Battery 101 For The Average Electric Golf Cart Owner

This Document uses information provided by Trojan Batteries to educate the reader on the use and care of deep cycle flooded batteries used in most golf carts

Golf Cart battery chargers have a logic circuit that determines the voltage of the battery before turning on.

In the case of the EZGO PowerWise charger, the logic board is actually powered by the DC voltage from the golf car. If there is no voltage in the batteries, the logic board does not even activate.

In a normal situation, the logic board gets its current from the cart through the small red wire in the DC power cord. That current powers up the board and the board determines if the voltage is within a certain range.

On a 36 volt system, that range is somewhere between about 30 volts and 39 volts. When the charger sees voltage in that range, it closes a relay and sends power to the transformer which sends a DC current to the golf cart. When the charge reaches certain parameters, the relay opens and the charge is complete.

In the case of the PowerWise charger, the charger will NOT restart by itself if the plug is left in the cart. In order to restart the charger, you need to unplug the DC cord from the cart plug it in again, restarting the process.

If the batteries are dead and the charger won't start there is a way to get it started, you will need to charge the batteries with a 12 Volt automotive battery charger and charge them (6 Volt) two at a time in "Series" for 30 minutes or so. This will bring the cart voltage into range to start the charger.

Charging Dead Golf Cart Batteries Manually

How to Test Golf Cart Batteries

Battery Capacity & Life Expectations

- Battery Capacity – the amount of energy delivered under a load
- Capacity is measured in amp hours
- Batteries have a finite amount of energy
- Actual capacity delivered depends on:
  - Battery Age
  - Battery Temperature
  - Battery State of Charge
  - Battery Discharge Rate or Load

Battery Rated Capacity

- Rated capacities are included on the label
- Amp hour (Ah) delivery examples:
  - A 200 Ah rated battery can deliver:
    - 10 amps for 20 hours
    - 20 amps for 10 hours
    - 50 amps for 4 hours
  - Lower the discharge current or load = More time battery will provide energy

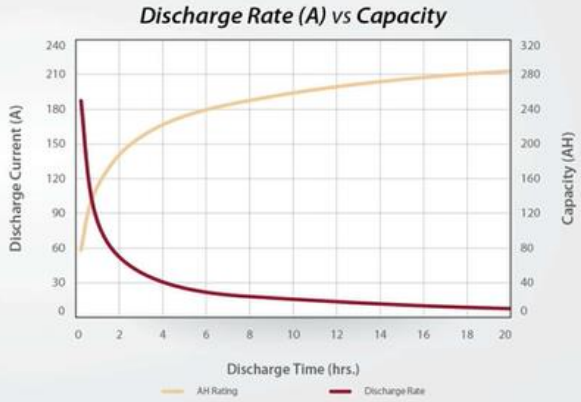
IMPORTANT: **Understand your application and usage patterns to correctly select the correct battery capacity**

Achieving Max Capacity

- Ensure battery is fully charged before use
- Cold Batteries
  - Batteries deliver less than 100% capacity when operating in cold environments
  - For every 20°F/7°C below 80°F/27°C you lose 10% of available capacity
    - Based on temperature of electrolyte – NOT ambient temperature
- Warm Batteries
  - Deliver more than 100% rated capacity
  - BUT, operating in higher temperatures = lowers overall battery life

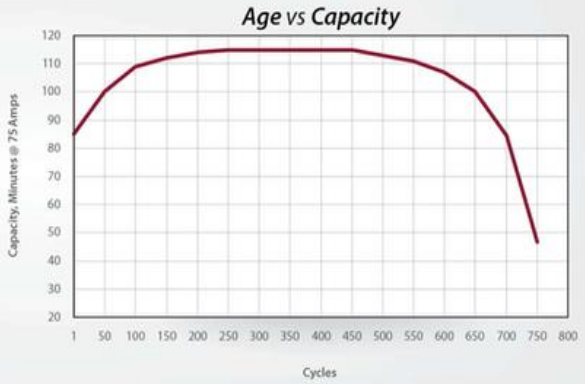
Capacities of New Deep-Cycle Batteries

- New deep-cycle batteries – do not deliver 100% of rated capacity
- When will it achieve rated capacity?
  - Depends on application
  - Typically it will take 75 – 150 cycles



