

Batteries

More than you ever wanted to know

By: Norm Keller

Several Email requests have asked that I try to discuss battery life and "Why Batteries Die". Please keep in mind that I am not a battery engineer and as always, I hope to provide some information which may be of service.

Let's consider some aspects of battery theory which may be useful in understanding how lead-acid storage batteries work. The battery which we find in motorcycle and automotive applications is intended to produce a high current for a short length of time for starting purposes. A secondary (maybe considered primary depending on law) purpose is to provide park lights and to allow for the operation of lighting loads and some accessory loads such as cooling fans when the engine is not running or is running at too low a speed to allow the alternator to produce enough to keep up with the load. If we didn't need to electrically start (crank) the engine, we could make do with a much smaller battery or no battery at all. That would be another world however so let's look at this one.

The typical lead-acid battery is made up of a case, positive plates, negative plates, plate separators, cell connectors, filler caps, and electrolyte. The battery case used to be made of a type of rubberized material but is now of a specialized type of plastic. I use the term "specialized" to indicate that I don't know what kind of plastic that is made from. (Saying that it is "specialized" sounds more informed don't you think?) It has the ability to withstand the effects of the sulphuric acid mixture, a fair amount of impact, extremes of temperature from below minus 55 degrees C (60 below F) up to over 150 degrees C (300 degrees F). I have observed batteries surviving these extremes 60 below outside temp and 300 degrees under hood temp.

The positive plates are made of lead peroxide and the negative plates are of sponge lead. "Sponge lead" in that the plates are formed of lead which is manufactured with a surface having a great number of surface irregularities as has a sponge. A battery's capacity is dependent on the surface area of plates which is exposed to electrolyte - the more plate area exposed to electrolyte, the more capacity the battery has to deliver current.

At this point, I should mention that the battery is called a "battery" because it is a "battery" of "cells" and that it is easier to refer to the construction of one cell. A cell is made up of at least one positive plate (lead peroxide) and one negative plate (sponge lead) which are surrounded by a sufficient quantity of electrolyte to chemically involve the plate material. In order to provide enough current (amps) to do the work required, the plate area required (for one cell) is about 75 square inches for the negative plate group and 85 square inches for the positive plate group. If you put a light behind your battery next time you have it out, you will be able to see the plates quite clearly. You will also see that there are dividers, one for each filler cap which divides the battery case into six separate sections or cells. Each cell has its own electrolyte and its own set of plates. If you tip the battery a bit, you will see that the electrolyte does not flow from one cell into

the next.

If you have the opportunity to see a battery which has been cut apart, you will see the construction quite clearly, you will see also that the positive plate material (if new) is a brown colour (lead peroxide).

Looking at a battery which has been taken apart or with a bit of persistence and a flashlight looking down the filler cap holes, you will notice that the plates are connected in two groups and that the plates alternate in order. Starting at one end, they start with a positive, then negative, then positive, etc. ending with an "extra" positive plate.

Looking at the cell nearest to the positive battery post, you will notice that there are a number of plates in the first cell. Looking carefully, you will be able to see that the first plate from the end is connected to a connector bar off the positive battery post and that this connector does not go through the cell wall into the next cell. Going from the first plate in the cell which is a positive plate, you can see that there is a separator between this first plate and the plate next in line. Looking through the filler hole, you will see that the separators extend beyond the plates to ensure that nothing can "bridge" between two plates. The separator plate is of porous material which (in the cells which I have taken apart) looks like a heavy piece of unbleached kraft paper. Sort of like a rectangle of super heavy shopping bag paper. This separator plate is porous to allow it to be fully impregnated with electrolyte so that it does not impede the flow of electrons. The separator plate also has vertical raised ridges which provide some small space between the separator and the plate. The ridges allow small bits of material which can become separated, to fall to the bottom of the battery case. The purpose of these separator plates is to prevent the cell plates from coming into contact with one another and to prevent the cell plates from moving in response to shock or vibration.

Battery plates:

As you have seen, a cell is made up of positive and negative plates which are constructed of different materials. You will also note that the area required would make the cells (and thus the battery) very difficult to fit into the bike if the cell were composed of only one positive and one negative plate. It is also easier to support a number of smaller plates to withstand shock and vibration than it would be if there were only two large plates per cell. Those of us who are a bit "long in the tooth" will remember some of the odd shaped 6 volt car batteries which were in service in the 1940's and 1950's- the shape doesn't matter as long as you can fit the right number of cells with enough plate area in each to do the job.

