GUIDE BATTERY STORAGE · 7 MIN.

LFP, NMC and Sodium-Ion from a Fire Protection Perspective: What Cell Chemistry Means for the Barrier

Onset temperature, gas quantity, heat release: cell chemistry defines the hazard profile of a battery energy storage system — and thus whether the compartmentation must be designed primarily against heat or against gas.

Why Cell Chemistry Shifts the Protection Objective

From a fire protection standpoint, "battery storage" is not a homogeneous category. Whether a cell is based on lithium iron phosphate (LFP), nickel manganese cobalt (NMC) or sodium-ion chemistry fundamentally changes three parameters: the temperature at which thermal runaway sets in, the heat released in the process, and the quantity and composition of the vent gases. For barrier design this leads to a simple but often overlooked consequence: the dominant protection objective depends on the chemistry — sometimes thermal compartmentation takes priority, sometimes gas and explosion management.

The structural difference lies in the cathode material: NMC cells use a layered oxide that can release oxygen at high temperatures and feed the fire from within. The olivine structure of LFP, by contrast, binds the oxygen firmly — the reaction is considerably less violent, but by no means harmless.

NMC: High Heat Release, Early Runaway

By comparison, NMC cells enter thermal runaway earlier — typical onset temperatures, depending on cell type and measurement method, lie roughly in the range of 170 to 210 °C — and then react most violently. Comparative studies record the highest vent gas temperatures for NMC (around 1,050 °C in a recent study, against roughly 446 °C for LFP) and the largest gas quantity per ampere-hour. On top of that come frequent flame ejection, sparking and cell particles that act as ignition sources for adjacent areas.

For compartmentation this means: with NMC systems the thermal load dominates. Partition walls and linings must absorb very high temperatures and heat fluxes for short periods without allowing the temperature on the rear face to rise critically. High-temperature-resistant insulation materials with proven behaviour above 1,000 °C, mechanically stable facing layers against particle impact and propagation-inhibiting interlayers between modules are the key building blocks here.

LFP: Less Fire, More Deflagration Risk

LFP is rightly regarded as thermally more stable: a higher onset temperature, lower heat release, and self-sustaining fires are rarer. But this frequently leads to the false conclusion that LFP is uncritical in fire protection terms. Comparative measurements do show the smallest gas quantity per unit of capacity (around 0.02 mol/Ah in a recent study, against roughly 0.07 mol/Ah for NMC), but with the highest hydrogen share in the vent gas — around 41 per cent in the same investigation.

Note: The LFP Paradox — Precisely because LFP vent gases often do not ignite immediately, they can accumulate unnoticed in the enclosure or room. If the hydrogen-rich cloud later meets an ignition source, a delayed deflagration threatens — a scenario that has been the principal cause of loss in several real incidents. With LFP, the protection objective therefore shifts from the pure fire barrier towards gas detection, ventilation and explosion venting to NFPA 68/69.

For the lining this means: it must not only contain heat but also support gas management — keep defined vent paths clear, avoid blocking explosion relief areas, and itself create no ignition sources or voids where gas can accumulate.

Sodium-Ion: Promising, but Not Hazard-Free

In initial comparative studies, sodium-ion cells show a favourable safety profile: onset temperatures roughly at LFP level (in the order of 220 to 260 °C) and considerably lower maximum vent gas temperatures than either lithium chemistry. The option of discharging cells to zero volts for transport and storage also reduces risks over the life cycle.

Nevertheless, sodium-ion cells also release combustible gases in a fault condition — with relevant proportions of hydrogen, carbon monoxide and electrolyte vapours. The data base is still thin, too: only a few independent studies exist and hardly any large-scale fire tests at system level. For design work this means: do not lower the requirements for compartmentation, gas venting and explosion relief across the board, but demand project-specific test data (for instance to UL 9540A) and base the design on it.

- NMC: design the barrier primarily against high temperatures, heat flux and particles
- LFP: focus on gas detection, ventilation, explosion venting and ignition-source-free execution
- Sodium-ion: favourable profile, but relax the design only on the basis of robust test data
- For all chemistries: propagation behaviour from test reports takes precedence over datasheet claims

Frequently asked questions

Does an LFP storage system need a fire barrier at all?

Yes. LFP reacts less violently than NMC, but in a fault condition it releases a hydrogen-rich, ignitable gas mixture and can release substantial heat if propagation spreads across many cells. The barrier remains necessary — complemented by rigorous gas management with detection, ventilation and explosion venting.

Are sodium-ion storage systems the answer to the fire protection problem?

They are progress, not a free pass. Initial studies show higher onset temperatures and milder reactions than NMC, but sodium-ion cells also vent combustible gases. As long as large-scale fire tests at system level remain rare, protection design should stay conservative and rely on project-specific test data.

Can a barrier designed for NMC systems be used unchanged for LFP?

Thermally it is then usually over-dimensioned, but functionally it may well be wrong: with LFP, what matters above all is that the enclosure does not obstruct gas venting and explosion relief and creates no unventilated voids. The design should always be derived from the chemistry- and system-specific test report.

Let us talk about your project

Reply within 24 hours on working days.

info@sbs-rs.de

+49 89 541 960 200

Read online: www.sbs-rs.de/batteriespeicher/ratgeber/zellchemie-brandschutz