The Technical Side

The Care & Feeding of Rechargeable Batteries-*Revisited*

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In this Technical Side we will be covering proper care of rechargeable batteries. This article will focus on nickel-cadmium batteries because of their wide use as a power source for electronic surveying instruments. The second installment will deal specifically with gelled lead acid batteries used in GPS and auxiliary batteries.

We will start off by giving some background information and explaining some of the terms we will be using. All batteries produce electrons from a chemical reaction. Different chemical combinations are used such as carbon-zinc, lead-acid, nickel-cadmium, nickel-metal hydride and lithium compounds. The reaction produced by these chemical combinations can be reversed in some batteries (secondary cells) by sending electrons back through the battery. The original reaction can occur again, producing more electrons. The amount of electrons produced, or the capacity of the battery, depends on the size and composition of the battery. This capacity is measured in amp hours, the amount of time the battery will provide a given amount of current. For example, a 2.8 amp hour battery should provide one amp of current for 2.8 hours or 2.8 amps for one hour. (Most batteries will only give the full rated capacity when discharged over a longer period of time, typically 20 hours.)

Our first concern with a rechargeable battery is charging it. The goal is to reverse the chemical reaction without inducing side effects such as overcharging the battery. There are several recharging methods. The most common and least expensive charger uses the constant current charging method. A constant current charger maintains a small constant amount of current through the battery for a period of time. The total amount of current delivered depends on the battery capacity and the charge time. Constant current chargers are designed for a 12 to 16 hour charge period so the battery can be charged overnight. Another common charge technique uses constant voltage. As the name implies, a constant voltage charger maintains a set voltage across the battery. When a dead battery is first connected to this charger, a high initial charge current flows into the battery. As the battery charges, the current tapers off to a maintenance current when the fast charge cycle is done.

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A constant voltage charger usually finishes this cycle in two to four hours. These are often referred to as quick chargers because the battery has about 90% of a full charge after an hour or so. Another method of charging nickel-cadmium batteries uses the temperature rise to indicate the charge cycle is done. A thermistor or thermal switch (temperature sensor) is placed inside the battery with connections available to the charger. When the charge is initiated, a high charge current is supplied to the battery. The charger monitors the temperature of the battery as it is charging. When a nickel-cadmium battery reaches full charge, its temperature starts to rise. This is detected by the temperature sensor, which allows the charger to shut the charge cycle down when complete. A new charge technique that shows some promise is the peak detection method. As a nickel-cadmium battery charges, its voltage rises. As the battery reaches full charge and starts to overcharge, its voltage reaches a peak and starts to drop. The peak detecting charger turns the high current off when it detects this peak, indicating the end of the fast charge cycle. A high current can be used, ensuring a full charge in 40 to 90 minutes.

The next thing we do with a nickel-cadmium battery is discharge it. This part is easy; we just use our total station, GPS receiver, data collector, radio, or other piece of portable electronic equipment. But what happens when the battery doesn't perform like it was supposed to? Rechargeable batteries are famous for having problems. They get over-charged, undercharged, take memory sets, develop shorted or open cells the list goes on. We will address these problems and some solutions that are available.

One enemy of nickel-cadmium batteries is heat. Storing batteries in an overly warm area greatly reduces their service life. Heat also reduces the battery's charge retention, or how long it will stay charged after it is removed from the charger. Charging a battery in higher temperatures causes specific problems. First, the battery will take less of a charge or appear to be fully charged sooner. When put to use, the capacity can be as much as a third lower than it should be. A battery that gets charged at room temperature will also lose capacity if used at a higher temperature. Second, if the battery is being charged in temperatures over approximately 100F (38C) it can start to draw more charge current if the charger is capable of supplying that current (like most quick chargers). More current through the battery produces more heat, multiplying the effect into thermal runaway. What you can end up with is a melted battery that is usually no good. Many batteries include thermal fuse protection to prevent this and a good charger will also have thermal shutdown to prevent overheating of the battery or charger.

Cold temperatures aren't kind to nickel-cadmium (and most other) batteries either. Batteries will exhibit some of the same loss of capacity characteristics that heat produces. Overall, nickel-cadmium batteries like the same temperatures we do; they lose capacity above and below 68F (20C).

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Overcharging batteries shortens their service life. Once the nickel-cadmium material is completely reformed (battery is charged), continued charging can result in an irreversible chemical reaction (read: you can't discharge and charge again). Overcharging also diminishes the capacity obtained from the charge cycle. When a nickel-cadmium battery is completely charged, continued charging depresses the cell voltage. The battery actually appears to have less of a charge the longer you leave it on the charger. For these reasons you should avoid overcharging batteries. Those of you using simple "overnight" or constant current chargers should be especially careful. It is easy to leave the battery cooking on the charger over the weekend or for days until it is needed. Then you use the battery and get less life out of it than you needed so you put it back on the charger and give it a "good" charge, a couple of days' worth. The battery ends up right back where you started, overcharged. If you use only half of a battery's rated capacity but give it a full overnight charge, you can overcharge it and send the cells into voltage depression. Most of these overcharged batteries will appear to have the dreaded memory set problem. Nickel-cadmium memory, or a condition where the battery gets partly used and then recharged many times until it only has that capacity, is actually quite rare. Overcharged batteries are much more common. The oft-repeated "memory" myth is blamed because the symptoms are the same.

The solution to overcharging or memory problems is to use the full battery capacity before recharging. If necessary, have an extra charged battery available. This will allow you to fully use the battery capacity before having to recharge it. Only charge the battery for the manufacturer's recommended time. If possible, use a charger designed to shut down when the battery is fully charged. On the other hand, don't worry about disrupting the ideal charge/discharge cycle by using half the battery's capacity or giving it a slight overcharge. One or two improper cycles will not hurt the battery or cause any kind of "memory set." Just remember that the battery might need a full discharge and charge cycle before it will provide its former capacity.

Battery conditioners or discharge units generally only use up a valuable discharge cycle, rather than help the battery. Be aware that a nickel-cadmium battery should not be discharged below one volt per cell to prevent damage. Most instruments have a voltage cutoff to prevent this. Don't hook up to a load and leave the battery to discharge completely. Depending on the health of the cells, you may find that the battery has suffered irreversible damage. Charging and a normal use with full discharge to voltage cutoff will usually return the battery to its best charge/discharge condition. If you suspect that the capacity has diminished, a charge/discharge/charge cycle with capacity monitoring should be performed. This test is best performed by a repair technician using equipment that profiles the battery capacity when charging and discharging. The test equipment can show the exact amount of accepted (charge) and delivered (discharge) capacity. Connection to a computer generates a graph of the charge and discharge curves, with amperage and voltage related to time. The results can be compared to the profiles for a new battery and a decision made about the condition of the battery.

Our next column will go into detail on the care and feeding of gelled lead-acid batteries. If you have further questions contact us at The Technical Side, 1562 Linda Way, Sparks, NV 89431, fax us at (702) 359 6693, or e-mail us at cothrun@ix.netcom.com. Visit our web site at:<http://ourworld.compuserve.com/homepages/cothrun/>