neuruppin

Lithium-ion Batteries

F-500 Portable Fire Extinguishers
Reliable Protection for Lithium-ion Batteries

Johnson Controls

Superior Fire Protection for Lithium-ion Battery Fires

From mobile phones to solar energy units, lithium-ion batteries power devices used every day in the industrial, commercial, and private sectors.

Due to their high energy density, even lithium-ion batteries used in smaller devices—such as laptops, appliances, tools, and electric bicycles—present a variety of fire hazards that demand superior fire protection.

These batteries pose risks that include overheating—especially during charging—and internal pressure build-up that can lead to the explosion of the battery. Multiple-cell batteries can present an even higher risk, as neighbouring cells can ignite and transform the entire battery into a hazard with temperatures potentially exceeding 1000°C/1832°F. Also, external forces, such as mechanical damage or external heat sources, can cause the battery to become a fire hazard.

Fire protection for these hazard areas must:

- Suppress the lithium-ion battery cell fire
- Cool the battery cells to help stop self-heating
- Halt the ignition of neighbouring cells (thermal runaway)
- Help ensure the safety of people in the hazard areas

New F-500 portable extinguishers deliver

The new F-500 fire extinguishers provide superior protection through the cooling of superheated surfaces; high penetration of the extinguishing agent into the flammable material; and encapsulation of liquid fuel and potentially toxic exhaust gases. Fire extinguishers that blanket the burning battery with the goal of cutting off oxygen to help prevent reflash (e.g., D-powder) have not yielded positive results in practice. In some cases, a lithium-ion battery may release oxygen itself when burning, and the explosions of the cells can destroy the battery's casing due to the kinetic energy of the violently discharged gases.

Why does the F-500 extinguisher agent succeed where other agents fail?

The F-500 extinguishing agent has proven more effective than other commonly used agents in the areas of cooling, agent penetration, and reduction of toxic gases.

Stronger cooling effect

Multiple tests have shown the more powerful the cooling effect of the extinguisher/extinguishing agent, the more rapidly the fire is extinguished. Combining water with the F-500 additive creates a stronger cooling effect compared with pure water and other extinguishing agents (e.g., foam). The evaporation and extraction of heat begin at 70°C/158°F.

Greater penetrative effect

The surface tension of water is reduced considerably with the addition of the F-500 agent. This significantly increases the ability of the extinguishing agent to penetrate the battery and deliver the substantial cooling effect where it is most effective.

Reduction of toxic exhaust gases

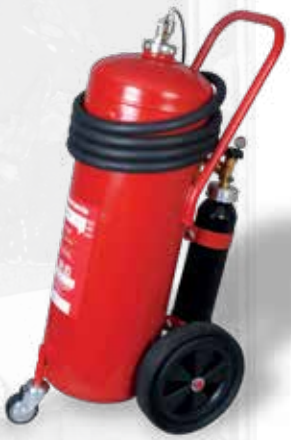
The F-500 is an "encapsulation agent" that can envelop/contain combustibles and flammable gases, thus inhibiting their oxidizing effect (SAFE effect). This also helps reduce the impact of possible toxic exhaust gases (HF).

Two portable extinguisher models tackle a range of hazards

Comprehensive testing was conducted on an E-scooter 182-cell battery (cell type 18650), a larger battery size than those generally used in devices such as mobile phones, laptops, power tools, gardening tools, model sports (e.g., remote-controlled cars, boats, drones), and E-bicycles (which can use 48-cell batteries). Neuruppin created two different portable 9L extinguisher models lithium-ion batteries up to the tested battery type with 1890 Wh (51.1 V / 37 Ah).

Cartridge-operated extinguisher WA 9 F-500

Stored pressure extinguisher WD 9 F-500



Wheeled extinguisher WA 50 F-500

These models deliver superior fire protection for a range of lithium-ion battery applications, from mobile phones to electric scooters. Additionally, a portable fire extinguisher with 50L content is available for enhanced user safety (greater extinguishing agent quantity, longer discharge time).

Larger risk areas, such as solar home storage (4-5 kWh), electric car batteries (over 15 kWh), and battery warehouses, demand the additional fire protection provided by installed F-500 extinguishing systems. These systems require sufficient supply units for the extinguishing agent in conjunction with pressure generators (pumps, propellant gas storage) or specific fire hose nozzles.

F-500 proves itself in rigorous testing

The fire hazard of lithium-ion batteries stems primarily from the flammable electrolytes—not the lithium—inside the battery that may ignite in the event of an increase in temperature.

In cooperation with the Energy Research Centre of Lower Saxony (EFZN) Goslar, rigorous month-long fire behaviour tests were conducted on various types of lithium-ion batteries to address: the spread of fire, temperature measurement, air emissions and sewage water analysis with and without extinguishing the burning batteries. The extinguishing agent additive, F-500 (2% admixture to water), proved to be exceptionally effective.

