

Basic Battery Care, Charging and Safety

This information and these procedures are were written mostly for the heavy-duty, deep cycle user of batteries, but most of the information can be applied to all lead acid batteries.



Basic Battery Care

- Add water as needed – do not overfill.
- Always keep electrolyte level above separator protectors.
- Keep vent caps tightly in place.
- Charge battery on properly matched charger.
- Allow battery to cool down before placing it back into service.
- Keep battery top clean, dry and free of foreign objects.
- Keep battery vent caps open during charging.
- Batteries produce explosive gases. Keep flame and sparks away from battery.
- Do not discharge beyond 80% (1.140-1.160 specific gravity).
- Report any problems or damage. Minor problems can become major ones.
- Good battery care is not a luxury, it's a necessity!



Types of Charging

There are a number of different charging methods; although only four need explanation. These are Freshening Charge, Cycling Charge, Equalizing Charge and Opportunity Rapid Charging.

Cycle Charge

Cycle Charging is the complete recharging of a battery after it has been fully or partially discharged during normal operations. Typically, a cycle charge is based on an 8 hour time period that recharges the battery and restores it to a fully charged condition.

Equalizing Charge

Each cell in a battery is an individual; each has a slight difference in uniformity of construction and content. The slight differences cause some cells to take less charge than the other cells in the battery. Over a period of time, the state of charge of some cells will require more charge than the other cells. To correct this condition, an equalization charge is given as it extends the charge cycle beyond the normal 8 hour charge period. This is typically an additional 3 hours, at a very low rate. The weaker cells that drift back in capacity will limit the battery from delivering its full capacity potential. To bring all the cells back to an equal state of charge, the battery must be given an equalizing charge. An equalizing charge should be given at the end of each work week. This will allow the battery to become fully charged and provide ample cool down time before the beginning of the next week.

Freshening Charge

A freshening charge is used to bring a new battery to a fully charged condition before it is placed into service, or when a battery has been standing idle for a short time period. A freshening charge is typically a soft charge at a low output (3 to 6 amperes per 100 ampere hours of the battery's rated capacity) for approximately 3 hours. This allows the battery to be restored to a fully charged condition maximizing the battery's electrical storage capability. All new batteries should receive a freshening charge before placing the battery into service.

Opportunity Rapid Charge

New charging technology has been developed to allow batteries to be charged faster and at substantially higher charge rates, called Opportunity Rapid Charging or Fast Charging. Opportunity charging is charging a battery at every opportune time possible. The battery should be charged at breaks, lunches, at the end of each shift and any other times when the battery can be charged for at least 10 minutes. Rapid charging is defined as charging the battery from 20% to 80% state of charge in two hours or less. By opportunity charging the battery, the state of charge is maintained between 30% and 80% during the normal work shift. Once a day, the battery is allowed to recharge to 100% of its rated capacity. On weekends, the battery will be automatically equalize charged while it is still connected to the charger. Opportunity Rapid

Charging can only be safely accomplished with a specially designed charger with sophisticated controls capable of monitoring battery conditions.



The Charging Process

When a battery is placed on charge, the opposite action of battery discharge takes place; that is, the sulfate in the active material of the plates is driven back into the electrolyte. This reduces the sulfate in the plates and increases the specific gravity of the electrolyte, an electrochemical process which continues until the on-charge cell voltages reach 2.50 to 2.70 volts per cell, dependent upon the type of charging equipment used. Finish rate or “normal” rate is that current which can be used safely any time charging is required, and which can be continued after the completion of the charge without causing excessive gassing or high temperature resulting from overcharge. Generally speaking, it is 3.5 amperes per 100 hours of the battery’s 6-hour rate capacity. A partially, or completely discharged battery can safely handle currents much higher than the finish rate, but as it approaches full charge, whatever charging rate is used must be reduced to the finish rate. The curves are typical of the recharge of an 18-cell battery, which was discharged 100 ampere hours, and shows specific gravity, current, voltage and cell temperature. Note that after approximately 5 hours of charge, when the battery is about 85% of its nominal full charge, the charging current is reduced sharply to a level which is maintained until charging is complete. Then the battery is fully charged, the current is stopped or should be reduced to a very low rate.



