



AF3 American Firefighting Foam

Product Data Sheet: Li-3X™ - Technology for Lithium-ion Battery Fires

Overview

The high energy density of Lithium-ion batteries poses an inherent risk called thermal runaway, a self-accelerating reaction that occurs when a battery's temperature rises uncontrollably, leading to catastrophic fires and explosions. ABC powder, foam and water **cannot extinguish these fires**. They are designed to starve a fire of oxygen in the air, but **thermal runaway produces its own oxygen**. **Li-3X** technology is effective in extinguishing these fires, halting thermal runaway and controlling the reaction. **Li-3X** mitigates the 3 main dangers and problems of Li-ion battery fires:

1. Effective penetration of battery cells

Li-3X technology uses specialty surfactants that significantly lower the surface tension of water. This non-foaming, low surface tension solution penetrates into the battery, spreading on all surfaces, which provides enhanced cooling. The optimum concentration is 3%, but surface tensions below 31 dyn/cm can be obtained at concentrations as low as 0.5%.

2. Strong cooling effect to combat Thermal Runaway

Li-3X has a stronger cooling effect compared with water alone and other extinguishing agents such as foam or powder. The evaporation of water and extraction of heat begin at approximately 70°C. Cooling continues even after application of **Li-3X** has concluded.

3. Reduction of toxic combustion products

By lowering the temperature of the burning cells, **Li-3X** slows down the decomposition of LiPF_6 and the formation of extremely toxic HF gas. This can exceed 2000 ppm. A value of 95 ppm is rated as life-threatening. Extinguishment with **Li-3X** reduces the concentration of HF to below 50 ppm. **Li-3X** halts combustion of the electrodes and prevents hazardous fine metal dust generation.

Applications

Lithium-ion batteries power devices which are used daily in the automotive, marine, industrial and consumer sectors. **Li-3X** can protect against fires in applications including:

- Electric cars, electric car parking buildings, car charging stations, e-bikes and consumer electronics
- Ships and shipyards - **Li-3X** is also effective in sea water
- Photovoltaic panel and wind turbine battery storage facilities
- Manufacturing, processing and storage of rubber and plastics
- Waste disposal and recycling

Physical Properties*	
Appearance:	Amber liquid
Surface tension in distilled water	27.6 dyn/cm at 3% 29.1 dyn/cm at 2% 29.9 dyn/cm at 1% 30.3 dyn/cm at 0.5%
Solubility	Soluble in tap and sea water
pH:	7
Specific Gravity (20°C)	1.0
Freezing Point	0 °C
Viscosity	<200 cPs at 25 °C
Flammability	Non-flammable
Stability	At least three years if stored in the original containers at temperatures between 5 °C and 50 °C

*Not for specification purposes

Packaging

3% in extinguishers with Li-3X battery fire lance nozzle:
2L, 3L, 6L, 9L

Liquid Concentrate:

5-gallon pails (19 L)
55-gallon drums (208 L)
275-Gallon IBC Re-usable Tote Tank (1000 L)

Safety, Precautions, and First Aid

GHS classification in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200)
H315 Causes skin irritation.
H319 Causes serious eye irritation
H360 May damage fertility or the unborn child
Avoid inhalation, ingestion and contact with skin and eyes.

Performance

In 2023 an extensive study using **Li-3X** at a 3% proportioning rate on 280Ah lithium-ion battery fires was conducted at the State Key Laboratory of Fire Science of the China University of Science and Technology, world renowned in Lithium battery fire science technology ([watch the video](#)). Excellent results were exhibited in performance and laboratory testing (see data in following pages). Product performance was tested in comparison to the control of water mist alone, yielding the following results:

- Extinguishment times were reduced by 65% to 81%.
- Secondary thermal runaway time was extended from 6.5 minutes to at least 16.7 minutes.
- Exceptional surface cooling effect was observed maintaining the battery surface temperature below 100 °C.

AF3 continues to bring sustainable fluorine-free firefighting products to market that have zero adverse effect on the environment, people and animal life.

