The risks of Li-ion battery fire

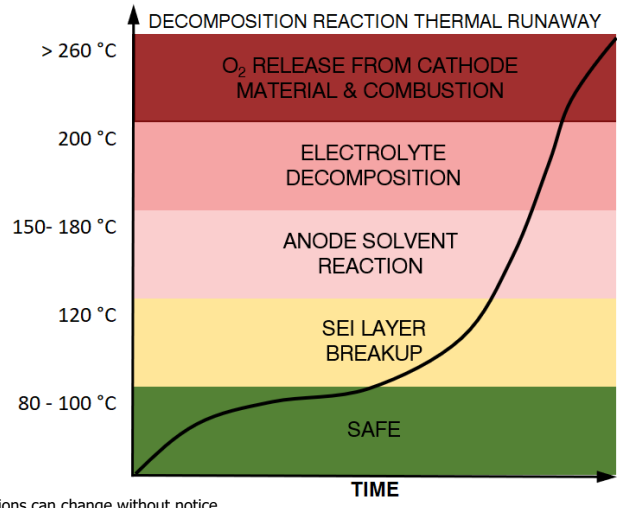
Suppressing a Li-ion fire

A Li-ion battery is named after its active material, Lithium. The name is abbreviated with the chemical symbol. The fire protection issues that arise with the processing, storage, and energy storage of and with this type of battery are for the K&G Groep BV and Fireaway Inc, as producer of Stat-X® aerosol fire suppression generators, not an unfamiliar phenomenon. DNV-GL USA investigated this.

When choosing how to set up the fire detection/extinguishing system, it is crucial to acknowledge that extinguishing is always preceded by something. The cause of a decomposition reaction, also known as thermal runaway, is usually overheating, improper use, or damage. Once the decomposition reaction has started, it cannot be stopped, and the cell will burn. Due to the occurrence of extreme temperatures, water as an extinguishing agent will usually evaporate immediately.

The deep-rooted nature of a battery fire poses a challenge to detection techniques and systems. Studies performed by respected test centers have shown that the first sign of an imminent battery fire is the emission of gases. The cell temperature at which these gases are formed is relatively low and lies between 120-150 degrees Celsius. Subsequently, the temperature can rise rapidly to above 260 degrees Celsius and, when exceeding this, can shift to thermal runaway and rise as high as 600 degrees Celsius. The danger that the gases, released with sufficient oxygen and ignition temperature, will ignite is evident. Therefore, it is essential to intervene before stage 3 of the temperature curve is reached.

In the event of a fire, a lithium-ion battery also produces gases in addition to extreme heat. In a situation whereby no external fire occurrence has yet been detected but is indeed developing, the battery will begin to emit gases, releasing a mix of hazardous substances and gases, including hydrogen fluoride (HF), hydrogen sulfide (H2S), and hydrogen chloride (HCl). These hazardous substances are highly corrosive and toxic. In addition, other toxic substances such as fluoridated organic components and carbon monoxide are released.



From C.Schafer Battery safety

Detecting a Li-ion fire

Detecting a Li-ion fire

A fire extinguishing system must be tailored to the object, the use, and the purpose. An automatic fire extinguishing system is controlled by a fire detection/extinguishing panel, which is a fire alarm panel adapted for the specific control, fire alarm, and monitoring of an extinguishing system. Therefore, the timely detection of a Li-ion fire is vital, and the relationship with the fire development phases is highly relevant.

With automatic extinguishing activation, the system is implemented in two stage fire alarm principle to prevent an undesired extinguishing activation. Interfering elements can generate a false fire alarm. A false fire alarm is when the alarm is not the result of a fire or a 'fire-like occurrence' but is the result of a malfunction or contamination of the fire detector. In extinguishing activation systems, the most common fire detectors are multi-sensor fire detectors equipped with optical smoke and thermal heat sensors.

With a Li-ion battery, there are two options when selecting a fire detector - a combination of a gas and smoke detector or one with two gas detectors. To reduce the risk of undesired extinguishing, we opted for two detectors in two fire alarm zones. The difference in response time determines the result. When there is not yet an occurrence of fire but is developing in the so-called incipient stage of a fire, the Li-ion battery will already begin to emit gases. For this reason, gas detection is recommended to immediately commence suppressing the (imminent) fire (still) in its early phase and prevent the temperature from rising uncontrollably. Thus, early detection and action will ensure an imminent battery fire is suppressed in the incipient stage of fire.

The most obvious and cost-effective gas detector is a CO gas detector. Unfortunately, not every CO gas detector reacts to the released substances. However, the KG/KT gas detector does respond to the substances and gases released in the early phase of a Li-ion fire. We refer to this as cross-sensitivity. K&G, therefore, recommends a combination of two CO gas and temperature detectors for the fastest detection of a Li-ion battery fire. The KG/KT CO gas detector reacts to carbon monoxide but also hydrogen sulfide H_2S. An important factor is the response of the CO sensor to H2S. This is partly determined by the catalyst and electrode system and how it processes the hydrogen detection reaction. Our CO sensor is very similar to the sensor that is specifically intended to measure H_2S. The CO sensor of the KG/KT fire detector reacts to both CO and H_2S but cannot distinguish between the two, which for this application is not necessary.

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Special automatic fire detectors

Special fire detectors

These conventional fire detectors from the K&G range feature technology that has only been found in intelligent fire detectors and provide unprecedented reliability in preventing false fire alarms in an unstable environment. These fire detectors are of the conventional type. There are two models in this K&G fire detector range that measure and respond to predetermined parameters.

These fire detectors are intended for use in conventional two-wire fire alarm systems, where fire detectors are connected in zones.
Depending on the model, the following parameters are monitored:

1. Presence of carbon monoxide
2. Smoke
3. Temperature
4. Rate of temperature rise

Each detector samples the ambient air every five seconds and if a fire condition is detected, a signaling current is drawn from the zone causing the Control and Indicating Equipment (fire alarm panel) to provide an alarm response for that zone.

The KG/OT/002 operates by sensing the optical scatter from smoke particles generated in a fire, and a rapid rate of rising temperature increases the smoke detection sensitivity. The thermal sensor will not raise a signal on temperature, but only increase the sensor sensitivity.

The KG/KT/007 CO gas detector is a unique fire detector for general use and special applications such as battery storage rooms and cabinets. This fire detector warns for very early-phase slow smoldering fires and is also suitable for applications where heat detection is insufficient, but smoke detection may cause false alarms, which is highly undesirable when it concerns the activation of an extinguishing system.

Because CO gas travels more freely than smoke, the positioning of a CO fire detector is more flexible. In addition to extreme heat, a Li-ion battery also produces gases. Not every CO detector reacts to these gases, but the K&G detector does respond to the gases released during the heating and outgassing of a lithium battery. The KG/KT/007 detector not only responds to Carbon monoxide but also on hydrogen sulfide and hydrogen gas. (H_2S)

The KG/OT/002 fire detector has an EN54-7, EN54-29 approval.

The KG/KT/007 CO gas detector comply to the EN54-5 and 7 and is LPCB 143ac approved.

Dimensions : 109 x 42 mm Ø x H
In base MS/4: 109 x 55 mm Ø x H

This combination is well suited for connection to the µ-FEP system and most EN 12094 approved panels.

Voltage: 10,5 - 33Vdc
Quiescent current: 65 tot 87 µA
Alarm current: 45 tot 53 mA
Reset Time: 2 - 5 seconds
Operating temperature: -10 /+55°C
RV value: 95% (not condensing)
Material: flame retardant ABS
Weight: 138 grams incl. MS/4