Determining if a Battery is Properly Charged

If the battery charging equipment is functioning properly, and if the battery is in a healthy condition, there is little chance for an improperly charged battery. If some doubt about its operation exists, the following checks are a quick way of determining a proper, fully charged battery:

1. Charging current readings will level off to the finishing rate.
2. Charging voltage stabilizes.
3. No rise in specific gravity.
4. Normal gassing.



Overcharging

An excessive amount of charge results in high battery temperature, reducing the battery’s service life.



Overheating

To obtain maximum service life from a battery, it should be charged and operated at temperatures below 115 degrees F. Above this temperature, overheating occurs. Overheating can damage the battery and shorten its normal expected service life. The extent of the damage and service life loss depends on how high the temperature, how often the overheating occurs, and how long the batteries are subjected to high temperatures.

A healthy battery charged on a properly functioning charger will have a 10 to 20 degree F rise in temperature when fully charged from a completely discharged state. What causes a battery to go beyond this range and overheat? The temperature rise is affected by several variable factors:

1. Age and condition of the battery.
2. Battery temperature compared to ambient temperature.
3. Start, intermediate and finish rate of the charger.
4. The amount of overcharge given the battery.

In lift truck operations, a battery can overheat because of the operating requirements of the truck, as well as the operating environment. If a lift truck requires almost continuous current draws that are higher than normal, the temperature will rise. Ideally, for this operation, a “cool” battery whose temperature is 90 degrees F or lower should be installed in the truck. However, if the lift truck operations start with an overheated battery whose temperature is above 115 degrees F, the continuous high current draws will tend to make the temperature rise even higher and battery damage is likely.

Typical working environment where batteries must operate in an overheated condition are in a foundry, where ambient temperatures reach 120 degrees F and higher; and in heavy-duty operations where they must be charged every 5 to 6 hours with no time for cooling before charge. The latter problem can often be alleviated by having more than two batteries per truck. For the former, an inexpensive way to cool the battery is by directing a fan over its inter-cell connectors and since they conduct 60% of the heat out of the battery, the battery will cool rapidly. Charge with battery covers open. Operating and charging batteries at elevated temperatures is a frequent cause of battery damage and reduced service life. An experienced lift truck operator, given the levels of operation and changing temperatures, and time span for which they are held, can estimate the percentage of service life lost. The estimated loss expressed as a percent, can serve as the basis for deciding whether to invest in extra batteries, higher capacity batteries or battery cooling equipment.

Gassing

When a battery is charging, the electrolyte breakdown of the water in the electrolyte produces oxygen on the positive plates and hydrogen on the negative plates. This is normal. However, if a high charging rate is continued after the battery has been brought to its gassing voltage, the gassing becomes excessive and abnormally large amounts of hydrogen and oxygen gases are produced. The best indication of excessive gassing is a very noticeable “bubbling” action of the electrolyte and high electrolyte temperature. Hydrogen is a highly combustible gas and will explode on ignition when it mixes with air, if it reaches any level between 4% and 74%. (Below 4% the concentration is too weak; above 74% there is not enough oxygen left in the air to support combustion.) If you have reason to suspect excessive gassing, troubleshoot the battery and charging equipment. An unusually high usage of water indicates that excessive gassing is occurring.

Keyed Connectors

Sometimes, batteries of several different voltages and ampere-hour capacities are charged at the same time at the same centralized location. Precautions must be taken to make sure that batteries are charged on chargers with mating voltages and ampere-hour ratings. Rather than rely on the persons placing the batteries on the chargers, we recommend the use of plugs and connectors of different types or the use of keyed and color-coded connectors.

Undercharging

Undercharging a battery, even to a small degree, if continued, leads to excessive “sulfation”. The same is true of batteries which have been left standing in an uncharged state for an extended period. High temperatures rapidly accelerate sulfation when batteries are left standing in a partially charged condition. The cells of a sulfated battery will give low specific battery and open circuit voltage readings. On charge, voltage readings will be unusually high. The battery will not become fully charged after a single, normal charge when sulfation has taken place over a prolonged period.