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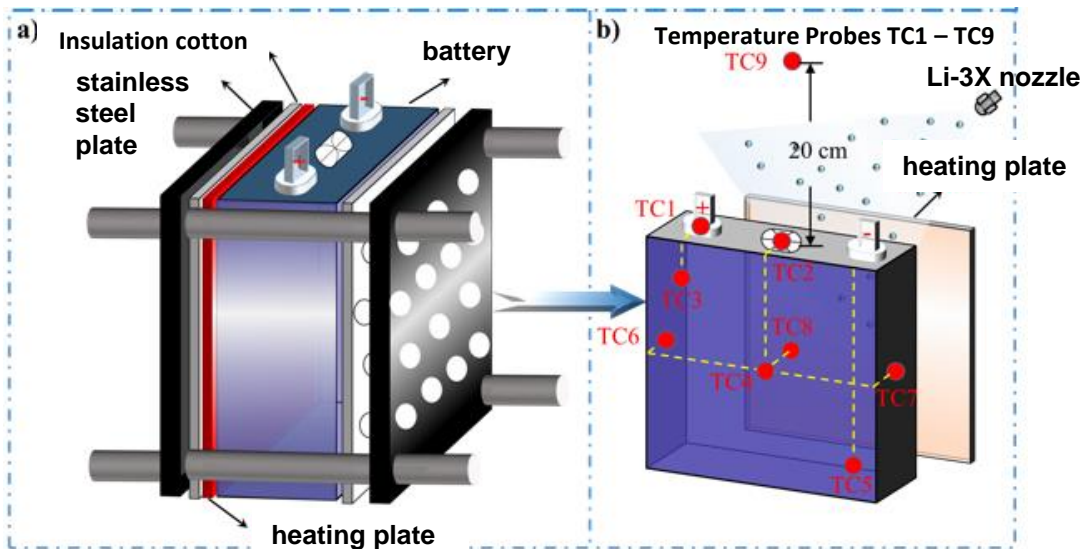
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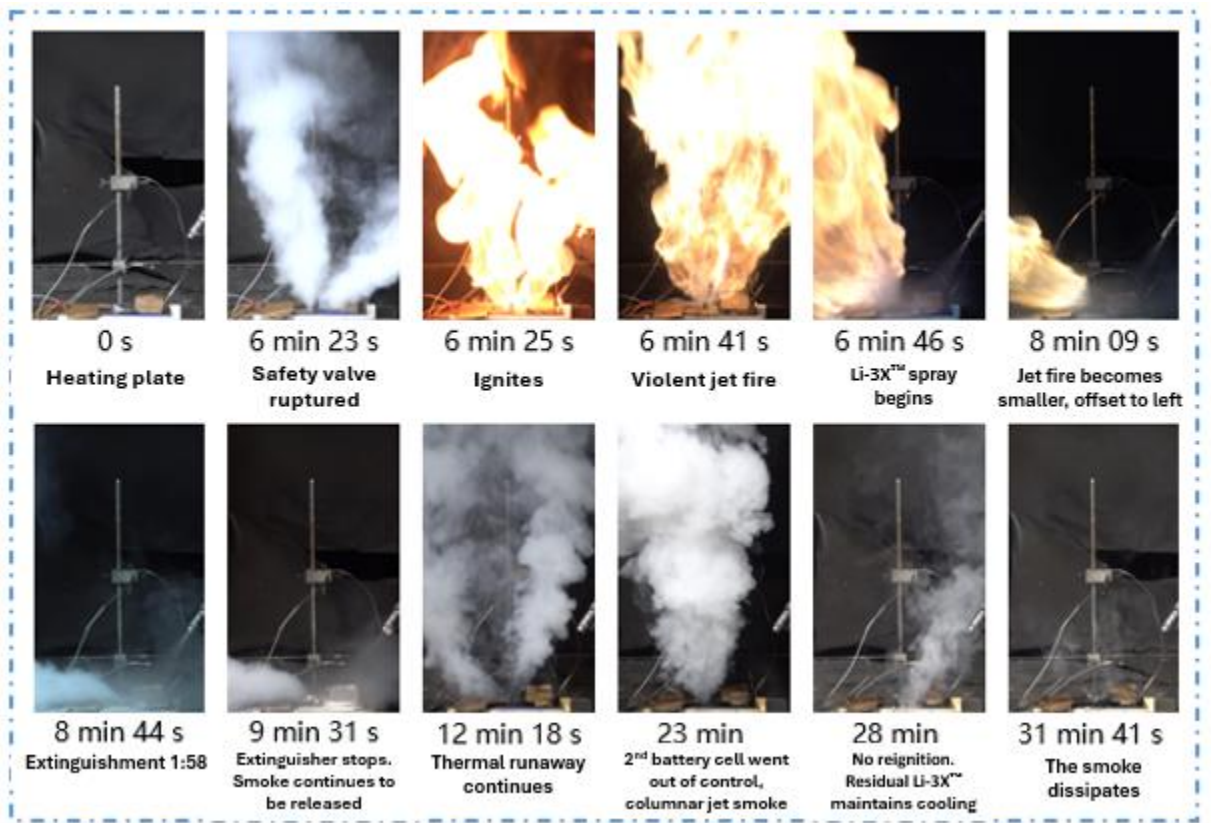
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Performance testing at the State Key Laboratory of Fire Science of the China University of Science and Technology

- **Battery used in the experiment:** 280Ah 100% SOC lithium iron phosphate battery
- **Thermal runaway trigger method:** 1kw heating plate external heating
- **Extinguishing method:** 3% Li-3X, pressurized extinguisher with atomization nozzle
- **Extinguishing conditions:** 20cm away from the safety valve, spray angle 45°, 1.5 MPa



