How to keep scanner batteries healthy

Improving battery reliability while lowering operational cost

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Battery users ask for longer runtimes and increased longevity, and manufacturers have responded with better battery systems. Let's explore what makes the modern lithium-ion so desirable and why this battery chemistry surpasses the older nickel-cadmium and nickel-metal-hydride systems.

Sony first introduced lithium-ion in 1991. Used primarily for cell phones, laptops and digital cameras, the *cobalt* version of the lithium-ion family has the highest energy density within this battery group. Since its birth, manufacturers have managed to increase the capacity a cell can hold by eight to ten percent per year. This impressive gain may be nearing its full potential as the battery makers begin focusing on improving manufacturing methods to ensure enhanced safety. The recent recall of millions of *Cobalt lithium-ion* packs caused by thermal runaway should become a thing of the past.

Although superior in terms of energy density, the Cobalt Li-ion has its drawbacks. For one, it cannot deliver high load currents. Makers of power tools and medical instruments considered it delicate and fragile, and for many years continued using nickel-based batteries. Then in 1996, the Manganese Li-ion battery appeared, and Phosphate Li-ion followed a few years later (Phosphate Li-ion is also known by the brand name *A123 System*). Today, these new lithium-ion systems deliver currents comparable to nickel-based chemistries, with the added benefit of increased energy density. In addition, manganese and phosphate offer superior thermal stability to cobalt. Figure 1 compares the Wh/kg of the older lead acid, nickel-cadmium and nickel-metal-hydride against the modern lithium-ion family.

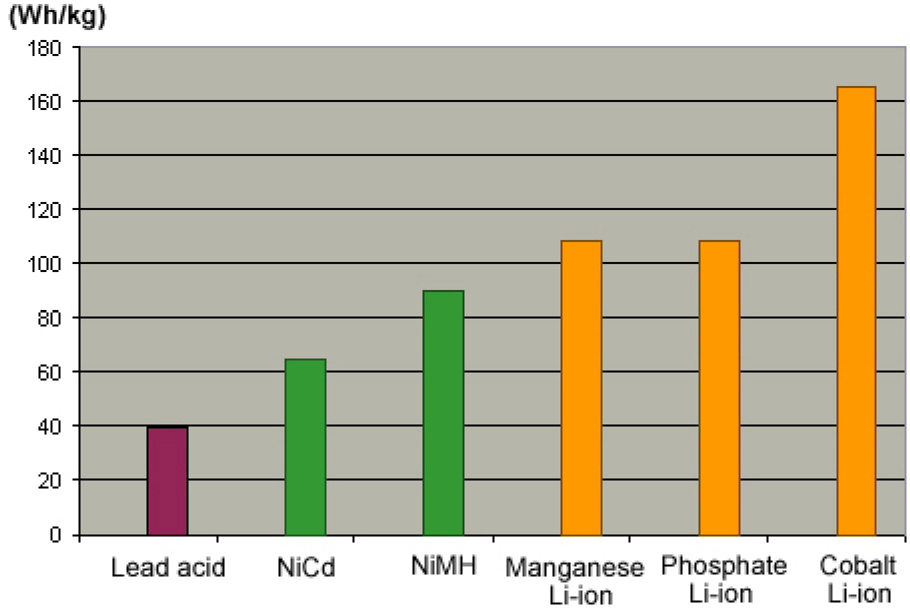

Figure 1: Energy densities of common battery chemistries.

Cobalt Li-ion enjoys the highest energy density. Manganese and phosphate systems are thermally more stable and deliver high load currents.

Lithium-ion is often quoted as having twice the energy density of nickel, but this only applies to consumer type Cobalt Li-ion. The batteries are made in high-volumes with limited consideration to longevity. As we know all too well, batteries do fail, and the relative short service life is acceptable for consumer applications because the devices are replaced after a few years and fading capacity during the service life does not pose undue safety risks. The focus on medical, aviation, military and satellite applications is different, and the packs are normally larger and more expensive. Lithium-ion for hybrid and plug-in cars, for example, will likely be manganese and phosphate.

