# Deep Cycle Battery Technology 101

## Content
- Innovative EV Traction Battery Technology for Floor machines
- Lead Acid Battery technology overview
- Comparison of Deep Cycle battery Technologies

## The Opportunity
- Reduced costs
- Increased Equipment Performance
- Environmental and LEED compliance

## The Potential
- Providing best in class battery solutions for floor machines
- Increased Customer Satisfaction
Presentation Outcomes

- Understand basic Battery terminology as it relates to the deep cycle battery market.
- Define the three main types of Deep Cycle battery technologies used in floor care equipment.
- Understand the four main construction differences between Deep Cycle battery types.
- Understand how construction and active material composition used in battery design affects the longevity of the battery.
- Identify which Deep Cycle battery types are most expensive to maintain.
- Identify how to evaluate best value and lowest cost of ownership for your customer’s battery purchases.
- Identify Deep Cycle Battery types which are certified for LEED certified facilities and environmentally sensitive areas.

Outline of Presentation:

Section one:
1. Battery Construction basics
2. Battery Plates or Grids
3. Active materials
4. Electrolyte Composition
5. Electrolyte Volume

Section two:
1. Comparing technologies

Section three:
1. Determining best value in Deep Cycle battery technologies for floor machines.
Battery Technology Overview

- Not All Deep Cycle Batteries technologies provide the same benefits and performance.
- It is important to understand how construction variables affect lead acid battery performance and life.
- By understanding Discover EV Traction benefits and features, you can ensure you are providing the best value to your customers.

Next:
Review of the basics of battery construction and battery technology types available.

You can ensure that you are providing the best battery solution for Floor Machine Applications considering these factors:

1. Deep Cycle Performance
2. Environmental compliance
3. Total cost of ownership
Lead Acid Battery Construction

These are the main construction components that comprise a lead acid battery.

This generic diagram for lead acid batteries exposes the major components that we will explain further in the next 6 slides.

These components and how they differ in battery types affect performance and life of a battery.
Battery Construction - Plates

- Plates or Grids are the lead framework of a lead acid battery.
- Battery plate thickness is a major factor of durability and longevity of a battery.
- The thicker the plate, the more capable the battery is of repeated deep discharge cycling for applications like floor machines.
- Lead Calcium alloys are used in Discover EV Traction product to reduce internal heat and gassing during charging, designed for extending the overall battery life.

Next:
We will illustrate the difference between a thin plate lead acid battery and a true deep cycle battery with thick plate technology.
Battery Construction - Plates

**Thin plate (starting) battery**
The thin plate technology has many thin plates in parallel to achieve low resistance, with high surface area.

The thin plate battery does not allow deep cycling, and is most applicable for short bursts of power mostly used in automotive starting applications.

**Thick plate (deep-cycle) battery**
The deep-cycle battery has thick plates for improved cycling abilities. The deep-cycle battery generally allows upwards of 500 cycles and are designed to withstand repeated discharges over long durations.

It is important that batteries used for floor machines are constructed with thick plate technology.

Batteries with thin plate technology are typically less expensive, however are not designed for floor machine applications.

Next we will look how the active material of a deep cycle battery is added.
Battery Construction

Thicker plate technologies hold more active material on the grid for more capacity, longer life and durability.

Battery capacity is lost when active material is shed from the plate.

This occurs through use-over-life, but also occurs prematurely by exposure to excessive heat and incorrect or overcharging situations.
Construction - Active Material Composition

The active material is proprietary to the manufacturer.

The density of the active material is important to the deep cycling ability and life of a deep cycle battery.

Discover EV Traction uses maximum density active material in the design of EV Traction Batteries.
Construction: Electrolyte Composition

- Electrolyte is a liquid substance that acts as a medium to conduct electricity.
- The **Specific Gravity** of electrolyte can be higher or lower.
- Lower specific gravity of Electrolyte generates less heat.
- **Higher acid** in the Electrolyte result in more power and shorter life.
- Discover EV Traction uses **Lower acid** ratios resulting in reduced heat and longer life.

![Diagram showing the relationship between specific gravity, acid to water ratio, heat, and life expectancy.](image)
Construction - Electrolyte Volume

More Electrolyte Volume to Active Material

- Shorter Life
- Longer initial Run time
- Faster Plate breakdown and shedding

Less Electrolyte Volume to Active Material

AKA “Acid Starved”

Lower Electrolyte Volume to Active Material Ratio:
- Longer life
- Consistent Run time over life of battery
- Better Plate Preservation

For floor machine applications the electrolyte volume is an important factor to the longevity of battery and the ability of the battery to provide consistent power over the life of the battery.

ACID STARVED is sometimes what this construction feature is called.
Comparing Deep Cycle Battery Types

These are the three types of lead acid batteries being compared.

Two major cost factors for floor machine batteries are:
- the cost of maintenance to service flooded batteries
- the cost of early replacement for batteries not specifically constructed for robust traction applications.
Deep Cycle Batteries

1. Flooded Lead Acid

These are the three main construction factors of flooded lead acid batteries that add to the overall cost to the customer.

Flooded Lead Acid batteries are rarely maintained to manufacturers specifications resulting in shortened life.
# Deep Cycle Battery Types

## Flooded Lead Acid Advantages:
- Low initial cost
- Widely available

## Flooded Lead Acid Disadvantages:
- FLA is Hazardous “flooded” technology and contains liquid sulfuric acid solutions.
- With internal chemical reactions and heating during charging, they inherently lose water that must be replaced through regular maintenance, or damage to the batteries will occur.
- Off-gassing results in corrosion and acid damage to equipment, surroundings, and potential personal injury.
- FLA requires caution and venting to minimize Health and Safety issues during charging and maintenance.
- FLA has a high cost for storage, HAZMAT shipping and handling regulations.
- FLA is NOT maintenance-free and should last as long as Traction types but often doesn’t due to its required maintenance schedules to achieve life expectancy.
- Highest cost to own when maintenance and premature failure replacement factored in.
Deep Cycle Batteries

AGM

This Battery Technology is also known as VRLA (valve regulated lead acid).

