

# CR and SOF Behavior in LABs Under Advanced Operating Conditions

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**ITEMM**  
Laboratórios

Identify the mechanisms that truly define charge recovery relevant to real vehicle operation and to determine how they should guide charging strategies and battery design.

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## Battery Specifications:

|          | EFB  |
|----------|------|
| Voltage  | 12V  |
| Capacity | 49Ah |



## Mechanisms to study

- 1- Advanced aging states (end of life)
- 2- Electrolyte conditions inside the plate pores
- 3- The first minutes of charging
- 5- Different charge voltage strategies
- 5- Aggressive duty cycles such as FOTA
- 6- The contribution of carbon additives

## Why the First Minutes of Charge Really Matter

### 1- Early Charge Recovery Dynamics

Most state-of-function recovery happens in the first 0–6 minutes of charging, forming the critical window for SOF.

### 2- Minor Role of Electrolyte Redistribution

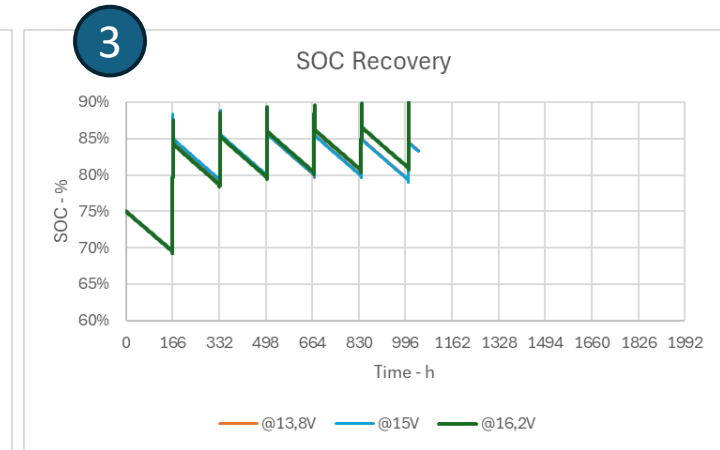
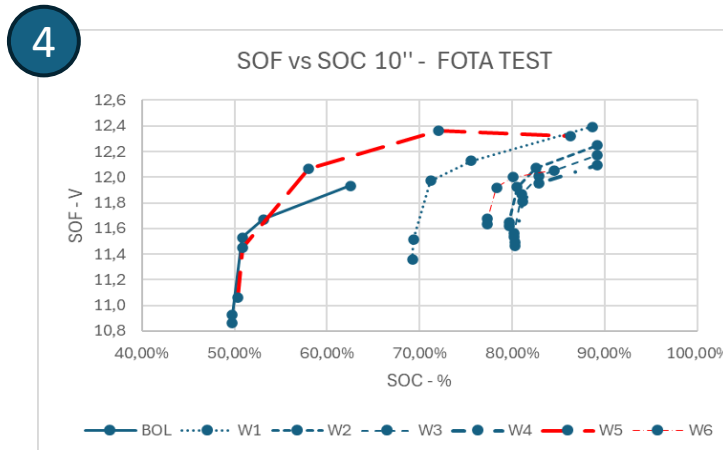
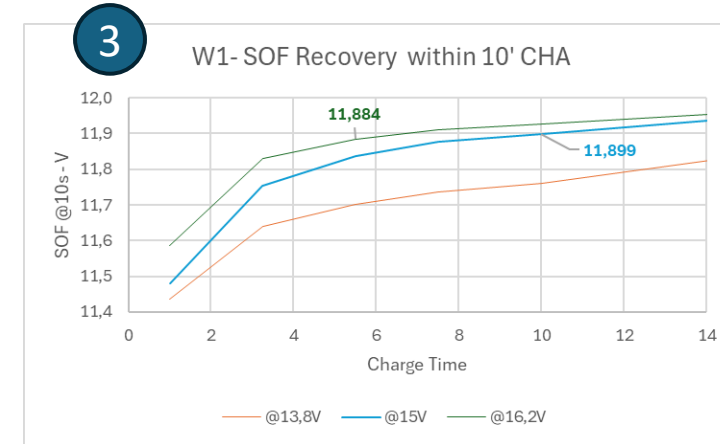
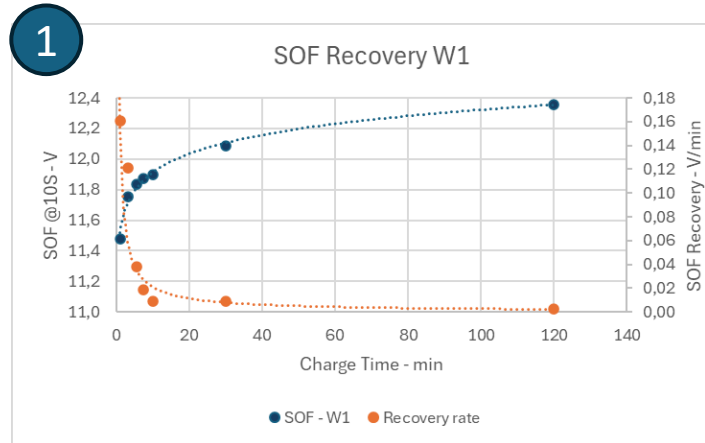
Electrolyte redistribution inside battery pores has limited impact on recovery within realistic time scales, challenging assumptions.

