

RISKS AND SIDE EFFECTS THE UNDERESTIMATED DANGERS OF LITHIUM-ION BATTERIES

With its high energy density and low self-discharge rate lithium-containing batteries offer some great advantages compared to conventional and rechargeable batteries. Indeed, operator errors and design faults frequently result in explosions and fires with injuries to personnel and damage to property. Wouldn't it be better to avoid using this controversial and highly flammable battery type - particularly in areas with a potentially explosive atmosphere?



Lithium-ion batteries have recently come under the microscope because of their potential for creating fire related incidents. Dell, the US based computer manufacturer, recalled millions of notebook batteries with cells containing lithium made by Sony. In 2000, they replaced about 27,000 notebook batteries, after it became known that lithium-ion batteries could suddenly catch fire. At the beginning of 2013, Boeing reported two alarming events in connection with lithium-batteries. Having loaded a Dreamliner in Boston, the cleaning crew discovered a battery fire. Only a few days later, the pilot of a Japanese domestic flight initiated an emergency landing at Takamatsu Airport. The board system indicated battery problems as well as smoke development. Finally, Boeing averted the danger with a steel armour housing together with a titanium exhaust piped to the outside, so that a battery fire could not spread through the aircraft.

There were also some problems in the production of Tesla cars in the US. In Indianapolis, a Tesla S hit a tree at high speed. The electrical energy storage ignited and the whole vehicle burnt out.

Life-threatening situations

Laptops, tablets, PCs, mobile phones and smartphones again and again prove to be a talking point with failures and accidents creating life-threatening situations. After battery fires, Samsung pulled out all the stops. First, it halted the production and later announced the termination of the Galaxy Note 7, an unprecedented fiasco in the smartphone business and the latest negative event in a long chain of events with lithium batteries: The Honeywell group ceased the production and delivery of two of its portable multi-gas detection devices as a precaution when customers reported about overheated battery cells. The group announced that purchase and dispatch locks would remain in existence for the time being.

The International Civil Aviation Organisation (ICAO) also thinks that the safety of men, machines and the environment are at risk from lithium-ion batteries. Since April 2016, it has prohibited the transportation of lithium-ion batteries in the cargo spaces of passenger aircrafts. The background of the decision is the



Portable Gas Detectors
Polytector III G999 (left) & **Microtector III G888** (right)

legitimate concern about a fire hazard caused by the batteries. In fact, the ICAO has taken the same stance as Boeing, in 2015 the aircraft manufacturer requested that its customers no longer transported any large charges of lithium-ion batteries.

Two billion pieces were built in to electrical devices every year, since lithium batteries came out on the market in the mid 1990s. For a long period, this technique was regarded as the hallmark invention of the battery industry, since they were not impaired by the problems of memory effect, i.e. the loss of capacity due to frequent partial discharge. Today, we know: The risks of this

battery technology have been underestimated for years, or even ignored. Now, the numerous accidents and incidents have alarmed the public. Lithium-ion batteries consist of dozens of layers coated with metal foil. Plus and minus layers are kept apart by a separator, i.e. a wafer-thin protective layer. If this protective layer cracks due to overheating, the stored energy can be released uncontrolled. The battery burns through and might even explode. The larger the battery, the stronger is the chemical reaction. The battery size of a mobile phone is already sufficient to form flames. In addition toxic gases are released which may yet be lethal. A film made by the Institut für Schadenverhütung und Schadenforschung (IFS)

(= Institute for Risk Management and Damage Research) in Kiel shows conclusively that lithium batteries are energy stores which might catch fire easily and recommends the installation of smoke detectors anywhere where lithium batteries are being loaded.

Not only is handling and using these batteries potentially hazardous, storage of these batteries has its risks too. The fire load needs to be classified considerably higher than for conventional batteries:

The American National Fire Protection Association (NFPA) has carried out a study on the mass storage of lithium-ion batteries. They reached the conclusion that, due to the flammable electrolyte liquid, several special fire hazards emanate from lithium-ion batteries. In case of fire, cylindrical lithium-ion cells and polymer cells which are very close together behave differently than conventional batteries.

Battery experts are aware of the disadvantages of a lithium-ion battery: "They react more sensitively to environmental influences than other types of batteries. For temperatures below freezing point the resistance within a lithium-polymer battery is so high,

that it can only emit little to no charging voltage. In this way, devices can only go into operation again without limitations if the battery has a certain operating temperature."

Lithium is highly reactive, it reacts to stimuli and is difficult to control. Influences such as high environmental temperatures, too high charging voltage, short circuit, or even too much of a heavy strain can cause exothermic reaction in the battery.

Nickel metal hydride batteries are safer

Due to the significant safety concerns already discussed, the lithium-ion technology is absolutely taboo for Gesellschaft für Gerätebau (GfG). The globally renowned manufacturer of gas detection devices only uses nickel metal hydride batteries. According to GfG's battery technology experts, these are far safer than batteries containing lithium technology. They also provide a sufficiently long service life with a reliable energy output without creating the risks associated with locating cells containing lithium in areas where explosive gases are present.

Hans-Jörg Hübner, manager of GfG, wonders why external specialists and inspection bodies still approve the lithium-ion technology considering the known risks and required re-evaluation needed in the battery industry. The traditional company with headquarters in Dortmund wants safe devices and directives, which target the safety technology of batteries and require reliable framework conditions, technologies and international standards. Hans-Jörg Hübner warns that batteries containing lithium must not be used in potentially explosive atmospheres or safety-relevant areas. A reliable energy technology – coupled with a continuous quality control – would be essential to survive.

The energy density of batteries, even though it would be highly preferable, cannot be increased in any way. Even if today's technology seems to be highly advanced, it would be wrong to expect any miraculous solutions in the battery industry. However, battery systems with a highly specific capacity, an excellent cycle behaviour, a low tendency to self-unloading and with high safety measures will be considered as the core factors and will also play a leading role in the battery technology in the future.

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