As radio operators we often go to the field where we power our equipment with lead batteries. This is the second of three articles on those types of batteries. Some of the important things we learned from Part I are:

1. A not-so-nice feature of lead acid batteries is that they discharge all by themselves even if not used. A general rule of thumb is a one percent per day rate of self-discharge.

2. The higher resistance of a discharged battery allows it to accept a higher rate of charge without gassing or overheating than when the battery is near full charge.

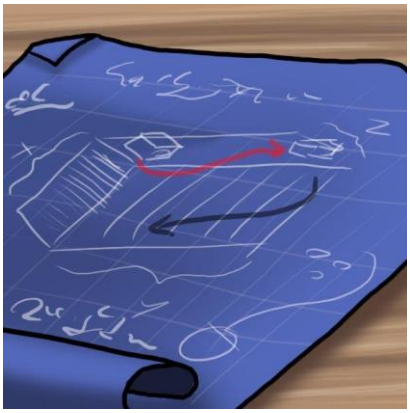
Part III (coming soon) will cover:

1. Testing your battery

2. Building a simple fast/trickle charger

3. Building a switch for your go box that will instantly switch between the power supply and battery, and trickle charge the battery

—Andy KE5KOF



**By Stu Oltman - Technical Editor, *Wing World Magazine***
*Edited and reprinted with permission*
Continued from part I

## How Long Will My Battery Last?

*There are many things that can cause a battery to fail or drastically shorten its life. One of those things is allowing a battery to remain in a partially discharged state*. We talked about sulfate forming on the surface of the battery's plates during discharge, and the sulfate also forms because of self-discharge. Sulfate also forms quickly if the electrolyte level is allowed to drop to the point that the plates are exposed. If this sulfate is allowed to remain on the plates, the crystals will grow larger and harden till they become impossible to remove through charging. Therefore, the amount of available surface area for the chemical reaction will be permanently reduced. This condition is known as "sulfation," and it permanently reduces the battery's capacity. A 20-amp hour battery may start performing like a 16-amp hour (or smaller) battery,

losing voltage rapidly under load and failing to maintain sufficient voltage during cranking to operate the bike's ignition system. This last condition is evident when the engine refuses to fire until you remove your finger from the start button. When you release the starter, the battery voltage instantly jumps back up to a sufficient level. Since the engine is still turning briefly, the now energized ignition will fire the spark plugs. In the next installment, we'll see exactly why increased internal resistance due to sulfation causes less power to be delivered to the starter.

Deep discharging is another battery killer. Each time the battery is deeply discharged, some of the active material drops off of the plates and falls to the bottom of the battery case. Naturally, this leaves less of the stuff to conduct the chemical reaction. If enough of this material accumulates in the bottom of the case, it'll short the plates together and kill the battery.

Overcharging is an insidious killer; its effects often aren't apparent to the innocent purchaser of the ten-dollar trickle charger who leaves it hooked to the battery for extended periods. A trickle charger charges at a constant rate regardless of the battery state of charge. If that rate is more than the battery's natural absorption rate at full charge, the electrolyte will begin to break down and boil away. Many a rider has stored a bike all winter on a trickle charger only to find the battery virtually empty in the spring. Also, since charging tends to oxidize the positive plates, continued overcharging can corrode the plates or connectors till they weaken and break. (One solution for this is to get a charge maintainer instead of a trickle charger, this is talked about in part III).

Undercharging is a condition that exists on many motorcycles. Your voltage regulator is set to maintain your system voltage at around 14 to 14.4 volts. If you're one of those folks who rides the interstate highways with your voltmeter showing only 13.5 volts because you're burning more lights than Macy's Christmas display, you should be aware that that voltage is sufficient to maintain a charged battery but insufficient to fully recharge a depleted one.

Remember, we said that gassing occurs when all or most of the lead sulfate has been converted back to lead and lead dioxide. The voltage at which this normally occurs, known as the gassing voltage, is normally just above 14 volts. If your system voltage never gets that high, and if you don't ever compensate by hooking up to a charger at home, the sulfate will begin to accumulate and harden just as plaque does in your mouth. Consider a thorough occasional charging to be like a good job of flossing and brushing your teeth. If you practice poor dental hygiene, you can go to the dentist, and have him blast and scrape at the yucky stuff. When your battery reaches that stage, it's curtains!

