Battery fires: balancing safe energy storage and sustainability

Energy storage technologies are evolving faster than our ability to design fire safety strategies that protect buildings and its occupants in the event of a fire that involves them. At present time there are large gaps in our understanding of the conditions resulting in thermal runaway of lithium-ion battery cells and the resulting ejection of toxic and flammable gases, aerosols, and liquids. Moreover, the highly exothermic nature of this process facilitates cascading failure of cells across a battery pack and between arrays of battery packs. Significant research attention is focusing on understanding these gaps to develop improved prevention, detection, and counter measures. However, there has been very limited, if any, work assessing how current fire safety strategies deal with the fire risks associated with energy storage devices.

The need to address the impact of increased use of batteries on fire safety in the built environment and in our physical infrastructure becomes clear when the extent of their penetration into different fields is considered. Based on their presence in, e.g. EV's, Hybrid EV's (HEV) and mild Hybrid EV's (mHEV), and personal mobility devices, batteries are becoming more common in many environments, for example in shipping and transportation (e.g. passenger and car transport RO-RO ferries); in car-parks including underground, above ground, and stackers; on the open road; on closed roads, such as tunnels; and in homes and garages.

Issues arise in all the above use cases when considering the potential for charging / discharging of batteries at various rates, and to and from various states of charge – and the impact of aging and physical abuse which can contribute to an increased likelihood of thermal runaway occurring. Other issues arise from the use of non-OEM manufacturer parts, conversions, maintenance, as well as certification of parts used by those carrying out the conversions or maintenance (with certification and regulatory control being one mechanism that may reduce the frequency of fires in many instances). Many of these use cases have already been the subject of incidents, despite the relatively young age of the technology.

There has been a great deal of research undertaken to contribute a body of knowledge about the thermal runaway process and the energy released during fire events [1 – 7]. There is also a significant body of work already underway to study fire brigade response to EV fires [8], and a significant body of work has been published looking at the efficacy of various suppression systems for lithium ion and other high energy density battery systems [9, 10]. However, one area that remains unexplored but which is of critical importance to avoiding future catastrophic impacts of battery fires in the built environment is the holistic integration of consideration of the impacts of battery fires on the elements of the fire safety strategy of a building. Currently redundancy measures such as suppression and ignition prevention appear to be our only strategy. Clearly battery technology is here to stay. However, there is a need to balance the benefits of this energy storage technology with the responsibility for providing a fire safe built environment. It is therefore critically important to consider the impacts of battery fires holistically on the fire safety in buildings and in other applications.

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