



-LIFE+

EQUIPRO

FIRE SAFETY PRODUCTS & SOLUTIONS

Lithium-ion Battery Hazards

Fluorine Free Fire Protection Solutions



Industry Overview

Expansive Utilization

The global lithium-ion battery market size is projected to grow from USD 41.1 billion in 2021 to USD 116.6 billion by 2030. Lithium-ion batteries continue to be utilized heavily in **Personal Electronics** such as smartphones, power tools and digital cameras.

Demand continues to skyrocket in the **Transportation** industry for utilization in passenger cars, trucks, buses, railway systems, aircrafts and much more. **Manufacturing** sectors and **Solar Power** are likely to surge as well with the rising need for mass **Energy Storage Systems (ESS)** to fuel the world's growing need for lithium-ion energy to transform **Power**. As utilization increases, so do hazards faced by the **Waste & Recycling** industry as lithium-ion batteries and various lithium-ion battery powered electronics find their way into these facilities.



Lithium-ion battery hazard protection is a must throughout the lifecycle of the battery.

Hazard protection is essential in production, storage, transportation, usage and disposal of lithium-ion batteries.



Hazard Overview

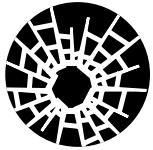
Lithium-ion Batteries

To better understand the extent of Lithium-ion Battery Hazards, it's important to explore the following factors:



▣ Short Circuiting

Lithium-ion batteries can become unstable and short circuit. This makes some battery fires unpredictable.



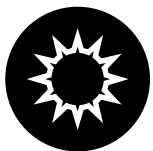
▣ Damage

Lithium-ion batteries that experience trauma or damage can become unstable, increasing the risk of a fire.



▣ Overcharging

Overcharging lithium-ion batteries can cause them to overheat, triggering thermal runaway.



▣ Extreme Temperature

Exposing lithium-ion batteries to either extreme heat or extreme cold can trigger cell ignition.



▣ Material Diversity

Lithium-ion batteries contain diverse materials. A lithium-ion battery fire contains Class A, B and C elements. A proper NFPA classification and set of suggested guidelines in the event of a lithium-ion battery fire has yet to be agreed upon due to the innovative and complex nature of the hazards they pose.

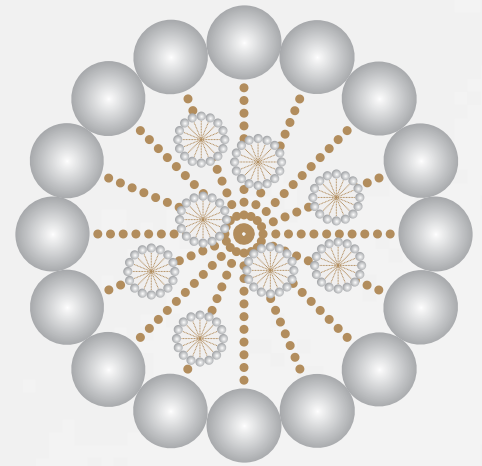
▣ Concentrated Energy

Lithium-ion batteries contain a high energy density. This means even a partially charged battery can cause a powerful fire that can be extremely difficult to extinguish. Even previously extinguished lithium-ion batteries can re-ignite hours or days later.

▣ Toxicity

Lithium-ion batteries emit toxic gases and release flammable electrolyte as they burn.

Encapsulator Agents



NFPA 18A 7.7

Encapsulator - Spherical Micelle Stability Test

This section covers the test procedures to evaluate the ability of a water additive solution to form and maintain stable spherical micelles capable of encapsulating combustible and flammable liquids (nonpolar and polar), rendering the flammable liquids nonflammable, nonignitable and nonexplosive and maintaining that encapsulation in the presence of high heat over an extended period of time.

Encapsulator Agents work on all four legs of the Fire Tetrahedron at once, removing the heat, neutralizing the fuel by separating it from the oxygen on a chemical molecular level and interrupting the free radical chain reaction.



F-500 EA is mentioned under NFPA 18A Annex 4.3 Encapsulator Agents.

Water additive based on spherical micelle technology (Encapsulator Agents) conforming to Section 7.7 has been tested extensively by independent third-party testing organizations, including Kiwa, Dekra, Daimler, Dutech, Bosch, Fraunhofer, University and TU Clausthal.

This testing has been controlled, scientific and highly instrumented, documenting fire suppression, control and elimination of thermal runaway and encapsulation of both flammable electrolyte and other explosive off-gases, rendering them nonexplosive.

Encapsulator Technology reduces the toxicity of HF gas exposure to humans.

