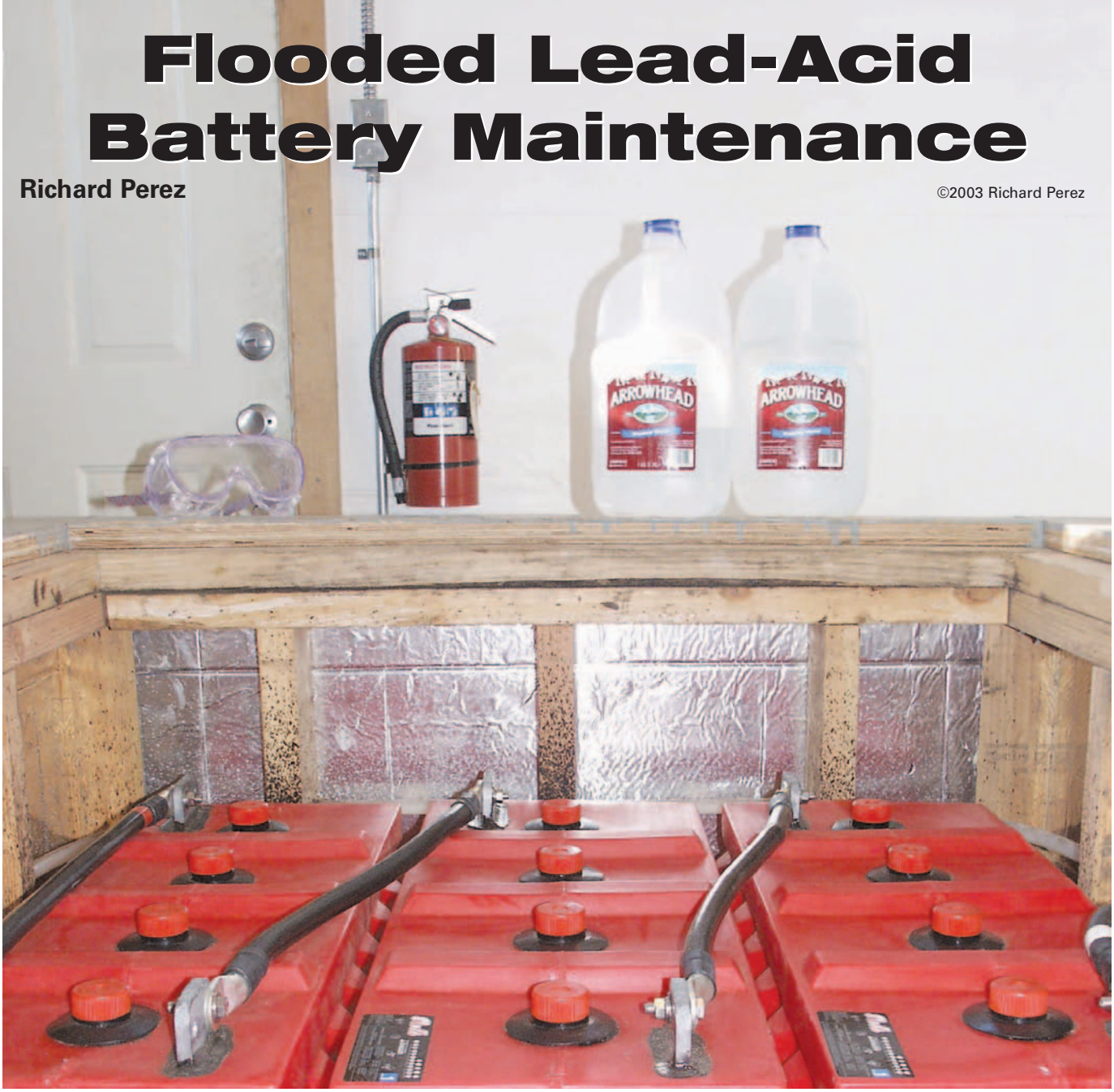
Flooded Lead-Acid Battery Maintenance

Richard Perez



For Richard and Karen Perez's Surrette battery bank, safety comes first—eye protection, fire extinguisher, smoke detector, and baking soda and rubber gloves (not shown) for neutralizing and cleaning up spilled electrolyte.

