Improved ESS Safety through Early Detection of Thermal Runaway

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Abstract

Projections for new installations of energy storage systems continue to grow. This growth can be seen in energy storage targets established by an increasing number of states. However, concerns over the safety of these systems are evidenced by ongoing work on NFPA 855, the release of the UL9540A test method, and number of battery fires in South Korea and the US. Monitoring and controls play a vital role in the safety of these systems. During this presentation, Li-ion Tamer will report on gas analyses conducting during recent large-scale fire testing using methods specified in UL9540A. New gas monitoring capabilities are being developed to improve detection of faults in the ESS. These methods have also been demonstrated to improve operational safety by preventing fires when the signal is used to electrically isolate the battery prior to thermal runaway.

Li-ion Tamer has developed a monitoring system that provides advanced diagnostics to enhance situational awareness of the state of lithium ion battery systems. The off-gas monitor detects electrolyte vented from battery cells with sufficient early warning to stop thermal runaway (Figures 1 and 2). Machine learning algorithms have been incorporated in the controls to distinguish environmental anomalies from potential catastrophic events. Early warning provided by the off-gas monitoring system has been demonstrated to detect faults prior to smoke detectors and flammable gas detectors that are commonly used in lithium ion battery installations. Further, third party testing has confirmed the off-gas monitor signal tracks with FTIR gas measurements. Gas analysis is required for propagation testing during certification of many of today's large-scale lithium ion battery systems such as those required by UL 9540A. While FTIR measurements are not required during field operation of a battery system, installing a network of off-gas monitors into a battery system enables advanced diagnostics to detect off-gas from a single cell within the system. This provides the earliest possible warning of battery failure when compared to other detection systems currently used. Fault detection information supplied by a battery management system can be used in combination with gas detection to diagnose battery health issues prior to an event. Multiple mitigating actions including system shut-down, fire suppression and alarms are possible. Because the gas detection system does not

require physical integration with the cells, it offers the potential for redundant safety monitoring, even during transport or storage conditions. Nexceris has monitored the off-gassing characteristics to a range of operational and abuse conditions, including over-temperature, over-charging, and slow leak/pinhole tests in pouch, prismatic, and cylindrical cells.

This presentation will provide an overview of the enhanced safety that is enabled through off-gas detection in lithium ion battery systems and how it can add additional layers of safety to protect systems from thermal runaway.

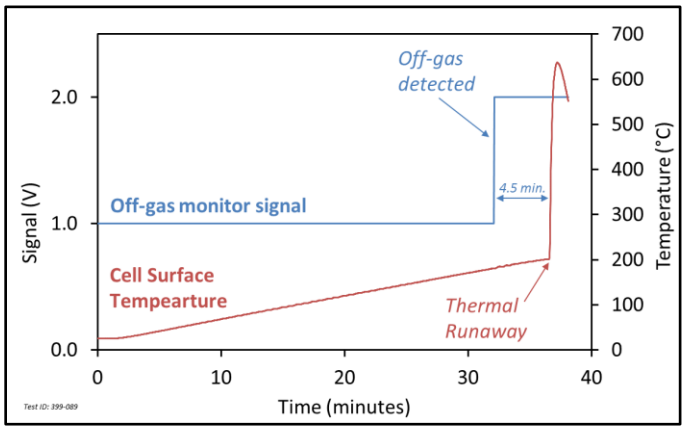

Figure 1. Results of lithium ion battery thermal runaway testing. Nexceris off-gas monitor provided 4.5 minutes of early warning prior to failure.

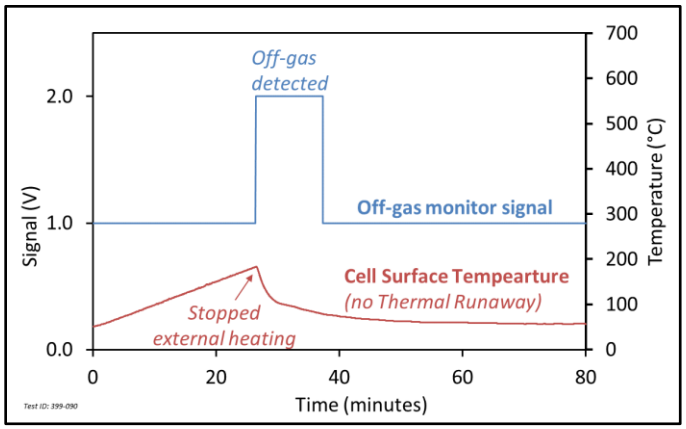

Figure 2. Results of lithium ion battery abuse test when abuse is mitigated. External heating was stopped when Nexceris' monitor detected off-gas, demonstrating early warning can be sufficient to prevent thermal runaway.

Speaker Bio

Steve Cummings is the Director of the Sensors Business Unit at Nexceris where he has worked for the past 15 years. Steve has worked in the area of battery safety for much of his career including design and development of safety related products for the battery industry. He was the primary inventor of Nexceris' Li-ion Tamer technology during which he worked as principle investigator for several projects with the US Navy and technical lead for Nexceris' ARPA-E AMPED project with DNV GL. His experience includes

battery testing and characterization of off-gas species from lithium ion batteries prior to thermal runaway with a focus on mitigation of battery failures. He is active as a subject matter expert for development of codes and standards addressing gas detection and battery safety. Steve is also an active participant in the EPRI Energy Storage Integration Council (ESIC) working group on safety. Steve received his Bachelor of Science in Chemical Engineering from The Ohio State University prior to joining Nexceris.