When the cell plates are made, they are created by first forming a plate "grid" of solid metal. This grid looks like a coarse screen with rectangular holes inside a heavier frame which surrounds the "screen". The purpose of the "frame" is to support the plate and to provide an electrical conduit for the flow of electrons to and from the active material. The rectangular "screen" holes are arranged so that the short sides are vertical. The positive plate group is assembled by welding a connector bar across the top of the plate "frames" along one side. If the group is to form the first cell at the positive end of the battery, the connector bar will have the positive battery post

(external connector for the cables) attached. The negative plate group (often containing one less plate) is assembled in the same manner. If the negative plate group were part of the cell at the negative end of the battery, this connector bar would have the negative post attached. In this case however we are discussing the cell nearest the positive (post) end of the battery and the negative plate group will not have a battery post attached. Instead of a battery post, the negative group's connector bar will have a "U" shaped piece attached which is connected (really it is part of the connector since these are all made in one piece) to the connector bar for the next cell. If you look at the top of your battery, you will note that there are two raised areas on either side of the filler caps. The raised area on the same side as the battery posts has a vent hose attached and is intended to vent gases resulting from charging and to prevent electrolyte from splashing out. On both sides of the battery top is a narrower raised area which accommodates the "U" shaped connectors which go between the cells.

Going back to the subject of the plates, the grid or frame is composed of a lead-antimony alloy or a lead-calcium alloy. Older batteries used lead-antimony and the new generation of batteries (often called "maintenance free") use the lead-calcium alloy. The active material (lead peroxide or sponge lead) is placed into the spaces in the grid (into the holes in the screen). The active material is not very strong and requires the support of the grid.

The battery electrolyte is a mixture of 36% Sulphuric Acid (H_2SO_4) and water. If the two plate groups together with their separators are placed into the case and the electrolyte added the battery must be "formed" by charging it for the first time.

Something which applies a load to the battery (either inside or outside the battery) will drain it given enough time. The small load required to the "keep alive" circuits to radios and CB's to allow them to remember stations will eventually drain a battery. It's a good idea to disconnect the negative cable or main fuse (I prefer the cable) when the bike is parked for a month or more. Shops are remarkable stupid in this regard! A battery will self discharge, that is it will drain internally given enough time which is why batteries need periodic recharging when in storage even if the cable is disconnected. Even more frequently if the cable is not disconnected. An unfortunate fact of life is that batteries which are designed to produce high starting currents do not like to be drained. You can completely discharge a new automotive battery and recharge it 3 or 4 times and then load test and you will often find that the battery's capacity (ability to deliver current) is markedly less. I've seen many occasions where a new auto battery was finished after being drained (flat) dead two times. The best advice I can offer is to avoid at all costs, deep cycling (draining down a lot and recharging) a bike or car battery. At one time I worked for a Honda car dealer in northern Canada and salvaged a lot of batteries which were not good enough to provide good starting in the cold although they would have been fine in cars in warmer climates. These Honda batteries were Yuashas and I used them on a battery storage system to provide lighting and power to a house in a remote location. The batteries were placed in two groups in which they were connected in parallel to produce 12 volts with large current potential. The two groups were used separately to power the system so that one group was in use while the other was charged. By having one group out of service at a time only one group could be drained if a load was left on inadvertently. We experienced many occasions where one or the other group was discharged due to an internal fault in one battery of the group. The interesting thing (to me

anyway) was that the Yuasha batteries seemed to be remarkable tolerant of cycling and some survived this treatment for several years. In no occasion did another make (Delco, Motorcraft, Firestone, ESB, Exide, Sears, you name it) survive for more than three or 4 months. This likely has little to do with our GW service but if this is indicative of the relative tolerance of Yuashas to drain-charge cycling, we should be glad that we don't have to use other types. (Note* I say "other types" I did not say "other makes". Someone else could make a battery of this type, I have just never seen an auto battery which exhibits these characteristics). Since car and bike batteries are not called upon to provide deep cycling (deep levels of charge-discharge) this does not speak to their ability to provide good service in a starting mode.

One could finance a new SE and retirement on the value of batteries which are unnecessarily replaced in this country in one week. If you have time, disconnect the battery negative, top up the electrolyte with the best water which you can reasonably obtain and charge the battery. Let the battery sit for a few days (good winter test) and measure voltage or specific gravity, if its below 12.6 - 12.8 volts (1.280 - 1.290 specific gravity @ 80 F) you've probably found an offender. I am always surprised that people will continually recharge a battery which is dead every morning. Why not disconnect the negative and see if it still goes dead over night? If it dies while disconnected the battery is the problem. An unlikely problem with bike batteries is that there is enough electrolyte on the battery top to provide a discharge route.

This couldn't happen anyway because you rinse the top off with a bit of baking soda and water a couple of times per year, right. Don't forget to have the filler caps in place and tight!

If the battery only goes dead when connected then the drain is via the bike's wiring. If you have a sensitive induction ammeter or an ammeter to connect in series, you can measure a drain on the battery and find the drain by disconnecting things until the drain goes away. Keep in mind the small drain to the radios & clock, etc.

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(James R. Davis is a recognized [expert witness](#) in the fields of Motorcycle Safety/Dynamics.)