### 3- Charge Voltage Influence

Higher charge voltages speed up recovery but do not change the final charge recovery level significantly.

### 4- Influence of OTA discharges

Huge charge and SOF recovery after periodic discharges

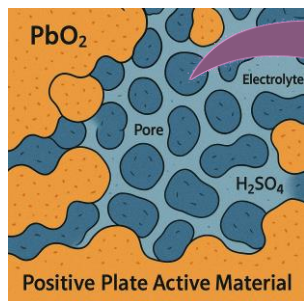


# CR and SOF Behavior in LABs Under Advanced Operating Conditions

## WHAT IS THE INFLUENCE OF ELECTROLYTE DENSITY INSIDE THE PORES ON SOF RECOVERY?

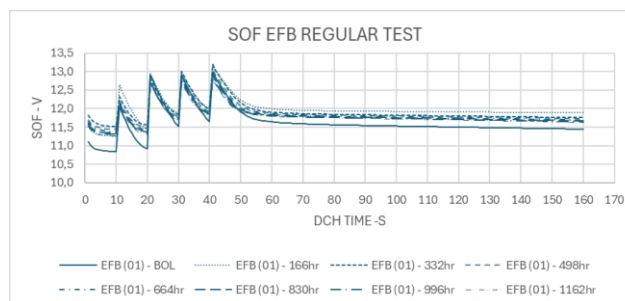
Test CR rep using pauses before SOF discharge

