Experiments and Numerical Modeling of Fires Associated with Lithium-Ion Batteries Thermal Runaway

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A numerical model is developed using Ansys Fluent to simulate fires associated with thermal runaway of lithium-ion batteries. In the preliminary simulation, an 18650 cylindrical cell is considered. Upon heating, the temperature rise of the cell, the venting, and the subsequent fire events are simulated. To obtain the modeling parameters, experiments are conducted. In each experiment, a cell is conditioned to a desired state-of-charge (SOC) and then placed in an environmental chamber (volume ~ 600 L). The cell is forced into thermal runaway by an electrical heating tape at a heating rate of 10 °C/minute. Two video cameras are used to record the process of cell venting, thermal runaway, and fires. The chamber is connected to a FTIR gas analyzer to obtained time-resolved venting gas compositions. Thermocouples are used to monitor the cell surface temperatures. The mass and voltage of the cell are also recorded. Based on these data, cell pseudo-properties, venting gas compositions, and venting mass rate are deduced as functions of cell temperature and cell SOC. The fire events in the experiments and the modeling results will be compared, first for single and then for multiple cell levels. After the model is comprehensively validated, it will be used to study fire propagation between cells, and to understand the scalability of battery fire.