It's winter again, and time to make sure that your batteries are ready for this heavy-use season. After the long sunny days of summer, the typical PV system's battery has had it easy. It's during winter's heavy use that you often discover battery problems. Routine maintenance is the key to making sure that your battery is ready.

The information in this article applies to flooded lead-acid batteries—the type to which you can add water. It does not apply to sealed lead-acid batteries, or other battery technologies, such as alkaline types (NiCd or NiFe).

Living with Batteries

Batteries in an off-grid RE system are the most easily abused component in the system. How you treat them will make or break your renewable energy lifestyle, and your battery budget. Your battery bank allows your home to function normally when the sun isn't shining and the wind isn't blowing. But it only holds a limited amount of energy. You need to be aware of how deeply you are discharging your battery bank, and adjust your usage or start your back-up generator at the appropriate times.

Lead-acid batteries will last the longest if they are shallowly discharged rather than deep cycled. I personally consider it time to use the backup energy source once the battery gets down to a 50 percent state of charge. It's important that the battery be fully recharged several times a week. If this is not happening, you need to add more charging capacity to the system. In a well-designed system, the battery will receive an average nightly depth of discharge of less than 12 percent.

Safety Equipment

Winter is a good time to check all the safety equipment located near your battery bank. The following safety gear should be present and in good condition—rubber gloves, safety goggles, a smoke detector, a fire extinguisher, and a supply of baking soda for neutralizing spilled electrolyte.

The gloves should be the heavy-duty type sold by chemical supply houses, not the lightweight dishwashing models found in the supermarket. The goggles should be tight fitting and totally protect your eyes from any acid that may be splashed during watering. The smoke detector should have its battery replaced annually, and winter is a good time to do this.

The fire extinguisher should be of the ABC type that can handle wood, chemical, and electrical fires. Check it annually to make sure it still has its charge. Have lots of baking soda on hand—it takes two pounds of baking soda to neutralize one quart of battery electrolyte. Be prepared for an accident in which a battery disgorges all of its electrolyte.

Equalizing Charges

Over time, the individual cells that make up a battery will come to have unequal states of charge. The only way to bring each cell back to a fully recharged state is to overcharge the entire battery to ensure that each cell is fully recharged. If a battery is to perform well and efficiently, all cells must have the same state of charge.

An equalizing charge is a controlled overcharge of an already fully charged battery. The maximum charge rate for equalizing charges is C/20—which means that a fully discharged battery pack will be totally recharged in a 20 hour period. The charge rate in amperes is equal to the capacity of the battery in ampere hours (C) divided by 20 hours. Charging at a higher rate will cause the battery to overheat and will reduce its life. Equalizing charges can be done at slower rates, but they will take longer to achieve a state of cell equalization.

An equalizing charge should be done every five to seven deep cycles or every two months, whichever comes first. A deep cycle is when the battery has sustained a discharge cycle of 50 percent or more of its capacity. The beginning of winter is a great time to do one or more equalizing charges. This ensures that the battery is ready for the deep cycles it is sure to receive during the winter's sunless periods.

Equalizing: Step-by-Step

1. Make sure that the battery is fully charged. Your battery ampere-hour meter will supply this information.

2. Make sure that an adequate supply of distilled water is on hand.

3. If catalytic battery caps (such as Hydrocaps) are being used, remove them and replace them with the original factory-supplied caps. An equalizing charge will generate far too much hydrogen and oxygen gas for catalytic caps to convert back to water. The caps will overheat and in some cases even melt.

4. Apply a charge rate of C/20 to the battery and let it overcharge for between five and seven hours. During this period, the battery's voltage will get much higher than normal—up to 16.5 VDC in 12 VDC systems, and over 33 VDC in 24 VDC systems. If any voltage-sensitive DC appliances are on-line, switch them off before equalizing.

5. An hour before stopping the equalizing charge, add distilled water to each cell to bring the electrolyte up to the manufacturer's recommended "full" level. Equalization charges will electrolyze water from the cells. The electrolyte will have the appearance of a "rolling boil" as water is converted into hydrogen and oxygen gas. Four to five hours into the equalizing charge is the perfect time to add water to the cells. They will need to have their water replenished. And the agitated state of the electrolyte will thoroughly mix the added water with the existing electrolyte.

