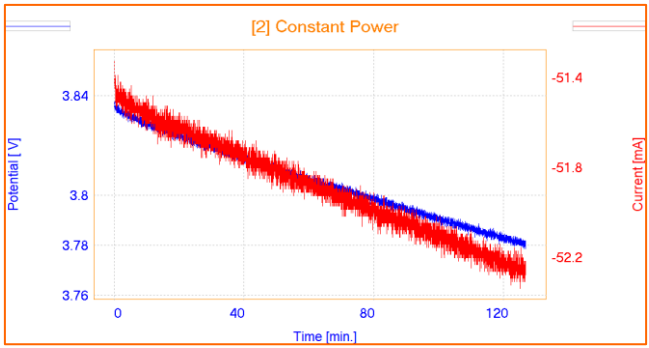


Figure 2: Constant Power curve after imposing negative current to battery sample

The slope of changing potential of battery during the constant power test is directly related to the quality of battery. The higher the slope the lower the quality of material used inside the battery.

Figure 3 also shows the constant power test on the same battery by imposing positive currents and measuring the potential. Here the value of current imposed decreases as the battery measured potential increases as the power must remain constant at 200 mW for 5 hours. Here the current is positive, so the battery is charging in constant power.

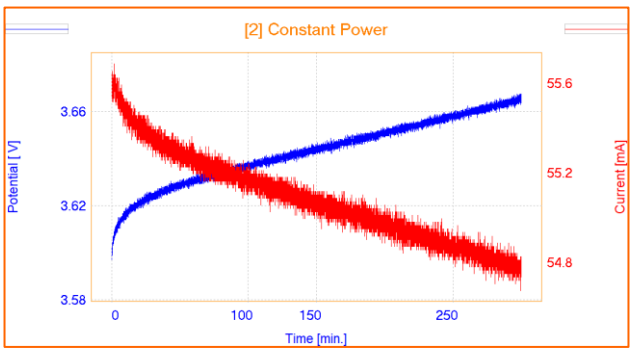
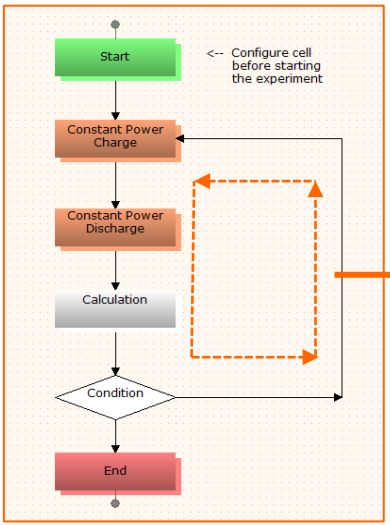


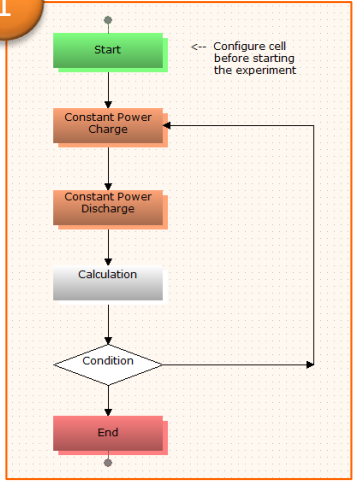
Figure 3: Constant Power curve after imposing positive current to battery sample

HOW TO INCREMENT Charge/Discharge cycles with Constant Power method



TIPS: By using "Calculation", "Condition" and "Linkable line" tools, we create a manual loop. By this way, the Constant Power method can be repeated as many time as needed through a defined cycle for charging and discharging the battery.

1



CREATE THE FLOWCHART

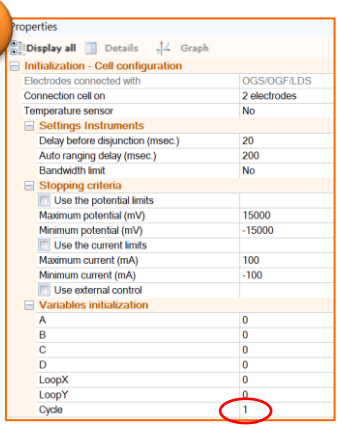
Insert all the methods and tools in the right place:

1. Start
2. 1st method (Constant Power with positive current)
3. 2nd method (Constant Power with discharge current)
4. Calculation
5. Condition
6. End

Then, with "Linkable line" tool, create a line between the beginning of the loop and the condition.

Finally, link this line with "Condition" and the first method of the loop.

2



CHECK THE VARIABLE

In the START, we define a variable which will be used for the manual loop:
A, B, C, D, LoopX, LoopY and Cycle.

Here the "Cycle" is defined as variable loop.

