

## **APPLICATION NOTE**

### **EQUALIZING BATTERIES**

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Equalizing or conditioning batteries refers to a method of charging deep cycle wet-cell batteries and is intended to restore battery capacity, revive battery efficiency, and extend battery life. The process involves periodic application of a controlled overcharge cycle to batteries. This type of charge cycle requires that certain procedures and precautions be followed.

#### **WHY EQUALIZE BATTERIES?**

While a battery is being discharged, sulfuric acid in the electrolyte reacts with the lead plates in a chemical reaction that produces electricity and lead sulfate. When the battery is re-charged, electricity flows back into the battery and causes a reverse chemical reaction that turns the lead sulfate back into lead and sulfuric acid. However, with each discharge and recharge cycle, a small amount of lead sulfate will remain on the plates. Using a three-stage charger, the amount of residual sulfate left on the plates will be less but some will still accumulate with each discharge and recharge cycle.

If this sulfate is left in place for very long, it will harden or crystallize and eventually reduce the battery's capacity, increase its internal resistance and destroy the battery's ability to produce an adequate amount of power. When this occurs, even an equalize charge can not remove the sulfate and the battery becomes useless except as a recyclable item. (Recycling batteries is recommended to reclaim the lead and prevent contamination of the environment.)

Over time, the electrolyte tends to stratify into layers of acid and water with higher concentrations of acid near the bottom of each cell and more diluted electrolyte near the top. This causes uneven specific gravity within a cell and further reduces its capacity and efficiency.

#### **THE EQUALIZING PROCESS**

An equalizing charge is a controlled overcharge cycle that performs several actions within the battery and provides certain benefits. During equalization, the voltage is raised to approximately 2.7 volts per cell, or about 16.2 volts for a 12-volt battery. The current output of the charger should be limited to about 5% of the battery's capacity. In other words, a 200-amp hour battery should be allowed to accept no more than about 10 amps of current. This will help prevent overheating. The equalize cycle is timed to be between 4 and 8 hours depending on the features of the charging source, but the cycle can always be terminated early if necessary. The particular battery manufacturer's recommendations for equalization time should be followed.

This elevated voltage results in a vigorous charging action to take place within each cell that has several effects on the battery. First, much of the residual sulfate is forced to re-combine with the electrolyte in the form of sulfuric acid. Crystallized sulfate that will not re-combine is broken loose from the plates and falls harmlessly to the bottom of the battery. Deep cycle batteries have additional space beneath the plates intended to collect this material. This action cleans the plates exposing fresh lead to the electrolyte and restores battery capacity.

The vigorous bubbling action that occurs during equalization stirs up the electrolyte and restores it to a consistent mixture of acid and water. The equalizing process also causes all cells in a battery to reach their maximum idle potential of 2.1 volts.

## **WHEN TO EQUALIZE**

It is best to check with the battery manufacturer's recommendations before equalizing since each manufacturer has slightly different suggestions on how often and how long to equalize their batteries. But, as a general rule, it is a good practice to equalize batteries after every 10 or 12 deep discharge and re-charge cycles. For batteries in constant discharge and recharge usage, this would mean about every two weeks. For periodic users, it would mean about two or three times a year. For seasonal users, this could mean at the beginning and end of the season. When using a battery monitor such as a Link 2000, equalizing should be done when you notice the Charge Efficiency Factor (CEF) begin to drop.