This battery type is maintenance-free and non-hazardous (sealed).

AGM requires a specific charging profile.

Typically constructed with a thin plate technology, which shortens overall battery life.
Deep Cycle Battery Types

AGM Lead Acid Advantages:
- Sealed VRLA category
- Non Spillable and Maintenance–free
- Minimal Health and Safety requirements
- Shipped as non-hazardous goods
- Widely available
- Low self discharge rates.

AGM Lead Acid Disadvantages:
- Reduced life due to thinner plates.
- Reduced life due to reduced active material density.
- Reduced life due to higher active material to acid ratio.
- AGM grids cannot withstand being repeatedly cycled to depth of Discharges greater than 50%.
- Higher cost to own when performance and capacity (run time and life) are factored in.
Deep Cycle Batteries

EV Traction Dry Cell

This Battery Technology is known as VRLA (valve regulated lead acid).

This battery type is maintenance-free and non-hazardous.

EV Traction Batteries are constructed with thicker lead plates, high oxide densities and measured electrolyte ratios and volumes designed to tolerate discharge currents and greater depths of discharge.

This technology has the lowest cost to own.
Deep Cycle Battery Types

EV Traction Advantages:

- Non-Hazardous, Non-gassing and Non-spillable.
- Approved for environmentally sensitive areas.
- Safeguards against spill related injuries and damage.
- Eliminates corrosion due to off gassing.
- Does not require ventilated charging room.
- Widely available in replacement footprints.
- Less charging time than Traction Gel Dryfit.
- Thicker plates, and higher density/more active materials, resulting in longer life and increased capacity.
- Lower Specific Gravity (Acid Density ratio to active material) resulting in longer life.
- Lower total cost of ownership when maintenance, health and safety and environmental compliance, and performance are factored in.

EV Traction Dry Cell Disadvantages:

- Proprietary Charging algorithms required.
- Higher initial cost to own than flooded Lead Acid and AGM.
## Compare Design Factors:

<table>
<thead>
<tr>
<th>High Quality Deep Cycle Technologies</th>
<th>Flooded</th>
<th>Advanced AGM</th>
<th>EV Traction Dry Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designed for Longer Run Times</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Designed for High-rate/long duration discharges</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Designed for longer life</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>High Charge Retention</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Shorter Charging time</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Maintenance Required A. Inspection B. Cleaning C. Watering</td>
<td>Often A.B.C</td>
<td>Periodic A.</td>
<td>Periodic A.</td>
</tr>
<tr>
<td>Initial purchase price</td>
<td>$</td>
<td>$$$</td>
<td>$$$</td>
</tr>
<tr>
<td>Lowest Cost to own</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
# Compare Health & Safety Factors:

<table>
<thead>
<tr>
<th>High Quality Deep Cycle Technologies</th>
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<th>EV Traction Dry Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Gassing / Non- Spillable</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>HVAC regulations compliant</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Eliminates corrosion due to off-gassing</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Does not require ventilated charging rooms</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Safeguards against spill-related injuries &amp; damage</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>
### Compare Environmental Sustainability

<table>
<thead>
<tr>
<th>High Quality Deep Cycle Technologies</th>
<th>Flooded</th>
<th>Advanced AGM</th>
<th>EV Traction Dry Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recyclable and made with recycled products</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Designed for use in Sensitive areas</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Exempt from HAZMAT Shipping requirements</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Compliant with LEED (USGBC) Certification</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Compliant with OSHA Occupational Health &amp; Safety Regulations</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Delivers maximum Maintenance-Free life without additional resources</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Comprehensive design to conserve resources, improve safety and reduce waste</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
As tested in Accordance with the BCI-06 specification or cycle life testing of electric vehicle and cycling capacity.

**EV Traction Dry Cell outperforms high quality Deep Cycle competitors in:**
- Peak capacity
- Sustained capacity,
- And usable life to 80% of original capacity

<table>
<thead>
<tr>
<th>Manufacturers Published Rates:</th>
<th>Capacity @ 75A</th>
<th>Capacity @ 20 Hour Rate</th>
<th>Cycle Life to 80% of Original Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>115 minutes</td>
<td>225 AH</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>114 minutes</td>
<td>216 AH</td>
<td>325</td>
<td></td>
</tr>
<tr>
<td>115 minutes</td>
<td>225 AH</td>
<td>375</td>
<td></td>
</tr>
<tr>
<td>125 minutes</td>
<td>220 AH</td>
<td>420</td>
<td></td>
</tr>
</tbody>
</table>

**Discover® EV Traction Dry Cell Outperforms Competitors**

6V Deep-Cycle Battery Cycle Life Test
The Graphic Truth

**EV Traction Dry Cell** provides the lowest total cost of ownership.

**Compare your total cost of ownership:**

- **Discover® EV Traction Dry Cell**
- **High Quality Flooded Lead-Acid Battery Maintained to Manufacturer’s Specifications**
- **High Quality Flooded Lead-Acid Battery Typically Maintained Battery**

<table>
<thead>
<tr>
<th>Cost of Maintenance</th>
<th>Initial Cost of Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ COST OVER 3 YEARS</td>
<td></td>
</tr>
</tbody>
</table>

- **Initial Battery**
- **2nd Battery**