**Introduction**

Large-can aluminium electrolytic capacitors are widely employed in medium power converters at CERN for energy recovery purposes. Resulting voltage discharge cycles are about 25 % of capacitors rated voltage which is classified as charge-discharge application. The ultimate goal of this project is to run accelerated ageing tests in order to assess the quality of capacitors from different suppliers for charge-discharge applications.

**Background**

- **Requirements** – voltage and current cycles analyse
  - Single capacitor – voltage waveform
  - Single capacitor – current waveform

- **Construction technology** – increased heat dissipation capability: extended cathode; corrugation along capacitors
  - Taps
  - Arcade foil
  - Paper
  - Extended cathode
  - Cathode foil
  - Safety vent
  - Cover foil
  - Tabs
  - Tape
  - terminals
  - Sealing
  - Crimping
  - Stiffering
  - Corrugation
  - Extented electrodes

- **Manufacturing process** – foil pre-treatment: 1) - 2); construction and assembly: 3) - 6); foil post-treatment: 7)

- **General ageing effects** – internal causes and failure modes

- **Additional ageing effects** – charge-discharge applications:
  - High surge currents: Local tab-heating; dielectric smoothing & damage.
  - Negative voltage after completion of full discharge.

  Solutions: Low ESR; high number of tabs, more robust dielectric layer.

**Results**

- **Waveform approximation** – developed MATLAB tool for waveform processing, PSIM and DSP implementation
  - Voltage waveform: original vs. approximation
  - Current waveform: original vs. approximation

- **Cycling speed** – $\Delta V$ and $I_{peak}$ vs. cycling speed at rated RMS current
  - Voltage discharge depth vs. cycling speed
  - Peak current vs. cycling speed

- **Test set-up** – SIRIUS 2P power supply used in voltage controlled mode:
  - Test capacitor bank connected to SIRIUS 2P power supply output.
  - Anti-parallel diode for reverse voltage protection.
  - Damping resistors in series with each capacitor under test.
  - Disconnector switch for voltage ramp-up: avoid negative voltages on test capacitors.
  - Capacitor discharge switch and resistor for safe discharge.

- **Capacitor voltage cycling** – internal temperature rise for applied voltage cycle of $V = 100 \text{ V}$, $I_{peak} = 17 \text{ A}$, $I_{min} = -93.4 \text{ A}$, $I_{max} = 78.4 \text{ A}$

**Conclusions**

Accelerated lifetime tests of capacitors are prepared and the thermal investigation has to be further continued for different cycling waveforms, before selecting a definitive test waveform for charge-discharge test. All suppliers provided capacitor samples with integrated thermal couple in order to measure and analyse the internal temperature rise due to voltage cycling. The first results conclude that for higher ambient temperatures, the capacitor’s internal heat generation and hence the power losses are reduced due to lower ESR at higher temperatures.

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**References**