

BATTERY CARE

This information is taken from Trojan Battery Company's website at www.trojanbattery.com. Remember to follow all proper safety precautions when working around any battery and when in doubt, contact a qualified professional for help.

FAQ

- **When should I water my batteries?**

Water is lost during charging. Therefore, the best time to water your batteries is always at the end of the charge cycle.

- **How often should I water my batteries?**

How often you use your batteries will determine the frequency of watering. For example, the weekend fisherman may find he only needs to water the batteries in his boat once a month. While a maintenance supervisor for a golf course might need to service the batteries in their golf cars every week. Also using batteries in a hot climate may require more frequent watering. It is best to check your new batteries regularly as this will give you a good feel for how often your application will require battery watering. **WARNING:** A brand new battery may have a low electrolyte level. Charge the battery first and then add water if needed. Adding water to a battery before charging may result in overflow of the electrolyte.

- **What is the proper electrolyte level?**

Liquid levels should be 1/8 inch below the bottom of the vent well (the plastic tube that extends into the battery). The electrolyte level should not drop below the tops of the plates.

- **Do you ever add acid to a battery?**

Under normal operating conditions, you never need to add acid. Only distilled, deionized or approved water should be added to achieve the recommended levels mentioned above. When a battery is shipped in a dry state or accidental spillage occurs, electrolyte should be added to the battery. Once filled, a battery should only need periodic water addition.

- **Can batteries freeze?**

In a partially discharged state, the electrolyte in a lead acid battery may freeze. At a 40 percent state of charge, electrolyte will freeze if the temperature reaches approximately 16.0 degrees F. The electrolyte in a fully charged battery freezes at approximately minus 92.0 degrees F.

- **What is the proper torque value for my battery connections?**

You should always check with the dealer where you purchased your batteries or the manufacturer for the recommended torque values. A good rule of thumb, however, is to initially torque the hardware connection to 70 inch-pounds and re-torque annually, or as needed, to 65 inch-pounds.

- **What is the specific gravity of a fully charged battery?**

A hydrometer reading of 1.277 or greater indicates full charge for Trojan batteries. This value is

based upon a specified temperature of 77 to 80 degrees F. For temperature corrections values, see battery maintenance or temperature.

- **What are common mistakes made by lead acid battery owners?**

Undercharging: Generally caused by not allowing the charger to restore the battery to full state of charge after use. Continually operating the battery in a partial state of charge, or storing the battery in a discharged state results in the formation of lead sulfate compounds on the plates. This condition is known as sulfation. Both of these conditions reduce the battery's performance battery failure. Undercharging will also cause stratification.

Overcharging: Continuous charging causes accelerated corrosion of the positive plates, excessive water consumption, and in some cases, damaging temperatures within a lead acid battery. Deep-cycle batteries should be charged after each discharge of more than 50 percent of the batteries rated capacity, and/or after prolonged storage of 30 days or more.

Under-watering: In deep-cycle lead acid batteries, water is lost during the charging process. If the electrolyte level drops below the tops of the plates, irreparable damage may occur. Water levels should be checked and maintained routinely.

Over-watering: Excessive watering of a battery results in additional dilution of the electrolyte, resulting in reduced battery performance. Additionally, watering the battery before charging may result in electrolyte overflow and unnecessary additional maintenance.

- **Can I reduce my maintenance by not gassing or bubbling my batteries?**

You will reduce the frequency of watering, but will cause a condition known as stratification, which results in poor performance and reduced battery life.

- **When should I water my batteries?**

The first indication of a battery problem is reduced performance. To determine if the battery is experiencing a problem, isolate the battery from all electrical loads and the charging source. Allow each battery in the system to stand on open-circuit for about one hour. Measure the voltage of each battery. If the battery voltage spread exceeds .15 volts for a 6 volt battery, or .30 volts for a 12 volt battery, a problem is indicated. Battery voltage alone does not confirm a problem. When the voltage spread indicates a problem, confirmation is accomplished by taking electrolyte specific gravity readings using a hydrometer. If the specific gravity readings show a spread greater than .030 (30 points), corrective action should be taken. The appropriate corrective action is to give the batteries an equalization charge.

Inspection

There are many tools that may help in properly caring for and maintaining batteries. Below is a list of basic items that Trojan recommends for this task:

Recommended Equipment:

- wrench
- distilled water
- voltmeter
- hydrometer
- post cleaner
- baking soda
- vaseline
- goggles & gloves

CAUTION: Always wear protective clothing, gloves and goggles when handling batteries, electrolyte and charging your battery.

Batteries should be carefully inspected on a regular basis in order to detect and correct potential problems before they can do harm. It is a great idea to start this routine when the batteries are first received.

