Detailed Characterization of Particle Emissions from Battery Fires

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This presentation will cover details about our program that involved characterization of particulate emissions and limited analysis of gaseous emissions from Li-ion battery systems that experience thermal runaway. Test articles included four identical lithium iron phosphate (LFP) modules and one nickel manganese cobalt oxide (NMC) module. Thermal runaway initiation of two LFP modules and the NMC module was performed via nail penetration. The remaining two LFP modules were subjected to overcharging. The objectives of this test matrix were to understand the impact of battery chemistry, trigger mechanism and variability of emissions from thermal runaway events. Particle emissions were characterized in terms of total particulate matter mass (PM2.5), real-time total (solid + volatile) and solid particle number (PN)/size, real-time black carbon concentration, organic/elemental carbon partitioning and volatile weight fraction of PM2.5. Selected gaseous species that include CO_2, CO, CH_2O, NO, NO_2, HCl, HF, HCN, CH_4 and C_3H_8 were measured in real-time using Fourier Transform Infrared (FTIR) spectrometry. Results suggest that battery fires can result in significant particle and gaseous emissions that may be a function of initiation mechanism, battery chemistry, cell arrangement within a module among other variables. Further, particle emissions were observed to be in the respirable size range with peak concentrations in the ultrafine size scale (sub 100 nm).

While this program provides some insight on emissions from battery fires, additional research focusing on battery SOC, chemistries, packaging materials, abuse mechanisms, and repeats are required to gain in-depth understanding of safety and health implications of battery fire emissions. Such studies would not only help with the development of safer battery systems, but also ensure selection of appropriate personnel protective equipment for first responders dealing with accidents related to batteries.