Heat Generation Measurement of Li-ion Battery Cells under Fast Charging Conditions by Employing Isothermal Calorimeter

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Introduction

Lithium-ion batteries are employed in so many applications including electric vehicles (EVs), hybrid electric vehicles (HEVs) and many consumer products such as cell phones, tablets and computers. Notwithstanding, the foregoing, there are still concerns about the safety of Lithium-ion batteries. Abuse conditions such as excessing external heat, over-charging, over-discharging, nail penetration, crush, high charging currents and external and internal short-circuit can cause battery temperature to go far beyond the manufacturer ratings.
If the heating rate exceeds dissipation rate for the longer time, then thermal runaway will occur. Thermal runaway leads to many unwanted accidents such as a leak, smoke, gas venting , flames and rapid battery disassembly. Several previous studies have been conducted on the thermal safety of Lithium-ion batteries. Bernardi *et al.* [1] constructed a heat-generation model for battery systems containing the mixing enthalpies, electrochemical reactions and phase changes. Guo *et al.* [2], by employing a finite element method, developed a three-dimensional thermal model. Kim *et al.* [3] developed a three-dimensional thermal abuse model concerning the chemical reactions. He *et al.* [4] investigated the thermal management of a Lithium-ion battery module by employing a two-dimensional computational fluid dynamics model. Wang *et al.* [5] studied the thermal management of the battery module and optimum structure through employing a lumped model and three-dimensional computational fluid dynamics method.
Future electric vehicles will need to be charged in time comparable to refilling time of nowadays conventional combustion vehicles. In consequence, in this work, the thermal behaviour and heat generation of different Lithium-ion battery chemistries subjected to fast charging protocols will be investigated. Heat generation of different Lithium-ion battery cells will be measured by employing isothermal calorimeter.

Methodology

The experiment is performed by means of IBC (Isothermal Battery Calorimeter) 284 from NETZSCH [6]. Calibration of the IBC 284 consists of applying a controlled electrical current to a precision resistance located inside the calorimeter chamber of the IBC 284[6].The calibration of the calorimeter was performed at different temperatures (from -30°C to +60°C).

Results

Three different chemistries (LTO, NMC and LFP) will be tested during fast charging. Heat generation will be quantified and will be compared amongst these three li-ion battery cell chemistries. Processing of the data will be accomplished by means of Proteus Analysis Software (PAS).

References

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