Third-Party Tested Agent

F-500 Encapsulator Agent (F-500 EA)

F-500 EA works on a chemical molecular level, effectively extinguishing Class A, B (Polar & Non-polar), C, D, K and Lithium-ion Battery fires without the use of fluorinated ingredients. F-500 EA is fluorine free, biodegradable and noncorrosive, making it the economical and environmentally friendly option.

F-500 EA is backed by over a decade of third-party testing, including testing completed by KIWA Institute, a global specialist in testing, inspection and certification in the Netherlands, Fraunhofer Institute and TU Clausthal located in Germany. Testing overseen by HCT Europe points to one conclusion:

F-500 EA is the only agent on the market today proven to stop thermal runaway in its tracks, safely extinguishing lithium-ion battery fires and greatly reducing the risk of re-ignition.



We offer a full line of engineered Mobile Equipment and Fixed System solutions powered by Encapsulator Technology.



Multi-level Protection

Thermal Runaway

The leading cause for unexpected lithium-ion battery fires is thermal runaway. F-500 EA provides **Rapid Cooling** that can successfully halt thermal runaway.

Reignition

The chance of reignition after a lithium-ion battery fire can be high due to an inability to cool all cells effectively. **Rapid Cooling** and **Encapsulation** can prevent reignition.

Toxic Gas

Toxic gas during a lithium-ion battery fire can exceed the NIOSH limit and result in adverse health effects. **Encapsulation** can stop toxic gas production and reduce concentration below the NIOSH limit.

Electrolyte

Flammable and toxic electrolyte released during a lithium-ion battery can increase with the use of plain water. **Encapsulation** can render this electrolyte non-flammable.



▣ Water

Thermal Runaway: No Rapid Cooling

Reignition: No Encapsulation, No Rapid Cooling

Toxic Gas: No Encapsulation, No Reduction

Electrolyte: No Encapsulation, Flammable

▣ Foam

Thermal Runaway: No Rapid Cooling

Reignition: No Encapsulation, No Rapid Cooling

Toxic Gas: No Encapsulation, No Reduction

Electrolyte: No Encapsulation, Flammable

▣ Dry Power

Thermal Runaway: No Rapid Cooling

Reignition: No Encapsulation, No Rapid Cooling

Toxic Gas: No Encapsulation, No Reduction

Electrolyte: No Encapsulation, Flammable

▣ CO2

Thermal Runaway: No Rapid Cooling

Reignition: No Encapsulation, No Rapid Cooling

Toxic Gas: No Encapsulation, No Reduction

Electrolyte: No Encapsulation, Flammable

Engineered Equipment

Our engineered equipment is powered by Encapsulator Technology. Contact us for a full line of loose equipment and fixed system offerings.

Multi-class Fire Extinguishers

Land & Marine



Quick Attack Mobile Unit

50L Wheeled Units

Diamond Doser Fixed Systems

Land & Marine
Sprinkler & Watermist



F-500 Encapsulator Agent

Next generation, eco-friendly, fluorine free, reliable and most versatile firefighting agent available.

- › Effective on 98% of fires
- › Fully extinguishes lithium-ion battery fires
- › Saves up to 80% water
- › Encapsulates fuels, gases and toxins
- › Superior heat dissipation and cooling properties
- › Eco-friendly, non-hazardous and readily biodegradable

Product Details

Innovative Encapsulator Technology provides this multi-purpose firefighting agent with unique properties, allowing effective application on class A, class B, class D and class F/K fires. It currently is the sole technology to fully and sustainably extinguish lithium-ion battery fires. Actively intervening in a thermal runaway, F-500 EA encapsulates the electrolyte and rapidly cools the battery as well as surrounding structures below critical temperatures. For class D fires, F-500 EA currently is the only available water-based extinguishing technology in the market. F-500 EA can be used on certain combustible metals, such as aluminum, magnesium, titanium and other. Also, F-500 EA works exceptionally well with three dimensional fires.

F-500 EA is proven, tested, widely certified and can be used with existing, standard equipment, such as sprinklers, hydrants, fog/mist systems or mobile solutions. Foam based extinguishing systems can easily be retrofitted for use with F-500 EA. Fire and rescue services can use the unique venturi Turbo Nozzle, exclusively produced by AWG fittings. F-500 EA is certified for use in many proportioning appliances and systems. The F-500 EA concentrate is admixed to water at a ratio of 0.1% to 3%, depending on application. It is just as effective in closed rooms as in outdoor applications.

