- Do lithium rechargeable batteries die or self destruct or whatever if left in storage for a long time like maybe a year? Should they be charged first or discharged?
- Constable Mike S.

Before I start, I need to mention there are two generic types of batteries: primary and secondary. Primary means use once and throw away, like flashlight batteries. Secondary refers to rechargeable batteries. There are several types of each. The information which follows refers to secondary, or rechargeable, battery packs.

In reviewing technical literature by manufacturers, all indications are lithiums are happiest when kept charged. However, I have seen several recommendations they be stored discharged. These recommendations are from manufacturers of devices using lithium battery packs, not from the manufacturer of the actual battery.

I've come to believe storing discharged is purely for safety reasons. Lithium batteries pack a lot of energy in a small space, and can give it up almost explosively if shorted. In fact, when lithiums were relatively new, a staple in a shipping container poked through and shorted some lithiums which exploded and brought a plane down. Since then there have been restrictions on air shipping of certain types of batteries, and standard practice is to ship them discharged.

Charged lithiums are treated in some circles like stored gasoline.

We of course should be concerned about safety, being in the safety business. But when it comes to a tradeoff of safety versus the instant readiness of having a battery pack charged and ready for use, I know which option I'll choose. I can see more liability from a nonfunctioning emergency device due to a dead battery than from the real but minuscule safety threat.

Places like IBM who sells hundreds of thousands of lithium batteries a year to power their excellent laptops (I'm on one now ...) and have deep pockets are the ones most concerned about liability. If one battery in one hundred thousand causes a problem, they'll be sued. A hundred thousand batteries is several years' worth even for a huge public safety agency. And any advice a reseller of batteries gives which results in a shorter life of the battery likely means you'll need to buy another one more quickly, so consider these factors.

For batteries not in standby service but simply being stored, like a spare laptop battery, I believe it will last longer if kept charged. I keep all mine charged, and top rarely-used ones off a few times a year.

You're intelligent and having the facts, now can make your own informed decision on this as suits your particular situation.

Lithium batteries currently offer the highest power to size/weight ratio of any rechargeable battery type readily available to consumers. There are some exotic and expensive special purpose super high performance batteries like silver/zinc used in missile systems and related applications, but since they're not really accessible to us we won't discuss them further. And the benefits of these special batteries generally are offset by disadvantages, such as a 3 month life on a silver/zinc once charged the first time. The military can afford to replace them in cruise missiles every 3 months. You and I can't. Or at least I can't!

An advantage of lithiums is they hold their charge a very long time. If in good shape, they lose only a few percent of their charge a year. This makes them excellent for standby and emergency service applications. Lithiums are expensive, but worth it in the long run for most applications. Lithiums are a good choice for applications where you need maximum operating time per charge and may not be near a charger for long periods. They're actually an unnecessary expense although harmless if you use your device 8 hours a day and drop it in a charger at the end of the shift (cell phones and portable transceivers are good examples).

Most rechargeable battery types are life-limited by the number of charge/discharge cycles, depth of discharge, and factors such as over or under charging. Lithium packs are an exception as will be discussed in depth in a little bit.

Lithium battery packs last longest when not cycled, or when discharged only partially before being charged. However, the things are meant to be used, so don't be scared to use them. If you have a choice, charge the thing before it's completely dead, and charge it as soon after use as is practical. Most lithium packs are relatively decent quality and should be good for several hundred charge/discharge cycles.

You do need a special charger designed for lithium packs, but the charger usually is included with the device so you're OK there. More on this later.

The main factor dictating the overall life of a lithium rechargeable battery is calendar time.

Whether in use or not, the lithium metal electrode is absorbed slowly into the electrolyte starting from the day it's manufactured. There's nothing you can do about this. It's a design characteristic. Lithiums generally last 2 or 3 years with reasonable performance presuming other conditions are met like not overcharging or discharging too deeply too often.

So you can budget a new battery for your lithium-powered device every 3 years based on this info, and be safe. 2 years would be better especially for critical applications.

For this same reason, it's not smart to stock up on batteries when you buy a new device. They'll go bad sitting in your desk drawer. Buy what you need, and when those go bad, buy new fresh ones.

I frequently see sales on Motorola cell phone lithium batteries in the electronic distributor catalogs. I see them all the time on the large Internet auction site. These batteries are low priced, but are not a good deal. They're near the end of their useful shelf life, and the sellers want to dump them while they still have a few months' worth of life left in them. Don't fall victim to this.

