The Battery Caffé, Episode 4: Electric Vehicle Fire Safety

Nikoleta

Welcome everyone to the fourth episode of the Battery Caffé, focusing on electric vehicle fire safety. I'm Nikoleta Piperidou from the clean energy and infrastructure team at KTN hosting today's episode, alongside my colleague Sheena Hindocha. Hi Sheena!

Sheena

Hi everyone, great to be back. I am Sheena Hindocha from KTNs Chemistry and Industrial Biotechnology team.

Nikoleta

Thank you. And for those of you who haven't listened to our previous episodes, the Battery Caffé is an initiative of the Cross-Sector Battery Systems Innovation Network, a community funded by KTN and the Faraday Battery Challenge. The Innovation Network aims to open new markets for the battery industry, promote innovation in batteries and help decarbonise a wide range of end-users. If you haven't already, go check out our online platform at UKbatteriesnetwork.org, you'll find lots of useful material and our previous episodes on investment in batteries, batteries recycling and market trends for solid-state batteries.

Today with us two special guests, Thomas Bartlett, Innovation Lead batteries at Innovate UK. Hi Thomas.

Thomas

Hi, everyone.

Nikoleta

Thank you, and Jonathan Bastien principal scientist at the Health and Safety Executive, hi Jonathan.

Jonathan

Hello everybody.

Nikoleta

Hi Jonathan! So, everyone, make yourselves a coffee and join us.

So, today we're discussing EV fire safety. The topic is very broad, and the interest is not only to sector specialists but also to the wider public. So, let's start by framing the challenges, what are the key elements to be considered Thomas, is it what happens to an electric vehicle at the crash incident, or what happens to the battery or how they should be treated by first responders, or perhaps all of that and more?

Thomas

So, I mean, really, all these things need to be deeply considered I guess when we start looking vehicle start rolling off the production line, I mean they have to pass strict tests to show they are safe which are

internationally seen and ratified standards and these are all safe, most of the time. I guess the interesting thing is when vehicles are made in the real world amazing things can happen.

You know, how will eventually happen. But really, it's looking at how things can go wrong. So, you know as we see more and more EVs on the road, the best way in the world is another bullet actually something will go wrong somewhere. It's the same for all products, worldwide ready. And you're seeing that sometimes the QC quality control is not 100% effective, and you're seeing already from, you know, a large number of recalls from vehicles batteries, you know, there's been a small number of issues detected, so that's how one thing can go wrong.

Also, in terms of actually own vehicles, they are controlled by a battery management system which can damage in the real world. Of course, it's not working effectively as it was when it came off the production line or actually the batteries are not being managed effectively.

And then obviously you know the obvious: one crashes. You know, basically, the high-speed crashes can cause major impact damaged to the battery packs themselves and the management systems, and no collision crashes.

There are some reports out there where EV going to failure park just parked up. You could be potentially using those as collisions and there's no failure. So, there are lots of ways that things can go wrong as we're looking at the large volume of electric vehicles on the road.

Secondly, it's critical that when they do go wrong, and we can deal with it. I guess that's the interesting thing is that combustion engines and EV's, that's very different in terms of how we should deal with it.

The main difference is we got a really high voltage system that got hundreds of volts in these batteries and vehicles. When they do go wrong, I'm talking about fires and things like the gas they emit, and they even catch fire are different.

We've got things which are really ignition electric vehicles, you know, these classic pictures of this the Tesla's you see reigniting on the back of some recovery vehicles things like that. How emergency responders need to deal with them and the public needs to sort of alter their approach into the accidents and when things happen.

And then the third really is what we do after the accidents in terms of removing from the highways declaring his vehicle safe to go on to our recovery units and go away for recycling or investigation or, you know, you sort of if they are being investigated by police as well, and the same difference in the environment as well attacking EV fires. You know, typically, EVs need a lot more water to put them out.

So, it's really, you know, how we understand the amount of water we need and the run-ups of chemicals etc... And also showing the mechanisms and policies in place to be able to recycle establish these parks and make sure these things don't end up in refuge yards and backyards and things.

Really it all comes down to sort of training awareness and constantly improving our approach is a sort of global Learning improves everybody.

I remember saying that you know, internal combustion engines benefited from over 100 years of infrastructure learning. With EVs, we need to quickly get to the same points. It's a big challenge but I know a lot are pretty passionate about it.

Sheena

Wow, Thomas, that was brilliant! It is such a great overview and everything from production to in-use, to what happens after the accident is important and needs to be considered thanks so much for that.

Jonathan, thinking specifically about the battery cells, could you talk us through what causes the lithium battery cells to fail. What happens when it does fail?

