Understanding Cordless-Tool Batteries

Misused batteries die young. Replacements are costly. Here's how to get the longest life from your batteries.

BY GARY M. KATZ

Higher-voltage batteries pack more 1.2v cells than do the old 9.6v batteries. This fact leaves each cell less surface area to dissipate heat, shortening higher-voltage batteries' lives.

Three months ago, I carried a boxful of one-year-old 14.4v batteries into my local tool dealer's service center. The service technician tested the batteries and confirmed what I knew: Those batteries would no longer take a charge. He couldn't tell me why they lasted for just a year, which only added to the aggravation of buying six new batteries for $60 each.

The batteries in my old 9.6v tools lasted for years, driving thousands of screws. However, I've noticed that 12v, 14.4v and 18v batteries degrade faster. After about one year, they don't deliver their original run time or torque, regardless of the claimed amp-hour rating. (Amp-hour is the industry's standard measurement of the electricity that a battery can store and release on demand.) Other carpenters had similar complaints.

To learn what was going on, I spoke with representatives from Makita, DeWalt, Porter-Cable, Bosch, Milwaukee and Hitachi, as well as Sanyo and Panasonic, which manufacture most cordless-tool batteries.

The manufacturers confirmed what I suspected: Higher-voltage batteries have shorter lives. Manufacturers estimate battery life along these lines: 1,000 to 1,300 charges for a 9.6v battery; 800 to 1,000 charges for a 12v battery; 650 to 800 charges for 14.4v battery; and 500 to 800 charges for an 18v battery.

Battery life isn't wholly dependent on voltage ratings, though. How a battery is used also affects its life. What follows is a summary of my conversations with the manufacturers.

Heat is a battery's worst enemy

My crews use today's high-voltage cordless tools for harder tasks than the light, occasional duty we expected of 9.6v tools. Now, cordless tools run large spade bits, hole saws, auger bits, 6-in. circular saws and even reciprocating saws. High-voltage cordless tools are often our primary tools for tasks that two years ago would have required a corded tool. Unfortunately, cutting and other high-torque applications result in a fast discharge rate. This is bad. Because of the internal resistance of battery cells, fast discharges create more heat. Heat degrades the material within cells that stores and releases electricity.

All cordless-tool batteries, regardless of total voltage, are packages of individual 1.2v battery cells (photo above). There are eight cells in a 9.6v battery, 12 in a 14.4v battery and 15 in an 18v battery. Higher-voltage batteries are more vulnerable to heat than 9.6v batteries because with more cells joined together, higher-voltage batteries have less surface area per cell to disperse heat. So not only do we use higher-voltage batteries in ways that create more heat, but also because of these batteries' construction, they are less able to dissipate that heat than are 9.6v batteries.

New battery technology isn't necessarily better

Nickel-cadmium (Ni-Cd) batteries are the standard. They powered all cordless tools

until about one year ago, when nickel-metal hydride (Ni-Mh) batteries were introduced as an environmentally friendly alternative. Worn-out Ni-Cd batteries are a hazardous waste and must be recycled. Ni-Mh batteries are still free from that mandate.

Ni-Mh batteries also have a higher amp-hour potential than Ni-Cds, potentially as high as 3 amp-hours for a standard cell. The current ceiling for the Ni-Cds used in cordless tools is about 2.2.

What's the downside? Ni-Mh batteries haven't yet reached their full amp-hour potential. But more important, Ni-Mh batteries also have a higher internal resistance than Ni-Cds. This internal resistance makes the battery discharge faster and generate more heat doing so, reducing both run time (see my comparison in *FHB* #119, p. 126) and cycle life. Additionally, Ni-Mh batteries are extremely sensitive to temperature changes; heat easily damages the cells. Several tool manufacturers explain that Ni-Mh batteries are not as "robust" as Ni-Cds. In fact, some manufacturers expect only 500 charge-discharge cycles from a 14.4v Ni-Mh battery (compared with 650 to 800 cycles for an Ni-Cd battery).

New chargers may extend battery life

Ironically, the power that restores a battery can also degrade it because charging a battery also heats it. Cordless-tool manufacturers all agree on this. They are all making efforts to reduce charging-generated heat, thereby maximizing cycle life.

Professional-grade chargers operate in stages, first sensing the initial temperature of a battery. If the battery is too hot to be charged, the charger waits for the battery to cool off. The fast charge then takes anywhere from 30 minutes to an hour, after which the battery is near its full capacity. Because charging a battery that's too cold also can damage it, Porter-Cable's chargers also sense if a battery is too cold. If it is, the charger slowly ramps up for several minutes before going into the fast-charge stage.

Professional-grade chargers sense when a battery is near full charge and shut down to minimize heat buildup. However, each cell may not get a full charge. Each cell takes a fast charge differently, and chargers shut down before they damage those cells that reach capacity soonest. After the fast charge, one cell may be at 98% capacity and another at only 85%.

According to the instructions supplied with DeWalt and Porter-Cable tools, their chargers follow the fast charge with an equalization, or topping-off, stage that balances the cells. A trickle charge that makes up for the power the battery would ordinarily lose through nonuse is last. Other manufacturers say their trickle charge equalizes the cells. Leaving batteries to trickle-charge, even for days at a time, won't hurt them.

Full discharge kills weak cells

Heat may be a battery's worst enemy, but unequally charged cells also reduce cycle life, run time and torque. With each succeeding fast charge, the weakest cell slips farther and farther from its full-charge potential.

Weakened cells become prone to the irrevocable damage of reversed polarity, called reversal, which is comparable to short-circuiting. Reversal is caused by using a battery until it no longer operates at all. The weakest cells drain first. While the stronger cells continue to operate the tool, the weakest cells are emptied of power. When a fully drained cell is called on to produce power it no longer has, reverse polarity occurs. Cells that have been forced into reversal will never again take a charge. The result is that a freshly charged 12-cell battery might operate on only 11 cells. Reversals mean shorter run time, less torque and faster degradation of the remaining cells.

DeWalt suggests that a battery's run time and its cycle life can be increased (by up to 30%) with proper care. Because DeWalt believes that maintaining cell balance is crucial to long-lived batteries, the company advises that after a maximum of ten charge-discharge cycles, a battery should be left in the charger for about six hours to ensure complete cell equalization. Leaving batteries in the charger overnight once a week is even better. Other manufacturers weren't as forthcoming as was DeWalt, but my conclusion is that the same advice applies to any battery whose charger has a topping-off stage.

Batteries have no significant memory

If your charger doesn't have a topping-off stage, there are still steps you can take to extend battery life. Batteries should not be left in heat or cold, or operated or charged while extremely hot or cold. Batteries will not usually take a full charge at other than room temperature.

Batteries like room temperature. Operated there, they run most effectively, take the most complete charge and have their longest run time and cycle life. Try not to use cordless tools continuously, and let them cool down between applications.

Finally, no matter what contradictory advice you may have heard, never fully discharge a battery. For years, carpenters have passed along the myth that batteries have memories, and if not fully discharged, they won't fully charge. I've even seen carpenters tape a drill's trigger down to extract every last electron from a battery. This action reverses cells and makes your batteries die young. Use the battery only until you notice a power loss that affects performance, and then recharge the battery. □

An overnight charge can equalize cells. Because the fast-charge stage might leave some cells partially charged, DeWalt recommends that every tenth charge be about six hours long to equalize the cells.

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