If you're a fleet user, and especially if you're buying on competitive bid, learn to read date codes on the batteries and make sure you're getting fresh stock. Low bidders may be offering older batteries with little life remaining. They are unused, but aged. Better, specify as a condition in your Request For Quotation (RFQ) all batteries offered must be recent manufacture, and the date of manufacture must be included with the shipment as well as a list of interpreting the various formats of date codes used by each manufacturer included with the shipment. I personally would reject any lithium battery sold as new which had been manufactured more than six months earlier. Read the date code to see.

Each manufacturer has a different method of indicating dates, and they're coded instead of being in plain English because the manufacturer generally wants to hide the age of the battery. The only date code I know offhand is Motorola:

- The first digit of the three number date code is the year and the next two digits are the week of manufacture. 334 would be the 34th week of 2003.
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Now you know.

Another interesting point about lithium battery packs. Unlike most other types of batteries, lithiums hold their voltage constant while they are being used until they are dead, at which time they pretty much just switch off. Other batteries start at their original voltage then start dropping in voltage as soon as you start using them. At some point, the device they're powering decides the voltage is too low and stops working. That may be only halfway into the total capacity of the battery. So half the battery's capacity you never may be able to use.

With lithiums, since they hold their voltage steady during their life, you can use essentially the entire capacity of the battery. This is another way the things give you good power to weight ratio.

Other battery powered devices generally simply read the battery voltage to determine the state of charge of a battery. As the voltage drops during discharge, the battery voltage is a reasonably accurate indicator of how much power is left in the battery. A car battery – lead acid – is a perfect example of measuring voltage to determine level of charge.

But, since lithiums hold their voltage steady until they're dead, you can't just measure the voltage and make any determination. You need to get fancy and play some games.

Lithium batteries measure their remaining charge using the electronic equivalent of a fuel tank and gauge. Inside every lithium rechargeable battery pack is a microprocessor. Yeah. A computer in your battery pack. This microprocessor talks back and forth to another microprocessor in the device being powered.

The micro in the battery pack knows the capacity of the battery with which it's mated. By knowing the current drain of the device and the capacity of the battery, the device's micro knows how long the battery, with a full charge, will power the device.

The micro in the battery is a fuel gauge, where the battery is the fuel tank. When you use the battery, it monitors that and deducts the time used from the time it knows it can operate. The battery's micro tells this to the device, and the device tells you via some or another indicator.

When you charge the battery, the battery's micro sees this, and adds operating time back in.

At any given time, the battery's micro theoretically knows how much power you've used and how much you've put back in, and should know pretty accurately how much power is remaining to be used.

Should know.

Remember the battery loses capacity as the months tick by, as described above.

And the battery's fuel gauge micro needs to know the capacity of the battery to make a determination how much charge is remaining.

Well, there is no provision for telling the battery's micro to compensate for aging and reduced capacity of the battery. So as the battery ages, the fuel gauge will start to lie to you. It thinks its fuel tank is larger than it really is, to make an analogy.

This means your device may tell you you've got 3 hours of operating time remaining, only to shut down in 20 minutes. Very bad juju if in a critical device. Annoying at best.

When this happens, many simply presume the battery has gone bad, and replace it. This will, usually, fix the problem presuming they use a fresh battery as a replacement.

However, the old, aging lithium still has plenty of life. It may not give full capacity, but it's got plenty left. But, if the fuel gauge lies to you, something has to be done.

Fortunately, you can force the battery's micro to reset and reread the decreasing capacity of the aging battery. This will bring the fuel gauge back into calibration so you get correct battery life readings again from the device.

To reset the micro, charge the battery fully. Then discharge it completely by leaving it on until the device goes completely dead. Ignore any warnings from the device about low battery.

After the device shuts down from a dead battery, charge it fully as normal. It doesn't hurt to leave the charger on several hours after it thinks the pack is charged completely.

Repeat the above cycle once. That is: a full charge, a full discharge, a full charge again, a full discharge again, then another full charge to return to normal service. May take a few days to do this. By doing this, you force the micro to reread the battery capacity. When the battery goes completely dead, the micro in the battery pack loses power and its memory. When you start it again by charging, it resets and rereads the various parameters, and adapts to the aging battery.

Do this perhaps 2 or 3 times a year. More often is unnecessary and will put needless wear on the battery. Also reprogramming the micro for decreasing battery capacity prevents overcharging from the battery's micro thinking the battery is larger than it really is anymore.

I refresh the lithium batteries in my laptop, portable two way radios, camcorder and cell phones in this manner and the battery gauges are accurate. Note the above applies only to rechargeable lithium battery packs.

- A battery analyzer which I believe charges and discharges nicads for our portables to keep them from developing a memory. Is this necessary for lithium rechargeable batteries our agency is starting to issue…

  First, some background on nicads to set the stage.

