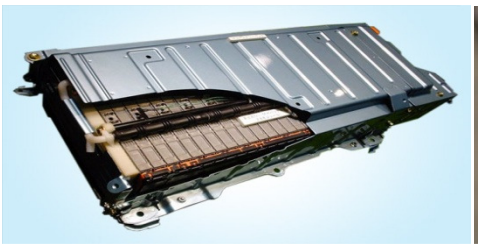
MultiPoint ™

NEW for 2009

Battery Performance Calorimeter from Thermal Hazard Technology

manufacturers of the Accelerating Rate Calorimeter

World leaders in the Application of Calorimetry to Lithium Batteries



In the race to implement Lithium Battery technology within modern vehicles many challenges must be met. A key issue is the heat generated by ***RAPID DISCHARGE*** and removal and limitation of this heat. Stability and safety of the power unit is paramount, knowledge of the thermal effects of the battery pack in use is vital. This knowledge allows ability to control and remove the heat to give safe working; to implement a successful Thermal Management System and also to determine quality and best choice of batteries and the effect of ageing.

Calorimeters (in particular the Accelerating Rate Calorimeter) have been used for many years to measure the heat release from lithium batteries and to quantify the heat produced by lithium batteries under conditions simulating use and abuse. The Accelerating Rate Calorimeter is unique in that it can accommodate very large batteries; the battery can be connected to a cycler or load and if needed the test can be done with pressure measurement. Early focus related to the stability and safety of small lithium ion batteries, this aided battery chemistry development. Implementing *in situ* use and abuse conditions; for example over-voltage, shorting, nail penetration, charge-discharge gave vital information on safety, on efficiency and on lifecycle of the battery; cycling produced fundamental thermodynamic data for modeling. These small batteries are now in common use in cellphones, camcorders and laptops and of course a range of consumer electronics. ***From the start, THT pioneered applications and today the THT Accelerating Rate Calorimeter is in use worldwide helping groups working in this area.***

The THT website (www.thtuk.com) details applications.

Large batteries and battery packs to be implemented within Electric Vehicles pose other challenges and different information is needed. The main concern is to understand heat release upon discharge, to know the spatial distribution of this heat and if over the complete power unit there are vulnerable parts. Discharge current employed in vehicle acceleration may be in excess of 100Amps and power well in excess of 10kW, and discharge times will be variable. The battery and its use give operational conditions far removed from the applications with consumer electronics batteries. Also conditions of use may be more severe; the vehicle may be operated in sub-zero or hot climatic conditions.

Quantifying heat output, temperature rise, heat retention and heat loss can accurately be done with the Accelerating Rate Calorimeter. However in the original form there are limitations. Indeed all calorimeters employ a single thermocouple for sample temperature measurement and calorimeter control. This is of restricted value to the study of large inhomogeneous devices such as an EV Battery. To aid Engineers working to determine heat release from EV batteries a calorimeter must have multiple sites for temperature measurement and the ability to measure 'average' temperature. There is the need to control from any measured temperature and the ability to measure within a wide temperature range; -50C to +100C. To fulfil this need and…

To make the future happened sooner…

THT INTRODUCE THE ***MULTIPOINT BATTERY PERFORMANCE CALORIMETER***.

