

|| DAFO - SafEV Vehicle Fire Protection

the challenge

The global shipping industry is evolving – and so are its fire risks.

As we move towards a more sustainable future, businesses in almost every sector are searching for sustainable alternatives to power vehicles and machinery. The port industry is no different – and in recent years it has seen a huge increase in electric vehicle (EV) and machinery use on site, as operators make the move from traditional combustion engines.

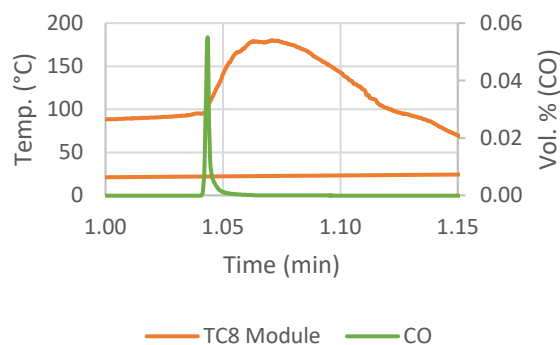
In 2019, there was a cargo-related fire incident every ten days at ports across the globe. As new electric technology comes into play, the risks – and fires – are only increasing, and when it comes to electric fires, the risks can be even more severe.

EVs at ports are often powered by lithium-ion (li-ion) batteries, which bring their own unique fire risks. Should li-ion batteries become damaged, experience mechanical failure or overheat, they can enter a state called thermal runaway. This is the result of rapid temperature increases, and can lead to dangerous fires, with toxic gas emissions, and potentially even large explosions.

In thermal runaway, a battery can also produce its own source of oxygen, propelling flames from within its cells. In an EV, a battery fire requires up to eight times more water than a traditional combustion engine vehicle fire, which needs to be applied for up to four times longer to reduce the likelihood of reignition. As such, suppression using traditional methods for EV fires was challenging; it needed a new solution to reduce risk to life and operations.

the innovation

Working with RISE (Research Institutes of Sweden) on an EU-funded initiative, Dafo Vehicle Fire Protection developed SafEV – the result of three years of research, data collection and extensive testing on li-ion batteries and EVs. The research found EV batteries need a unique fire detection system that identifies the early stage of thermal runaway. Low levels of carbon monoxide were emitted and measured prior to the battery entering thermal runaway. Detecting the level of carbon monoxide – before temperatures increase – maximises safety.



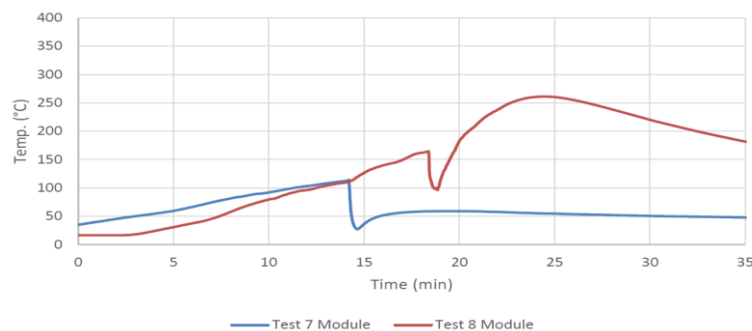
***CO-detected at the beginning of the temperature increase.
Tests conducted at RISE by Dafo VFP.***

This research found that, when tackling EV fires, aside from applying large quantities of water, you can also apply appropriate cooling in the venting stage, which occurs prior to thermal runaway. This will halt the process in its earliest stage, reversing the battery to a dormant stage.

SafEV applied exactly that concept – as a new system that focuses on prevention as well as suppression. SafEV consists of:

- CO sensors for li-ion batteries, which can detect CO particles at 10ppm with integrated temperature monitoring.
- Heat detection systems for conventional risks – detecting from 180 °C.
- A CEV-3 control unit – to manage multiple zones and detection methods and to control the alarm, battery shutdown or activation.

Once CO is detected, the battery will be immediately shut down, and rapid cooling will take place using the suppression agent inside the battery module.



***Temperature development with suppression system either at venting or thermal runaway.
Tests conducted at RISE by Dafo VFP.***

how it was implemented

Currently, Dafo Vehicle's SafEV is on the verge of entering the international shipping market as a new product, following successful testing with key port industry players. As part of this, sensors were installed on port equipment EVs for several large shipping companies (unable to name due to NDAs), and following the results, there are now plans in place for their imminent use to protect these companies' EVs around the world.

To adapt to the high-risk port operations environment, SafEV complies with extensive vigorous shock and vibration testing standards, as well as Low Voltage Directive Standards. This ensures its continued effective operation in the port environment, as vehicles are placed under intense pressures and long hours to meet busy work schedules.