Battery Life

A battery is a corrosive device that starts fading from the moment it leaves the manufacturing plant. With most chemistries, the capacity loss is permanent and cycling does not restore the battery. The speed of age related capacity loss depends on the number of discharge/charge cycles, depth of discharge and ambient temperatures; the warmer the temperature, the shorter the service life will be. This can be compared with a jug of milk that stays fresh longer when refrigerated.

The life of a lithium-ion battery varies between 2-5 years. This large swing in life expectancy hinges on how and where the battery is being used. In a laptop, for example, the pack is in one of the worst working conditions. Being fully charged while plugged into the main and enduring inside temperature of 40-45°C (104-113°F) causes accelerated deterioration. This explains the short service life of only 18 to 24 months. Newer laptops mount the battery on the back where heat is less of an issue.

In most cases, lithium-ion delivers between 300-500 full discharge/charge cycles. Applying shallow rather than full cycles reduces battery stress and extends service life. If at all possible, do not discharge the battery too deeply and charge more often. Furthermore, avoid exposing the battery to excessive heat. Batteries for cell phones and laptops have markedly shorter life spans if left in a hot car for long periods of time; dashboards in a car are the worst. On a sunny day, place equipment on the vehicle floor instead.

Although Lithium-ion has no memory and does not need periodic exercise cycles to keep fit, the “smart” battery may be the exception. An occasional full discharge and charge is sometimes required to reset the digital part of the battery that is responsible for the fuel gauge. With use, an error develops that makes the fuel gauge inaccurate, and a full discharge and charge calibrates the battery. Running the battery down in the device or with a battery analyzer can do this. Calibration is an unfortunate side effect of the smart battery and some engineers call this “digital memory.” It must be noted that cycling only calibrates the digital circuit and normally does not improve the performance of the chemical battery.

In the first year after installing portable computing devices, most batteries in a fleet work well. Confidence begins to fade after the second and consequent years when some batteries start losing capacity. Reliability starts to decline, new packs are added, and in time the battery fleet becomes a jumble of good and failing batteries. That’s when the battery headaches begin. Unless date-stamped or other controls are put in place, the user has no way of knowing the history of the battery, much less its performance.

The ‘green light’ on the charger does not guarantee the performance of a battery. “Ready” only indicates that the battery is fully charged. Most battery users are unaware that weak packs charge more quickly than good ones. The low performers go on ‘ready’ first, gravitate to the top and become a target of the unsuspecting user when freshly charged batteries are needed in a hurry. Ironically, batteries that go to “ready” first could be deadwood that should be retired from the fleet.

A new battery provides a capacity of about 100 percent. Equipment manufacturers rate the runtime based on a perfect battery, but this performance level is only attainable for a short time while the battery is new.

As we have learned, the amount of energy a battery can store gradually decreases with usage. With each charge, the pack gets a little smaller in terms of capacity storage. If no procedure is in place to replace the battery when the capacity drops to a preset performance threshold, the fading continues and the pack will eventually reach a level that compromises system reliability. Batteries for portable scanning and computing devices should be replaced when the capacity drops to between 70% and 80%. Figure 2 illustrates a battery that exhibits advancing capacity loss.

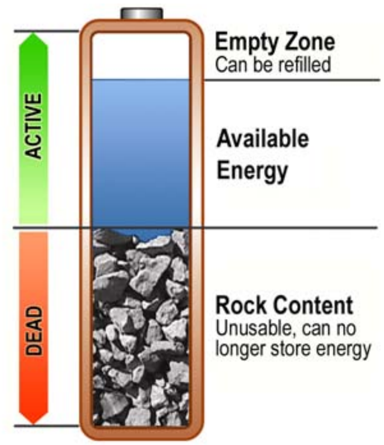

Figure 2: Aging battery. *Batteries begin fading from the time they are manufactured. Very few produce 100% capacity.*

Most organizations follow strict maintenance and calibration procedures on machinery as part of QA but the battery is often forgotten. Yet the energy source is a key element that must be given proper attention. In essence, checking battery performance will be more important than fulfilling regulatory disciplines for the sake of satisfying mandatory requirements.

How can the state-of-health of a battery be measured? The best tool is a battery analyzer. Over the past years, these analyzers have gained critical inroads into industries such as radio communications, medical and portable computing. Figure 3 shows a Cadex C7000 Series battery analyzer that can be configured to service packs for laptops, scanner, cell phone and other portable devices.