- Fresh batteries regular test
- Fresh batteries using 5min Pau before SOF pulse

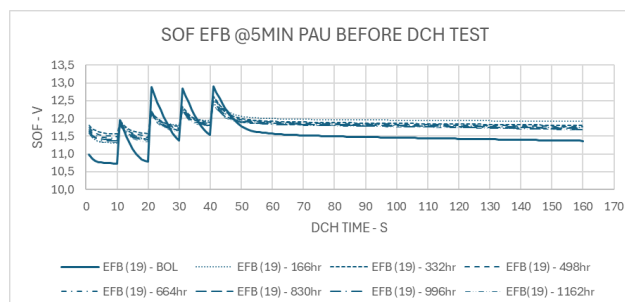


5min PAU before SOF pulse to allow fresh electrolyte comes out of the pores

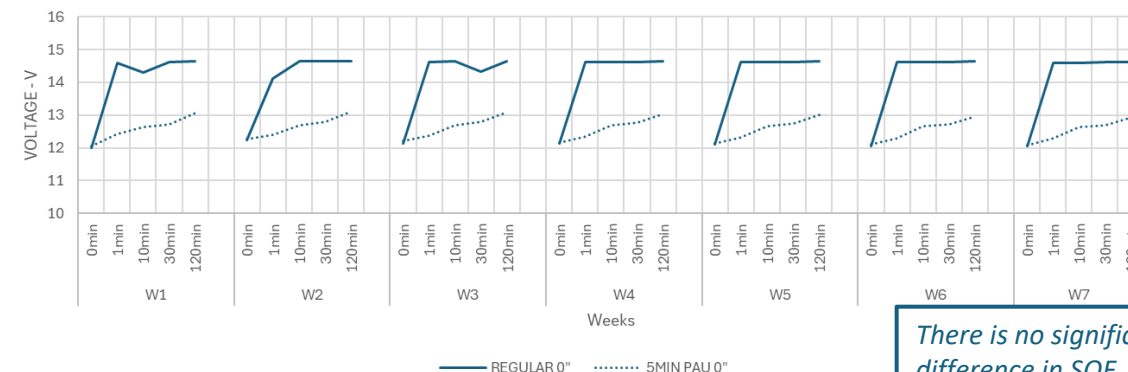
### REGULAR



### 5 Min PAU

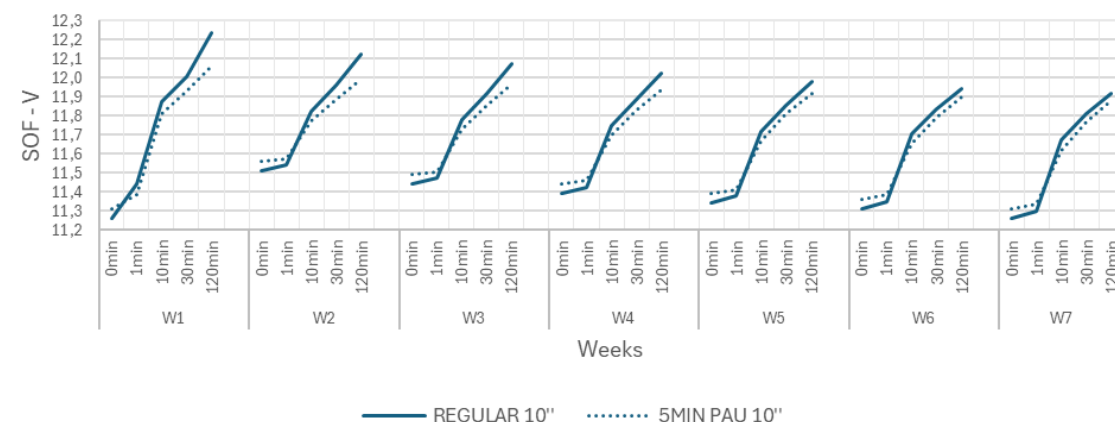


### VOLTAGE BEGINNING OF DISCHARGE



There is no significant difference in SOF using 5min PAU before discharges