Jonathan

Thank you. Well, that's again quite a broad question and I'm going to apologize for purists out there I can't possibly cover everything there is to say about this subject that would take you several hours of academic lectures and I'm not going there.

But broadly speaking, a lithium-ion battery will fail when there's some kind of internal short circuit. There are many ways you can get that internal short circuit: could be a production fault, it could be a fault that's grown into the battery is an aging process. It could be a crashed incident, however, or it could be an overheating incident one of the things that stopped short circuits and forming is a separator that's part of the battery. If you get to a high enough point on the battery temperature scale that separate is going to stop working and you get an internal short circuit.

There are many other things as well. Many bits of the chemical reaction. So, trying to pin down exactly what causes a battery to fail, well there can be any number of things and they can be caused by a collision vibration electrical failure, either internally or externally of cause.

And I think the other big thing we've got to be aware of is that when you're putting that into the context of an electric vehicle, it might be that the battery starts to fail first and causes a fire. It could quite easily be that something else in the vehicle or external to the vehicle fails first, and then you've got your electric vehicle battery pack engulfed in a car fire that happens to be the car it is built-in. And that may well join in at that point.

So, there's a number of reasons. So, when a battery does fail, it will generally produce some gas, it will generally get hot and self-heaters. And, as it does so that gas is going to escape, it may ignite immediately, sometimes it doesn't. But more often than not, it does. It may then start to inject different contents out of the pack. And that really just depends on how the battery pack is put together and the types of cells being used. So, it's really quite hard to produce some kind of generalization. But I think the key message from this actually is that the battery pack is made up of between hundreds and thousands of individual cells. And as I've talked about, one of the things that can cause a cell to fail is getting hard. So, if you have a service that failed and generates a lot of heat, then the heat that the first cell generates can settle for cells around it. And so, you're more likely to get this thermal propagation type event. So, the event grows just by the heat generated, you don't have to have flames involved, it is just a heat who sorted out.

So, that has the implication on how you look at these fires just because you don't see the flame, doesn't mean that the chemistry that setting off a thermal propagation is finished, or is it not happening.

Just because you get rid of flame doesn't mean you events over, and that ties back in with what Thomas was saying about using huge amounts of water to deal with these events the waters they're not just put out the flame, but to take the heat out of the battery pack because without that heat coming off the

pack, your event is not over. And I think that's a slightly different thing with electric vehicle fires, it is knowing when that event is over because it's more than just a flame-based fire event.

Nikoleta

Thank you very much, Jonathan. It sounds it is, indeed, a very complex area with many challenges. So, I don't know. Tell us a little bit more.

Jonathan

Well, I think just trying to work out how as a nation we cover this off is quite an interesting challenge. If, as Thomas has said when you look at across the whole of the electric vehicle life spectrum. There's a range of challenges at every stage there, and who within the UK gets to see those different challenges would depend on a little bit where it is. So, I think trying to share the knowledge there is trying to share the understanding that we've gained is going to be important. I think we can be frustrated about the amount of knowledge that's out there we would all love to have far more evidence to where we're going forward and there's a challenge there.

But there is there's good precedent about how we deal with these. But I don't think we've necessarily yet seen the full spectrum of the events that we might yet see.

Sheena

Excellent. Thanks so much, Jonathan.

So, Thomas you recently led, and we supported with the delivery of two workshops in this area with a range of stakeholders and it was really interesting to engage with and hear the views for different services like police, fire service, and other first responders. Are you able to share some of the key findings from that work?

Thomas

Sure, yeah absolutely. So, I guess it would be useful to talk a bit of background about how these workshops came about really. So that part of the battery challenges involved a lot of talking with the community on fire safety. When I say "fire", I think we can group this in terms of battery accidents because it's not just regular fires because these fire incidents you know interest people and people are working in these areas but not everyone is sure about what everyone is doing.

And we want to help really pull together some of the players, and start you know have at least a forum where people start talking about this us. And that's what we did, we had two workshops, early this year. Really looking at this issue. I think a bit earlier which is in terms of when things rolling off production lines at the end of life and sort of how what challenges there are there in terms of accidents and safety, for batteries differs to internal combustion engine vehicles. And what we use in the UK can do to sort of you know, help.

And so, the key fight is really is that there's already a lot of really good work happening in the UK and internationally. I think that's a really good thing to say, you know, we all started from scratch from this right.

You know, just in terms of the challenge and our parts of the institution really funding projects in this area so the LIBRIS (Lithium-Ion Battery Research In Safety) projects which your agency and Jonathan himself were involved in which recently closed. It was looking at, you know, improving so the thing around the thermal propagation and understanding how that happens. The Safe back project and the advisor, one and a half million-year project that the all aspects of battery safety and how we can help you improve that.