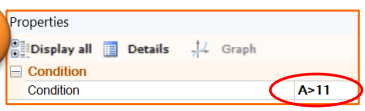
3

CREATING THE EQUATION OF THE LOOP

The calculation is the incrementation, so the concept is to create an equation. In this example no value of each parameter will be changed, and just the charge and discharge in constant power will be performed in 11 cycles, so "Cycle" will be defined as default:

Cycle = Cycle + 1

4



CREATING THE CONDITION OF THE LOOP

We have defined the equation behind the loop, now we need to define when the loop ends.
In this example, we want to stop the test after 11 cycles of charge and discharge.

We put Cycle > 11

HOW TO PERFORM A PROCESS
to analyze the evolution of the battery

After ending the test, now we have 11 cycles of charge and discharge. Then, by overlaying (see below the process) and by clicking on the "process" button, the whole cycles will be showed in one curve enabling user to compare and analyzing the result (figure 5).

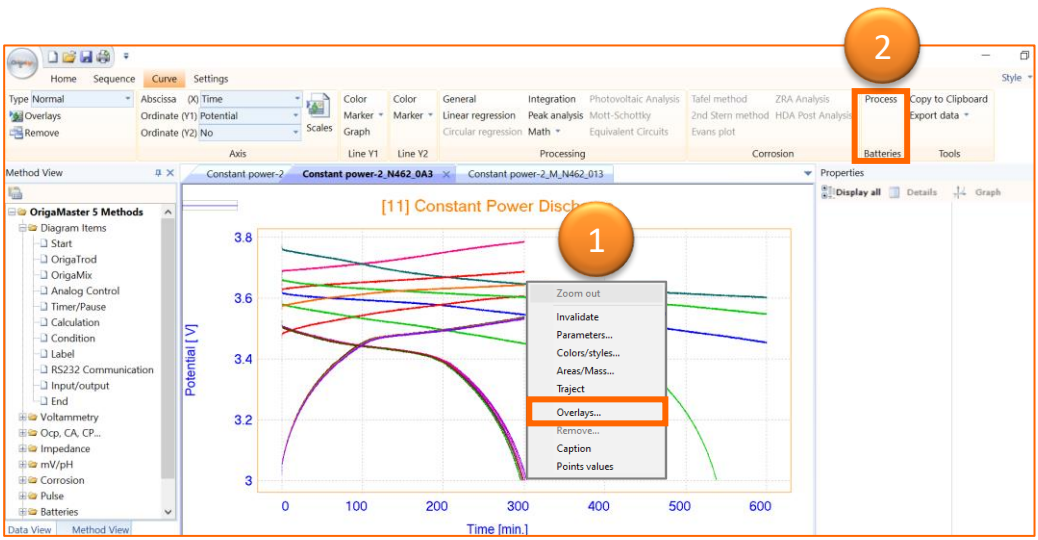


Figure 4: 22 curves (11 charges and 11 discharges) of Constant Power after performing overlay

1

OVERLAY ALL THE CURVES IN THE SAME GRAPH

Right click on the graph and choose Overlay option.
Then, select all the curves you want to overlay.

2

PERFORM PROCESS

In Curve section, go to Process.
The software will put all the curves in a raw versus time, select all the curves you want to overlay.

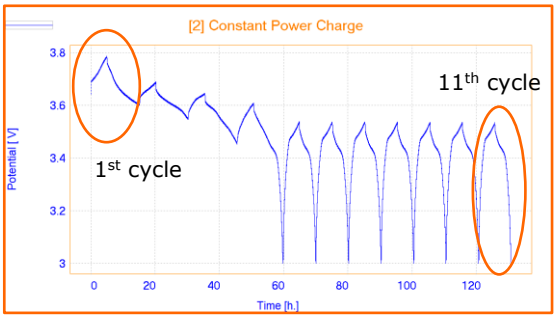


Figure 5: 11 cycles of Constant Power after performing Process

It could be understood from figure 5 that during the first 4 cycles the battery is going to be discharged but not completely. From the 5th cycle the battery is completely discharged.
All these behavior directly depend on the quality of the battery and the parameters of the method.

APPLICATION: Long life of a battery, quality of the materials inside a battery can be tested and analyzed by Constant Power method.

This method is beyond a simple charge and discharge method and could be used for wide range of samples covering both qualification and quantification analyzing.

Instrument and Electrodes

Figure 6: OrigaFlex OGF500

Electrode setup	
Battery Sample	Ni-Cd 1.2V, 600 mAh
Instrument	OrigaFlex OGF500
Software	OrigaMaster

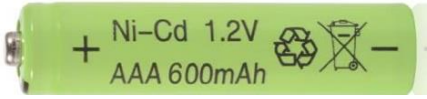


Figure 7: The battery sample

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