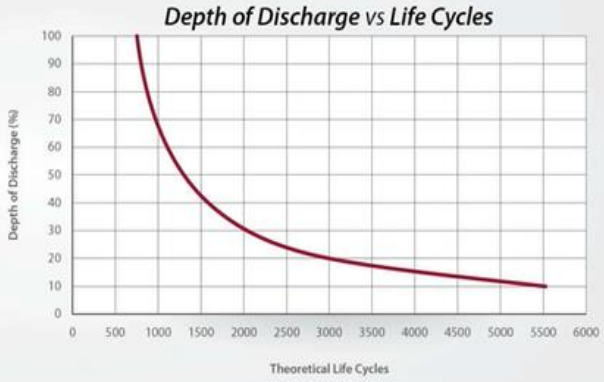
Aging Batteries

- As batteries age – will not deliver 100% of rated capacity
- Battery life related to battery capacity
  - A battery with a higher rated capacity will have a longer rated life than one with a lower rated capacity
- Total cycles depend on battery use and maintenance



Battery Life & Depth of Discharge

- Battery life is related to the depth of discharge
- The deeper the discharge, the less cycles the battery can achieve
- Maximize life – limit depth of discharge



OCV and SG vs. State of Charge

Open Circuit Voltage (OCV)

- Measurement made after voltage stabilizes (no load)

Percentage Charge	Specific Gravity	OPEN CIRCUIT VOLTAGE							
		Cell	6V	8V	12V	24V	36V	48V	72V
100	1.277	2.122	6.37	8.49	12.73	25.46	38.20	50.93	76.4
90	1.258	2.103	6.31	8.41	12.62	25.24	37.85	50.47	75.7
80	1.238	2.083	6.25	8.33	12.50	25.00	37.49	49.99	75.0
70	1.217	2.062	6.19	8.25	12.37	24.74	37.12	49.49	74.2
60	1.195	2.04	6.12	8.16	12.24	24.48	36.72	48.96	73.4
50	1.172	2.017	6.05	8.07	12.10	24.20	36.31	48.41	72.6
40	1.148	1.993	5.98	7.97	11.96	23.92	35.87	47.83	71.7
30	1.124	19.69	5.91	7.88	11.81	23.63	35.44	47.26	70.9
20	1.098	1.943	5.83	7.77	11.66	23.32	37.97	46.63	69.9
10	1.073	1.918	5.75	7.67	11.51	23.02	34.52	46.03	69.0

Equalization

- Equalizing is an overcharge performed on flooded lead acid batteries after they have been fully charged
- Set charger for equalization mode
- Charge should result in specific gravity readings representative of the battery's true state of charge
  - Refer to your battery user's manual to determine the battery manufacturer's recommendations
- **NEVER Perform Equalization on AGM or Gel Batteries**

Inspection & Cleaning

- Keep batteries clean and dry
- Check that all vent caps are tight
- Use solution of baking soda and water to clean tops of batteries and terminals using a wire brush
- Ensure all connections are tight
- Apply terminal protection solution to terminal posts to reduce corrosion

Watering Deep-Cycle Flooded Batteries

- Will lose water/electrolyte during the charge cycle, so watering is necessary
- Add water to cells after charging (distilled water is recommended)
- Never add acid or electrolyte to cells
- Frequency of watering will depend on use - Trojan recommends monitoring water levels every 2 weeks
- Add water after fully charging batteries to a level of 1/8" below the bottom of the fill well or up to maximum level indicator
- Do not overfill the batteries
- If the plates are exposed, add water to discharged batteries to a level just above the plates

When to Water Deep-Cycle Flooded Batteries

- Monitor the electrolyte level every two weeks to determine the required frequency of watering for your application
- Never add water to discharged batteries if the electrolyte is visible above the plates
- If the plates are exposed, add distilled water only to discharged batteries to a level just above the plates
- Do not overfill the batteries
  - Why? During equalization the electrolyte will rise and if vents are overfilled the electrolyte will spill out of the battery. This loss of electrolyte will impact the performance of the battery.

Equalization

What is equalization?

- It is an overcharge performed on flooded lead acid batteries after they have been fully charged

Why is equalization important?

- To reverse the process of stratification which can harm performance and lower the life of the battery
- Reverses the buildup of negative chemical effects like stratification, a condition where acid concentration is greater at the bottom of the battery than at the top
- Equalizing helps to remove sulfate crystals that might have built up on the plates. If left unchecked, this condition, called sulfation, will reduce the overall capacity of the battery

NEVER equalize valve regulated batteries such as AGM or Gel

Avoid Stratification

Flooded batteries need to be overcharged, or equalized, to mix the electrolyte to address imbalanced cells and reduce stratification

Why?

- If batteries are left to sit unused for extended periods of time, stratification occurs and will severely reduce performance and life

What is Stratification?

