Safety concepts for battery energy storage systems

Fire protection and explosion safety of lithium-ion battery energy storage systems

Lithium-ion batteries are now an essential part of our everyday lives. They have proven themselves for many years due to their high efficiency as rechargeable energy storage in small appliances such as mobile phones, notebooks, cameras, tools and model making. Lithium-ion batteries have now also made their way into electric cars, bicycles, forklift trucks and battery energy storage systems (BESS).

Alongside the many performance advantages of lithium-ion batteries, safety-related investigations show that battery cells can pose a risk if temperature limits are exceeded. Above corresponding temperatures, strong exothermic chemical reactions can be initiated in the material at a cell level, which can spread to the entire module or even to the entire battery system. This can result in temperatures of up to 700°C within a short time.

These chemical chain reactions at a cell level cannot be interrupted, which is why they also are referred to as thermal runaway. As the thermal decomposition of the battery cell produces ignitable gas mixtures, there is a significant risk of fire and explosion . **Lithium – Batterien – Brandgefahren und Sicherheitsrisiken, Risk Experts, Dr. Buser**

The temperature above which there is a risk of thermal runaway depends significantly on, for instance, the cell type. According to the literature, lithium-ion cells are not usually designed for operating and storage temperatures above 60°C . **Brandschutz-Forschung, IMK Bericht 175, KIT, Herr Kunkelmann – 2017**

In addition to temperature, there can also be other causes of thermal runaway: for example, internal or external short circuits (e.g. due to quality defects, deformation, external fire load, damaged cells) or to high currents during charging or discharging.

To reduce these risks, high demands are placed on the safety and reliability of battery cells. Manufacturers have to successfully pass through many tests in the run-up to a market launch, including tests that go far beyond normal use (e.g. nail penetration test). Protective measures are also implemented in battery systems in order to avoid a thermal runaway scenario during operation or to identify it at an early stage. The measures include e.g.

- Safety systems inside the cell, such as safety valves or explosion vents
- Battery management systems that monitor, among other things, electricity, voltage and temperatures
- Venting of the battery module housing
- Circuit breaker/galvanic isolation
- Gas sensors
- Ventilation technology
- Cooling systems

Commercial-scale use of battery energy storage systems (BESS)

Thanks to their high storage density, lithium-ion batteries are increasingly being used as battery energy storage systems (BESS) in order to secure the energy supply or balance out fluctuations from renewable energy sources in the power supply. These battery systems – also referred to as battery storage power stations – play an important role in the global expansion of the renewable energy supply. The battery modules in the power stations are mostly installed in large numbers in man-high racks inside 20- or 40-foot