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Industrial Secondary Batteries In A Stationary Application An Overview Of Available Options ©

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Introduction

Due to the varied demands that we place on batteries, how can we be sure that the batteries that are being specified are the correct batteries for the application?

We hope to provide an overview of the commercially available technologies, their advantages and limitations, and relevant application considerations for the electrical engineer.

We will look at available Lead Acid technologies.

Lead Acid Batteries

- ◆ Plante designs (Pure Lead)
- ◆ Flat or pasted plate designs
- ◆ Tubular plate designs
- ◆ Valve Regulated Lead Acid
Gel and Absorbed Electrolyte

“Plante” Designs

Plante Designs

Features

- Pure Lead Plates
- Design dates back to the 19th Century
- High performance, Long Life (25 Years)
- 100 % Capacity throughout life
- Proven Performance in a wide range of environments
- Incorporated into small VRLA designs

Plante Designs Disadvantages

- Large Physical Size
- Very heavy
- Very high capital cost

Plante Designs Applications

- High discharge rate applications
- Turbine control
- Emergency diesel starting
- UPS
- Switchgear

“Pasted (Flat) Plate” Batteries

Pasted (Flat) Plate Batteries

Features

- Traditional Design
- A lead alloy grid covered with a active material paste
- The grid provides both physical strength and a conductive path to the positive and negative post

Pasted (Flat) Plate Batteries

Features

Grid alloy consisting of the following

- **Lead Antimony (Traditional)**
- **Lead Calcium**
- **Low Antimony**

“Lead Antimony Alloy” Batteries

Lead Antimony Alloy Features

- The antimony alloy is the oldest pasted plate technology currently available.
- The alloy typically contains from 6-13% antimony.

Lead Antimony Alloy Features

The antimony battery has Three major advantages

- The ability to withstand repeated deep discharge cycles.
- The battery will deliver 1,800 cycles during its life
- Another advantage is its predictable life in float service. One can expect 15 reliable years in temperature controlled environment.

Lead Antimony Alloy Disadvantages

The major drawback of lead antimony is the phenomenon of “antimonial poisoning” of the negative plate.

- Antimony oxidized from the positive plate plates onto the surface of the negative plate, lowering the back EMF (resistance to charging) of the cell.
- In turn, the current required to keep the cell fully charged increases.

Lead Antimony Alloy Disadvantages

- Resulting a gradual rise in the watering requirements
- The end of life for an antimony system is some times dictated by high maintenance cost not by the mechanical or electrical degradation of the battery
- The rate on “antimonial poisoning” is greatly affected (increased) by high temperatures.

Lead Antimony Alloy Applications

Any application were high cycle requirements
are to be expected

- Switchgear
- UPS
- Solar

“Lead Calcium Alloy” Batteries

Lead Calcium Alloy Features

- Batteries using the lead calcium alloy were first documented by Haring and Thomas in 1935
- The concept was picked up and developed in the 1950's with support from Bell Laboratories
- The alloy consist of an alloy of .5 - 1.2% Calcium and Lead
- Primary applications as a Telecommunications Battery

Lead Calcium Alloy Advantages

- Stable float charge characteristics over its life
- Low Maintenance requirements (Water added every 18 months)
- Exactly what the telephone industry required.
- Unfortunately, you rarely get something for nothing, and this is true in the battery world

Lead Calcium Alloy Disadvantages

- Very Poor cycling potential (Less than 100 deep cycles)
- Marked increase in grid growth (as much as 28%)
- The rate of grid growth is greatly affected (increased) by high temperatures and cycling.

Lead Calcium Alloy Disadvantages

Growth of the grids has caused secondary problems

- Such as a disruption of the post seals
- Acid creepage to the connector hardware
- Can result in high resistance connections
- Corrosion of the posts in the seal area may lead to a cracked lid and jars
- These problems have led to serious battery fires in the past.

Lead Calcium Alloy Applications

- Telcom
- The manufacture of valve regulated lead acid batteries

“Low Antimony Alloy” Batteries

Low Antimony Alloy Features

- Since 1974, work on optimizing the low antimony alloy (less than 3.5%) for battery grids)
- By adding small amounts of selenium or tin (approximately 0.2%). This tiny amount of selenium or tin restores the necessary hardness to the grid, while changing the grain structure of the lead alloy to be highly regular and densely packed.