6. After the equalizing charge is finished, replace the battery's catalytic converter caps if they are being used.

If the battery has been abused by not performing equalizing charges, or by operating it without routinely bringing it to 100 percent state of charge, multiple equalizing charges may be necessary. Sulfation is a clogging of the plates with large sulfate crystals, which occurs when the cell is not fully recharged. Equalizing charges should be performed routinely during all seasons, but especially during the winter when the battery is more deeply discharged.

Water for the Battery

Only distilled water should be added to replace the water lost by the cells. Well water will probably contain

Tubing, clamp, and a flashlight help get the exact amount of distilled water where you want it.

These two Zephyr battery vents safely pull hydrogen gas from the battery boxes (inside) to the outside.

dissolved minerals and should not be used. Municipal water supplies usually contain not only dissolved minerals, but also chlorine, and should not be used. Though rainwater starts out pure from the clouds, it is often polluted by the time it can be collected on the ground. Batteries are electrochemical machines—they either fly or die on the purity of the reactants. Use only distilled water, and check the water levels at least every six to eight weeks.

Do not let the plates of the battery become exposed to air by letting the electrolyte level become too low. This will lead to oxidation of the cell's plates and permanent decrease in cell capacity.

Cleaning the Battery & Its Connections

Eventually, most lead-acid batteries develop a schmaze of acid electrolyte covering their tops. This smeared haze of acid will corrode the connectors attached to the battery. The acid schmaze is electrically conductive and can form discharge paths across the tops of the batteries. It should be carefully cleaned off the battery's tops. Quickly wiping the tops of your batteries with a paper towel each time you water them will keep them clean, and make the job easy.

While baking soda is an excellent neutralizing agent for acid electrolyte accidents, it should *never* be used on the top of a battery. If the acid can get out, then the baking soda can get inside the cells and neutralize the electrolyte. Use baking soda only on the sides of the battery, to neutralize the acid on connectors after removing them from the battery, and to clean up spilled acid. Once again—never use baking soda on the battery's top!

After corroded connectors are cleaned with a baking soda solution, they can be brightened with sandpaper or with a wire brush. Be sure to brighten the battery posts too. The general rule for all connections made to the battery is that they should be "tight and bright." Corroded connections will cause differing states of charge between the battery's cells, and lead to inefficient operation and early battery demise.

Temperature & Ventilation

The lead-acid chemical reaction employed in a battery is temperature sensitive. Temperatures below 50°F (10°C) will lead to temporary battery capacity loss, depressed voltage during discharge, and elevated voltage during recharge. The optimum temperature for the lead-acid reaction is 78°F (26°C). Keep the battery as close to this temperature as possible.

If the battery is in a conditioned space, keeping it warm is easy—just allow it access to heated air from inside the living space. But make sure that this air path is one way—into the battery containment and exhausted outside by a vent fan. It's important that the hydrogen gas, which is highly flammable, be exhausted outside of the battery containment and building. The air intake should be located low on one side of the containment. The outlet should be located high on the opposing side of the containment and vented outside. If the battery is in an unconditioned space, keeping it warm is more difficult. Use solar heat, super-insulation, or do whatever is necessary to keep the battery 50°F (10°C) or warmer.

This battery box is super-insulated, and heated with solar hot water circulated through hydronic tubing.

You should keep your batteries cool in the summer too. When a lead-acid battery is kept at over 95°F (35°C), its rate of self-discharge (energy lost inside of each cell) increases radically, and its effective lifetime will be far shorter. So when you plan for keeping the battery warm in the winter, don't forget to also allow for keeping it cool in the summer.

Be Prepared

Winter is a tough time for your batteries. The shorter days and longer nights mean that the battery has to work harder, with shorter recharge periods and longer discharge periods. While letting battery maintenance (especially equalizing charges) slide during the lazy, long summer days is not a huge disaster, slacking off on maintenance during the winter can kill a battery.

So now is the time. Run an equalizing charge. Check the battery's water. Clean the connections. In addition, double-check the safety equipment. A well-maintained battery is a happy battery, and will see you through the winter.

Access

Richard Perez, *Home Power*, PO Box 520, Ashland, OR 97520 • 541-941-9716 • Fax: 541-512-0343 • richard.perez@homepower.com • www.homepower.com