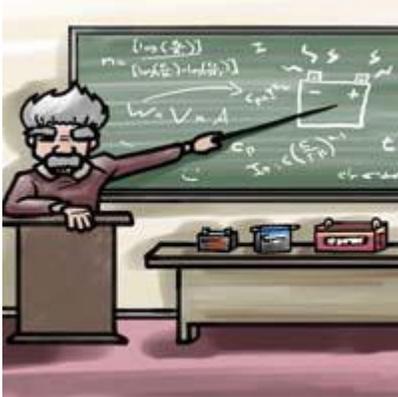


Battery Basics: A Layman's Guide to Batteries

<http://www.batterystuff.com/kb/articles/battery-articles/battery-basics.html>



If you have done any research on how batteries work or what you should look for when selecting a battery, you are probably buried in information, some of which is conflicting. At BatteryStuff, we aim to clear that up a bit. You have most likely heard the term K.I.S.S. (Keep It Simple, Stupid). I am going to attempt to explain how lead acid batteries work and what they need without burying you with a bunch of needless technical data. I have found that battery data will vary somewhat from manufacturer to manufacturer, so I will do my best to boil that data down. This means I may generalize a bit, while staying true to purpose.

The commercial use of the lead acid battery is over 100 years old. The same chemical principal that is being used to store energy is basically the same as our Great Grandparents may have used.

If you can grasp the basics you will have fewer battery problems and will gain greater battery performance, reliability, and longevity. I suggest you read the entire tutorial, however I have indexed all the information for a quick read and easy reference.

A battery is like a piggy bank. If you keep taking out and putting nothing back you soon will have nothing. Present day chassis battery power requirements are huge. Consider today's vehicle and all the electrical devices that must be supplied. All these electronics require a source of reliable power, and poor battery condition can cause expensive electronic component failure. Did you know that the average auto has 11 pounds of wire in the electrical system? Look at RVs and boats with all the electrical gadgets that require power. It was not long ago when trailers or motor homes had only a single 12-volt house battery. Today it is standard to have two or more house batteries powering inverters up to 4000 watts.

Average battery life has become shorter as energy requirements have increased. Life span depends on usage; 6 months to 48 months, yet only 30% of all batteries actually reach the 48-month mark. You can extend your battery life by hooking it up to a solar charger during the off months.

A Few Basics

The Lead Acid battery is made up of plates, lead, and lead oxide (various other elements are used to change density, hardness, porosity, etc.) with a 35% sulfuric acid and 65% water solution. This solution is called electrolyte, which causes a chemical reaction that produce electrons. When you test a battery with a hydrometer, you are measuring the amount of sulfuric acid in the electrolyte. If your reading is low, that means the chemistry that makes electrons is lacking. So where did the sulfur go? It is resting on the battery plates and when you recharge the battery, the sulfur returns to the electrolyte.

1. We must think *safety* when we are working around and with batteries. Remove all jewelry. After all you don't want to melt your watchband while you are wearing the watch. The hydrogen gas that batteries make when charging is very explosive. We have seen several instances of batteries blowing up and drenching everything in sulfuric acid. That is no fun, and would have been a good time to use those safety goggles that are hanging on the wall. Heck, just break out your disco outfit. Polyester is not affected by Sulfuric Acid, but anything with cotton will be eaten up. If you do not feel the need to make a fashion statement just wear junk clothes, after all Polyester is still out of style. When doing electrical work on vehicles it is best to disconnect the ground cable. Just remember you are messing with corrosive acid, explosive gases and 100's amps of electrical current.

2. Basically there are **two types of lead acid batteries** (along with 3 sub categories); The two main types are Starting (cranking), and Deep Cycle (marine/golf cart). The **starting battery (SLI starting**

lights ignition) is designed to deliver quick bursts of energy (such as starting engines) and therefore has a greater plate count. The plates are thinner and have somewhat different material composition. The **deep cycle battery** has less instant energy, but greater long-term energy delivery. Deep cycle batteries have thicker plates and can survive a number of discharge cycles. Starting batteries should not be used for deep cycle applications because the thinner plates are more prone to warping and pitting when discharged. The so-called **Dual Purpose Battery** is a compromise between the two types of batteries, though it is better to be more specific if possible.