  Nickel cadmium (nicads) are a mature yet still popular rechargeable battery. They are great choices for many applications and are nice and rugged. They can have a very long life if cared for properly. I have a 10 year old nicad powered electric screwdriver I use on a regular basis for various chores which works as new. I have two Wahl rechargeable soldering irons, nicad powered, which I've had since they were developed, and they work as new. I can get adequate life per charge out of them.

I've never replaced the batteries although they've had probably twenty tips each over the years.

The major factors in nicads, and in fact all batteries, is not to overcharge them. A secondary characteristic of nicads is the oft-touted memory effect. This generally refers to a phenomenon in nicads where if they're not exercised they'll lose capacity.

In early generation nicads this was very true. I use my older nicad-powered stuff enough to where they don't develop a memory. Newer cells (manufactured within the last 5 years maybe) for all practical purposes do not suffer from memory effect.

Memory effect was exaggerated even back when. For a battery to develop a memory, it needed to see precisely the identical service day after day. Breaking that cycle only a few times a year would erase memory. The worst situation is something like a portable radio sitting in a charger all the time, against the day when it might be needed. In my own county's underground Emergency Operations Center some years ago, I remember seeing perhaps a hundred portables all lined up in rack chargers along one large wall. They looked nice and pretty and impressive, and the county thought they were ready. Those radios were never used, and I am certain if they would have been needed they'd have been nearly useless from enormously reduced battery capacity from the nicad memory.

Battery analyzers, sometimes called battery conditioners, are special purpose devices designed to help get the longest life and best performance out of a rechargeable battery.

They charge and discharge the battery several times, to erase any memory effect. While discharging, a microprocessor measures the capacity of the battery and displays this on a readout. By comparing the capacity of the battery in milliamp hours as measured to its design capacity, you can weed out failing batteries. Generally, a battery falling below 80% of rated capacity is considered worn out.

Analyzers were a good idea. With modern nicads I don't believe they are necessary, but I don't believe they'll hurt. Nicads generally are happiest when exercised. Make them work for a living and they'll last longer than if you coddle them. I have an Itech brand analyzer and use it for nicads several times a year on fleet radios we maintain.

For lithium batteries, analyzers are not a good idea. Other than for the purpose of reprogramming the battery's microprocessor to compensate for aging as described above, cycling a lithium battery simply wears it out. The analyzer people may have differing reasons for recommending analyzers for lithiums. I personally would not use an analyzer on any chemistry of battery other than a nicad.

I'm running short on space for this issue, so I'll mention a few things briefly about other types of rechargeable batteries just so users of them aren't left hanging. If you would like me to cover anything about batteries in more detail, email me at my address at the end of this article and I'll try to help.

Lead acid (car batteries and gelcells mostly) definitely want to be kept charged. They self discharge a lot more in warm weather than in cold, so machines with batteries you don't use in the summer like snowmobiles or starter batteries for emergency generators need to be kept on trickle charge especially during the warm months. This self discharge also damages the battery by causing sulfating, which is active material falling off the plates, settling on the bottom of the battery and shorting out the cells. Don't discharge lead acid any more than is necessary, and recharge as soon as practical after use. Special maintenance chargers designed for infrequently-used lead acid batteries are worth the money. They'll double the life of a battery. Overall life depends on the quality of the battery, how it is used, and how it is maintained. 'Maintenance free' car batteries are a lie. Most have flat recessed lids you can and should pop loose with a screwdriver to check the electrolyte level. In my vehicles, I check them a few times a year and frequently have to top them off with distilled water. If I believed the manufacturer and never checked them, I'd be replacing them a lot more often and getting jump starts more often during the winter when lead acid batteries suffer a big hit in performance from the cold weather.

Nickel metal hydride, or NiMH, batteries self discharge so quickly they are not practical for any use except where they're charged nearly on a daily basis. They're environmentally friendly compared to nicads and therefore pushed hard by regulated manufacturers. They're more power and lighter weight than nicads. But once taken out of the charger, they start to lose their charge and generally in a week or so are down to half charge whether used or not, and in 2 weeks are dead. They're ideal for items in regular use like cell phones or cordless phones where you charge them daily, want light weight and max battery life per charge. They're poor choices for digital cameras unless you're a very heavy user and are willing to remove and charge the batteries once or twice a week. In general I do not care for nickel metal batteries and the only ones I own are in my cordless phones. They have a good life and their life is measured in charge/discharge cycles. They're happiest when not deeply discharged and like to be kept charged. Their higher price over nicads may or may not be justified depending on your application.

More batteries are damaged from overcharging than any other cause.