Tutorial Title:

Electric Vehicle Batteries and Charging Systems: A Primer

Organizer:

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Abstract:

A number of automobile manufacturers have released electric vehicles (EV) over the past few years with an even larger number of EV models being prepared for release in the not too distant future due to the demand for clean energy and reduction in carbon emissions. The charging infrastructure for these vehicles is also aggressively being rolled out by different organizations. While Lithium-ion (Li-ion) cells have been around for decades powering a variety of consumer electronic devices, their use in electric vehicle applications is relatively new. The requirements that the cells have in these applications where hundreds if not thousands of cells are connected together are completely different from the requirements that the cells have in consumer electronic products due to many factors including the significantly higher battery operating voltages in EV applications. Similar challenges also exist for the charging infrastructure required to power these vehicles.

A number of organizations in the world have developed standards that guide the design and development of both EV batteries and chargers. These standards address everything from crash worthiness requirements for the vehicles and their batteries, to the requirement for the batteries to be designed with passive propagation resistance that prevents a single cell thermal runaway condition from propagating and resulting in a larger failure. Relatively newer standards also require vehicles to provide a 5 minute warning to the driver of possible fire ingress into the passenger compartment due to a thermal runaway in the battery.

The tutorial will start with a basic overview of Li-ion cells and then delve deeper into how these cells are incorporated in EV battery packs and the infrastructure required to keep the cells operating both safely and reliably. The tutorial will also address the need for passive propagation resistance and how this is achieved in EV battery packs on the road today. The discussion on EV batteries will include an overview of the reliability and abuse standards that have been developed around the world and how these standards dictate some of the design aspects of EV batteries.

The second half of the tutorial will focus on EV chargers. EV chargers are designed with different capabilities. The tutorial will discuss the various EV charger designs that have been deployed in the field and the advantages and limitations of these chargers. This section of the tutorial will also detail the various EV charger standards and the requirements in these standards.

The tutorial will end with a discussion on recent EV battery and charger recalls and detail two case studies: one focused on an EV battery failure in the field and the second detailing the failure of an EV charger that resulted in an electric shock to a user.

Bio:

Mr. Ashish Arora is a principal engineer at Exponent, an engineering and scientific consulting firm. Mr. Arora also has extensive experience with energy storage systems in the consumer products, aviation, automobile and utility industries. In addition to performing root cause analysis of battery system failures, he assists clients by performing design reviews and risk analyses of battery systems to evaluate the potential for field failure and safety issues. He has also assisted his clients in evaluating and choosing battery vendors that can produce battery systems with the required quality and safety on an ongoing basis. He has authored numerous publications on Li-ion battery systems including a book on the subject of Li-ion Battery Failures in Consumer Electronics in 2019.

Dr. Rita Garrido Menacho is an associate at Exponent, an engineering and scientific consulting firm. Dr. Garrido Menacho has assisted clients on the failure analysis and safety design reviews of consumer products, energy storage systems, and automotive electronic systems. She has worked extensively on evaluating safety and the overall design quality of Li-ion batteries and battery pack protection circuitries. These evaluations include risk assessments, design failure modes analysis, and dedicated electrical and mechanical testing. Additionally, she has assisted in investigations involving automotive electronic system failures and recall-related matters.