procedure to try. First, fully recharge the cell, and then continue to charge the cell at a C/20 rate for five to seven hours. During equalization charges, the cell voltage will become very high, about 2.7 VDC per cell. This overcharge contains the necessary power to break up the smaller lead sulfate crystals and return these sulfate ions into solution in the electrolyte. The larger sulfate crystals, however, cannot be broken up even by an equalizing charge.

EDTA Treatment

If a sulfate bond spends several months on the plates and forms large crystals, then the lead sulfate can be chemically stripped from the plates. This is a job for an organic acid called EDTA, a close chemical cousin of vinegar. EDTA stands for the compound "ethylenediamine tetraacetic" acid. In chemical techie terms, EDTA is a "chelating agent" (chela is a Greek word for claw) that works particularly well on metal ions with a double positive charge. That's what makes it so effective on lead sulfate crystals. EDTA will dissolve lead sulfate, but it won't dissolve the lead or lead peroxide that makes up the healthy portions of the electrodes. EDTA comes in several forms. Use the tetrasodium variety.

The EDTA procedure is simple. Use one tablespoon of the EDTA powder for each quart of electrolyte in the cell. Mix the EDTA with a small amount (an ounce or two) of distilled water and add it to the cell. Recharge the cell and give it an equalizing charge. Recharging the cell speeds up the EDTA's reaction with the lead sulfate and strips the large sulfate crystals from the surface of the cell's plates more rapidly. After this reaction takes place, these large crystals fall to the bottom of the cell as a precipitate. The reaction can take from several days to several weeks depending on temperature, recharge rate, and depth of sulfation. Once the large sulfate crystals are stripped from the plates, new lead is exposed and can enter into bonding with the sulfuric acid electrolyte.

The amount of EDTA specified here is a ballpark guess. If your cells are badly sulfated, then you may wish to repeat the EDTA treatment in a month or so. In severe cases of sulfation, more sulfuric acid may be added to the cell to replace lost sulfate ions in the electrolyte. Here, your hydrometer is your best guide. A specific gravity of 1.260 is standard for a fully charged cell. If after EDTA treatment, your specific gravity is below 1.200, then replace water lost from the electrolyte with new electrolyte (specific gravity 1.260) instead of distilled water. Feedback from hundreds of HP readers who have tried EDTA indicates that it will not harm the cells. For a complete discussion of EDTA treatment, see HP #20- pg. 36, and HP #21- pg. 36.

Hi-Tech Sulfate Solutions

I *(Richard)* am testing two new products which prevent and reverse sulfation in lead-acid cells. These devices are called "MiniPulse™" which runs on 12 or 24 VDC and "DuraPulse™" which is powered by 120 vac. These devices use pulses of electricity, timed to the resonant frequency of the sulfate bond, to break up large sulfate crystals. These pulse devices may well replace EDTA as the cure for sulfated cells. Their use on new batteries may prevent or delay sulfation. The sulfate ions liberated by the pulse method return into solution in the electrolyte, rather than dropping uselessly to the bottom of the cell. These devices are relatively inexpensive ($100 to $170) and may pay for themselves many times over by extending battery life. I am currently testing both models on some seriously sulfated lead-acid cells, so look for a report on our experiments in the near future.

Working with, rather than against, the lead-acid cell

Here is a short list of things that you can do to help your lead-acid cells live long and prosper:

1. Bring all the cells in the battery to a full state of charge weekly. This is really a matter of system design and energy management. Systems with undersized power sources will eventually have battery problems. Folks who consume more than they produce will eventually have battery problems.
2. Perform equalization charges every two months or every six deep cycles, whichever comes first.
3. Never replace lost water from the cells with anything other than distilled or de-ionized water. Well water and, sadly, even rainwater are not pure enough for the cells.
4. Keep your cells warm in the winter and cool in the summer. The lead-acid reaction works best and most efficiently between 60 and 80 degrees F. Operation above 110°F or below 40°F will decrease apparent battery capacity and shorten battery life.
5. Keep the tops of the cells clean and corrosion free. Cells are electrochemical machines which don't tolerate contaminants, so run a clean scene. While baking soda is excellent for cleaning corroded hardware, don't use baking soda on the tops of cells. If the acid schmaze can get out, then the baking soda can get in. Baking soda can neutralize the electrolyte within the cell and cause cell failure.

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