## LEAD Batteries Part I of III

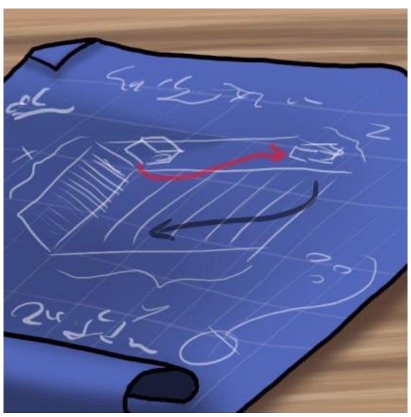
As radio operators we often go to the field where we power our equipment with lead or lithium batteries. Since theses batteries have different chemistries, their use and charging are completely different. We will devote the next three months to talking about LEAD Batteries.

The major two types of lead batteries are sealed and flooded. I use only use sealed lead batteries with my Go-Boxes. Sealed rechargeable batteries are Gel and AGM (Absorbed Glass Mat). Gel battery contains a putty-like substance, whereas AGM battery contains special acid-saturated fiberglass mats. AGM batteries are quite powerful and more cost effective that gel battery for the same capacity, however gel batteries provides more longevity and cheap used ones are available.

The main advantage of a sealed maintenance-free battery over a flooded battery is that the electrolyte inside it is completely absorbed in the separator and does not require water to be added. It does not need regular maintenance (except charging maintenance, which is talked about later), ventilation, and can resist different climates in a better way than flooded ones. They also tend to charge faster than flooded battery, but charging methods and types are about the same.

We ran across the following article when researching battery charging. This article talks about motorcycle batteries, but this information applies to our use also. We are going to break this article into three parts. Part II will be presented in May; part III will be presented in June and include some of my experiences.

—Andy KE5KOF



**By Stu Oltman - Technical Editor, *Wing World Magazine***
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A 12-volt motorcycle battery is made up of a plastic case containing six cells. Each cell is made up of a set of positive and negative plates immersed in a dilute sulfuric acid solution known as electrolyte, and each cell has a voltage of around 2.1 volts when fully charged. The six cells are connected to produce a fully charged battery of about 12.6 volts.

That’s great, but how does sticking lead plates into sulfuric acid produce electricity? A battery uses an electrochemical reaction to convert chemical energy into electrical energy. Let’s have a look. Each cell contains plates resembling tiny square tennis rackets made either of lead antimony or lead calcium. A paste of what’s referred to as “active material” is then bonded to the plates; sponge lead for the negative plates, and lead dioxide for the positive. This active material is where the chemical reaction with the sulfuric acid takes place when an electrical load is placed across the battery terminals.

### How It Works

Let me give you the big picture first for those who aren't very detail oriented. Basically, when a battery is being discharged, the sulfuric acid in the electrolyte is being depleted so that the electrolyte more closely resembles water. At the same time, sulfate from the acid is coating the plates and reducing the surface area over which the chemical reaction can take place. Charging reverses the process, driving the sulfate back into the acid. That's it in a nutshell but read on for a better understanding. If you've already run from the room screaming and pulling your hair, don't worry.

The electrolyte (sulfuric acid and water) contains charged ions of sulfate and hydrogen. The sulfate ions are negatively charged, and the hydrogen ions have a positive charge. Here's what happens when you turn on a load (headlight, starter, etc.). The sulfate ions move to the negative plates and give up their negative charge. The remaining sulfate combines with the active material on the plates to form lead sulfate. This reduces the strength of the electrolyte, and the sulfate on the plates acts as an electrical insulator. The excess electrons flow out the negative side of the battery, through the electrical device, and back to the positive side of the battery. At the positive battery terminal, the electrons rush back in and are accepted by the positive plates. The oxygen in the active material (lead dioxide) reacts with the hydrogen ions to form water, and the lead reacts with the sulfuric acid to form lead sulfate.

The ions moving around in the electrolyte are what create the current flow, but as the cell becomes discharged, the number of ions in the electrolyte decreases and the area of active material available to accept them also decreases because it's becoming coated with sulfate. Remember, the chemical reaction takes place in the pores on the active material that's bonded to the plates.

Many of you may have noticed that a battery used to crank a bike that just won't start will quickly reach the point that it won't even turn the engine over. However, if that battery is left to rest for a while, it seems to come back to life. On the other hand, if you leave the switch in the "park" position overnight (only a couple of small lamps are lit), the battery will be totally useless in the morning, and no amount of rest will cause it to recover. Why is this? Since the current is produced by the chemical reaction at the surface of the plates, a heavy current flow will quickly reduce the electrolyte on the surface of the plates to water. The voltage and current will be reduced to a level insufficient to operate the starter. It takes time for more acid to diffuse through the electrolyte and get to the plates' surface. A short rest period accomplishes this. The acid isn't depleted as quickly when the current flow is small (like to power a tail light bulb), and the diffusion rate is sufficient to maintain the voltage and current. That's good, but when the voltage does eventually drop off, there's no more acid hiding in the outer reaches of the cell to migrate over to the plates. The electrolyte is mostly water, and the plates are covered with an insulating layer of lead sulfate. Charging is now required.

## Self-Discharge

One 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. This rate increases at high temperatures and decreases at cold temperatures. Don't forget that your Gold Wing, with a clock, stereo, and CB radio, is never completely turned off. Each of those devices has a "keep alive memory" to preserve your radio pre-sets and time, and those memories draw about 20 milliamps, or .020 amps. This will suck about one half amp hour from your battery daily at 80 degrees Fahrenheit. This draw, combined with the self-discharge rate, will have your battery 50 percent discharged in two weeks if the bike is left unattended and unridden.

## When A Battery Is Being Charged

Charging is a process that reverses the electrochemical reaction. It converts the electrical energy of the charger into chemical energy. Remember, *a battery does not store electricity; it stores the chemical energy necessary to produce electricity.*


A battery charger reverses the current flow, providing that the charger has a greater voltage than the battery. The charger creates an excess of electrons at the negative plates, and the positive hydrogen ions are attracted to them. The hydrogen reacts with the lead sulfate to form sulfuric acid and lead, and when most of the sulfate is gone, hydrogen rises from the negative plates. The oxygen in the water reacts with the lead sulfate on the positive plates to turn them once again into lead dioxide, and oxygen bubbles rise from the positive plates when the reaction is almost complete.

Many people think that a battery's internal resistance is high when the battery is fully charged, and this is not the case. If you think about it, you'll remember that the lead sulfate acts as an insulator. The more sulfate on the plates, the higher the battery's internal resistance. 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. Near full charge, there isn't much sulfate left to sustain the reverse chemical reaction. The level of charge current that can be applied without overheating the battery or breaking down the electrolyte into hydrogen and oxygen is known as the battery's "natural absorption rate." When charge current is more than this natural absorption rate, overcharging occurs. The battery may overheat, and the electrolyte will bubble. Some of the charging current is wasted as heat even at correct charging levels, and this inefficiency creates the need to put more amp hours back into a battery than were taken out. More on that later."

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