Here is a guideline on what to look for:

1. Examine the outside appearance of the battery.
 - Look for cracks in the container.
 - The top of the battery, posts and connections should be clean, free of dirt, fluids and corrosion. If batteries are dirty, refer to the cleaning section for the proper cleaning procedure.
 - Repair or replace any damaged batteries.
2. Any fluids on or around the battery may be an indication that electrolyte is spilling, leaching or leaking out.
 - Leaking batteries must be repaired or replaced.
3. Check all battery cables and their connections.
 - Look closely for loose or damaged parts.
 - Battery cables should be intact; broken or frayed cables can be extremely hazardous.
 - Replace any cable that looks suspicious.
4. Tighten all wiring connections to the proper specification (see below). Make certain there is a good contact with the terminals.

Proper Torque Values for Connection Hardware:

Flooded	65 to 75 in-lbs
VRLA	90 to 100 in-lbs

WARNING: Do not overtighten terminals. Doing so can result in post breakage, post meltdown and fire.

Cleaning

Batteries seem to attract dust, dirt and grime. Keeping them clean will help one spot trouble signs if they appear and avoid problems associated with grime.

1. Check that all vent caps are tightly in place.
2. Clean the battery top with a cloth or brush and a solution of baking soda and water.
 - When cleaning, do not allow any cleaning solution or other foreign material to get inside the battery.
3. Rinse with water and dry with a clean cloth.
4. Clean battery terminals and the inside of cable clamps using a post and clamp cleaner.
 - Clean terminals will have a bright metallic shine.
5. Reconnect the clamps to the terminals and thinly coat them with petroleum jelly (Vaseline) to prevent corrosion.
6. Keep the area around batteries clean and dry.

Storage

Periods of inactivity can be extremely harmful to lead acid batteries. When placing a battery into storage, follow the recommendations below to insure that the battery remains healthy and ready for use.

NOTE: Storing, charging or operating batteries is perfectly OK.

The most important things to avoid:

1. Freezing – Avoid locations where freezing temperature is expected. Keeping battery at a high state of charge will also prevent freezing. Freezing results in irreparable damage to the battery's plates and container.
2. Heat – Avoid direct exposure to heat sources, such as radiators or space heaters. Temperatures above 80 degrees F accelerate the battery's self discharge characteristics.

Step by step storage procedure:

1. Completely charge the battery before storing.
2. Store the battery in a cool, dry location, protected from the elements.
3. During storage, monitor the specific gravity (flooded) or voltage. Batteries in storage should be given a boost charge when they show a 70 percent charge or less.
4. Completely charge the battery before re-activating.
5. For optimum performance, equalize the batteries (flooded) before putting them back into service. Refer to Equalizing section for this procedure.

Testing

Visual inspection alone is not sufficient to determine the overall health of the battery. Both open-circuit voltage and specific gravity readings can give a good indication of the battery's charge level, age and health. Routine voltage and gravity checks will not only show the state of charge but also help spot signs of improper care, such as undercharging and over-watering, and possibly even locate a bad or weak battery. The following steps outline how to properly perform routine voltage and specific gravity testing on batteries.

I. Specific Gravity Test

(Flooded batteries only)

1. Do not add water at this time.
2. Fill and drain the hydrometer 2 to 4 times before pulling out a sample.
3. There should be enough sample electrolyte in the hydrometer to completely support the float.
4. Take a reading, record it, and return the electrolyte back to the cell.
5. To check another cell, repeat the 3 steps above.
6. Check all cells in the battery.
7. Replace the vent caps and wipe off any electrolyte that might have been spilled.
8. Correct the readings to 80° F:
 - Add .004 to readings for every 10° above 80° F
 - Subtract .004 for every 10° below 80° F.
9. Compare the readings.
10. Check the state of charge using Table 1. The readings should be at or above the factory specification of $1.277 \pm .007$. If any specific gravity readings register low, then follow the steps below.
 1. Check and record voltage level(s).

2. Put battery(s) on a complete charge.
3. Take specific gravity readings again.

If any specific gravity readings still register low then follow the steps below.

1. Check voltage level(s).
2. Perform equalization charge. Refer to the Equalizing section for the proper procedure.
3. Take specific gravity readings again.

If any specific gravity reading still registers lower than the factory specification of $1.277 \pm .007$ then one or more of the following conditions may exist:

1. The battery is old and approaching the end of its life.
2. The battery was left in a state of discharge too long.
3. Electrolyte was lost due to spillage or overflow.
4. A weak or bad cell is developing.
5. Battery was watered excessively previous to testing.

Batteries in conditions 1 - 4 should be taken to a specialist for further evaluation or retired from service.