Adding Water

Generally, a certain amount of battery loss is normal in all batteries, and it should be replaced with “pure” tap water or distilled water. In some areas around the country, tap water may contain chemicals or other impurities harmful to batteries. If water is needed, add just enough to bring the electrolyte to the proper level. Batteries should be filled only at the end of the charging cycle. Overfilling is the most common error made when watering, and it can cause tray corrosion. Because tray corrosion can cause EXTENSIVE DAMAGE to batteries and vehicles, extreme caution must be taken to avoid overfilling the batteries. The level of the electrolyte should be between the top of the battery plate and the bottom of the filler tube. Never fill until the level is at the filler tube.

Tray Corrosion

Most trays for motive power batteries are made of steel that is protected with an acid resistant coating. Regardless of how good the coating is, if a break in the coating exposes the steel tray to the sulfuric acid spilled from the battery, the acid will corrode the tray. How quickly the tray corrodes depends on how much and how often acid is spilled on top of

the battery, and how often the battery is cleaned. The major cause of tray corrosion is over watering or overfilling a battery. When overfilled, the electrolyte will spill on top of the battery. Although the water in the electrolyte will evaporate, the highly concentrated acid solution remains and gives the appearance of dampness. If the acid is not removed, the tray will eventually corrode. To prevent corrosion, batteries should be cleaned any time the accumulation of dampness or acid becomes significant. A good technique to follow in watering batteries is to use a flashlight focused on the vent hole being watered. Visually, watch the level of the electrolyte rise, and stop watering the instant the proper level is reached. Each cell is filled in the same way. Cell filling equipment that automatically fills batteries to proper level is available. In addition to causing tray corrosion, the accumulation of acid in conjunction with the corrosion can cause grounds. Two significant grounds can create an external short through the case of the battery. As a result, some or all of the cells continually discharge. And as the current carrying ability of the multiple grounds increases, further complications such as jar leakage, overheating, cell failure, etc., can occur. Furthermore, grounds can also cause serious problems or failures in the electronic controls or electrical components of the vehicle. To test for a ground in the battery, set the voltmeter to handle the open circuit voltage of the battery being tested. Place the positive probe on the positive terminal of the battery and the negative probe on the spot of the steel tray where bare steel is exposed. Make sure that the negative probe penetrates the paint to the steel. To detect the location of the ground, move the positive probe from inter-cell to inter-cell connector until the lowest voltage reading is found. This will be the grounded cell. To clear the ground, clean the top of the battery of acid and corrosion and dry. If the ground is still present, reseal the battery with a sphalitic compound.



Watering Schedule

Low electrolyte level in a cell can cause the plates to oxidize and shorten the life of the cell and the battery. To prevent this needless and wasteful damage, water should be added often enough to keep the electrolyte level above the perforated separator protectors. Ideally, a watering policy or schedule should be adopted and followed strictly. One of two systems can be used. In the first, the electrolyte level of two or three cells is checked each time the battery is charged. In the second, water is added to all of the batteries assigned to each charging area on a regular time schedule. The electrolyte levels are also spot checked periodically to determine if the proper levels are being maintained, if the second method is used. Determining a reasonable and proper battery watering schedule could be easy or difficult, depending on how widely the three factors vary:

1. Frequency of charge (daily, 1 ½ times a day, three times per week, etc.).
2. Water storage capacity of the specific cell type.
3. Age and condition of the battery.

Older batteries and those in poor condition will consume water more rapidly than newer batteries and those in good condition. Also, some cell types have a greater water storage capacity than others. Depending on the preceding variable factors, the batteries assigned to a specific charging area will require watering at different intervals. The frequency of watering is best determined by first-hand experience. Example: if some batteries have low electrolyte levels when a weekly watering schedule is followed, change the schedule to twice a week.



Cleaning

To prevent corrosion and the resultant problems, batteries must be cleaned and dried routinely. Sometimes minor spills or overflows of electrolyte occur due to overfilling. Instead of giving the battery a general cleaning at this time, the moisture can be removed with rags or paper towels. The frequency of a general cleaning depends upon two factors:

1. How quickly dust, dirt, oil and other foreign matter accumulates on top of the battery.
2. How quickly the electrolyte spillage accumulates.

