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APPLICATION NOTE:

ISOTHERMAL-BATTERY TESTING CALORIMETER (ISO-BTC)

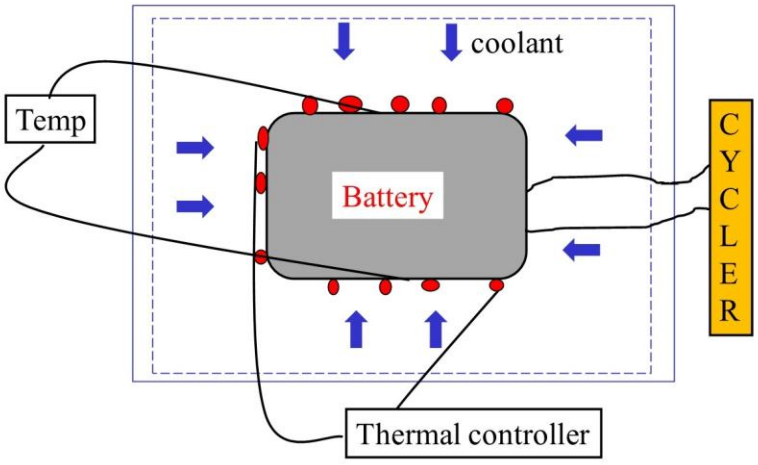
Operating Principle

Batteries generate heat when they are used – for example during charging or discharging. This can lead to a rise in temperature if the heat is not removed and in extreme cases, the battery can go into thermal runaway if the temperature is too high. Power management systems are designed to remove the heat generated in this way and attempt to keep the temperature constant.

The objective of the iso-BTC is to measure the amount of energy which is being generated while holding the battery temperature constant, thus performing the battery management task. Typically, the battery or pack is integrated with a cycler so that different charging/discharging routines can be programmed.

The operating principle of the iso-BTC is well established for chemical reactions and HEL has supplied hundreds of commercial calorimeters which operate isothermally under extreme conditions of temperature and pressure. The operation requires two opposing controls:

- Cooling, at a constant and fixed rate. This must be greater than the maximum heat likely to be generated by the battery during cycling.
- Thermal control (power input/output) – this counter- acts the effect of cooling and is adjusted automatically so as to hold the battery at the specified temperature.

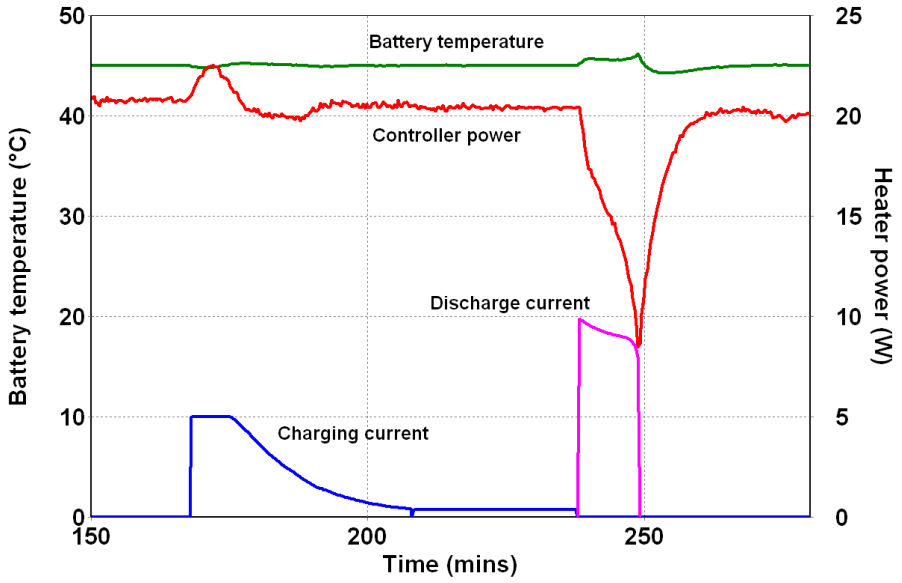


When the test battery is set up, before charging/discharging is commenced, it's temperature is stabilised by applying the necessary power, sometimes called a base-line. When cycling commences, the power compensation systems responds to small changes in temperature that are caused: if the temperature falls (typically during charging), the adds more heat (to keep the temperature constant); conversely, when the temperature rises (during discharge), it reduces the heat addition (again to keep temperature constant. The increase and decrease in heat input are exactly equal to the energy changes taking place in the battery: it is precisely what a battery management system would need to do.

Illustration: Basic Data

The operating principle of the iso-BTC was demonstrated by charging and then discharging a 3-cell Li-ion battery pack and the main data is shown in the diagram below. When the battery is charged (current 5 A), the temperature starts to fall and causes the power compensation controller to add more heat. As the charging current falls, the amount of heating being added also falls.

When the discharge cycle commences (at 10 A), these effects are reversed. The temperature starts to rise and is accompanied by a rapid fall in the amount of compensation power being added; eventually as the discharge rate falls, the powder input is adjusted and eventually becomes constant (which is the new baseline).



Basic Operating data from Iso-BTC

Notice that the powers involved are quite high – the standard version of iso-BTC can handle up to 150W.