The independent Dutch certification body KIWA, which oversees the testing and certification of extinguishing devices, tested and evaluated the F-500 extinguishing alongside common extinguishing agents like powder and foam.
Tests (KIWA no. 16120045) concluded that of the tested agents, when used properly, only the F-500 was able to extinguish the burning lithium-ion batteries and reliably stop the spread of fire caused by thermal runaways before the cells exploded. The battery did not re-ignite in any test after suppression. This is due to the F-500's ability to penetrate and cool, a characteristic not found in dry chemical or powder agents.

Type	Result			Remark
	Nr. 1	Nr. 2	Nr. 3	
Powder Extinguisher	Poor	Poor	Poor	Do not apply on Li ion battery fire
Foam Extinguisher	Moderate	Poor / Moderate	Moderate	Not recommended to apply on Li ion battery fire
F-500 Extinguisher	Sufficient	Sufficient	Sufficient	Can be recommended to apply on Li ion battery fire

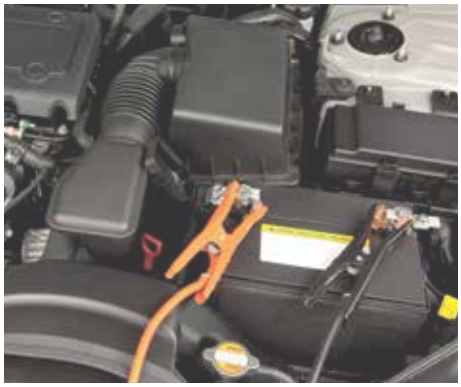
kiwa

According to the KIWA report:

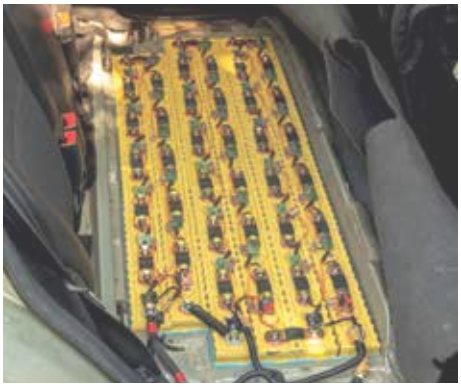
A hand fire extinguisher unit with F-500 Encapsulator Agent as an additive is significantly better able to achieve suppression mode directly after ignition of a single 1.9 kWh Cleantron battery than a hand fire extinguisher unity with standard powder or foam.

The F-500 hand fire extinguisher can be recommended to apply on a Li-ion battery fire taking into account that the attempt to achieve suppression of a Li-ion battery is not without any danger because of the possible explosive behaviour of a Li-ion battery.

Solar storage for homes (magnitude 4-5kWh)



Electric car batteries (magnitude more than 15kWh)



Large and/or unattended battery storage areas

Advantages of the F-500 Extinguisher

	Safety	Environment
Strong cooling effect (evaporation starts at 70°C/158°F)	+	+
High penetrative effect of the extinguishing agent into the flammable material	+	+
Encapsulation of liquid fuel and exhaust gases	+	+
Significant reduction of toxic gases (HF)	+	+
Simple and safe operation	+	
Fluorine-free extinguishing agent		+
Quick and completely degradable		+
Extinguishing agent certification per UL, EN, maritime navigation regulations	+	
NATO stock number	+	
Low corrosive effect (pH value approx. 7)	+	
Fulfils EN3 specifications on the applicability with electrical systems (up to 1 kV, 1m minimum distance)	+	
Trajectory length 4-6 m	+	
Tried and trusted inner and outer plastic coating of the containers	+	
100% pressure testing of all containers	+	
Easy maintenance	+	
Made in Germany	+	

In addition to lithium-ion batteries, F-500 portable extinguishers help protect a wide array of potential fire hazards

Solar panels

Manufacturing, processing, and storage of rubber, including tyres.

Plastic and foil processing

Mixed waste (disposal and recycling)

Manufacturing, processing, storage, and warehousing of plastics. F-500 also protects small load carriers.

About Johnson Controls' Building Technologies and Solutions

Johnson Controls' Building Technologies & Solutions is making the world safer, smarter and more sustainable – one building at a time. Our technology portfolio integrates every aspect of a building – whether security systems, energy management, fire suppression or HVACR – to ensure that we exceed customer expectations at all times. We operate in more than 150 countries through our unmatched network of branches and distribution channels, helping building owners, operators, engineers and contractors enhance the full lifecycle of any facility. Our arsenal of brands includes some of the most trusted names in the industry, such as Tyco®, YORK®, Metasys®, Ruskin®, Frick®, PENN®, Sabroe®, Simplex® and Grinnell®.

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