

Overview

Since the inception of Lead Acid Batteries, the market has pushed for more reduced maintenance solutions. The collective introduction of Valve Regulated Lead Acid (VRLA) technology introduced in the 1980's promised a "maintenance free" solution.

Maintenance free meant that the task of adding water and taking specific gravity readings, which is a significant time consuming practice for flooded batteries, was not necessary or possible because of this technology.

It has, however, become evident that VRLA batteries should have certain preventive maintenance procedures performed, some of them different from their flooded counterparts as evidenced by the growing list of industry publications and standards aimed at defining the recommended VRLA battery practices.

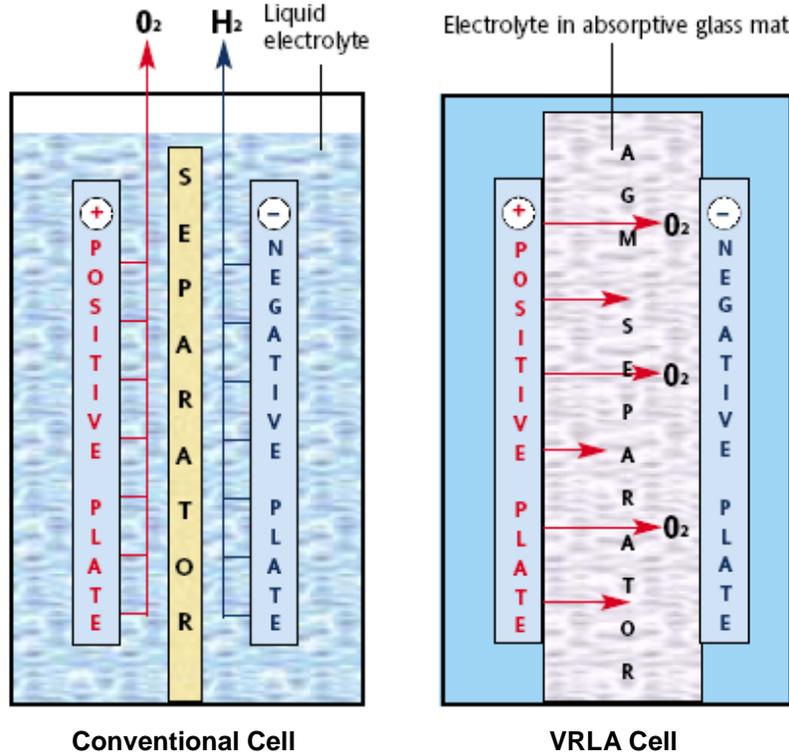
The claims of no water addition, acid adjustment or specific gravity measurement in early designs did not always hold up to original promises. While the battery manufacturers were busy tweaking electro-chemical and physical cell designs, there was a separate market developing with the aim of designing an alternative solution that would modify the electrochemical characteristics of the cell. The current mechanism of the catalyst is believed to correct the problem of negative plate self discharge and be a counterbalance to the secondary reaction of positive grid corrosion. This is blamed as the unbalancing effect that causes overall loss of capacity and increased rate of water loss. This solution, when placed inside a cell, prevents a small amount of oxygen from reaching the negative plate and depolarizing it and also would limit water loss and allow the VRLA battery to "water itself." This technology is commonly referred to as catalyst vents.

Before expanding on the catalyst vent claims and what conclusions EnerSys can make, it is prudent to give some background on the VRLA battery technology.

VRLA Battery Technology

In the VRLA battery, the oxygen evolution rate at the positive electrode and the oxygen reduction rate at the negative electrode are in balance, but this occurs at the cost of depolarization of the negative electrode. See the following diagram

Principle of the oxygen reduction cycle



Oxygen and hydrogen escape to the atmosphere.

Oxygen from the positive plate transfers to the negative and recombines to form water.

At the POSITIVE: $H_2O = 2H^+ + (1/2) O_2$

At the NEGATIVE: $(1/2) O_2 + Pb = PbO$
 $PbO + H_2SO_4 = PbSO_4 + H_2O$
 $PbSO_4 + 2H^+ = Pb + H_2SO_4$

VRLA Battery Failures

In addition to the designed failure mode of positive grid corrosion, some other failures of VRLA batteries include;

