Modeling thermal runaway in li-ion cells under overheating abuse: a CFD study of gas and particle interactions

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1 ABSTRACT

Lithium-ion batteries have become critical for numerous applications, including electric vehicles and portable electronics, due to their high energy density. However, thermal runaway represents a significant safety concern, characterized by rapid temperature increases and potential combustion. The objective of this study is to examine the propagation of thermal runaway in 18650 lithium-ion battery cells, specifically analyzing the venting phenomena and combustion dynamics of emitted gases and solid particles. This work integrates internal heat generation, gas venting, particle combustion, and heat exchange with surrounding structures within a single three-dimensional computational fluid dynamics (CFD) model based on Reynolds-Averaged Navier-Stokes (RANS) equations. The simulation framework reflects realistic conditions by replicating tests conducted in a vessel with an opening triggered by overheating abuse. Preliminary results highlight comparative assessments of temperature profiles at various positions, offering valuable insights into the spatial development of thermal runaway and supporting improved safety design and risk mitigation strategies for battery systems.

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