



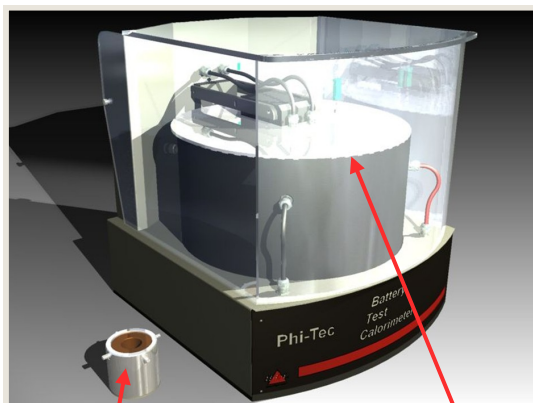
Battery Testing Calorimeter (BTC) from the Process Safety Experts

- The PHI-TEC is able to study :-
- Battery components (anode, cathode, electrolyte, SEI)
 - Complete batteries
 - Overcharged or over discharged batteries
 - Charged, discharged and cycled batteries

Even large batteries (EV and HEV, for example) can be directly tested to obtain safety, lifecycle and electrochemical efficiency data.

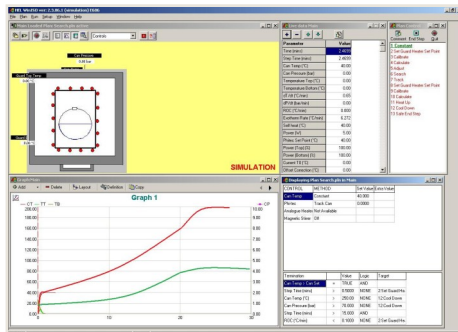
BTC is a special version of the Phi-TEC I Adiabatic Reaction Calorimeter, modified to enable easy and reliable safety testing of Li-ion batteries of different sizes. This is possible under different conditions of battery use as well as undesirable modes of use.

Depending on battery size to be tested, “standard” and “customised” versions of the BTC are available.



Standard Phi-TEC I heating chamber

Custom BTC Chamber Internal free space 35cm diameter x 35cm high



The system is fully software controlled with integral safety trips. A software screenshot is shown here.

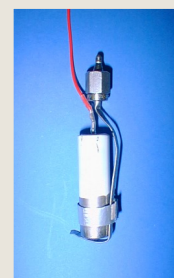


AA Batteries after a test in a ‘Standard’ BTC .

Stability Testing

Lowest temperature at which battery starts to self-heat can be accurately determined in the standard Heat-wait-search test. To assist with chemical development, the kinetics and energy release can be easily qualified.

Phi-TEC also has a second test modes where the sample is ramped and this provides quick screening data during battery development



Testing to “destruction”



It is also possible to place batteries in a pressure “cell” so that the decomposition can be allowed to proceed to “destruction” – allowing gas rates and temperature increase to be measured in the event of the battery decomposing in a closed space.

BTC Design Choices

“Standard” Calorimeter

Compact design that can be used for battery types : -

- 18650
- Prismatic
- Polymer
- Coin
- AA
- 3/4A
- 4/5A
- Battery packs
- Prototypes

**Standard Phi-TEC I
Footprint
30 x 37 x 50 cm**



“Custom” Calorimeter

The Custom Testing Calorimeter is used for batteries larger than 18650.

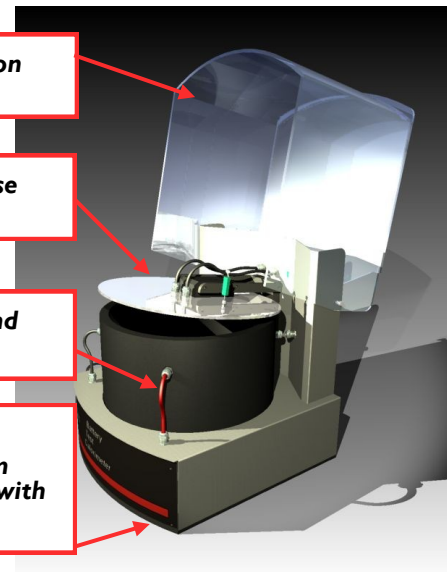
This Calorimeter will allow batteries up to 35cm x 35cm to be tested, and typically includes batteries for EV and HEV, military use, space aircraft and also large packs of smaller batteries.

**Fume extraction
enclosure**

**Easy open-close
cover**

**Cable ports and
sample vent**

**Size approx
60 x 60 x 60cm
(1 meter high with
hood open)**



Technical Advantages of Phi-TEC BTC

Controlled heating

Phi-TEC is able to evenly distribute heat over the body of a battery while heating to higher temperatures, ensuring that data is representative of natural slow heating and that results are realistic – especially important in large batteries.

Direct temperature sensing

Wall and internal temperature can be sensed and either can be used for judging the battery stability. This is critical in large batteries where wall temperature can be very different to the internal value.

Battery “abuse” simulation

Either of the two BTCs can be integrated with an electronics unit that can simulate battery shorting and overcharging (to 24V) using the calorimeter control software. Stand-alone (customer supplied) cycler units can also be used with the BTC to determine the effect on battery safety and performance.

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