SafEV can be installed during EV manufacture, as well as through retrofit to existing port EVs. To engage in best practice from the outset, Dafo Vehicle has partnered with various officials and vehicle manufacturers for the industry (again, unable to name due to NDAs), and once the testing phase is complete, there are plans to implement this solution globally.

Dafo Vehicle's SafEV system is easily installed to any EV – old or new. Once installed, it can be easily maintained as part of the EV's routine maintenance, requiring no additional service engineer visits.

SafEV is part of a whole fire protection system, which will provide an early stage alarm to the vehicle user should the battery malfunction.

result

There are currently several hundred SafEV systems in operation for on-road vehicles around the globe. For the port industry specifically, extensive testing is now nearing completion, which ensures the system is as effective as possible for this specific application. These tests have explored the difference in wind conditions and the impact of these on the functionality of the system. With a significant number of systems agreed for install at ports across the globe following the conclusion of this testing phase, the appetite from the market is clear.

SafEV will have a large-scale impact on port fire safety around the world. From initial research and testing, once implemented, the systems will result in:

- Cooling being implemented up to five minutes before thermal runaway takes hold
- Reduction in the temperature of the battery from 100 °C to below 50 °C in under a minute, which will then level at around 50 °C.

In comparison, a conventional fire suppression system, which is activated after thermal runaway takes place – at just over 150 °C – will reduce the temperature of the battery down to approximately 100 °C for a few minutes. After this, the temperature will then increase to over 250 °C, as the system fails to reverse the effects of thermal runaway.

SafEV is able to restabilise the battery to reduce the overall risk of fire, injury and damage to the port environment. This means that when an inevitable malfunction does occur, the risks to life, valuable equipment and the surrounding environment is minimised.

conclusion

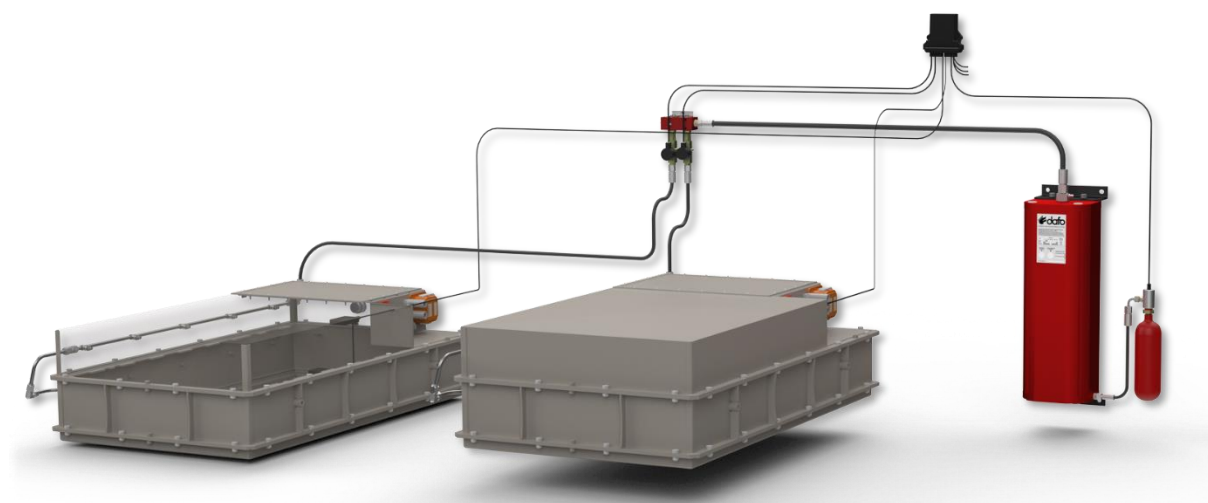
Dafo Vehicle and SafEV are set to play a leading role in the cargo industry's EV fire safety. Once final testing is complete, and it is clear the system can effectively address port-specific conditions, and vehicle manufacturers and large shipping companies are already committed to implementing SafEV globally.

Looking forward, Dafo Vehicle is now focusing on how it can



spread its SafEV solution around the world, to ensure all ports understand and are able to mitigate the risks associated with these new, sustainable vehicles. It also plans to use similar technology to protect the cargo industry's transportation of EVs across the globe, as this is becoming an ever increasing hazard, which again needs a new solution.

Dafo Vehicle recognises the risks associated with the cargo industry's holistic operations – including both battery materials handling and transportation. It is positioned perfectly with SafEV to support companies large and small across the globe as the numbers of lithium-ion batteries increase.



Further information can be found at <https://www.dafo-vehicle.com/>