EV+ ARC System

Safety & Performance Testing of EV Cells and Small Modules

Designed to facilitate testing of larger EV cells and modules, fulfilling requirements of SAND 2005-3123, SAE J2464. USABC / Freedom CAR and UN & UL tests

Video Monitoring • Cryogenic Operation • Battery Clamping
Controlled Speed Nail Penetration & Crush • Gas Collection
Data Examples

**EV Battery Thermal Stability Test**
*Heat-Wait-Seek leading to thermal runaway*

**EV Battery Thermal Stability Test**
*Zoomed plot showing onset temperature*

**External Short Circuit of Fully Charged Battery**
*Shorting leads to temperature rise of 100°C. After charge is depleted battery continues to self-heat until disintegration occurs*

**Nail Penetration Test**
*Nail penetration results in initial temperature rise as the battery is shorted leading to slow battery decomposition*

**Specific Heat Capacity Determination**
*This parameter allows conversion of thermal data (temp & temp rate) to heat (joules) and power (watts)*
**EV+ ARC: Specification**

### Specification

**EV+ Calorimeter**
- 40cm diameter, 44cm depth
- Side 6mm thick aluminium, Lid & Base 12mm thick aluminium, 8 heaters, 6 measuring, control and safety thermocouples
- Thermocouple Resolution 0.001°C, Precision <0.2%, Accuracy 0.7%
- Sealed lid designed for integral gas collection; safety release near 1 bar overpressure
- Sealed lid pressure limit to 1 bar over pressure
- Integrated high-current connectors (300A)
- Integrated video monitor
- Integrated inert gas purging facility
- Pre-installed facilities for options

**Temperature range**
- Ambient to 300°C temperature range
- (-40°C with liquid nitrogen flow option LNF)

**Sensitivity** (applicable to new calorimeters only)
- 0.05°C/min
- Potential to achieve 0.02°C/min to 200°C

**Pressure**
- Pressure Range 0-14bar (or specify higher range with alternative transducer)
- Resolution 0.00 5bar, Precision 0.02%, Accuracy 0.05%

**Control Modes**
- Adiabatic; Ramping, Isothermal modes, True Isothermal, Isoperibolic, Step Isothermal.

**Safety**
- 1.93 cubic meter containment vessel (Blast Box);
- 3mm reinforced Steel, Proximity Switch, Door interlock;
- Automated Fume Extraction facility

**Sample Holders**
- Special open or closed holders for any battery type.

### Software

**Control Software**
- NI Labview based ARC-ES control software
- Full on-the-fly change of test conditions
- Full on-the fly system control
- Ability to transfer operation of system to any allowed PC over network or internet
- Virtual Technician facility - Set up multiple tests to automatically run successively.

**Data Analysis Software**
- NI Labview based ARCCAL+ analysis software
- Features include:
  - Graphical and tabulation of raw data including Phi Corrected TMR plots
  - Data Conversion to Enthalpy, Power, Gas Generation Kinetic Modelling for thermodynamic and kinetic data analysis
  - Phi Correction through kinetic modelling
  - Report generation in Microsoft Word, Excel, HTML
  - Analysis of 9 concurrent data sets; 3 analyses on each data set, merge all data sets to a single plot.

### Operation / Ambient Environment

**Electrical Specification**
- Single Phase Electrical Supply 100-250V, 32A 7kVA
- Instrument conforms to CE, UL, VCCI, CSA standards

**Environmental Requirements**
- Temperature 5-45°C, Humidity 0-95%,
- Air supply (Optional for rapid cooling post test)

### Customer Support

**Installation & Training**
- 1 week, full training and performance qualification

**Support**
- 1 year warranty, free of charge phone and email support over lifetime of instrument

**Part Supply**
- 10 years guaranteed

**Manuals**
- Full Operations and Data Analysis Manuals with Tutorials
EV+ ARC: Options

**For battery applications**

**CPU Option**
- Automatic Specific Heat Measurement up to 120°C

**SSS Option**
- Gas collection during or after test into collection vessel, up to 4 litre sample

**SSU Option**
- Gas collection, 4 samples – automatic collection at any time, temp, pressure, 500ml collection vessel

**KSU Option**
- Single Channel Battery Cycler – Customer specified voltage and current range

**SCO Option**
- Button operated electronic contactor and high-current cables for external short circuiting of batteries under adiabatic conditions. Optional current transducer for shorting current measurement.

**NPC Option**
- Automated Mechanical Abuse testing (Nail Penetration, Crush) up to 34kN force

**MPO Option**
- Multipoint thermocouple for spatial distribution measurement

**LNF Option**
- Liquid nitrogen flow for low temperature application, to -40°C start temperature

**Kits:** Low cost add-ons designed to facilitate testing in specific fields

**Battery Safety Kit** – for those working with own cycler and abuse tester +EV

**Battery Abuse and Pressure Kit** – hardware add-ons to allow simulation of abuse tests +EV

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