When the top of a battery is “dirty” or looks damp, it is ready for general cleaning. It could be as often as every two weeks or as infrequent as every six months, depending on the battery’s environment and the care it receives. The average battery needs general cleaning every three months. To give a battery a general cleaning, use hot water (103 degrees F to 170 degrees F) with a neutralizing detergent solution. The neutralizer/detergent solution is made by mixing ½ pound of baking soda, or a ½ pint of household ammonia, with the recommended amount of detergent for general cleaning with one gallon of clear water. Apply the solution with a clean paintbrush to the top of the battery, working it under the inter-cell connectors and the terminals to loosen the grime and neutralize the acid. If baking soda is in the solution, apply the mixture until the “fizzing” action stops. (An ammonia solution will not “fizz”). Then rinse the battery

with clean, hot water from a low-pressure hose to remove all traces of the solution and loose dirt. Cold water works, but hot water cleans better. During any cleaning, but particularly when using a neutralizer/detergent solution, make certain that all vent caps are tightly in place.



Recycling

American Battery Corporation is committed to excellence and leadership in protecting the environment. Lead-acid batteries are the environmental success story of our time. Roughly 99% of all lead used in batteries is recycled, compared to 42% of newspapers, 55% of aluminum soft drink and beer cans and 40% of plastic soft drink bottles. American Battery Corporation encourages everyone to recycle their spent or “junk” batteries by bringing them to us where they will be sent to a battery recycling facility.



Safety

A lead-acid motive power battery can be an extremely useful, safe source of electrical power. On the other hand, if improperly used, it can be an extremely dangerous piece of equipment. The difference between the two conditions is determined by the care and safety procedures exercised in handling batteries. Before considering the safety procedures, first consider the hazards inherent to a lead-acid battery:

The Hazards

1. A lead-acid battery, by its very construction, exposes working personnel to four potentially dangerous elements: sulfuric acid, explosive gases, electricity and heavy weight.
2. A sulfuric acid solution used as the electrolyte in lead-acid storage batteries and has a concentration of approximately 40% by weight of sulfuric acid in water. Even in this diluted state, sulfuric acid is a strong oxidizing agent and can burn the skin and eyes and “eat” holes in clothes made of many common materials.
3. An explosive mixture of oxygen and hydrogen is produced in a lead-acid storage battery during the charging process. The two gases can combine explosively if a spark or flame ignite them. Because hydrogen is so light, it normally floats away and disperses into the air before it can collect into an explosive mixture. However, if it accumulates into gas pockets, it will explode when ignited.
4. Electricity is produced by the battery on discharge and while most persons cannot “feel” voltages through their bodies below 35 or 40 volts, all motive power batteries should be regarded as potentially dangerous. A lead-acid battery is capable of discharging at extremely high rates and under conditions of direct shorting, which can cause much damage and serious injury.
5. The weight of these heavy batteries can crush hands and feet if care is not taken when charging and handling them. Adequate and proper handling equipment should be provided. The average truck lift battery weighs over 2000 pounds.

The Safety Procedures

The primary safety standards that battery professionals recognize can be found at the Occupational Safety and Health Act's (OSHA) website. The safety procedures suggested on this website have been compiled by standards developed over the years by professional and technical organizations and by battery manufacturers and users who have had the experience necessary to create the most effective safety standards. They exceed the minimum standards for OSHA for personnel safety and include procedures for safeguarding equipment as well.

Safety Tips:

1. ALWAYS use safety glasses or face shield when working on or near batteries.
2. NEVER wear jewelry when working on or near batteries.
3. ALWAYS use caution when using tools around batteries.
4. KEEP all open flames, sparks, etc., away from batteries and battery charging areas.
5. ALWAYS make sure that the charger is off before connecting or disconnecting battery to the charger.
6. REPORT any damage or problems immediately so that it can be repaired and not pose any threat to safety.
7. ALWAYS use the proper equipment for lifting and changing out batteries.