Why batteries have started catching fire so often

11 November 2016, by Richard Andrew Williams

Watch out. Credit: Igor Zh.

All our lives we have relied on batteries in everything from mobile phones and cars to hand torches, but confidence in the technology has deteriorated of late. Many airline passengers have had to surrender their Samsung Galaxy Note 7 phones in recent weeks because their batteries are considered a fire risk, while those left in baggage holds have delayed aircraft and caused angst to travellers.

These batteries were supposedly the remedy for a previous design that saw 2.5m units recalled in September when they too were deemed a fire risk. Other mobile phone batteries have also been ignition-prone.

Meanwhile, airlines banned hoverboards a few months ago, again because their batteries were considered a fire risk. And we are seeing hundreds of incidents of battery fires in electric vehicles, particularly in China. What's the cause of all this trouble?

Enter lithium

The story starts in the early 1990s with the arrival of lithium-ion batteries as a common feature in phones and other devices. Lithium is a lightweight metallic element which is less toxic than previous battery materials such as cadmium or lead. Unlike earlier "single use" batteries, they can normally be recharged thousands of times.

The other clever innovation in lithium-ions lies in the detailed compact structural design of the layered battery. These optimise the thermal pathways and the accompanying software-driven power system control that (normally) avoids overcharging and over-discharging the cells.

Credit: Derin Khsro, CC BY-SA

These designs have become more and more refined since the mid 1990s thanks to voracious investment in the technology. The energy density that the cells can achieve has grown from 100 watt hours per kilo to 270 watt hours per kilo, which means you can have far more power in a smaller space. This has of course been crucial for the advance of modern consumer electronics in which the size and weight of devices are critical selling points.

But with more energy comes more heat, and when things get hot inside a battery the packaging and physical space for expansion become increasingly critical. The race to produce better and better products and capture market share from rivals has required an enormous amount of manufacturing. In the process, it looks as though insufficient consideration has been given to these heating issues, and that new products are emerging that have not been fully time-tested.

This has resulted in batteries in which sudden friction or external heat can lead to a spontaneous explosion. Not only does this cause damage itself, it sometimes sets the surroundings on fire. We started seeing these problems about a decade ago, but now it has become more common – evidently with results that can be disastrous for the companies in question.

From a consumer point of view, there a couple of possible answers: accept shorter battery lives and recharge your device more often; or adopt my principle of being a late adopter of frontier technologies. At least being a late adopter only means waiting about six months these days.

Vanadium redox storage system. Credit: Wikimedia

Future-proofing

One might ask if there are other dangers lurking in the wings. The answer is yes, unfortunately. The investment appetite for batteries is producing a range of devices for large-scale use, such as battery parks for future residential areas and what are sometimes referred to as smart and resilient cities. These parks would be used to smooth the power supply, offer emergency storage and store power from sources like wind farms that can't produce all the time.

The concept is excellent. Various systems using redox flow batteries containing either lithium or vanadium are already being used to power residential areas in the US and Europe. For example the small town of Braderup in northern Germany has a system that produces 2MW of power and can store 2MWh – roughly three hours of output from the average onshore wind turbine, for instance. In Washington state in the US, the system pictured below is used to power laboratories.

China has been a leading player in the sector. Current experimental facilities at Zhangbei, a town near Beijing, are reported to be testing systems at 14MW and recently announced plans to create a single 500MWh storage facility with an intention to deliver 64GW of power across China by 2020 – enough for perhaps 50m homes.

The problem is that the sheer intensity and scale of energy in such parks poses a potential serious explosion and fire risk. If we are to avoid such consequences, designers will need to learn the lessons from smaller batteries. Close attention to safety and proper testing will be essential.

Aside from these risks, we also need to bear in mind that batteries are highly resource consuming. The high cost of reusing and recycling batteries is also rarely talked about. In short, the real challenge and opportunity is to seek to store energy without using batteries at all. That, however, is another story entirely.

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