- **Extinguishing conditions:**



[Watch videos of the tests](#)

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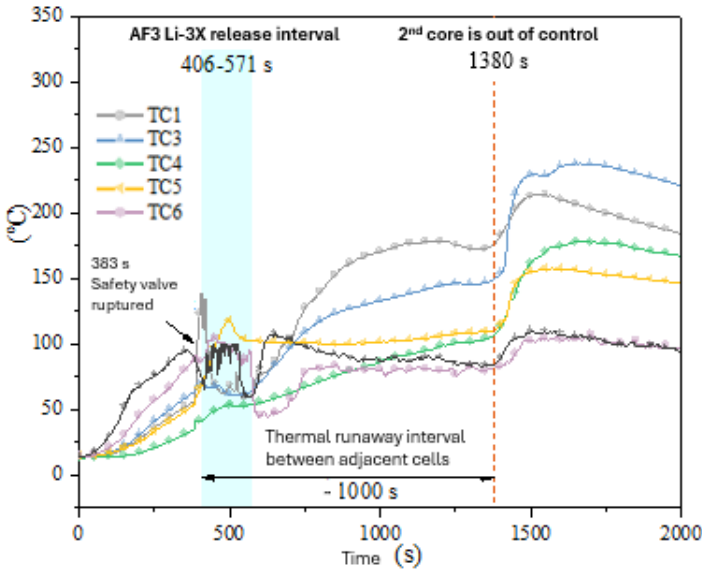


Figure 4 Battery surface temperature changes

- The battery surface temperature is kept below 100°C due to the cooling effect of **Li-3X™**.
- The temperature of TC5 (lower right corner, deepest in cell, furthest from extinguisher contact) increases, then drops to a plateau of 100°C.
- Extinguishment in 118s (1:58)
- The cooling performance of **Li-3X™** delays the spread of thermal runaway inside the battery, extending the time to 1000s (16:40).
- Residual **Li-3X™** prevents reignition.

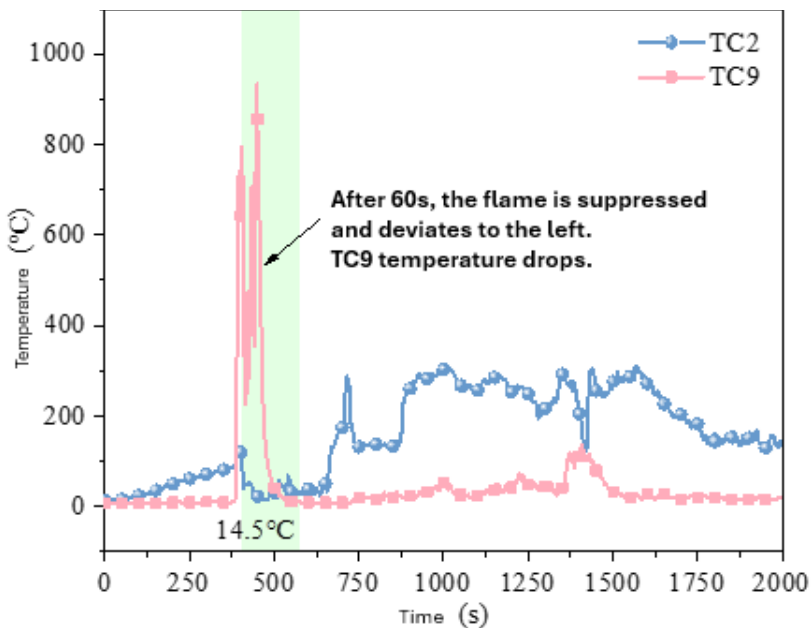


Figure 5 Temperature changes at the safety valve (TC2) and 20 cm above it (TC9)

Conclusions

- **Li-3X = 3X the extinguishing power** - extinguishes 3 times faster than water mist.
 - The average fire extinguishing time of water mist for a **243Ah** lithium iron phosphate battery is 337s (5:37)
 - The extinguishing time of Li-3X for a **280Ah** lithium iron phosphate battery is 118s (1:58).
 - Faster extinguishment reduces toxic emissions and controls thermal runaway.
- During **Li-3X** application, the battery surface temperature was controlled below 100°C, showing excellent cooling effect; the thermal runaway propagation time between cells inside the battery was extended to 1000s (16:40).
- After the second battery cell thermally ran out of control, a large amount of smoke was released but the battery temperature did not rise above 250°C and no reignition occurred.
- Thermal runaway of large-capacity lithium iron phosphate batteries continues after extinguishment and the battery still needs to be further cooled after the fire is extinguished. Residual **Li-3X** maintains cooling after application has ended, providing continued protection against thermal runaway of proximal cells.

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