SUCCESS STORY

FFG Promoting Innovation.

SafeBattery
Safe Lithium-Based Traction Batteries

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Project

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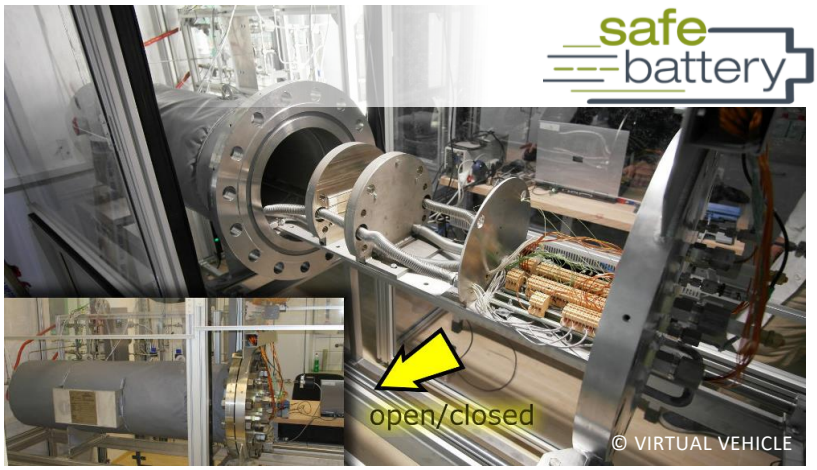

COMPREHENSIVE HAZARD ANALYSIS OF FAILING AUTOMOTIVE LITHIUM-ION BATTERIES

QUANTIFYING THE FAILING BEHAVIOR OF AUTOMOTIVE HIGH CAPACITY CELLS IS RELEVANT FOR SAFE PACK DESIGN. FOR THIS REASON, SAFETY RELEVANT PARAMETERS OF FAILING MODERN BATTERY CELLS ARE QUANTIFIED.

Hazards from Li-ion Batteries

Batteries are a key component for electric vehicles. Especially Li-ion batteries are gaining importance in the automotive sector because of the potential of electric vehicles to reduce greenhouse gas emissions and air pollution. In normal operation conditions batteries are safe, but under misuse battery failures may lead to critical situations inside the vehicle. The worst case of batteries failures is the uncontrollable exothermic chemical reaction - the thermal runaway.

With a good understanding of the critical battery conditions, an electric vehicle can be designed safer than a conventional vehicle carrying liquid fuel. For the design, the critical battery conditions must be analyzed in detail. Current methods to characterize possible battery failures are battery abuse tests. These abuse tests show the influence of cell chemistry, state-of-charge, state-of-health, trigger etc. on the failing behavior and the thermal stability of the cell.

Test facilities for battery abuse tests inside a defined environment are rare in Europe. So, VIRTUAL VEHICLE Research GmbH built up a custom-made TR reactor and focuses on comprehensive hazard analysis of failing automotive batteries. In the project ***SafeBattery*** Li-ion cells were extracted from a modern mass-produced electric vehicle. Together with industrial partners safety relevant parameters from failing batteries were defined and scientifically investigated inside the reactor. Five hazards are in focus, which may lead to safety and health risks (Figure 1): electrolyte vaporization, heat generation, amount and rate of gas emission, gas concentration and particle emission.

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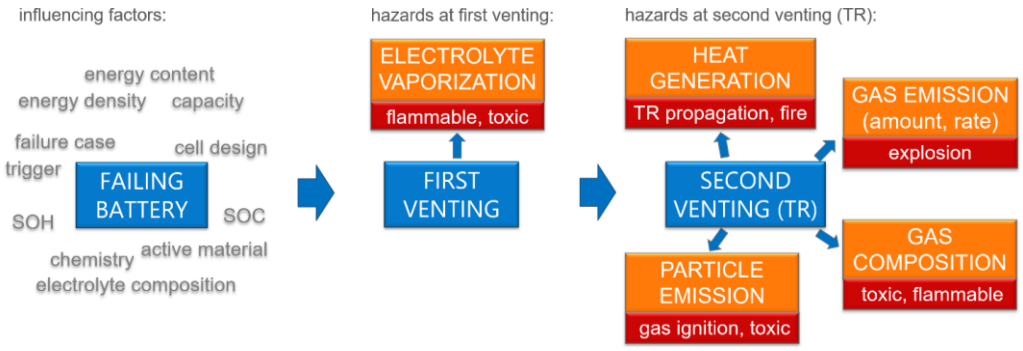

Figure 1: Five categorized hazards (orange) and their consequences on safety and health (red) © VIRTUAL VEHICLE

In the project ***SafeBattery***, for the first time all five hazards are characterized for a modern Lithium-Ion pouch cell and safety relevant parameters are quantified: the maximum reached cell surface temperature, the amount of produced vent gas, the gas venting rate, the composition of the produced gases and the size and composition of the produced particles at the thermal runaway. This makes it possible for the first time to identify complex interrelationships and use these findings to increase the safety of future electric vehicles.

Impact and effects

The experiments show that enormous heat is generated by the cell during the thermal runaway and the cell surface temperatures increased above 700°C.

Overall, huge amount of hot combustion gas and particles are produced. 47% of the produced gases are harmful to health (CO) or flammable (H_2, CH_4, DEC, etc.). For the Furthermore, the project provides the first evidence that the resulting particles are respirable.

Based on the quantitative results, car manufacturers can design the batteries in such a way that passengers remain safe even in the event of a thermal runaway in the battery system. Specifically, the measurement data are used for the design of thermal barriers, cooling systems, exhaust ducts and particle filters, as well as for the development of simulation tools. The new findings from the experiments are thus essential for the battery design in the vehicle, but also for the recycling and transport of these batteries.

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Project partner

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- AVL List, AUT
- Daimler, GER
- Porsche, GER
- Kreisel Electric, AUT
- Bosch, GER
- SFL engineering, AUT
- TU-Graz (ICTM/VSI), AUT
- VIF, AUT

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