## What Type of Charger and Why

Your alternator and a standard automotive taper charger have a lot in common; they seek to maintain a constant voltage. Here's the problem with trying to quickly charge a deeply discharged battery with either one. Remember, we discussed how a heavy current draw would make a battery appear dead. Then, as the acid diffused through the cells, the concentration at the plates' surface would increase and cause the battery to spring back to life.

In similar fashion, the voltage of a battery during charge increases due to the acid concentration that occurs at the plates' surface. If the charge rate is significant, the voltage will rise rapidly. The taper charger or vehicle voltage regulator will taper the charge rate drastically as the voltage rises above 13.5, but is the battery state of charge commensurate with the voltage? No! Once again, it takes time for the acid to diffuse throughout the cells.

Although the voltage may be high, the electrolyte in the outer reaches of the cells is still weak, and the battery may be at a much lower state of charge than the voltage would indicate. Only after charging for an extended period at the reduced current will the full capacity be reached. This is the reason you must not judge a battery's state of charge by measuring voltage while charging. Test it only after allowing the battery to sit for at least an hour. The voltage will reduce and stabilize as the acid diffuses throughout the cells.

Within the past several years, several companies have developed chargers that can charge a depleted battery quickly, and then hold the battery at a voltage that will neither cause it to gas nor allow it to self-discharge. These are sometimes referred to as "smart chargers" or multi-stage chargers. Here's how they work.


We said that a battery could accept a much higher rate of charge when it's partially depleted than when it's near full charge. These multi-stage chargers take advantage of that fact by beginning the charge in a constant current, or "bulk charge" mode. Typically, they provide a charge rate of between 650 milliamps and 1.5 amps, depending on make and model. This bulk charge is held constant (or should be) till the battery voltage reaches 13.5 volts, thus allowing the battery to absorb a larger amount of charge in a short time and without damage. The charger then switches to a constant voltage or "absorption" charge.

The idea here is to allow the battery to absorb the final 15 percent of its charge at its natural absorption rate to prevent undue gassing or heating. Finally, these chargers switch to a "float" mode in which the battery voltage is held at a level sufficient to keep it from discharging but insufficient to cause overcharging. The various companies disagree generally on what this float voltage should be, but it's usually between 13.2 and 13.4 volts. Actually, the float voltage should be temperature compensated between 13.1 volts at 90 degrees Fahrenheit to 13.9 volts at 50 degrees. Most of the very expensive high power multi-stage chargers for use on larger RV batteries are temperature compensated, but none of the motorcycle units are to my knowledge; they use a compromise float setting.

So, I can just set it and forget it, right? Well, not exactly. For one thing, you need to monitor the battery occasionally for correct fluid level (unless you own a sealed battery). Another problem is that of exercising the battery. Even if held at 13 volts, the unwavering voltage will allow the battery to eventually begin to sulfate. With most of these units, I recommend that you unplug the

charger at least once every 60 days during seasonal storage. Allow the battery to rest for a couple of days, and then plug the charger in again.

## Still Here?

If you're still reading this, you're a real trooper. I realize that the subject can be confusing or even boring, but take heart; I went easy on you. There's far more left untold than what appears here. This was "Battery's Greatest Hits." I hope that it was enough to get you interested without sending you into information overload, and, maybe, now that you know how many ways there are to shorten a battery's life, you know why no one can predict how long a battery will last. A lot of riders who believe they take excellent care of their batteries are actually killing them with kindness.

One of the facts of life is that batteries fail. Some take years, but eventually they will all bite the dust. However, there are so many factors in electrical systems that can go wrong, that the battery often takes the blame for other components' problems. The easiest and fastest thing to check for problems is the battery. Here is a simple test that can tell you a lot about what is going on inside a battery, and whether it is good or not. This is not meant to test anything other than the battery, but it is a great place to start if you are having electrical problems.