So, it's always good to work. But it really is already a fast-changing area that has new learning all the time. And there's a really good effort so close, you can get on the same page in the same room. So, some of the key findings from the hopping were this thing that I think Jonathan's already alluded to, which is this need to share knowledge and understanding, there's a lot of stuff happening in the UK, a lot of stuff happening internationally. But really, there's not a lot of people gathering all of that and making that evidence and all that sort of understanding work, presenting that to the community to everyone on the same page, there is a lack of really good data, or what happens.

It's the most common problem right, so taking you to know cell tests happening in the lab and then saying right now, now let's put it in a vehicle, how many different situations can you find yourself in the real world in terms of, you know, accidents involving vehicles there. Is this in a tunnel? Is this in a car park? Is this in a residential area? Is it raining? Is it, you know, all these different things?

So, it's really, I think the key thing is really needed to understand the knowledge gap so we can help close them, work internationally, with all the other people doing on this to close them. The other thing that the real key output is that everyone's really everyone all the people involved are really positive really engaged a lot of energy, the emergency services industry, academia, and government. A lot of work already happening just by joining it up, right.

And I guess is a selfish plug, this is where the Innovation Network comes in really. It is about pulling these people together, getting the conversations happening is making sure that information is shared, and then out of that will come these gaps that we need to fill be it from R&D funded competition that can help with the future, or if it's a regulatory issue. So for example the BSI that'll be working with recently how looking for the next phase, we've been working with them for three passes on all things batteries and really worth the read, and we're looking for where we can be next number one on that list was fire safely. You know, so that there's a lot of words, you know as well.

So yes, it is a real positive document and so yeah, it's big. I think it's been really interesting, creating a good community on it and I think he has a shared passion to get things done in the area.

Nikoleta

Thank you very much and, indeed, it was a great piece of work. And what do you have planned next, Thomas? How can companies get involved?

Thomas

So, I mean at the moment, the first two workshops, we're still looking at, well, getting more people's opinions and more people's thoughts on this really just trying to put everything together and all the actors is a widespread network of people. So, that's one of the things we're doing so again the UK is actually put together.

We are looking at, possibly doing something on the hub. We can't guarantee at the moment but looking at maybe putting this up on the hub getting a bit more wider feedback and that's what we did this in the process and tonics work and some people we would really like to get some people's opinions on that.

And really interested in how to get involved a good way, or just try and contact me through Innovate UK via ukri.org and the Faraday Battery Challenge and I'd love to talk to anybody who's interested in the space, really.

Sheena

Thanks so much, Thomas, and for those that don't know them, and Thomas mentioned the hub is the ukbatteriesnetwork.org. You can register there and get loads of information on activities we're doing here at KTN and also what's going on across the community and network with other members as well. So please do join up there.

So, Jonathan. Just going back to you, how can companies get more engaged with HSE on this, and then do you offer any specific services in the area? Have you offered to partner on projects? What is it that you're up to?

Jonathan

Yeah, so we have a whole range of offerings, so we have been involved with a number of Faraday's funded projects and live responding wanting important and as others and other sectors. So, we can happily partner with people in that. We do some work commercially as well we have a large site up here in Buxton where we take it undergo a lot of destructive test work across all kinds of weird and wonderful areas from hydrogen and safety through to slips and trips and all sorts of things.

So, I, my team, run a number of abuse test teams are about to commission up module a test chamber. So, we can do quite a lot of experimental evidence gathering that and that includes getting gas analysis getting pressure measurements of cells as they're failing, as we get the volume and composition and gas coming off. And we have another multidisciplinary team of folk working with us. So, we can draw in experts from all kinds of different areas, which we found really quite useful, and we've worked with stakeholders from a whole range of different areas and motorsport through to space and aviation at all sorts of things in the past so if you're wanting to talk to that again if you get in touch with me through the battery's hub, I think she has mentioned, I'm very happy to talk to you and how we could work together with that.

Nikoleta

Thank you very much and thank you to both our brilliant guests and thank you all for listening. We hope you enjoyed this discussion as much as we did. And don't forget to visit our online hub on ukbatteriesnetwork.org and register to receive our news and updates and participate in the networking area of the hub.

Hopefully, also work closely together further on the topic of EV fire safety. And, our next episode will focus on batteries for off-highway vehicles. Till the next time. Bye.

Notes: this transcript has been produced verbatim and includes all the quirks and idiosyncrasies of the speakers.