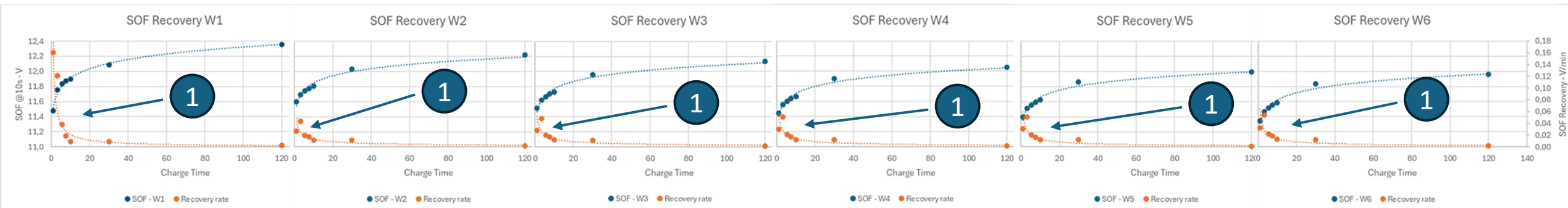
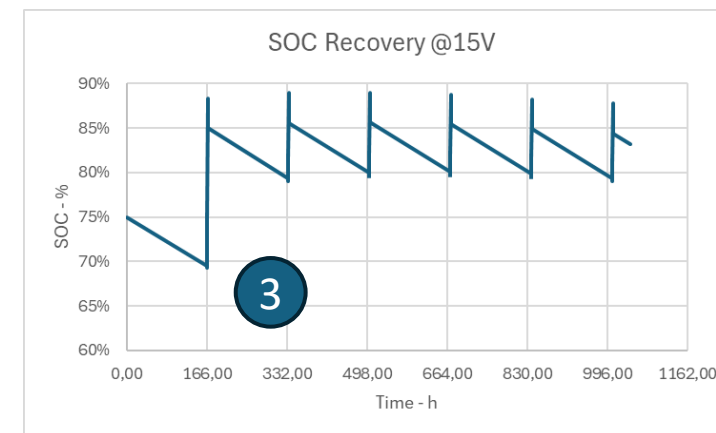
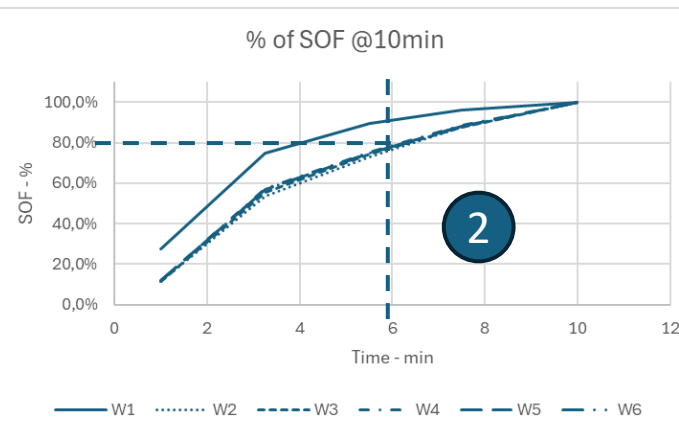
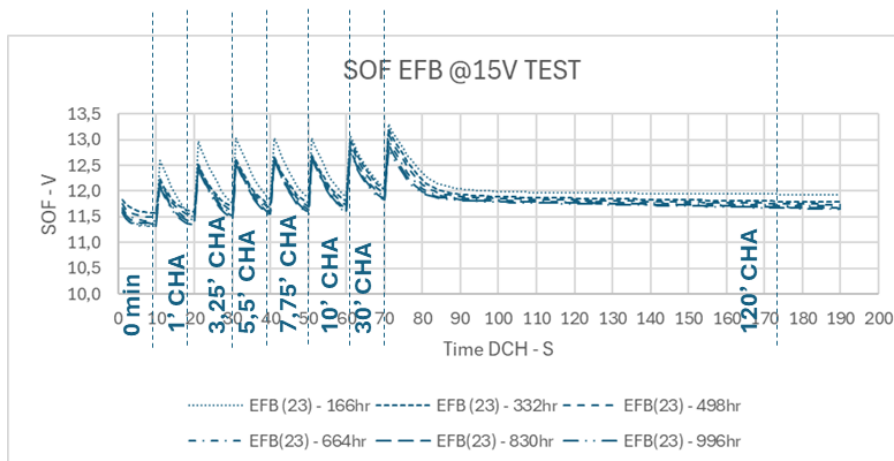
### VOLTAGE END OF DISCHARGE



Is the SOF 10" dependent on the voltage at the beginning of DCH??

### SOF recovery

- Fresh batteries including SOF pulses @1'; 3,25'; 5,5'; 7,75'; 10'

