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Review of Thermal Runaway Hazards in The Na-Ion Batteries in Comparison with The Li-Ion Batteries, and Suggest the Areas That Need to Be Improved to Make Batteries Safer

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ABSTRACT

As the demand for safer and more sustainable energy storage solutions for renewable energy sources grows, sodium-ion batteries (SIBs) emerge as a promising alternative to lithium-ion batteries (LIBs) due to their lower cost and resource abundance [1]. However, thermal runaway (TR) hazards remain a major challenge for both battery technologies, affecting their safety, reliability, and commercialization potential [2].

This review provides a comprehensive comparison of thermal runaway risks in SIBs and LIBs, analyzing their thermal stability, failure mechanisms, and safety characteristics. The discussion covers key factors influencing thermal hazards, including cathode and anode materials, electrolyte decomposition, gas evolution, separator integrity, and heat generation behaviors. Recent advancements in electrode design, electrolyte formulations, thermal management strategies, and next-generation materials are also reviewed, highlighting ongoing efforts to mitigate safety risks in SIBs.

Despite notable improvements in the thermal stability of SIBs, challenges remain in achieving the same level of safety performance as commercial LIBs. By summarizing current research progress and identifying critical areas for future innovation, this review aims to guide the development of safer, thermally stable, and commercially viable sodium-ion batteries to meet the growing needs of renewable energy sources.

Keywords: Thermal Runaway; Sodium-Ion Batteries (SIBs); Safety, Thermal Stability; Next-Generation Batteries