3. Wet Cell (flooded), Gel Cell, and Absorbed Glass Mat (AGM) are various versions of the lead acid battery. The **Wet cell** comes in two styles; Serviceable and Maintenance free. Both are filled with electrolyte and are basically the same. I prefer one that I can add water to and check the specific gravity of the electrolyte with a hydrometer. The **Gel Cell** and the **AGM** batteries are specialty batteries that typically cost twice as much as a premium wet cell. However they store very well and do not tend to sulfate or degrade as easily as wet cell. There is little chance of a hydrogen gas explosion or corrosion when using these batteries; these are the safest lead acid batteries you can use. Gel Cell and some AGM batteries may require a special charging rate. If you want the best, most versatile type, consideration should be given to the AGM battery for applications such as Marine, RV, Solar, Audio, Power Sports and Stand-By Power just to name a few. If you don't use or operate your equipment daily, AGM batteries will hold their charge better than other types. If you must depend on top-notch battery performance, spend the extra money. Gel Cell batteries still are being sold but AGM batteries are replacing them in most applications. There is a some common confusion regarding AGM batteries because different manufactures call them by different names; some of the more common names are "sealed regulated valve", "dry cell", "non spillable", and "Valve Regulated Lead Acid" batteries. In most cases AGM batteries will give greater life span and greater cycle life than a wet cell battery. SPECIAL NOTE about Gel Batteries: It is very common for individuals to use the term GEL CELL when referring to sealed, maintenance free batteries, much like one would use Kleenex when referring to facial tissue or "Xerox machine" when referring to a copy machine. Be very careful when specifying a gel cell battery charger, many times we are told by customer they are requiring a charger for a Gel Cell battery and in fact the battery is not a Gel Cell.

AGM: The Absorbed Glass Matt construction allows the electrolyte to be suspended in close proximity with the plates active material. In theory, this enhances both the discharge and recharge efficiency. Common manufacturer applications include high performance engine starting, power sports, deep cycle, solar and storage battery. The larger AGM batteries we sell are typically good deep cycle batteries and they deliver their best life performance if recharged before allowed to drop below the 50% discharge rate. The Scorpion motorcycle batteries we carry are a nice upgrade from your stock flooded battery, and the Odyssey branded batteries are fantastic for holding their static charge over long periods of non use. When Deep Cycle AGM batteries are discharged to a rate of no less than 60% the cycle life will be 300 plus cycles.

GEL: The Gel Cell is similar to the AGM style because the electrolyte is suspended, but different because technically the AGM battery is still considered to be a wet cell. The electrolyte in a Gel Cell has a silica additive that causes it to set up or stiffen. The recharge voltage on this type of cell is lower than the other styles of lead acid battery. This is probably the most sensitive cell in terms of adverse reactions to over-voltage charging. Gel Batteries are best used in VERY DEEP cycle application and may last a bit longer in hot weather applications. If the incorrect battery charger is used on a Gel Cell battery poor performance and premature failure is certain.

4. CCA, CA, AH and RC. What are these all about? These are the standards that most battery companies use to rate the output and capacity of a battery.

Cold cranking amps (**CCA**) is a measurement of the number of amps a battery can deliver at 0 ° F for 30 seconds and not drop below 7.2 volts. So a high CCA battery rating is especially important in starting battery applications, and in cold weather. This measurement is not particularly important in Deep cycle

batteries, though it is the most commonly 'known' battery measurement.

CA is cranking amps measured at 32 degrees F. This rating is also called marine cranking amps (**MCA**). Hot cranking **amps (HCA)** is seldom used any longer but is measured at 80 ° F.

Reserve Capacity (**RC**) is a very important rating. This is the number of minutes a fully charged battery at 80 ° F will discharge 25 amps until the battery drops below 10.5 volts.

An amp hour (**AH**) is a rating usually found on deep cycle batteries. The standard rating is an Amp rating taken for 20 Hours. What this means, say for a 100 AH rated battery is this: Draw from the battery for 20 hours and it will provide a total of 100 amp-hours. That translates to about 5 amps an hour. $5 \times 20 = 100$. However, it's very important to know that the total time of discharge and load applied is not a linear relationship. As your load increases, your realized capacity decreases. This means if you discharged that same 100 AH battery by a 100 amp load, it **will not** give you one hour of runtime. On the contrary, the perceived capacity of the battery will be that of 64 Amp Hours.

