Best’s Insurance Law Podcast

How Materials Science Impacts Insurance Claims - Episode #216

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John Czuba: Welcome to “Best's Insurance Law Podcast,” the broadcast about timely and important legal issues affecting the insurance industry. I'm John Czuba, Managing Editor of *Best's Insurance Professional Resources*.

We're very pleased to have with us today Sanket Kadam from Qualified Member expert service provider, S-E-A. Mr. Sanket Kadam earned his Bachelor of Chemical Engineering from the Institute of Chemical Technology, along with his Master of Science in chemical engineering from Michigan State University.

He has held prior roles in battery research, agile battery technology, and electric vehicle start-ups.

His experience includes engineering, materials, and test-driven battery cell-to-module-to-pack safety profile improvement, product development process, electric vehicle builds, commissioning and launch activities, cell, module and pack level testing, design of experiments and design validation plan, and report activities.

At S-E-A, he is responsible for consulting on battery engineering, safety testing, and development projects for electric mobility and other battery applications, including overall battery system or subsystem evaluation at the cell, module, or pack level.

He is also responsible for investigating losses involving or alleged to involve batteries, energy storage products, or systems.

Today's discussion is centered on risk mitigation for lithium-ion battery failures. Sanket, today for our first question, can you tell our audience what is a lithium-ion battery? What are its different applications?

Sanket Kadam: First and foremost, thanks for having me, John. I look forward to this.

In regard to the question, lithium-ion batteries are used in wide-ranging applications, including consumer electronics, stationary storage, and electric mobility due to their high energy and power density, long cycle life, and low self-discharge rate.

In regard to their name, a lithium-ion battery is a type of rechargeable battery. Within the cell, lithium ions move between the negative electrode, called the anode, and the positive electrode, called the cathode, during charging and discharging.

Chemical reactions occur that generate electrons and convert stored chemical energy in the battery to electrical current. A higher energy capacity lithium-ion battery pack is essentially assembled using several cells, along with other components.

In regard to examples, think about a smartphone. Most typical smartphones are made with a single battery cell. When you think about power tools as an example, they are made out of multiple battery cells, the battery pack, essentially.

In regard to specific applications, we have different cell chemistries, depending on tradeoffs related to energy, safety, power, cost, or even lifetime.

For example, lithium cobalt oxide-based lithium-ion batteries are used in your smartphones, laptops, tablets, and cameras, while lithium nickel manganese cobalt oxide-based batteries, or NMC batteries, are used for electric vehicles and power tools.

John: Sanket, what is lithium-ion battery thermal runaway? What are the different failure modes for them?

Sanket Kadam: Lithium-ion battery cell thermal runaway occurs when a chain reaction is initiated at critical onset temperature, leading to increased heat and temperatures or an uncontrollable self-heating state.

Cell thermal runaway can lead to cell venting, flames or smoke, flames, fire, and/or an explosion. Cell thermal runaway can also spread to neighboring cells or additional components, which is typically called thermal runaway propagation.

Cell thermal runaway can be triggered by thermal abuse, mechanical abuse, electrical abuse, or a latent defect. Let's discuss some examples here.

Some potential situations that can trigger cell thermal runaway include a high-intensity or high-impact electric vehicle collision, improper shipping and handling, faulty packaging, maybe using an incorrect or non-manufacturer recommended charger, or manufacturing-induced cell component damage.

Other than energetic failures like cell thermal runaway, lithium-ion batteries can also experience non-energetic failures. For example, capacity loss or swelling within a smartphone or a laptop battery.

Last but not least, high-energy capacity battery systems that we spoke about in one of the earlier questions, they can include tens, hundreds, or even thousands of battery cells connected together in a defined configuration along with other components, which can introduce unique failure modes.

John: Sanket, can you discuss potential risk mitigation strategies for thermal runaway in lithium-ion batteries?

Sanket: Mitigation strategies can be implemented prior to, during, or after a thermal event to help reduce the risk of potential fire or explosion. For example, safe venting at the cell level and optimal venting strategies at the battery pack level can be employed.

