

The role of gas sensors in advanced safety systems

ACTIVE PREVENTION APPROACH FROM FLASH BATTERY USES CHEMICAL SENSING AND REMOTE MONITORING TO IDENTIFY BATTERY RISKS IN EARLY STAGES OF DEGRADATION

▶ As industrial machinery and off-highway vehicles become increasingly electrified, lithium battery safety has become a central design factor. As energy density and system complexity increase, so does the focus on solutions capable not only of reacting to anomalies but of anticipating them. It is in this context that the approach of active prevention is emerging, redefining how safety systems are designed for the most critical applications.

Traditionally, lithium battery protection has been based on monitoring electrical and thermal parameters. Voltage, current and temperature remain fundamental indicators for ensuring proper system operation. However, these signals only become meaningful when a process of degradation is already under way. Most safety systems are thus triggered only once the anomaly is already evident.

In recent years, some advanced architectures have introduced an additional layer of protection aimed at identifying risks in their early stages. This is where the experience of Flash Battery comes into play, being a manufacturer of customised lithium batteries for industrial applications that has adopted a design approach based on active prevention for the most critical applications.

According to this vision, anticipating potentially risky situations before they turn into actual problems is an essential aspect of safety. For this reason, in highly critical operating settings Flash Battery has chosen to integrate advanced safety systems that provide an additional layer of protection for both the battery and the vehicle. Particular focus has been placed on two key technologies: gas sensors capable of detecting the presence of volatile substances released by cells at an early stage, even in the absence of smoke or rising temperature, and aerosol fire suppression systems designed to act rapidly in the event of a fire and limit its spread.

Chemical sensing, an indicator of risk

During the initial stages of lithium cell degradation, before any abnormal surges in temperature or the formation of visible smoke, gases generated by electrolyte decomposition



ABOVE: Gas sensor applied to a Flash battery lithium battery for the industrial sector

may be produced. These gases represent an early signal of internal instability.

Gas sensors are designed precisely to detect these emissions. Integrated within the battery pack, they continuously monitor the internal atmosphere and identify any abnormal gaseous compounds well before critical conditions can develop. This time advantage can be decisive in preventing an escalation to more severe events, such as thermal runaway.

In tests and real-world applications, gas detection has proven capable of preceding significant increases in temperature by several minutes, offering a margin for taking action that traditional systems cannot provide.

The role of the BMS

For active prevention to be effective, gas detection must be integrated into the battery management

system (BMS). Signals from these sensors are used as an additional data point to assist with assessing the battery pack's current safety level, alongside the monitoring of existing electrical and thermal parameters.

This enables targeted protection strategies to be activated, such as controlled power reduction, reporting the anomaly to the vehicle system or isolating the battery pack itself in the most critical cases. The objective is not merely to shut the system down, but to manage the event in a controlled manner, reducing the risk of uncontrolled reactions.

Remote monitoring

Active prevention does not end within the battery pack. In more advanced systems, the data collected is sent to remote monitoring platforms that allow battery behaviour to be recorded and analysed over time.

In the case of Flash Battery, this role is performed by the Flash Data Centre, a cloud-based platform that collects and analyses operational data from batteries installed in the field. The integration of gas sensors, the BMS and remote monitoring enables not only the management of individual events, but also the identification of recurring patterns and potentially critical operating conditions.

A multi-level safety system

The integration of gas sensors does not replace existing safety systems but rather complements them, creating a multi-level architecture. Within this framework, active prevention is combined with other solutions designed to act quickly and effectively.

These include aerosol fire suppression systems, used as an additional layer of protection. In the event of an incipient fire, the condensed aerosol is released inside the battery compartment, interrupting the combustion without damaging the electronics and without the use of liquid extinguishing agents. This solution is particularly suited to confined spaces and high-intensity industrial applications. **ivT**

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