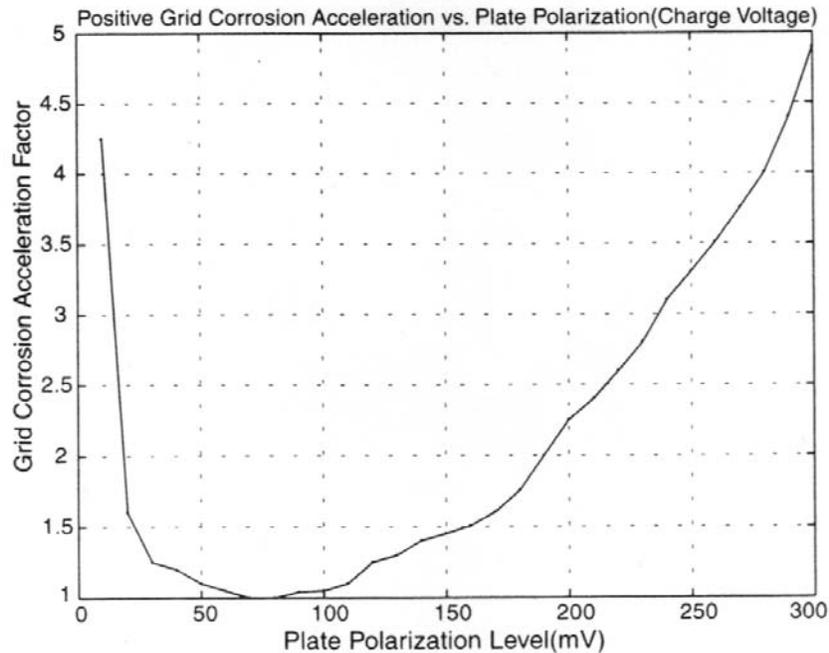
- Dry out
- Thermal runaway
- Oxidation of the negative plate

In most cases, the above conditions are preceded by symptoms of physical deformation of the cell or battery container, high charge currents, abnormal trends in Ohmic measurements and/or decrease in string capacity.

Catalyst Vents

The primary theory behind the catalyst vent is that all the above mentioned VRLA failures are attributed to one overriding factor – depolarization of the negative plate caused by excess oxygen recombination and negative plate sulfation. This leads to

increasing polarization of the positive plate and directly to higher charge currents. This higher charge current overcharges the positive plate and leads to increased corrosion of the positive plate and shorter life of the cell. The problem of increased positive grid corrosion with increased float current has been classically described by JJ Lander and is shown in chart below. Note that grid corrosion increases with high positive plate polarization above the optimum level. (Graph from *Storage Batteries*, G.W. Vinal, 4th Edition, 1955 John Wiley & Sons).



Additionally, the higher charge current generates more oxygen at the positive and hydrogen at the negative, dries out the electrolyte, increases the internal resistance of the cell, degrades capacity and in extreme cases can lead to thermal runaway.

By designing and introducing a catalyst that will capture the oxygen produced at the positive plate before it reaches the negative plate, the negative will not depolarize and the overall float charge currents will not increase. In other words, the catalyst recombines excess oxygen, thereby reducing the self-discharge rate of the negative electrode due to the recombination reaction. Eliminating the increase (or in some cases reducing the float charge current) minimizes all of the above mentioned failure modes and contributes to a longer battery life.

Initial catalyst designs (produced in the late 1990's) were susceptible to contamination by gases generated inside the VRLA cell and over time failed in use. More recent designs have incorporated filters to capture these gasses and protect the catalyst. These, in our opinion, hold the most promise to potentially enhance operational life with some risks.

These risks would include items such as;

- Palladium poisoning
- Inadequate or improper sizing of the catalyst leading to ineffectiveness inside cell

- Overheating of the catalyst when the charge current is too high, in some cases to the point of melting the plastic cover of the cell. This problem can be eliminated by properly sizing the catalyst.

EnerSys Evaluation

Several vents were acquired and placed on cells on life test. While specific information will not be provided here, we have seen enough evidence to reinforce the technology's claims of:

- Less water loss
- Lower float charge currents
- Less overcharge to the positive plate

Rehydration

There have been several studies done promoting the use of a rehydration technique. This technique generally involves older cells and entails opening the sealed cells and adding a known quantity of water. This water addition replaces the water lost throughout the cells life due to the oxidized negative and resulting overcharge condition of the cell. At this point in time, EnerSys does not support this technique without consultation and prior written consent.

Conclusion

The catalyst vents evaluated do appear to be effective in limiting negative plate oxidation in VRLA cells. This limitation of negative plate oxidation can lead to lower float charge currents and minimize water loss.

After assessing the risks and benefits, EnerSys does not see this technology as a necessary addition to our products. However, it is ultimately the users choice to install a catalyst and careful consideration should be paid to the benefits and risks associated with them for a particular application.

While EnerSys is not ready to wholeheartedly embrace this technology, we do acknowledge its success in certain instances and will continue to evaluate on a developmental basis. In most cases, a users installation of a catalyst vent will not void the stated warranty, however any questions should be directed to their local EnerSys representative.