5. Battery Maintenance is an important issue. The battery should be cleaned using a baking soda and water solution; a couple of table spoons to a pint of water. Cable connections need to be cleaned and tightened as battery problems are often caused by dirty and loose connections. A serviceable battery needs to have the fluid level checked. Use only mineral free water, Distilled is best as all impurities have been removed, and there is nothing left that could contaminate your cells. Don't overfill battery cells especially in warmer weather because the natural fluid expansion in hot weather can push excess electrolytes from the battery. To prevent corrosion of cables on top post batteries use a small bead of silicone sealer at the base of the post and place a felt battery washer over it. Coat the washer with high temperature grease or petroleum jelly (Vaseline), then place cable on the post and tighten. Coat the exposed cable end with the grease. Most folks don't know that just the gases from the battery condensing on metal parts cause most corrosion.

6. Battery Testing can be done in more than one way. The most accurate method is measurement of specific gravity and battery voltage. To measure specific gravity buy a temperature compensating hydrometer, to measure voltage use a digital D.C. Voltmeter. A quality load tester may be a good purchase if you need to test sealed batteries.

For any of these methods, you must first fully charge the battery and then remove the surface charge. If the battery has been sitting at least several hours (I prefer at least 12 hours) you may begin testing. To remove surface charge the battery must be discharged for several minutes. Using a headlight (high beam) will do the trick. After turning off the light you are ready to test the battery.

State of Charge Specific Gravity Voltage

		12V	6V
100%	1.265	12.7	6.3
75%	1.225	12.4	6.2
50%	1.190	12.2	6.1
25%	1.155	12.0	6.0
Discharged	1.120	11.9	6.0

Load testing is yet another way of testing a battery. Load test removes amps from a battery much like starting an engine would. A load tester can be purchased at most auto parts stores. Some battery companies label their battery with the amp load for testing. This number is usually 1/2 of the CCA rating. For instance, a 500CCA battery would load test at 250 amps for 15 seconds. A load test can only be performed if the battery is near or at full charge.

The results of your testing should be as follows:

Hydrometer readings should not vary more than .05 differences between cells.

Digital Voltmeters should read as the voltage is shown in this document. The sealed AGM and Gel-Cell battery voltage (full charged) will be slightly higher in the 12.8 to 12.9 ranges. If you have voltage readings in the 10.5 volts range on a charged battery, that typically indicates a shorted cell.

If you have a maintenance free wet cell, the only ways to test are voltmeter and load test. Any of the maintenance free type batteries that have a built in hydrometer (black/green window) will tell you the condition of 1 cell of 6. You may get a good reading from 1 cell but have a problem with other cells in the battery.

When in doubt about battery testing, call the battery manufacturer. Many batteries sold today have a toll free number to call for help.

7. Selecting a Battery - When buying a new battery I suggest you purchase a battery with the greatest reserve capacity or amp hour rating possible. Of course the physical size, cable hook up, and terminal type must be a consideration. You may want to consider a Gel Cell or an Absorbed Glass Mat (AGM) rather than a Wet Cell if the application is in a harsher environment or the battery is not going to receive regular maintenance and charging.

Be sure to purchase the correct type of battery for the job it must do. Remember that engine starting batteries and deep cycle batteries are different. **Freshness** of a new battery is very important. The longer a battery sits and is not re-charged the more damaging sulfation build up there may be on the plates. Most batteries have a date of manufacture code on them. The month is indicated by a letter 'A' being January and a number '4' being 2004. C4 would tell us the battery was manufactured in March 2004. Remember the fresher the better. The letter "i" is not used because it can be confused with #1.

Battery warranties are figured in the favor of battery manufactures. Let's say you buy a 60-month warranty battery and it lives 41 months. The warranty is pro-rated so when taking the months used against the full retail price of the battery you end up paying about the same money as if you purchased the battery at the sale price. This makes the manufacturer happy. What makes me happy is to exceed the warranty. Let me assure you it can be done.

8. Battery life and performance - Average battery life has become shorter as energy requirements have increased. Two phrases I hear most often are **"my battery won't take a charge, and my battery won't hold a charge"**. Only 30% of batteries sold today reach the 48-month mark. In fact 80% of all battery failure is related to sulfation build-up. This build up occurs when the sulfur molecules in the electrolyte (battery acid) become so deeply discharged that they begin to coat the battery's lead plates. Before long the plates become so coated that the battery dies. The causes of sulfation are numerous. Let me list some for you.