II. Open-Circuit Voltage Test

For accurate voltage readings, batteries must remain idle (no charging, no discharging) for at least 6 hrs, preferably 24 hrs.

1. Disconnect all loads from the batteries.
2. Measure the voltage using a DC voltmeter.
3. Check the state of charge with Table 1.
4. Charge the battery if it registers 0% to 70% charged.

If battery registers below the Table 1 values, the following conditions may exist:

1. The battery was left in a state of discharge too long.
2. The battery has a bad cell.

Batteries in these conditions should be taken to a specialist for further evaluation or retired from service.

Charger Selection

Most deep cycle applications have some sort of charging system already installed for battery charging (e.g. solar panels, inverter, golf car charger, alternator, etc.). However, there are still systems with deep cycle batteries where an individual charger must be selected. The following will help in making a proper selection.

There are many types of chargers available today. They are usually rated by their start rate, the rate in amperes that the charger will supply at the beginning of the charge cycle. When selecting a charger, the charge rate should be between 10% and 13% of the battery's 20-hour AH capacity. For example, a battery with a 20-hour capacity rating of 225 AH will use a charger rated between approximately 23 and 30 amps (for multiple battery charging use the AH rating of the entire bank). Chargers with lower ratings can be used but the charging time will be increased.

Trojan recommends using a 3-stage charger. Also called "automatic", "smart" or "IEI" chargers, these chargers prolong battery life with their well programmed charging profile. These chargers usually have three distinct charging stages: bulk, acceptance, and float.

Charging

Charging batteries properly requires administering the right amount of current at the right voltage. Most charging equipment automatically regulates these values. Some chargers allow the user to set these values. Both automatic and manual equipment can present difficulties in charging. Tables 2 & 3 list most of the necessary voltage settings one might need to

program a charger. In either case the original instructions for your charging equipment should also be referenced for proper charging. Here is list of helpful items to remember when charging.

1. Become familiar with and follow the instructions issued by the charger manufacturer.
2. Batteries should be charged after each period of use.
3. Lead acid batteries do not develop a memory and need not be fully discharged before recharging.
4. Charge only in well-ventilated area. Keep sparks or flames away from a charging battery.
5. Verify charger voltage settings are correct (Table 2).
6. Correct the charging voltage to compensate for temperatures above and below 80° F. (Add .028 volt per cell for every 10° below 80° F and subtract .028 volt per cell for every 10° above 80° F)
7. Check water level (see the Watering section).
8. Tighten all vent caps before charging.
9. Prevent overcharging the batteries. Overcharging causes excessive gassing (water breakdown), heat buildup, and battery aging.
10. Prevent undercharging the batteries. Undercharging causes stratification.
11. Do not charge a frozen battery.
12. Avoid charging at temperatures above 120° F.

Additional VRLA Charging Instructions:

1. Become familiar with and follow the instructions issued by the charger manufacturer.
2. Verify charger has necessary VRLA setting.
3. Set charger to VRLA voltage settings (Table 3).
4. Do not overcharge VRLA batteries. Overcharging will dry out the electrolyte and damage battery.

TABLE 1. State of charge as related to specific gravity and open circuit voltage

Percentage of Charge	Specific Gravity Corrected to 80° F	Open-Circuit Voltage					
		6V	8V	12V	24V	36V	48V
100	1.277	6.37	8.49	12.73	25.46	38.20	50.93
90	1.258	6.31	8.41	12.62	25.24	37.85	50.47
80	1.238	6.25	8.33	12.50	25.00	37.49	49.99
70	1.217	6.19	8.25	12.37	24.74	37.12	49.49
60	1.195	6.12	8.16	12.24	24.48	36.72	48.96
50	1.172	6.05	8.07	12.10	24.20	36.31	48.41
40	1.148	5.98	7.97	11.96	23.92	35.87	47.83
30	1.124	5.91	7.88	11.81	23.63	35.44	47.26
20	1.098	5.83	7.77	11.66	23.32	34.97	46.63
10	1.073	5.75	7.67	11.51	23.02	34.52	46.03

Table 2. Charger Voltage Settings for Flooded Batteries

Charger Voltage Setting	System Voltage				
	6V	12V	24V	36V	48V
Daily Charge	7.4	14.8	29.6	44.4	59.2
Float	6.6	13.2	26.4	39.6	52.8
Equalize	7.8	15.5	31.0	46.5	62.0

Table 3. Charger Voltage Settings for VRLA Batteries

Charger Voltage Setting	System Voltage			
	12V	24V	36V	48V
Daily Charge	13.8 - 14.1	27.6 - 28.2	41.4 - 42.3	55.2 - 56.4
Float	13.5	26.4	39.6	52.8