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Hazards of Lithium-ion Batteries in Electric Vehicles

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Introduction

Data published by the Federal Chamber of Automotive Industries in Australia reports 87,217 electric vehicles as sold in 2023, up 161.1 per cent on the 33,410 reported as sold the year prior.[1]

In a move away from hydrocarbon fuel sources, cars powered by lithium-ion batteries are now commonplace. The desire to be more environmentally friendly is driving the move away from hydrocarbon fuels. However, to safely use a new technology it is important to understand the risk.

This article considers the potential hazards of lithium-ion batteries in electric vehicles.

Hazards

Electric vehicles (EVs) have adopted lithium-ion batteries as a standard. These batteries include an electrolyte containing lithium ions that are highly volatile. They are flammable, energetic and produce highly toxic gases when heated and subsequently combust. This creates an event which is very difficult to control and almost impossible to extinguish.

Battery Fires

Batteries in electric vehicles are generally made from large numbers of small cells. Short circuits can occur due to factors including physical damage, overcharging, internal cell failures and manufacturing defects. This can cause a chemical reaction leading to overheating (known as thermal runaway). A single over heating cell may cause the escape of vapour to ignite. On ignition the electrolyte within the cell ignites adjacent cells and continues to burn vigorously.

This allows the batteries to continue to burn even while under water. Lithium also reacts with water and produces highly flammable hydrogen which continues to burn until all the fuel is consumed. When fighting lithium battery fires the primary focus is on trying to limit the ability for fire spread as extinguishment is difficult.

Charging Hazards

Overcharging can be the cause of thermal runaway events. Battery management systems are more advanced in cars when compared to lower value consumer items. However, a substantial number of battery fires associated with EVs still occur while charging.

Residential buildings can have many charging stations installed. With the potential for one charging station dedicated to each carpark.

Electrical systems inside residential buildings will need to cope with the extensive power demands of EV battery charging, which may cause overloading. Building electrical systems were not installed with EV charging in mind.

Managing Battery Charging Risks

1. Locate charging to open air carparks clear of buildings.
2. Group charging facilities into small numbers with extensive space between groupings.
3. Ensure charging stations are greater than 15 m clear of combustible building construction and areas of building access to ensure building egress or provide engineered fire walls and protection for structural steel.
4. Ensure no building utilities are in the adjacent areas such as gas or electricity lines, fuel tanks or air conditioning intakes.
5. Reduce the number of charging facilities that are provided.
6. Provide impact protection around charging facilities.
7. Install the charging station to the manufacturer's instructions and electrical regulations.
8. Ensure annual checks are completed by qualified electricians.
9. Install residual current devices (RCDs) on all charging systems to protect from ground faults.
10. Ensure isolation point for emergency shutdown of electrical supply is accessible.
11. Provide a battery off-gas detection system to automatically shut down charging systems and notify relevant parties.
12. Charging areas should be well ventilated to National Fire Protection Standard for Parking Structures (NFPA 88A).

Retrospective changes to building design are always more expensive and disruptive than incorporating these measures into the initial design.

Heavier Vehicle Weights

Some residential buildings have elevated and basement parking areas constructed with suspended concrete slabs which were built to local standards. Over recent years vehicle weights have increased from around 1,500 kg to around 2,000 kg.[2] This has the potential to overload structures.

Sprinkler Protection

The National Fire Protection Association and Factory Mutual have recently increased the sprinkler design requirements for parking structures. This requires much greater water density and subsequently water supply to manage and limit fire spread. This will be a major expense for building owners and owner's corporations if upgrades are required.

To ensure electric vehicle fires do not spread to surrounding vehicles and structures, a much higher volume of water is required when compared to a fire involving petrol-powered cars.

Conclusion

Vehicle battery technology is changing fast and may become safer in the future. Current EV battery and charging facilities present hazards which can be reduced by following good design, installation, and maintenance practices.

The potential consequence of an incident is best mitigated via separation from buildings, services and combustibles (wherever possible), robust emergency and electrical isolation procedures, and adequate ventilation, gas detection and fire protection systems.

References:

1. https://www.drive.com.au/news/best-selling-electric-cars-2023-full-year/ Date:24-1-2024
2. https://www.cnbc.com/2023/10/03/as-ev-sales-surge-and-cars-get-heavier-parking-garages-have-to-change.html Date: 24-01-2024

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