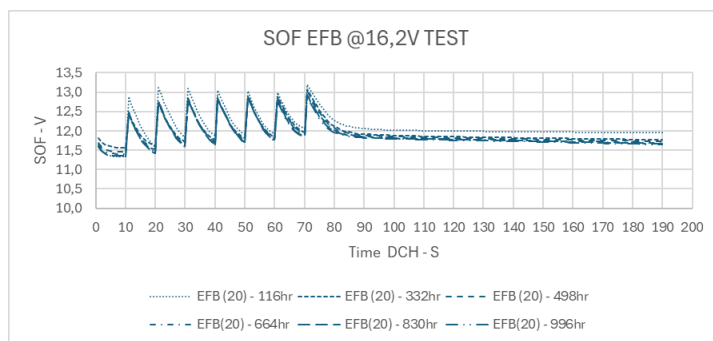
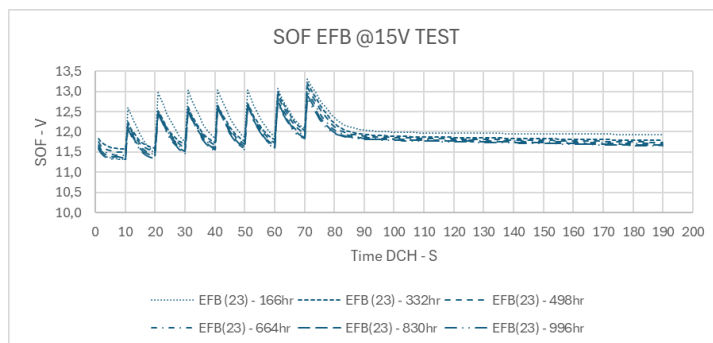
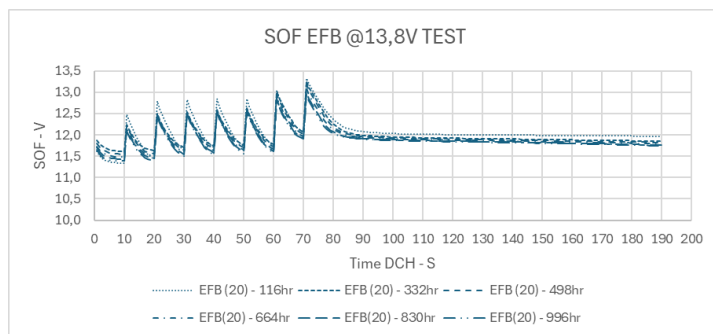
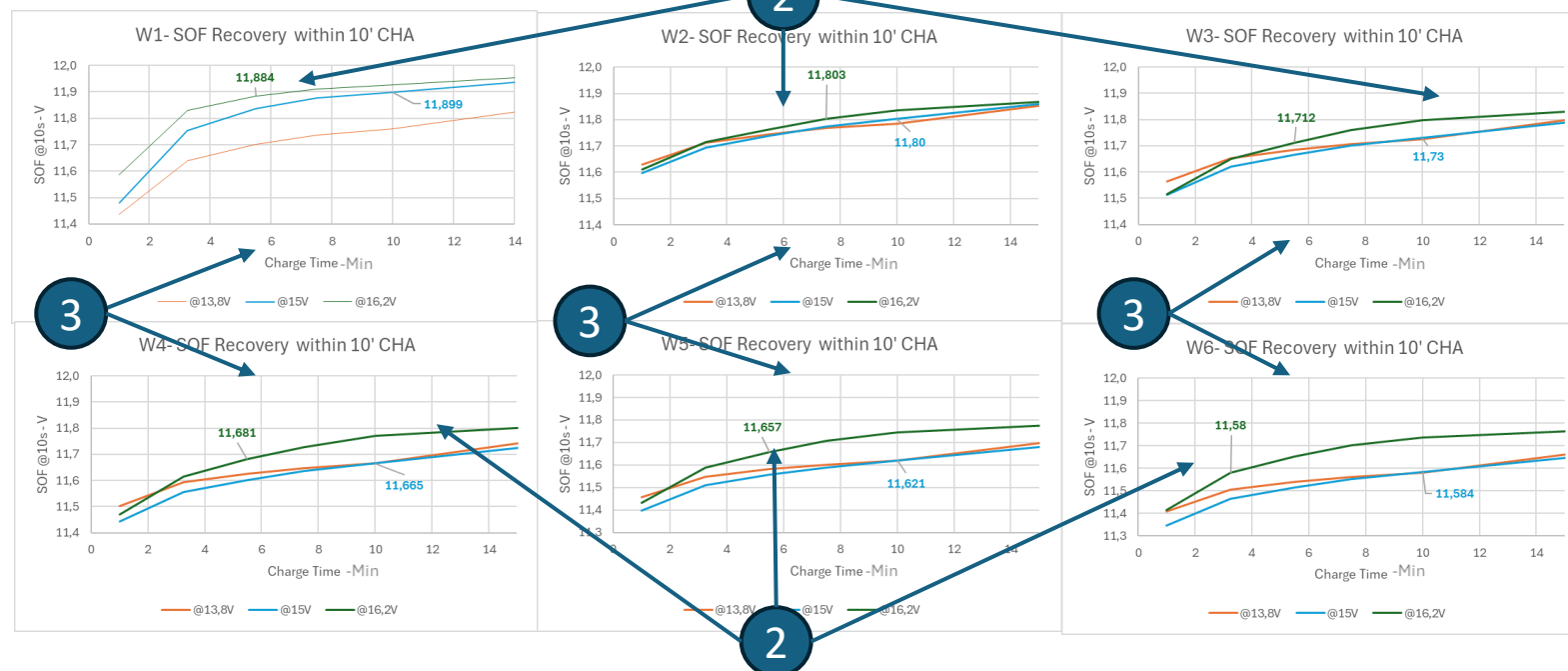
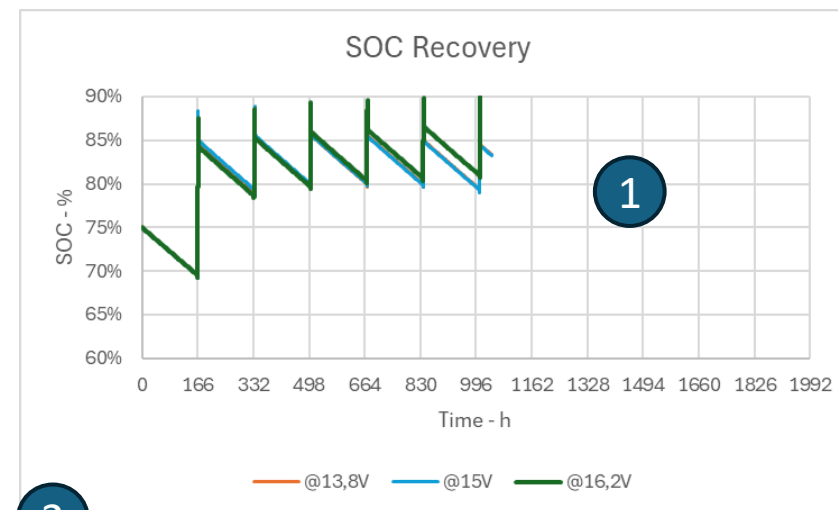


