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Battery Maintenance for Alternative Energy Systems February 11, 1998

Below are tips on maintenance and charging of vented lead acid batteries used in alternative energy systems.

Safety:

Lead acid batteries are dangerous devices if not handled correctly. They contain corrosive fluids and generate explosive gasses. It only requires modest protection measures to render these devices quite safe for residential use:

1. Eye safety: Always wear protective goggles or face shield. The corrosive electrolyte can splash into the eyes and cause blindness.
2. Skin safety: Wear rubber gloves to protect hands from the acid. Wear protective clothing. A cheap rain suit works quite well. Keep baking soda handy to neutralize battery acid. Wash tops of batteries with a solution of baking soda if there is an accumulation of acid residue.
3. Explosion: All battery enclosures should be hermetically isolated from electrical equipment and vented to the outside to prevent sparks from igniting volatile gasses produced in charging. Before maintenance, all batteries should be disconnected from charging sources and the enclosure allowed to vent.
4. Create a kit including all of the safety items mentioned above and also including a good hydrometer and a modest digital voltmeter. It is wise to keep this in a plastic tool box.

Battery Electrolytes:

1. Battery water level should be monitored at least once a month, more often after heavy charging. Water should be added when level drops to 1/2" below full level. Full level is within 1/8" of full indicator or 1/2" over top of separators. Use distilled water only to refill batteries. Fill cells slowly.
2. Add water after charging to avoid overflow due to expansion.

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Charging:

1. Do not let battery voltage fall below these values:

12 volt system:	11.7 volts
24 volt system:	23.5 volts.
48 volt system:	47.0 volts.

2. Daily charge: Ideally, charging should achieve these voltages each day (known as bulk charging voltage):

12 volt system:	14.5 volts.
24 volt system:	29.0 volts.
48 volt system:	58.0 volts.

A representative from Trojan manufacturing has told me that this voltage level should be maintained for 6 hours. This is rarely practical in alternative power systems, but it indicates that in charging the batteries it is not adequate to just reach target voltage, that level must be maintained for as long as is possible.

Although most charging systems have automatic control of charging voltages, these controls do need periodic adjustment, so the owner should monitor charging to ensure these values are met as closely as is possible. In some cases even automatic chargers require human intervention such as systems where a generator or water wheel requires manual control.

3. Equalizing charge: Eventually through daily charging and discharging, the electrolyte in lead acid batteries becomes stratified. That is the acid is concentrated in the bottom of the cells. This problem is resolved by a deliberate over charging of the batteries, called an equalizing charge. This is achieved by charging the batteries to the voltage indicated below and holding it for two hours. This should be done once a month. Most charging systems have a switch that when engaged will increase the charge voltage to the proper level. Here are the equalizing voltages:

12 volt system:	15.5 volts.
24 volt system:	31.0 volts.
48 volt system:	62.0 volts.

Testing batteries:

There are a number of ways a battery array can be tested. The two ways that are practical for the residential user are at-rest-voltage and specific gravity.

1. At-rest-voltage: Simply charge the batteries fully: Apply bulk voltage for 6 hours and equalizing voltage for two hours. See above for these voltages. Disconnect the batteries and let them rest for 6 hours. Voltage should read 25.2 volts for a 24 volt system or 12.6 for a 12 volt system. To check individual batteries, disconnect them from the array before letting them rest and check voltage of individual batteries. Batteries should read 2.1 volts per cell. 6 volt batteries have 3 cells and should read 6.3 volts at rest.

2. Measuring specific gravity: Batteries should be tested at least once every 6 months to ensure they are in good shape. One bad battery in an array can shorten the life of every battery in the array. Specific gravity should be checked after the batteries are fully charged. Stop charging and ventilate the battery compartment before testing specific gravity. Here's how to test specific gravity:

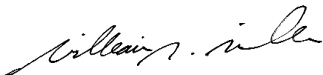
- A. Obtain a good hydrometer. This should have a numeric scale, not colored balls. I purchase mine at Napa auto supply. One with a thermometer is especially nice and not all that expensive
- B. Wear goggles, gloves and protective clothing.
- C. Charge batteries to full. Check water level. If significant water is added, charge batteries again.
- D. Lower hose of hydrometer into electrolyte. Squeeze bulb and draw in enough electrolyte to raise float, but not so much as to cause float to run into the top of housing. Hold hydrometer vertical. The surface of the electrolyte will have some curvature. Read scale at lower edge of this curvature.
- E. A good hydrometer will have a temperature gauge and a correction scale. Correct the reading for the temperature.
- F. Squeeze all of the electrolyte back into the cell from which it was drawn. Avoid dribbling any electrolyte onto skin or clothing.
- G. Record the reading and which cell it came from and the date. This will help track battery condition.

H. Apply reading to this scale:

Percent of charge	Specific gravity
100%	1.265
75%	1.225
50%	1.190
25%	1.155
Discharge	1.120

If you have applied proper charging voltage to a battery (bulk charging voltage for 6 hours and equalization charge for 2 hours) and its specific gravity is not close to 1.265, the battery may be past its useful life. Replace any defective batteries as soon as possible. If in doubt, the batteries can be taken to a battery shop for charge and testing. Marginal batteries can sometimes be revitalized with therapeutic charging.

If you have any questions, I would be happy to arrange an on-site inspection of your battery system. My numbers are listed above. I have available additional literature on this subject, please ask if you are interested.



William Miller