Trusting the Battery in Critical Situations

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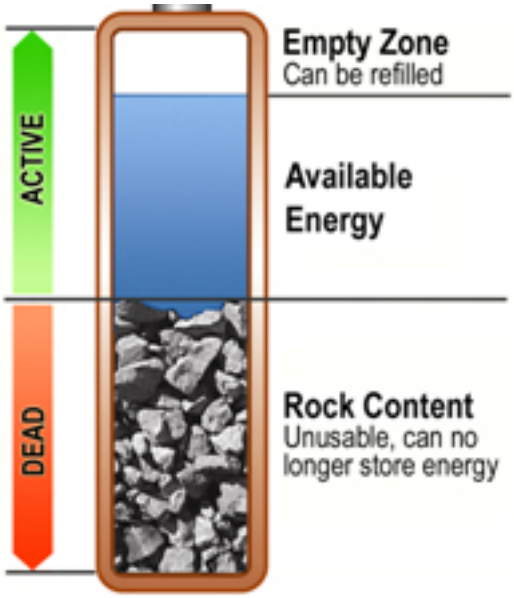
A battery is a corrosive device that begins to fade the moment it comes off the assembly line. The stubborn and unpredictable behavior of a battery has left many users in awkward situations. Battery failure is common; some are simply a nuisance but others can have serious consequences. Even with the best of care, a battery only lives for a defined number of years. There is no distinct life span, and the health of a battery rests on its genetic makeup, environmental conditions and user pattern.

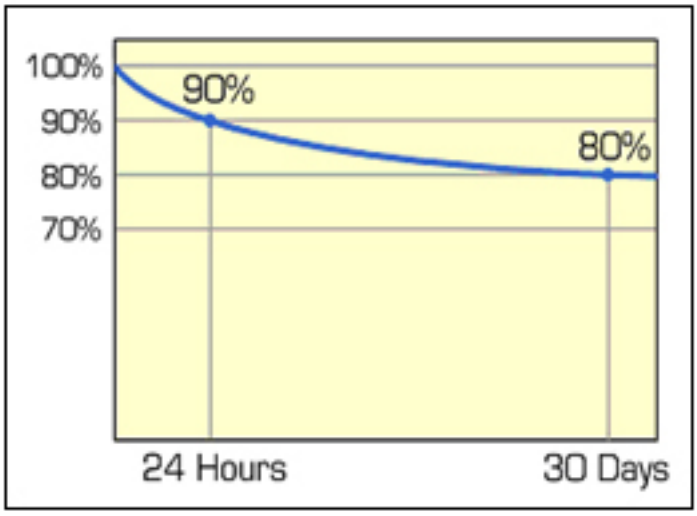
Most batteries deliver 300 to 500 full discharge/charge cycles, more on a partial discharge. Fleet batteries work well in the first and second year, but the confidence begins to fall after the third and fourth year. As batteries begin to lose capacity, new packs are added, and in time the battery fleet becomes a jumble of good and fading batteries. This is when the headache begins. Unless date stamped or other quality controls are put in place, the user has no way of knowing the history of the battery, much less the performance.



The energy in a battery can be divided into three segments: available energy, empty zone that can be refilled with charge, and unusable part (rock content). The Figure on the right illustrates these three sections graphically.

The “ready” light on a charger does not verify the “health” of a battery. Ready only reveals that the battery is fully charged. As the active space of a battery decreases with age, charge and discharge times are also shortened. This can be compared to filling a jug with water. An empty jug takes longer to fill than one with rocks.

Many battery users are unaware that weak batteries charge faster than good ones. Low performers gravitate to the top and become a disguise to the unsuspecting user who assumes that the “green light” guarantees full service.



A battery needs constant care and feeding. Even if fully charged, self-discharge consumes valuable energy. This is not a manufacturing defect per se, although poor manufacturing practices and improper handling can elevate the problem.

The amount of electrical leakage varies with the type of battery, and primary cells retain the energy better than rechargeable systems. The energy loss is asymptotical, meaning that the self-discharge is highest right after charge and then tapers off. The chart on the right illustrates the typical loss of a nickel-based battery in storage.

Lithium-ion has one of the lowest levels of self-discharge. It loses less than five percent in the first 24 hours, and one to two percent thereafter. The mandatory circuit protection increases the discharge by another three percent per month. The self-discharge of all battery chemistries increases with rising temperatures, cycle count and advancing age.