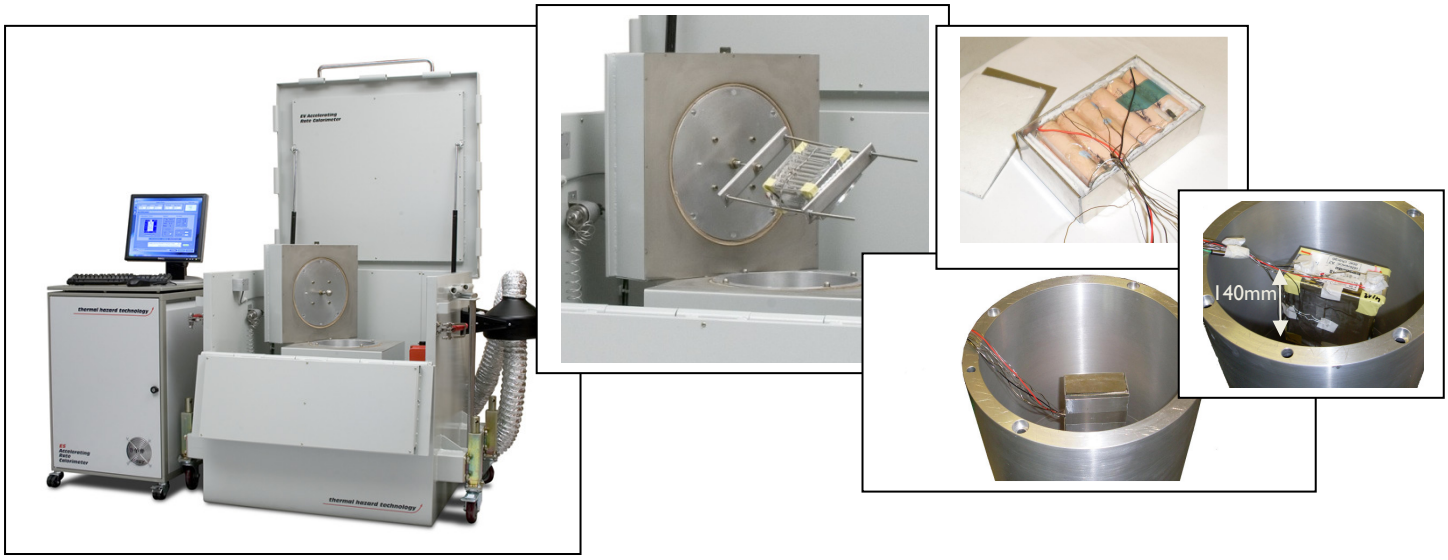
For the first time there is a calorimeter with ability to measure spatially the temperature over the battery surface and determine gradients and areas of primary heat. The BPC with MultiPoint option is a purpose developed system for EV development.

The BPC is an extra large volume fast response calorimeter; it has working volume of 40cm diameter and 40cm depth. The BPC has working range -50C to 400C. The MultiPoint allows up to 8 thermocouples to be positioned around the battery, for data logging and control from any of these thermocouples. The MultiPoint with CryoCool option provides the cold nitrogen supply direct to the BPC to allow sub-zero operation (and rapid cool).

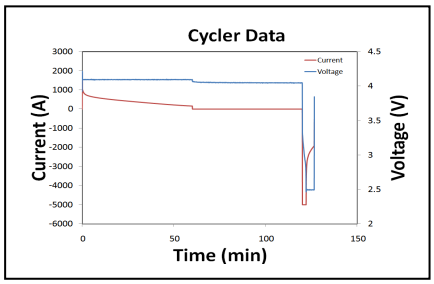
The BPC is available separately to add to any THT ACCELERATING RATE CALORIMETER (either the standard ES-ACCELERATING RATE CALORIMETER or the large volume EV-ACCELERATING RATE CALORIMETER) and this can be with the MultiPoint option. Systems are available with 2 or 3 calorimeters (BPC + EV + Standard size and shape)

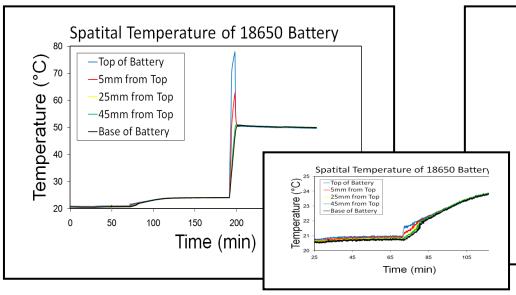
THT, working in joint projects with battery and car companies worldwide, to implement solutions to thermal issues.

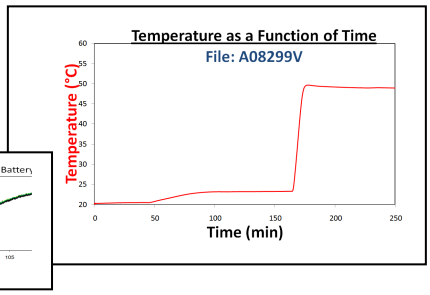
The MultiPoint™ with BPC™ in Operation



In its most simple form the MultiPoint BPC can be used with a small single battery – even as small as an 18650 – here the Voltage might be 4V and the 'fast discharge' may be 5A. The example below shows charge and discharge of such a battery. An 18650 is not as easy to test as a larger battery, but is a good demonstration. Here although the battery had been charged, it was further charged and then discharged. A series of 5 thermocouples were attached and the battery then placed in its holder. The holder is of same shape as the battery with a gap between battery and holder of 1-2mm. The gap is filled with high temperature insulating felt. On the outside of the container the control thermocouple is attached. For each battery or pack a similar holder is best used; see photographs above.