- Batteries sit too long between charges. As little as 24 hours in hot weather and several days in cooler weather.
- Battery is stored without some type of energy input.
- "Deep cycling" an engine starting battery. Remember these batteries can't stand deep discharge.
- Undercharging of a battery to only 90% of capacity will allow sulfation of the battery using the 10% of battery chemistry not reactivated by the incompleting charging cycle.
- Heat of 100 plus F., increases internal discharge. As temperatures increase so does internal discharge. A new fully charged battery left sitting 24 hours a day at 110 degrees F for 30 days would most likely not start an engine.
- Low electrolyte level - battery plates exposed to air will immediately sulfate.
- Incorrect charging levels and settings. Most cheap battery chargers can do more harm than good. See the section on battery charging.
- Cold weather is also hard on the battery. The chemistry does not make the same amount of energy as a warm battery. A deeply discharged battery can freeze solid in sub zero weather.

- Parasitic drain is a load put on a battery with the key off. More info on parasitic drain will follow in this document.

There are ways to greatly increase battery life and performance. All the products we sell are targeted to improve performance and battery life.

An example: Let's say you have "toys"; **an ATV, classic car, antique car, boat, Harley, etc.** You most likely don't use these toys 365 days a year as you do your car. Many of these toys are seasonal so they are stored. What happens to the batteries? Most batteries that supply energy to power our toys only last 2 seasons. You must keep these batteries from sulfating or buy new ones. We sell products to prevent and reverse sulfation. The PulseTech products are patented electronic devices that reverse and prevent sulfation. Also Battery Equaliser, a chemical battery additive, has proven itself very effective in improving battery life and performance. Other devices such as Solar Trickle Chargers are a great option for battery maintenance.

Parasitic drain is a load put on a battery with the key off. Most vehicles have clocks, engine management computers, alarm systems, etc. In the case of a boat you may have an automatic bilge pump, radio, GPS, etc. These devices may all be operating without the engine running. You may have parasitic loads caused by a short in the electrical system. If you are always having dead battery problems most likely the parasitic drain is excessive. The constant low or dead battery caused by excessive parasitic energy drain will dramatically shorten battery life. If this is a problem you are having, check out the Priority Start and Marine Priority Start **to prevent dead batteries before they happen**. This special computer switch will turn off your engine start battery before all the starting energy is drained. This technology will prevent you from deep cycling your starting battery.

9. Battery Charging - Remember you must put back the energy you use immediately. If you don't the battery sulfates and that affects performance and longevity. The alternator is a battery charger. It works well if the battery is not deeply discharged. The alternator tends to overcharge batteries that are very low and the overcharge can damage batteries. In fact an engine starting battery on average has only about 10 deep cycles available when recharged by an alternator. Batteries like to be charged in a certain way, especially when they have been deeply discharged. This type of charging is called 3 step regulated charging. Please note that only special SMART BATTERY CHARGERS using computer technology can perform 3 step charging techniques. You don't find these types of chargers in parts stores and Wal-Marts. The first step is **bulk charging** where up to 80% of the battery energy capacity is replaced by the charger at the maximum voltage and current amp rating of the charger. When the battery voltage reaches 14.4 volts this begins the **absorption charge** step. This is where the voltage is held at a constant 14.4 volts and the current (amps) declines until the battery is 98% charged. Next comes the **Float Step**. This is a regulated voltage of not more than 13.4 volts and usually less than 1 amp of current. This in time will bring the battery to 100% charged or close to it. The float charge will not boil or heat batteries but will maintain the batteries at 100% readiness and prevent cycling during long term inactivity. Some Gel Cell and AGM batteries may require special settings or chargers.

10. Battery Do's

- Think Safety First.
- Do read entire tutorial
- Do regular inspection and maintenance especially in hot weather.
- Do recharge batteries immediately after discharge.
- Do buy the highest RC reserve capacity or AH amp hour battery that will fit your configuration.

11. Battery Don'ts

- Don't forget safety first.
- Don't add new electrolyte (acid).
- Don't use unregulated high output battery chargers to charge batteries.

- Don't place your equipment and toys into storage without some type of device to keep the battery charged.
- Don't disconnect battery cables while the engine is running (your battery acts as a filter).
- Don't put off recharging batteries.
- Don't add tap water as it may contain minerals that will contaminate the electrolyte.
- Don't discharge a battery any deeper than you possibly have to.
- Don't let a battery get hot to the touch and boil violently when charging.
- Don't mix size and types of batteries.

There are many points and details I have not written about because I wanted to keep this as short and simple as possible.