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How Things Work: My Total Station Battery Has Alzheimer's ... And That's a Good Thing!

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How many times have you heard the phrase, "My battery pack is holding a memory"? Being in the battery business, we hear this all the time. This term is used to explain the tendency of a rechargeable battery to remember the point to which it was discharged over several cycles, before full discharge was attained. Subsequently, the battery behaves as if this were the point of full discharge. This is a generally misunderstood phenomenon and a term often misused to explain various battery problems. There are many scientific and theoretical explanations for why rechargeable batteries behave poorly at times. But in a practical sense, these problems can be analyzed and addressed without a degree in chemical engineering. So if your battery has "Alzheimer's," based on the explanation above, it's actually a good thing.

"Memory effect" occurs when a rechargeable battery is recharged to full capacity and then used in the field to a point where the battery never reaches full discharge before being placed on recharge again. For argument's sake, imagine a battery being a container of sugar, where you fill it up and then use what you need before refilling it again. If you constantly use only the top portion of the container and refill it with new sugar, the remaining portion you have not touched in awhile begins to get stale. The same is true for a battery. The remaining charge you never allow the instrument to access starts to stagnate over time. Initially, the charge in a battery is at a uniform voltage throughout the cells. The voltage begins to drop immediately after removal from the charger. If all the charge in the battery is not consumed before recharging, the portion left unused continues to drop in voltage and becomes stale. Eventually, the voltage in this stale portion drops so low that when your instrument is finished gobbling up all the fresh charge, it hits this stale portion like a brick wall. The instrument is confronted with a sudden drop in voltage, at a level below the "low battery" indicator threshold. The battery cannot power the instrument now without being recharged again.

The only way to recover the performance of the battery is to somehow remove that stale charge in the battery and restore a fresh new charge. Unfortunately, some total station manufacturers have designed their instruments and chargers in a way that makes it almost impossible to correct this problem. Chargers with a "discharge" function built in may not correct the problem at this point either. The low voltage point of stale charge will also cause the discharge operation to cease prematurely, leaving the stale charge still in the battery. In a case like this, a battery service shop with the proper equipment can analyze the battery, remove the stale charge, and solve the problem.

Trying to live with the problem will only make it worse and can actually ruin the chances of correcting the problem at all. Just like the container of sugar example, eventually this stale part will become so solid and entrenched in the battery that it will permanently ruin that part of the battery and diminish its ability to accept a usable charge again. It also appears that the portion of the battery able to receive fresh charge now goes through many rapid cycles and in effect "wears out" prematurely. You are now left with a container of hard-packed stale sugar at the bottom, with the top part of the container so worn out that it can barely contain the new sugar you keep replenishing it with.

Here are several things that can be done to avoid this problem. Some I am sure you have heard before, but they are still worth repeating.

1. 1 Always fully discharge the battery each time you use it in the field. Number all your batteries and learn the run-time of each one through regular use. If you still carry enough battery power with you for the next day's work, wait and use that all up before recharging again. Always avoid recharging batteries that have not been fully run down.
2. 2 At the first sign of a sudden decrease in performance, set that battery aside until returning to the office. At the office, put this problem battery back into the instrument and set the instrument on a heavy battery demand operation (like "tracking mode" measuring against a prism). Now run the instrument to the point where it shuts off on its own from lack of battery power. Wait five minutes and repeat the procedure. Repeat this until you feel the instrument has drained as much as possible from the battery. Now put the battery on charge (preferably a slow charge, if your charger has that setting).

3. 3 If storing the instrument for a week or two, do not recharge the battery until the night before it is needed in the field again.
4. 4 If storing the instrument for a month or two or even longer, charge the battery before storage and then once a month until the storage period is over. Every second month, fully discharge the battery before recharging.
5. 5 Always let the battery reach room temperature before recharging. Excessively cold batteries will resist being charged and actually fool auto shutoff chargers into thinking the battery is fully recharged when in reality it is not. When the battery is not allowed to fully recharge over many cycles, you may end up with the same problem as the "memory effect."

Within the last few years, many instrument manufacturers have switched to nickel metal hydrate (NiMH) cells in their battery packs of the old industry workhorse nickel cadmium (NiCd). The main advantage of NiMH cells is the ability to hold much more charge in the same size cell as the equivalent NiCd, and they are more environmentally friendly as well. NiMH cells have also been touted as not having the memory effect problem of the NiCd cells. However, our experience has shown that is not always the case. Although they may resist the effect from taking hold as easily as NiCds, the same maintenance procedure should be followed— always fully discharge the battery before recharging again. NiMH cells also have one big drawback compared to their NiCd counterparts: Their internal resistance is higher.

The internal resistance of a cell governs how readily it will accept a charge and how easily it will release that charge while maintaining its voltage. Internal resistance also explains why NiMH battery packs sometimes get much warmer during recharge than NiCds. Since internal resistance gets worse with the age of the cell for both NiCd and NiMH, designing the instrument and charger to meet these demands is a difficult balancing act, with some manufacturers having done a better job than others.

A NiMH charger designed to charge the battery in a 10- to 14-hour period will always do a better job of topping the battery than a charger designed to do it in two to three hours. The internal resistance of the battery will always force the charger to apply a higher voltage during recharging to overcome the resistance. This resistance is more pronounced during a fast charge procedure than during a slow charge. Eventually the charger is forced to such a high voltage that it assumes the battery is recharged and shuts off, never recharging the battery to its full potential. As the NiMH battery gets older, the problem gets worse. It is always best, if your field working procedure allows, to choose a slow overnight charger cycle. Many OEM chargers for NiMH cells offer both fast and slow charge cycles. Also, chargers that monitor the internal temperature of the battery during a fast charge seem to do the best job of recharging the NiMH batteries quickly.

Another point worth mentioning is the idea of replacing old NiCd cells in a pack with NiMH cells during a re-cell procedure. This is only recommended if you have just that one battery to run your instrument. You must also be prepared to accept that NiMH cells do not maintain original performance through as many cycles as NiCd cells. But the NiMH cells start out with the ability to hold much more charge than their NiCd counterparts, the advantages of the NiMH cells are still worth considering. Unfortunately, your old NiCd charger may never properly recharge the NiMH cells to their full potential because it was not designed for the different requirements of the NiMHs. Even at less than 100 percent performance, however, the greater capacity of the NiMH cells will generally be realized if that battery is properly maintained from the beginning. In reality though, many users will just add this NiMH battery into a mix of other NiCd batteries being carried into the field for the instrument. Our experience has found that in short order, the NiMH battery will get "lazy" and settle into a performance no better than if it had been re-celled using NiCd cells. The advantages of converting to NiMH cells over the original NiCd cells would be lost, not to mention that this "misfit" battery pack now has a diminished life cycle.

The final bit of advice I can give, similar to that we often get from our family doctor: Batteries stay healthier through regular exercise on a daily basis!

About the Author

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