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CHEMICAL HAZARDS IN LITHIUM-ION BATTERIES

SAFETY BRIEFING

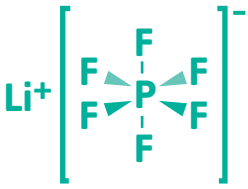
DO YOU KNOW THE CHEMICAL HAZARDS HIDING IN LITHIUM-ION BATTERIES?

> **“This technology is more sensitive and poses greater chemical risks than typical lead- acid batteries.”**

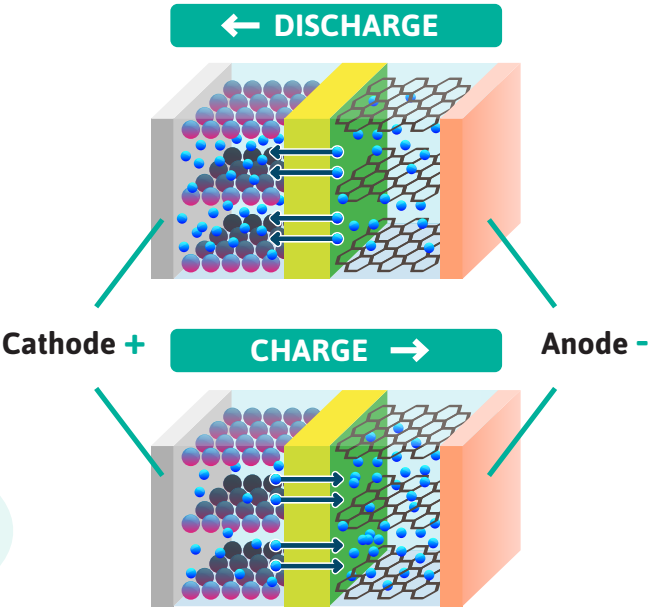
Lithium-ion (Li-ion) is the world’s most popular battery technology, employed in numerous applications from cellular phones to electric vehicles and large-scale electrical energy storage plants. The batteries have high energy density, are compact, can store several hours of electricity, and they can be quickly and easily recharged. However, this technology is more sensitive and poses greater chemical risks than typical lead- acid batteries.

THE CHEMISTRY BEHIND LI-ION BATTERIES

Li-ion batteries are based on a chemically reversible reaction between a negative electrode (e.g. graphite) and a positive electrode (e.g. cobalt dioxide, magnesium dioxide). **When the two electrodes are immersed in a liquid electrolyte (typically a solution of lithium hexafluorophosphate salts ($LiPF_6$) in a mixture of ethylene carbonate and propylene carbonate or tetrahydrofuran) a reaction occurs and the battery releases energy in the form of electricity.**



$LiPF_6$ structure



WHY IS ELECTROLYTE LEAKAGE A CONCERN?

One of the hazards with Li-ion batteries arises from the leakage of the liquid electrolyte. $LiPF_6$ is a flammable, hygroscopic (absorbs water), and corrosive compound in liquid form. It reacts very easily with mucous tissues causing burns to the skin, eyes, and gastrointestinal and respiratory tracts.

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TEMPERATURE SENSITIVITY AND THERMAL RUNAWAY

Electrolyte leakage isn't just the only potential hazard posed by Li-ion batteries. As these batteries are more sensitive to temperature than legacy batteries, irreversible thermal events can be initiated by spontaneous internal or external short-circuit, overcharging, external heating or fire, mechanical abuse etc. **This may result in a thermal runaway caused by the exothermal reactions in the battery, which can look anywhere from a rapid venting of thick smoke (i.e., smoke bomb/smoker), to a road flare, to a steady burn, to a fireball or to an explosion.** The severity of the reaction is generally a function of a number of parameters including battery size, chemistry, construction and the battery state of charge.

TOXIC EMISSIONS FROM BATTERY COMBUSTION

If a Li-ion battery burns, it will release toxic substances such as hydrofluoric acid, hydrogen fluoride gas, phosphorus pentafluoride (PF_5), and phosphoryl fluoride (POF_3). The amount of hydrogen fluoride formed during battery combustion is huge.

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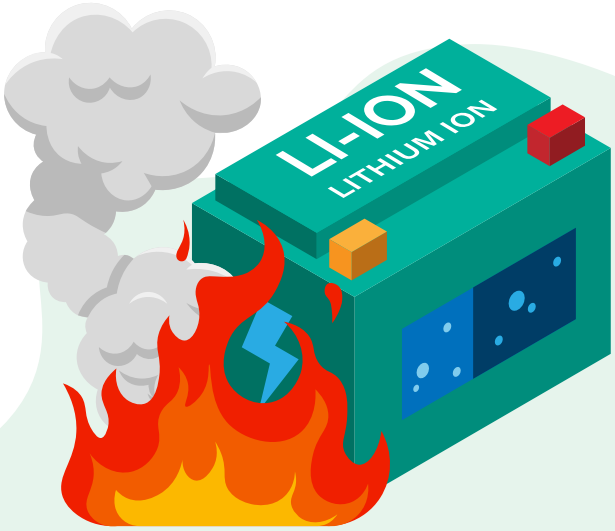

HOW DO LARGER BATTERIES AMPLIFY THE RISK?

Research conducted by Chalmers Institute of Technology in Sweden shows that a 14 kWh battery releases between 280 g (10 oz) and 2.8 kg (100 oz) of hydrogen fluoride when it burns[1]. Car batteries can be 7 times larger and therefore emit seven times the example above (between 2-20 Kg of hydrogen fluoride).

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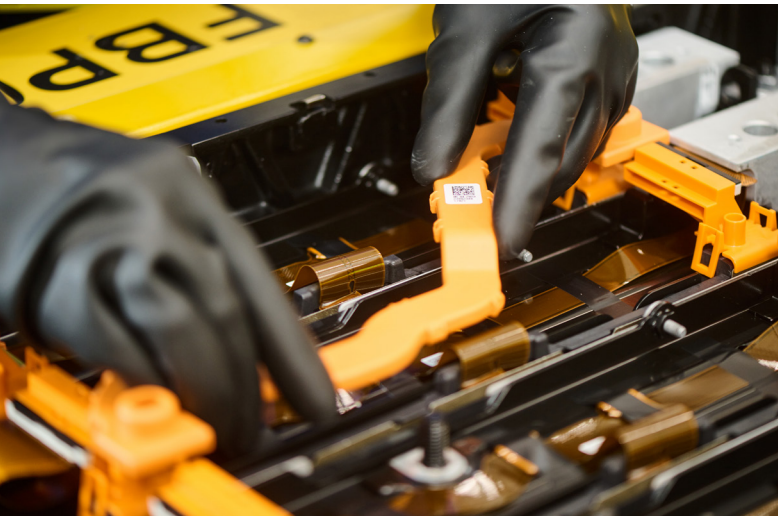
PRIORITISING SAFETY WITH LI-ION BATTERIES



In conclusion, while Li-ion batteries are generally safe during normal operation, it's vital for Safety Managers to recognise that potential hazards exist. When working with Li-ion batteries, especially during assembly, recharging, or when any physical damage is observed, the choice of the right PPE becomes crucial, serving as the last line of defence against unforeseen accidents and events that could lead to thermal runaways or other hazardous situations.

Safety Managers play an essential role in providing and ensuring the effective use of the right PPE – even in seemingly routine situations. Your commitment to safety ensures a secure environment for all.

1. Toxic fluoride gas emissions from lithium-ion battery fires – F.Larsson, P.Andersson, P. Blomqvist, B.E. Mellander, Scientific Reports, Vol. 7, 10018 (2017)

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