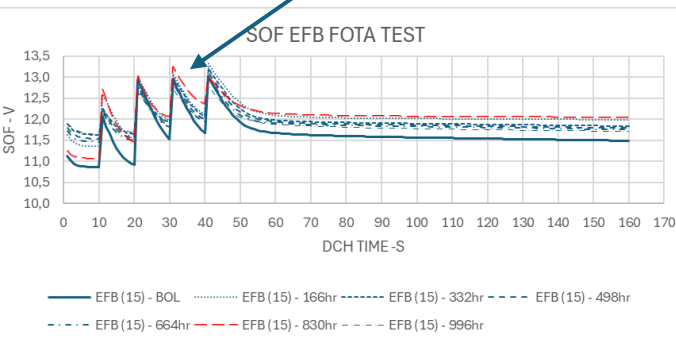
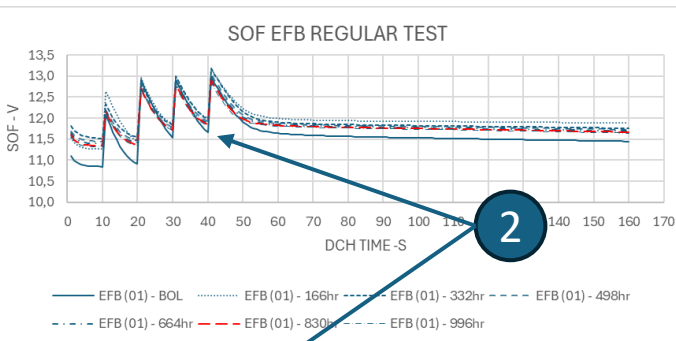
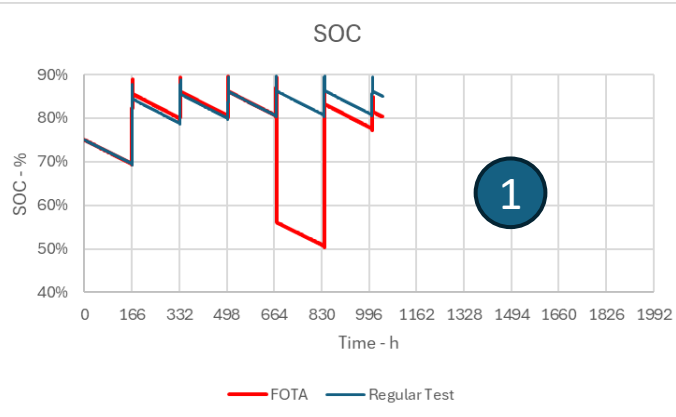
1-The SOF recovery rate decreases to a very low values after approximately 6'