At the lithium-ion battery pack level or system level, a battery management system, or BMS, is one of the most critical safeguards. A BMS is continuously monitoring all the relevant battery parameters and is also continuously working with the battery thermal management system to maintain optimal temperatures throughout the pack.

The BMS can protect the battery when the battery experiences undesirable conditions. Think overcharge, over discharge, overtemperature, etc. The BMS can subsequently perform appropriate trip or protective actions when it notices these undesirable conditions.

Testing and validation that meets applicable safety standards and regulations can also help reduce the risk of potential field incidents.

Some of the examples of product safety certification standards or regulatory organizations include United Nations, or UN, the International Electrotechnical Commission, IEC, the Society of Automotive Engineers, SAE, Underwriters' Laboratories, UL, etc.

John: Sanket, how can non-destructive techniques or battery testing help study lithium-ion batteries?

Sanket: We'll start with non-destructive techniques. For example, X-ray and CT scanning machines can detect imperfections such as voids or cracks inside a battery or their assemblies without destruction.

Computational fluid dynamics software, short for CFD, can help simulate thermal runaway scenarios, release of gases, or effectiveness of your venting mechanism or safety mechanisms in case of battery failure.

On the experimental testing side, we have equipment like battery charge/discharge cyclers. Essentially, a battery charge/discharge cycler can help facilitate studies such as capacity loss, battery aging with time or use under different load conditions, as well as other related safety testing or dynamic performance testing.

Battery test chambers can allow us to simulate specific specialized environments. For example, temperature, humidity, mechanical vibration or shock, or corrosion.

John: Sanket, can you tell our audience the kind of projects you've been involved with at S-E-A?

Sanket: I'm a part of S-E-A's battery and energy storage group. In the past 15 to 16 months at

S-E-A, I have been involved in projects related to electric vehicles and consumer electronics' product recalls, as well as other losses involving batteries.

I've also worked on technical consulting for a product or a site's overall battery safety, including engineering or manufacturing operations, fire protection, etc.

This is an evolving field with myriad challenges related to product development or failure. When you're looking to an organization who can help, you should look to one that can provide a multidisciplinary team approach.

S-E-A's battery energy storage group includes engineers (like myself) across multiple disciplines such as chemicals, materials, electrical, fire, etc., along with access to diverse analysis tools and equipment, for example, the ones that we mentioned in the previous question.

A couple of our recent in-house updates include a light vehicle dynamometer for evaluating electric mobility devices – for example e-bikes, e-scooters, etc. and forthcoming CT machine, a non-destructive technique that we mentioned before for 3D analysis.

John: Sanket, one final question today. How can innovations in battery technology impact performance, safety, or failure?

Sanket: There are efforts underway to develop sustainable next-generation chemistries. For example, sodium-ion batteries, lithium-sulfur batteries, etc.

Let's talk a bit about sodium-ion batteries. Relative to lithium-ion batteries, some of their advantages include sustainability, natural abundance, and lower cost of sodium as compared to lithium. Also, the ability to leverage existing infrastructure and mature lithium-ion battery technologies due to similarities.

When fully developed, sodium-ion batteries can be used for large-scale renewable energy storage systems, short-range electric vehicles, or power backup applications where the required demand for energy density is less as compared to lithium-ion batteries but still higher than, say, a lead acid or other traditional rechargeable batteries.

At the same time, research and development efforts should continue with a focus on evaluating their temperature and rate-dependent performance and safety hazards. An example at the battery design or assembly level would be combining different cell chemistries. Whereas this can compensate for limitations related to performance, cost, or lifetime, it can introduce additional complexity in electrical architecture and BMS, or battery management system design.

Regardless, S-E-A's battery and energy storage group is available to assist as we charge into the future.

John: Sanket, thanks so much for joining us today.

Sanket: Thank you, John. I appreciate it.

John: You were just listening to Sanket Kadam from qualified member expert service provider, S-E-A. Special thanks to today's producer, Frank Vowinkel. Thank you all for joining us for “Best's Insurance Law Podcast.” To subscribe to this audio program, go to our web page, www.ambest.com/professionalresources. If you have any suggestions for a future topic regarding an insurance law case or issue, please email us at lawpodcast@ambest.com.

I'm John Czuba, and now this message.

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