- There is a difference in density of the electrolyte between the top of the cell and the bottom of the cell
- If the electrolyte is not mixed routinely, the heavier sulfate particles will sink to the bottom of the cell which increases the density of the electrolyte causing the bottom of the plates to corrode

Equalization & Chargers

No Equalization Mode on Your Charger?

- You can still perform equalization by conducting the following steps:
  - Unplug your charger and then plug it back in on a fully charged battery

Pre-Programmed Chargers

- Some chargers on the market today come pre-programmed with equalization modes that schedule equalization every 30 days

Always consult your battery manufacturer's charging specifications for their recommendations

Importance of Charging Batteries

- Fully Charge to Maximize Capacity and Life
- Discharging Facts:
  - Batteries discharge during use
  - Batteries self-discharge when in storage
- Important – Charge Batteries After Every Use
- While in Storage – Charge Batteries Periodically to Ensure They Do Not Remain at a Low State of Charge

Rules To Follow When Charging

- Ensure vents are completely inserted
- Do not interrupt a charge cycle
  - Only acceptable when "opportunity charging"
    - A short charge given to the batteries in between uses
    - Used to extend vehicle range when needed
    - Does not take the place of a daily complete recharge
- Never charge a frozen battery
- Avoid charging in temperatures over 120˚F or 49˚C
- Ensure batteries have adequate ventilation
- Always refer to the user's manual for charging specifications unique to your battery

Flooded Battery Charging

- **Flooded batteries need to be overcharged**
  - Avoids stratification which can harm the performance and life of the battery
  - Should occur at every charge cycle – controlled by charger
- **Flooded batteries do not have a memory so do not need to be fully discharged prior to charging**

Flooded (wet) Battery Charging Voltages					
	SYSTEM VOLTAGE				
Voltage Settings	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	46.5	62

Additional Charging Considerations

- **Charge time will depend on how deeply the batteries have been discharged**
  - Batteries deeply discharged will take longer to charge, while those with shallower discharges will take less time
  - For example, those at 50% depth of discharge typically take 6 – 8 hours to fully recharge
- **Cold batteries take longer to recharge than batteries that are warm**
- **Charging should be limited to 16 hours**
  - Most chargers are programmed for this as a safety feature
- **Set battery charger for appropriate program for deep-cycle flooded, AGM or gel batteries**

Battery Storage Locations

- Store batteries in a cool area
- Storage in hot temperatures accelerates battery self-discharge
- Loads should be disconnected from batteries while in storage
- Monitor battery voltage every 6 weeks while in storage
  - Give batteries a boost charge when they are at 70% state of charge or less
  - For information on determining state of charge, review Trojan Tips "Determining the Health of a Deep-Cycle Battery" at: www.trojanbattery.com/trojan_tips

Important Storage Facts

- Batteries self-discharge while in storage
  - The rate of self-discharge is dependent on:
    - Location temperature
    - Duration of storage
- Store only fully charged batteries
  - Maximizes battery capacity and overall life

Battery Storage In Applications

- When storing batteries in the application, i.e. golf carts, be sure to refer to the application's charger manual for proper charging guidelines
- Some chargers will check battery voltage automatically and provide the necessary boost charge when connected to the batteries

Important Battery Storage Facts

- Never store discharged batteries
  - Storage of discharged batteries may incur irreversible damage
- Store batteries in a cool, dry place, avoid areas where freezing temperatures are expected
- Always recharge batteries before putting them back into service
- Always keep batteries fully charged to prevent freezing when stored in cold locations
- Avoid storage areas that are near heat sources such as radiators and heaters

Beware of Well-Intentioned Advice

- Before taking advice from friends or what you read on the Internet:
  - Check with your battery manufacturer
  - Refer to your battery user's manual
- "Tips" you read on the Internet or hear from friends and neighbors oftentimes will destroy or diminish the life of your deep-cycle batteries

Common Myths

Myth: Batteries will self-discharge if stored on concrete **False**

Fact: Batteries can be stored on any type of surface and will not discharge

Myth: Adding a non-buffered aspirin in a battery cell will extend battery life **False**

Fact: Aspirin tablets should never be added to a battery cell. Aspirin forms acetic acid which attacks the battery grid and will destroy the battery

Common Myths

Myth: Urinating in a battery will extend battery life **False**

Fact: *Uric acid will attack the battery grid and destroy the battery*

Myth: Additives, will extend battery life **False**

Fact: *While some additives may reduce waterloss and acid smell during charging, they will not extend battery life*

Myth: Use of Hydrocaps will extend battery life **False**

Fact: *Hydrocaps my reduce the frequency of watering, they will not extend battery life*