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Is Your Sterilization Process Putting Your Battery-Powered Device at Risk?

How Facilities Can Safely Disinfect Handheld Devices During COVID-19

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With the rapid spread of COVID-19, many industries are looking for strategies to clean and disinfect shared portable electronics and handheld devices. Of particular concern are shared devices, such as point-of-sale devices or reusable/rechargeable medical devices, whose surfaces may carry the virus into an employee or customer's personal space. Some of these devices can be disinfected with alcohol wipes, but sometimes more thorough sterilization is required.

Unfortunately, two of the most commonly used sterilization procedures, steam and dry heat, are not suitable for use with lithium-ion-battery-powered devices. These sterilization techniques may expose lithium-ion batteries to unsafe operating conditions that can lead to battery failure and compromise device reliability and, in extreme cases, user safety. With a more complete understanding of device limitations, it is possible to minimize the risk of device damage and optimize the health and safety of users by identifying alternative methods for sterilizing lithium-ion-battery-powered devices.

How Conventional Sterilization Techniques Impact Lithium-Ion Batteries

The temperatures for steam and dry heat sterilization cycles generally exceed the safe operating conditions for lithium-ion batteries. According to the U.S. Centers for Disease Control and Prevention (CDC), the two most common steam-sterilizing temperatures are 121°C and 132°C. These temperatures must be maintained for a minimal time to kill microorganisms. The most common time-temperature settings for hot air sterilization are 170°C for 60 minutes, 160°C for 120 minutes, and 150°C for 150 minutes. In contrast, a lithium-ion battery's functionality typically begins to degrade at temperatures above 55˚C. At 130˚C, the most common separator materials can begin to soften, shrink, and pose a potential safety hazard. Temperatures above 180˚C can prompt a thermal runaway.

To be clear, this does not mean a lithium-ion-battery-powered device that undergoes steam or dry heat sterilization will automatically go into thermal runaway. Cell and battery designs may include vents, shutdown-separators, electrolyte additives, electronic protections, and other safety features that allow a battery to fail gracefully. Several battery standards have foreseen some unintended heat exposure and require thermal exposure testing. As an example, UL1642 Standard ("Standard for Lithium Batteries") contains a thermal exposure test that ensures new batteries are stable for 10 minutes at 130°C, notably, a much shorter time than typical sterilization procedures. The test also does not evaluate used batteries, which may have decreased thermal stability. The extent to which a battery may experience a temperature-related failure depends on a variety of factors including the location of the battery within the device, the battery's chemistry and state-of-charge, and the device materials.

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Identifying Risks Associated with Sterilization of a Battery-Powered Device

Several resources can help facilities and device manufacturers determine the risks associated with sterilization methods for a given lithium-ion-battery-powered device. Medical devices containing lithium-ion batteries may be clearly labeled to have these batteries removed before sterilization, but facilities and manufacturers should still be aware of what can happen if these warnings are overlooked. Manufacturers of lithium-ion cells are increasingly seeking to improve thermal stability of their cells and may have more detailed information about how their cells fare when accidentally exposed to a hot environment. While standard lithium-ion battery requirements are also available for review, a specific cell's chemistry can significantly impact its thermal limits. As a result, facilities cannot assume that all lithium-ion batteries will fare the same when exposed to high-temperature sterilization procedures.

How Exponent Can Help

Exponent's multi-disciplinary team of materials specialists, toxicologists, and electrical, chemical, thermal, and biomedical engineers can help industrial facilities and manufacturers navigate the nuances of lithium-ion battery performance and identify the safest sterilization methods for their shared portable electronics and handheld battery-powered devices. We have expertise in the materials and chemistry associated with lithium-ion batteries and can help clients understand what changes in functionality or performance will occur if a cell's chemistry reaches a certain temperature or humidity level, even when guidance from the manufacturer or battery supplier is not readily available. We can also evaluate safety impacts at the cell and pack level, including the composition of gases that may be emitted and the risks involved for those exposed, the temperature at which thermal runaway may occur, and to what extent the electronics in the battery pack would disconnect the battery from the device or the other cells to prevent a thermal runaway from propagating further.

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