## **HOW TO EQUALIZE**

Again, check with the battery manufacturer's recommendations, but as a general rule, the following steps should be observed:

1. Only attempt to equalize wet cell deep cycle batteries. Never equalize gel batteries or maintenance free batteries.
2. The batteries should be fully charged and near ambient temperature before beginning an equalize charging cycle.
3. There should be a sufficient amount of electrolyte in each cell to cover the plates, but do not top-off each cell until after equalizing. Since there is some heating of the cells during equalization, the electrolyte will expand and could overflow the cells if they were topped-off before equalizing. This would not only make a mess, but force you to terminate the equalize cycle too early to gain maximum benefit and would result in diluted electrolyte when it came time to add water.
4. Leave the caps on each cell. The caps are vented, and when left in place will prevent splattering of electrolyte onto the top of the battery when the bubbles pop. It is a good idea to lay a paper towel over the caps. This makes it easy to spot a cell that may start spitting electrolyte, and will soak up the liquid when this does happen.
5. Since the batteries will give off significant quantities of explosive hydrogen and oxygen gas during equalization, and produce moisture that will contain some amount of corrosive sulfuric acid, it is imperative that sufficient ventilation be provided. Avoid smoking or generating sparks or flame near the batteries during this charge cycle.
6. All DC loads on the batteries should be turned OFF and disconnected. Since the battery voltage will be higher than normal during the charge cycle, some DC equipment could be damaged if left ON. These loads would draw current from the charger that should be available to the battery instead.
7. Equalize only one bank of batteries at a time.
8. With older Freedom inverter / chargers, to limit the charging current to less than 15 amps DC, set the power sharing feature of the charger to 5 amps AC using the remote control panel. Newer versions automatically set a special equalize current limit during the equalize cycle.
9. During the equalize cycle, periodically check the batteries for any spitting cells and if this begins to happen, terminate the equalize cycle early. Do not start an equalize cycle and then leave the batteries unattended.

10. After equalizing, turn OFF the charging source, and allow the batteries to cool to ambient temperature before resuming normal float charging. After the batteries cool, it is a good time to check the specific gravity in each cell. They should all be 1.265 +/- .050 at 80 degrees F.

11. Refill each cell with distilled water up to the FULL indicator.

### **START/STOP EQUALIZE CHARGE CYCLE**

1. When using the standard Freedom remote control panel, an equalize charge cycle is started by turning dip switch #1 ON for one second and then back OFF again. This will start an 8 hour equalize cycle. After the cycle times out, the charger will advance to float mode. To terminate the cycle early or to allow the battery to cool down after equalize, AC input power to the charger should be interrupted. When AC power is re-applied to the charger, it will resume normal charging.

2. When using the Link 2000 remote control panel, the equalize charge cycle is started by first turning ON the charger and waiting until it goes into the float mode. Then press the SETUP button and hold it until it begins to flash. Then release the SETUP button and immediately press both the VOLTS and A hrs buttons simultaneously and hold for five seconds until the red CHARGE LED begins to flash and the "E" in the display goes out. To terminate the equalize cycle and force the charger into the float mode, repeat the same setup procedure. The cycle will automatically terminate after 8 hours or if AC input power to the charger is interrupted.

3. When using Link 2000R to control equalizing while using the Freedom charger, it will operate the same as Link 2000 described above. If the alternator is the charging source, some differences will be apparent. The procedure for start/stop equalize is the same, but the control of the charging source (alternator) is different. The cycle is 3.5 hours long, and the charge current is limited to 4% of battery capacity up to 16 amps maximum.

### **ADDITIONAL PRECAUTIONS**

If some cells in a battery begin spitting electrolyte during equalize and continue spitting long after the charger has been turned OFF, this indicates that the spitting battery may have a shorted cell. If this happens, disconnect any batteries that are in parallel with the questionable battery as these batteries will continue to supply current to the questionable battery and cause it to get very hot. When things cool down, check the suspect battery with a hydrometer. A shorted cell will read much lower than the others. If this is the case, the battery must be replaced. Batteries which are likely to develop a shorted cell are more likely to do so during an equalize cycle since the battery is being subjected to more thermal stress during this type of charge than it is accustomed to. Chances are the battery would have developed the shorted cell sooner or later anyway, but its better to find this out when the batteries are being closely monitored as during an equalize cycle.

Whenever working with batteries, always wear protective clothing and eye protection. Avoid generating sparks, open flame, or smoking near batteries.