Figure 3: Cadex C7400 battery analyzer

A battery analyzer provides accurate state-of-health information and indicates when a battery should be replaced. Maintaining a large fleet of batteries should only take 30 minutes per day.

Organizations using battery analyzers service their batteries every one to three months and retire those that fall below 70-80 percent capacity. With maintenance, unexpected downtime caused by battery failure is virtually eliminated. Batteries do not quit all of a sudden, but gradually fade over time. Only packs that have declined to 50 percent and lower tend to experience the sudden death syndrome.

Modern technology has simplified battery maintenance. One such method is marking each battery with a permanent ID number. A label printer generates the labels in bar code format. To service a battery, the user simply scans the label on the battery and inserts the pack into the analyzer. Upon identifying the ID number, BatteryShop™ software retrieves the entire battery history on the PC monitor, configures the analyzer and commences service. Figure 4 illustrates this procedure graphically.

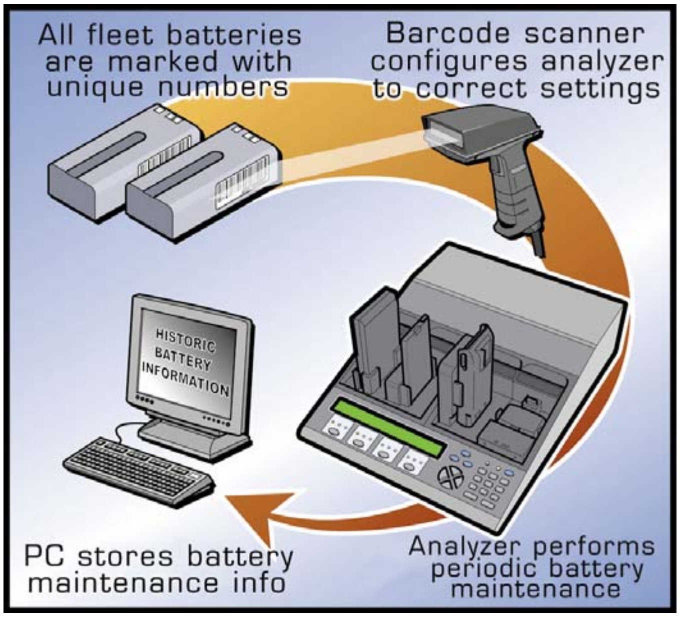

Figure 4: Fleet battery maintenance using bar code labels.

Marking the batteries with a permanent ID number simplifies maintenance. On due date, the technician scans the label and inserts the battery in the analyzer. The PC displays the battery history on the monitor.

Battery analyzers go beyond servicing batteries and also assist cost-conscious battery buyers in shopping for alternative packs. Changing a battery supplier should only be done after a replacement has been fully qualified, and the battery analyzer is the right tool for this. Verification involves extensive life cycle testing on multiple packs. Similarly, a battery analyzer can do spot checks as part of incoming inspections. This ensures that non-performing batteries are eliminated up front and the mandated capacity requirements are met between the batches received. Furthermore, battery analyzers come in handy to make warranty claims by verifying that the battery delivers the specified capacity before the warranty expires.

Charge-and-run without scheduled maintenance does not guarantee reliable results. Some level of quality control is essential to keep a battery fleet healthy. Weak batteries can hide comfortably among the strong and cause havoc during heavy usage and tight deadlines. Warehouses are beginning to take a proactive approach in terms of battery maintenance. Equipment manufacturers support this move because it supports the reliability of their devices. Battery maintenance is inexpensive to implement and contributes notably to system reliability and the bottom line.

About the Author
Isidor Buchmann is the founder and CEO of Cadex Electronics Inc., in Vancouver BC. Mr. Buchmann has a background in radio communications and has studied the behavior of rechargeable batteries in practical, everyday applications for two decades. Award winning and bestselling author of many articles and books on batteries, Mr. Buchmann has delivered technical papers around the world.

Cadex Electronics is a manufacturer of advanced battery chargers, battery analyzers and PC software. For product information please visit www.cadex.com and contact info@cadex.com.

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