Low Antimony Alloy Features

- Thus, the lead selenium /tin battery gives stable float charge characteristics over its life, and is able to deliver approximately 800 deep discharges.
- ◆ It would seem to be an ideal compromise; however, in common with some lead acid batteries, temperature is its enemy

Low Antimony Alloy Disadvantages

- Slightly more Maintenance than Calcium
- Half the cycle life of traditional Antimony but much superior to Calcium

Low Antimony Alloy Applications

- Switchgear
- UPS
- Telcom
- Solar
- Alarm & Control
- Emergency Lighting

“Tubular Plate” Batteries

Tubular Plate Positive Plate Features

- The tubular plate design of lead acid batteries utilizes an alloy grid that resembles a long toothed comb; this is placed inside a polyester “Tube” and the space between the lead spines and the polyester tube is filled with the active materials.
- The active materials are essentially the same as those applied as a paste to the grids of the pasted plate cells

Tubular Plate Positive Plate Features

- The polyester sleeve retains the active materials in contact with the spines during deep cycle service. Tubular plate lead acid batteries are the most tolerant of cycle service, delivering as many as 1800 cycles.
- Their cost is only marginally more than the pasted designs.

Tubular Plate Positive Plate Features

- Tubular Batteries are an orthodox technology
- Tubular Batteries are best suited to applications demanding high cycle requirements with discharge duration's of longer than one hour
- Depending on the alloy used they are viewed as a reduced maintenance battery

Tubular Plate Positive Plate Disadvantages

- One disadvantage of the tubular plate design is that it has relatively poor high discharge rate performance.

Tubular Plate Positive Plate Applications

- Telcom
- UPS long duration slow discharge
- Solar

Valve Regulated Lead Acid Gelled & AGM Designs

Valve Regulated Lead Acid Batteries (VRLA)

- A great deal of interest has been shown by all users of rechargeable batteries in “sealed,” “maintenance free” lead acid batteries.
NEITHER EXISTS !!
- What is true is that the VRLA batteries are a very reduced maintenance battery, requiring no water additions however cleaning and monitoring is still required

Valve Regulated Lead Acid Batteries (VRLA)

- VRLA batteries have immobilized electrolyte
- Either the acid is absorbed into a fiberglass mat separators, which is completely wrapped around the plates, or it is “jellied” to immobilize it.
- In either case the cells will have a pressure relief valve to prevent a dangerous pressure building

Valve Regulated Lead Acid Batteries

Features

What features make the VRLA battery so desired by System designers & Users

- ❏ No special battery room or ventilation required
- ❏ High energy density & a small footprint
- ❏ Batteries can be placed close to the load i.e. right in the computer room
- ❏ Batteries may be upright or placed on their side

Valve Regulated Lead Acid Batteries

Disadvantages

- High and low temperatures affect sealed lead acid systems to an even greater extent than their flooded counterparts. The reasons for this are:

Valve Regulated Lead Acid Batteries

Disadvantages

- At low temperatures, the charge current required to keep the cells charged is small, however, there is a serious loss of recombination efficiency.
- So the cell will tend to gas more - eventually leading to premature drying out of the cell.

Valve Regulated Lead Acid Batteries

Disadvantages

- At high temperatures, the efficiency of recombination is good, but the charge current required to maintain the cells in a high state of charge is also high.
- This high float current generates a larger amount of gas.
- The recombination reactions are exothermic, and so a temperature rise will be experienced inside the cells. If the rate of heat generation exceeds the battery's ability to dissipate this heat, a phenomenon known as thermal runaway may occur.

Valve Regulated Lead Acid Batteries

Disadvantages

- The Engineer can minimize these effects by using an accurate temperature compensated charger. This is currently the recommendation to all of our sealed lead acid customers.
- Second insure that Cabinet provides proper ventilation and cooling.
- Third insure that the rectifier provide less than 2% ripple.

Valve Regulated Lead Acid Batteries

Disadvantages

- One point that we do feel strongly about. When these products were first being developed, the battery industry was unanimous in its belief that these batteries would be offered only for noncritical applications. It is of concern to us to see them being sold for every conceivable application and under conditions where problems are bound to occur.

Valve Regulated Lead Acid Batteries

Applications

- UPS (Care must be taken in Selection)
- Switchgear
- Telcom
- Alarm & Control
- Solar
- Emergency Lighting