ULTRA-CAPACITOR MODELS
FOR ALL ELECTRIC AND HYBRID SHIP POWER SYSTEMS

Main Objective: Experimental comparison of ultra-capacitor models supporting all electric/hybrid propulsion and on board MVDC distribution marine systems in hybrid energy storage configuration.

Examples of Applications: Electric/Hybrid Ship Power Systems
- On-board Power System
  - Application of super-capacitors in on-board MVDC systems
- Ship Propulsion System
  - Architecture of a full-electric ship with batteries and super-capacitors
- Waterbus for Urban Transportation
  - ACTV Waterbus

Experimental Set-up

Experimental Tests on Single Cells
- Storage Cell Voltage Test
- Self Discharge Pulse (SDP) Test
- Dynamic Stress Test (DST) Profile
- Experimental Results on ECE 15 Driving Cycle

Experimental Tests on Super-capacitor Modules in HESS
- Super-capacitor modules
- Dynamic Stress Test (DST) Profile
- Experimental Results on ECE 15 Driving Cycle

Modelling and Experimental Results

Super-capacitor Equivalent Circuits
(A) RC equivalent circuit
(B) Equivalent circuit of the super-capacitor RC fractional model
(C) Equivalent circuit of the variable parameter model

Simulation vs Experimental Results on DST Profile
Simulation vs Experimental Results on SDP Profile

Model Performance Evaluations
- Fitting Performance Index
- Computational Effort Index

Super-capacitor Model Comparison
- RC Model
- RC Fractional Model
- Variable Parameter Model

The obtained results show that the variable parameter model (C), proposed in this paper, presents better fitting performance in comparison with both RC (A) and fractional order (B) model, with very low computational effort. In particular, for both SDP and DST test profiles, the value of error indexes is significantly reduced in comparison with RC model, whereas fitting performance of fractional and variable parameter models are quite similar.