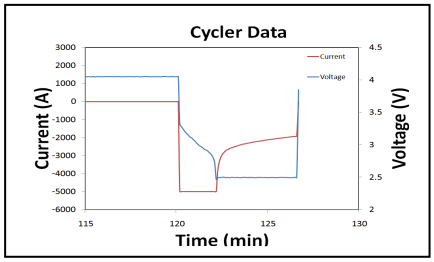


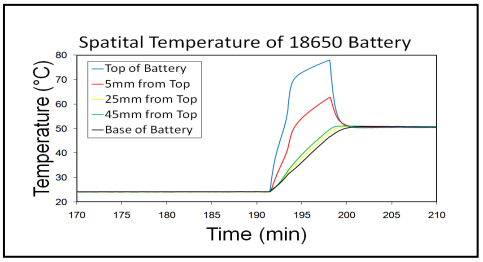


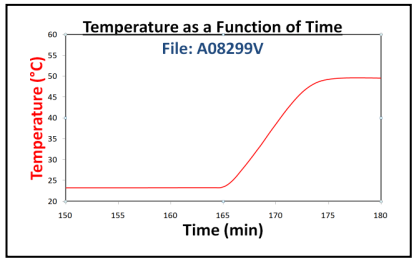
The initial charge was set at 1.1A (c/2) and then charge at constant voltage for 1 hour. This was followed by an idle period of 1 hour. Subsequently discharge was set at 5A to 2.5V followed by discharge at constant voltage. The BPC was set to equilibrate at 20C and to terminate the test and the discharge if the temperature reached 50C.
The 5 thermocouples were positioned at the centre of the top surface of the battery (on the anode) and on the canister near the top, at the midpoint, near the base and at the centre of the base. These were connected to the MultiPoint data acquisition system; the thermocouple on the outside of the battery holder was connected to calorimeter control.
The full result is shown above; the spatial temperature at the charge period on the battery is enlarged for clarity. Also for clarity the cycler, the calorimeter and the spatial temperatures are shown on different graphs.

During the charge period, the battery temperature increased. This increase is similar at all positions on the battery. The energy added by charge is small and the temperature rise is just 3C.

During the discharge period the battery temperature increased rapidly and not uniformly over the battery. Discharging at 5A gives an immediate rapid temperature rise at the anode; the rise slows on further discharging when the current is lower. Little if any heat is observed at the base of the battery and at positions towards the top of the battery there is greater temperature increase. This may be simply from thermal conductivity from the battery anode.
Discharge data is shown in more detail below. Aside from the MultiPoint BPC showing the spatial temperature variation, the calorimeter response is illustrated. The calorimeter, working in the adiabatic mode, will not allow heat loss from the system. The temperature rises and the test terminates when the battery temperature reaches the set upper limit of 50C. Soon after this time the battery comes in to thermal equilibration and there is equilibration with the battery holder. The battery surface equilibrates to 50C, the outer surface of the holder to 49C. The system remains then in thermal equilibration; from this information fundamental knowledge can be obtained of the overall battery efficiency.
This illustration is a simple introduction into the operation and capability of the THT MultiPoint BPC, further analysis is not added.







In conclusion and summary, the MultiPoint Battery Performance Calorimeter has been developed to aid those working to implement electric drive into automotive applications; there are other applications including satellites and power tools again where fast discharge is important. This product is an integral part of THT's products that will quantify the heat output from lithium batteries under conditions of use and abuse and the effect of heat on these batteries. This leaflet aims to introduce the MultiPoint BPC, for more information contract details are given below…

For fuller information contact THT at info@thtUK.com, info@thtUSA.com info@thtCHINA.com or contact your national THT exclusive distributor