F-500 EA is approved for use to extinguish Class A and Class B fires according to DIN EN2 (MPA Dresden, SP83/08), also according to UL and NFPA ("Encapsulator Agent" in accordance with NFPA 18A). It is approved for maritime use by RINA and is MED-certified ("Wheelmark"). F-500 EA complies with legal standards with regards to safety, toxicity and hygiene. It is fluorine free, non-toxic, non-hazardous and eco-compatible. F-500 EA is readily biodegradable (OECD 306 & OECD 301b) and REACH compliant. Up to 3% admixture of F-500 EA to water is non-hazardous and meets Water Hazard Classification of 0 (VwVwS 1999, version dated 2005). There is no fire extinguishing agent with a lower water hazard classification. Non-hazardous waste under RCRA CFR261.

Areas of Application

- › Ordinary combustibles such as wood, paper, fabric, plastics (Class A)
- › Flammable liquids and gases (Class B/C)
- › Lithium-Ion battery fires
- › Combustible metal alloy fires, such aluminum, magnesium, titanium and others (Class D)
- › Cooking oils and fats (Class F/K)

Technical Data

Description	F-500 EA 20 Liter	F-500 EA 1000 Liter
Container	Canister	IBC
Size (W × H × D)	30,5 × 38,1 × 24,1 cm	100 × 116 × 120 cm
Weight	20,5 kg	1050 kg
Admixture	0,1 % - 3 %	0,1 % - 3 %
Storage Temperature	-3°C bis +60°C	-3°C bis +60°C
Shelf life	15 years	15 years
Article Number	F500EA-0020L	F500EA-1000L



Advantages

F-500 Encapsulating Agent is a liquid concentrate which is admixed to water. This innovative technology brings several proven advantages:

- › **Encapsulating technology:** When admixed to water, F-500 EA forms stable, spherical micelles (in accordance with NFPA 18A), encapsulating fuels and flammable substances on a molecular level, permanently rendering them nonflammable and non-ignitable. Fires lose their fuels as a result of this innovative technology. Also, toxins, smoke and soot are encapsulated within the stable, spherical micelles (e.g. fluorine compounds with battery fires)
- › **Superior cooling:** F-500 EA reduces the evaporating temperature of water to 70 °C by impacting the hydrogen bonds of water. Heat energy from fires dissipates rapidly, surfaces and structures cool down substantially quicker.
- › **Surface tension:** F-500 EA reduces the surface tension of water by more than 50%. This creates smaller water droplets, increasing the available water surface for cooling and encapsulation. The reduced surface tension also allows for highly improved surface penetration and surface activity of the extinguishing water, helping F-500 EA to spread quicker and get to where it is needed.
- › **Battery fires:** As stated in NFPA 18A, F-500 EA is able to fully and sustainably extinguish lithium-ion battery fires. Actively intervening in a thermal runaway, F-500 EA encapsulates the electrolyte and rapidly cools the battery as well as surrounding structures below critical temperatures.

F-500 EA



Off-Gas Detection

Li-ion Tamer: An Innovative Solution for Enhanced Safety in Battery Energy Storage Systems / Energised Batteries Storage.

Off-gas detection is the cornerstone of the Li-ion Tamer system. It is an application-specific gas monitoring solution that is designed to provide early warning when a Li-ion battery cell starts venting gas, which is an indication of impending failure. This early warning system is crucial in preventing thermal runaway and the potentially disastrous fires that can result from it.

Li-ion Tamer provides 5 - 25 minute early warning allowing mitigation steps to prevent ignition.



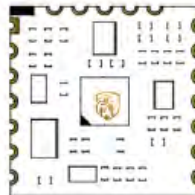
Li-ion Tamer SafeSpace

A comprehensive safety solution for lithium-ion energy storage systems



Li-ion Tamer Rack Monitor

An off-gas monitor for early indication of lithium-ion battery failures



Li-ion Tamer AWARE

A BMS implementable comprehensive solution for battery fault detection



Equipro Lithium Fire Extinguishing Technology



- F-500EA Portable Manual Fire Extinguishers Land & Marine
- F-500EA Wheeled Manual Fire Extinguishers
- F-500EA Fixed Watermist F500 Systems – domestic/residential/commercial/industrial
- F-500EA in bulk for Fire & Rescue Services, marine operators, oil & gas.

Applicable Fire Classes

A, B, D, F/K and Li

Independent Testing and Approvals

KIWA 8133:2021

MPA DRESDEN

BSI

EN3

RINA

MED

NATO Stock

UL / NFPA18A

REACH Compliant

Non-Hazardous waste RCRA CFR261

(Lowest water hazard classification fire extinguishant).

Shelf Life 15 Years



100% Fluorine Free

Li-ion Tamer

F-500 Lithium Battery Fire Extinguisher



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