The care and feeding of a battery begins with the arrival from the supplier and continues to its rightful retirement. The service includes the following:

Incoming inspection: All batteries should be checked before field deployment. Packs that fail to meet performance criteria should be returned. The open circuit voltage of a lead acid battery should be at least 2.10V/cell; the capacity of nickel- and lithium-based batteries should be close to 100 percent. Batteries below these requirements may need extra service, or could deliver shorter than expected service live. Many organizations performing incoming inspection will return non-compliant batteries to the vendor.

Field preparation: Lead acid batteries do not perform at peak performance when new and only reach full capacity after 20 to 50 cycles. Nickel-based batteries may need priming by cycling the battery a few times; lithium-ion should deliver full capacity when new. Spot checks provide quality assurance.

Periodic capacity check: Batteries should be treated like any other device. While date stamping offers an alternative to analyzing batteries, this method does not guarantee reliable performance. Some packs fail before the expiry date, but most

last longer. Quality products properly maintained tend to outlive the date stamp. Capacity, and not the manufacturing date, is the leading health indicator of a battery.

Retirement: The battery capacity decreases with usage and time. Fleet users may be unaware of the capacity fade and will continue using a weak battery. A battery should be replaced when the capacity drops to 80, in some cases 70%, and restoration is not possible. Do not retire batteries too soon. Discarding good batteries increases operational cost and adds to waste. Battery analyzers are helpful in predicting the correct replacement time.

Battery analyzers have gained steady inroads into public safety and other organizations relying on portable devices. The Cadex C7400ER (photo on right) services four batteries independently. Configured battery adapters permit plug-and-play, and automated programs provide secure service. PC-BatteryShop software allows shifting the operation to the PC, and a simple mouse click on a battery of choice will configure the analyzer to the correct battery type. More information is on http://www.cadex.com/prod_analyzers/7000_overview.asp [1].

Battery labeling offers a simple and practical way to manage battery fleets. PC-BatteryShop generates the label showing the service date, due date and capacity. The system is self -governing in that the user will only pick a battery with a valid service date and sufficient capacity. Expired batteries are removed and serviced on a battery analyzer. The photo on the right illustrates a printer with a sample label.

A speaker at a battery conference once said, “The battery is a wild animal and artificial intelligence domesticates it.” He hinted to making the battery intelligent. While adding a SMBus may assist in battery management, the system comes with baggage. Fuel gages are not standardized among manufacturers and most show only the remaining charge without reference to the actual capacity. In addition, a battery equipped with a fuel gauge needs periodic full discharges for calibration.

An expert servicing smart batteries for specialty applications comments on his personal experience. He says: “I have more problems dealing with the smart part of the battery than the actual cells. Many batteries have logic problems, memory errors, glitches or low voltage recovery issues.” Most smart batteries for laptops and other consumer products have solved these problems.

To eliminate system failures, regulatory authorities have implemented strict maintenance and calibration guidelines. This also applies to the battery, but here lies the difficulty. Regulators see the battery as a black box and correct size, weight and color may satisfy the requirements. State-of-function, the key ingredient of a battery, is commonly ignored. Yes, the battery is difficult to evaluate, and to this day there are few reliable devices that can check a battery with certainty. Measuring capacity with discharge is time-consuming, and rapid-test methods are not always reliable.
Failing batteries enjoy some level of immunity, even if human lives are at stake. The battery escapes scrutiny and a breakdown is often seen as “uncontrollable.” Less critical malfunctions have been heard in court and dealt with in a harsh way. Up to 50 percent of system failure can be attributed to a weak battery and much of this is avoidable.

Summary
The user is always at the mercy of the battery. Charge-and-run without maintenance does not guarantee reliability. To avoid unnecessary risk, many responsible organizations are taking a proactive approach towards battery maintenance. There is also a strong interest in cutting costs by prolonging battery life and keeping each pack in service for the full duration of the useful life. Modern battery analyzers make this possible.

About the Author

ISIDOR BUCHMANN is the founder and CEO of Cadex Electronics Inc., a company that manufactures innovative battery test and diagnostic equipment. Active in wireless communications, Isidor has studied the behavior of rechargeable batteries in practical and everyday use. To share battery knowledge, he wrote many articles, delivered technical papers around the world, published several books, and created www.BatteryUniversity.com [2]. For product information, please visit www.cadex.com [3].

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