2-At this moment 80% of SOF 10min is recovered

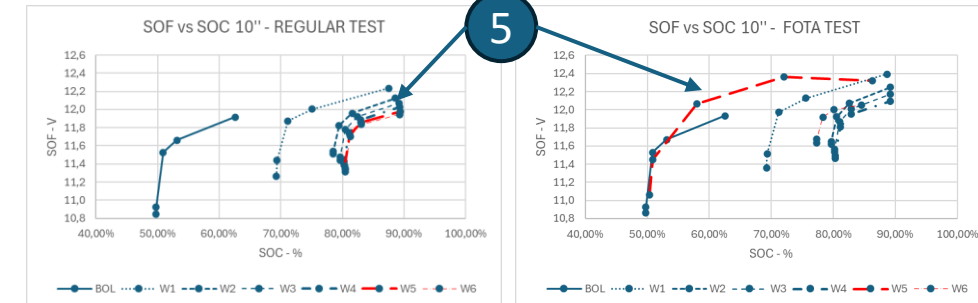
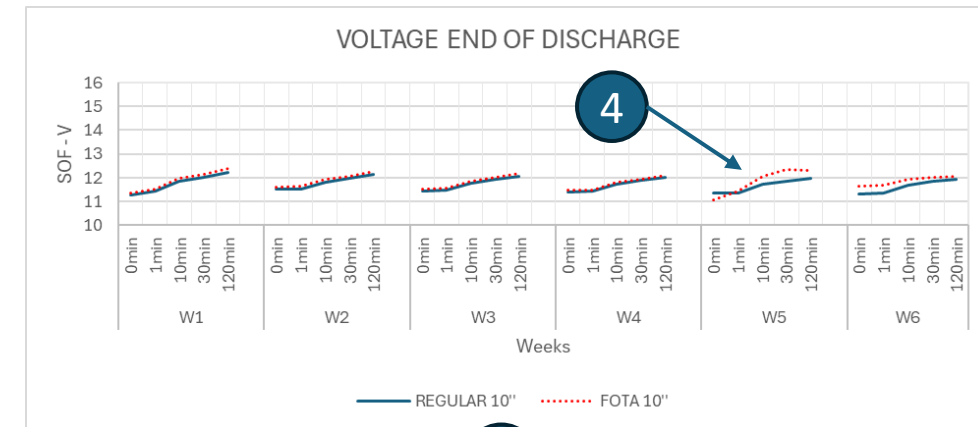
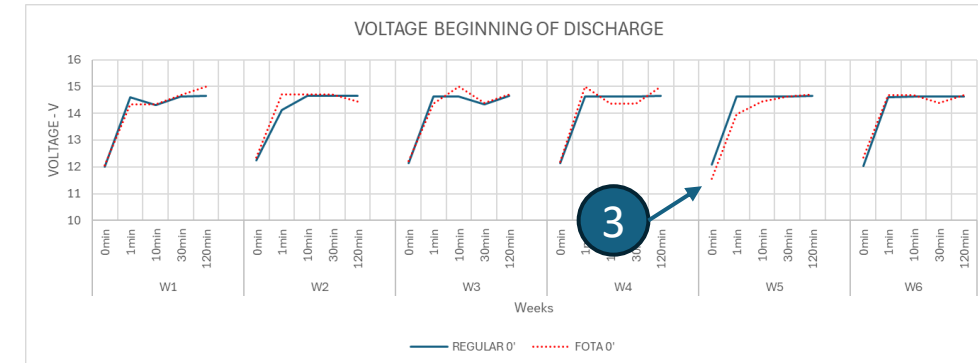
3-First week show Higher SOF recovery → low initial SOC!!!

1. No substantial advantages related to charge recovery (1st month)
2. Faster SOF recovery using 16,2V
3. 6' at 16,2V reaches the SOF10 min @15V





1. FOTA discharge removes 30% SOC
2. Recharge after FOTA (5<sup>th</sup> week) shows higher SOF recovery
3. No significant impact on voltage before discharge
4. Increase of SOF after 10'
5. Extremaly high charge recovery after FOTA discharge



1. SOF recovery rate decreases after 6'
2. Using 16,2V during recharge anticipates the SOF 10'@15V
3. SOF recovery in EFB+C using 16,2V during 5' is greater than SOF after 10' charging using 15V.
4. Extremally high charge and SOF recovery after FOTA discharge

