TECHNICAL PAPER

VRLA battery life extension saves millions for U.S. Air Force

Battery rejuvenation using Battery Research's Inter-Ohmic Value Recovery (IOVR+) process increases the capacity of depleted batteries at MacDill Air Force Base; will save the U.S. Air Force millions in telecom battery costs

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Abstract

The US Air Force is extending the life of their telecommunications backup power batteries by employment of a new, proven, inexpensive technology – the addition of a small amount of catalyst material to each battery cell. This material is housed in a cell replacement cap. You snap out the old cap and snap in the new.

Using this battery rejuvenation process, telecom engineers at MacDill Air Force Base brought a string of 9-year-old batteries from 33% of design capacity to at least 80% of design capacity. As a result we expect the rejuvenated batteries to actually last 20 years. Rolling out the process to the rest of our battery supply, we are certain to save millions in battery replacement costs.

VRLA battery lifetime falls well short of 20-year rating

It has been common knowledge for years in the world of telecommunication batteries that VRLA (Valve Regulated Lead Acid) batteries do not last as long as they should. The VRLA batteries used by the military and telephone companies (telcos) as emergency power backup for telephone switches are sold as "20 year" batteries but have really been lasting between 3 and 7 years. By IEEE and telco standards a battery is considered failed when its capacity has diminished to 80% of what it was when new.

Before going any further, let's have a very short tutorial on lead-acid batteries.

The original lead-acid batteries are called wet cells or flooded cells. The plates of a wet cell sit in a "vat" of electrolyte (dilute sulfuric acid). Wet cells are open to the atmosphere and vent both hydrogen and oxygen, making it necessary to periodically add water. The venting of hydrogen and oxygen makes it very important that battery rooms be well ventilated, because hydrogen and oxygen make a very explosive environment. These wet cells really did last about 20 years without losing significant capacity.

The VRLA batteries that the Air Force uses for its telephone switches are VRLA AGM (Valve Regulated Lead Acid Absorbent Glass Mat) batteries. (They are not gel cells - gel cells are also VRLA batteries but quite different from VRLA AGM.)

VRLA AGM cell plates do not sit in a vat of liquid electrolyte. Instead, the electrolyte (still dilute sulfuric acid) is held in very fine fiberglass mats between the plates. For this reason, they are sometimes called "starved electrolyte" batteries. VRLA batteries are sealed (except for a pressure relief valve) and were designed to be recombinant - meaning that the hydrogen and oxygen that would be vented in a wet cell instead recombine within the cells so that it is no longer necessary to periodically add water.

Developed in the early 1980s, VRLA cells were initially marketed as "maintenance-free" batteries. However, by the late 1980s, reports were coming in about VRLA batteries losing capacity. Many of these old reports are still on the Internet.

To make a long story short, it was eventually determined that these cells were venting hydrogen, but only insignificant amounts of oxygen. The oxygen was sticking around in the cells to do other mischief such as depolarization of the negative plates – a bad thing.

Without hydrogen, you can't have water. So the cells lose water, and the loss of water causes loss of amp-hour capacity.

Realizing the promised benefits of VRLAs

So why shouldn't we just continue to use wet cells instead of the shorter-lived VRLA cells? There are three reasons:

1. *VRLA battery maintenance costs are lower*. With wet cells you must periodically add water to the cells.
2. *VRLA batteries take up less space.* Wet cell batteries are nearly twice the size of comparable-capacity VRLA batteries.
3. *VRLA batteries are safer.* Wet cells contain large amounts of sulfuric acid solution and vent explosive gases (both hydrogen and oxygen).

While researching possible alternatives to VRLA batteries and possible better ways to test batteries, we came across reports (again on the Internet) on the efforts of Philadelphia Scientific to correct the chemistry of VRLA cells and prevent dry-out by introduction of a small amount of catalyst into each cell.

You may remember from chemistry that a catalyst is a material that promotes or enhances a chemical reaction without becoming part of the reaction. Catalysts, therefore, are not consumed in the chemical reactions they enhance. In this case, the catalyst promotes the recombination of oxygen and hydrogen in the cell. The catalyst material is introduced into the cell as part of a replacement cell cap.

Philadelphia Scientific has performed some very convincing tests over several years. In one test, they placed two sets of VRLA AGM cells on float (trickle) charge in 90°F water bath. The temperature elevation makes for an accelerated life test – one year at 90° equals at least two years at normal temperature (about 75°F). One set of cells had the Philadelphia Scientific catalyst caps and the other set had standard (no catalyst) caps. Both sets of cells were load tested after 3 years and again after 5 years.

- After 3 years, the cells with catalyst caps were still at 100% capacity and those without catalyst caps were at 65% capacity.
- After 5 years, the cells with catalyst caps were still at close to 100% capacity and the cells with standard caps were at 12% capacity.

(These numbers lead me to believe that the life acceleration of the test is more than 2 to 1).

In years 4 and 5, some of the cells were dismantled and analyzed. Cells with catalyst caps were in good condition, while the cells without catalyst caps suffered dry-out and massive corrosion of the negative plates, as well as some corrosion of the positive plates.

Battery Research experience with VRLA rejuvenation

Harold Vanasse, Technical Director of Philadelphia Scientific, told us about Battery Research and Testing, a company headquartered in New York State. Battery Research has had considerable experience and success in rejuvenating capacity-depleted VRLA batteries by adding water and installing the catalyst caps. Peter DeMar, President of Battery Research, supplied us with several reports on rejuvenations using their IOVR+ (Inter-Ohmic Value Recovery) process. For example:

- A battery string was load tested and found to have 32% of design capacity (the amp-hour capacity it had when new).
- The rejuvenation process was performed.
- Catalyst caps were installed on all cells. This is an integral part of the IOVR process.
- A year later, a load test showed that the battery string was at 92% of design capacity.
- Two years later (3 years after the rejuvenation), another company did a load test on the same string and the capacity was still at about 92%.

VRLA rejuvenation at MacDill AFB

Based on these successes, we decided to have Battery Research perform a test rejuvenation on a 9-year-old string of batteries at MacDill AFB.

The load test revealed that the battery string had **33% of design capacity**. The rejuvenation (IOVR+ process) was performed the same day, following the load test. The IOVR+ process consists of the following steps:

1. Measure the impedance of all cells. (Impedance increases as cells dry out.)
2. Add distilled water to the cells in a quantity proportional to the cells' impedances. These proportions have been determined by Battery Research over years of testing.
3. Install catalyst caps.
4. Pressure test each cell and perform a high-impedance test to determine if there are sneak-path current leaks.

A follow-up load test was performed two weeks later. This test revealed that the battery string was at **71% of design capacity**.

Experience and theory indicate that the capacity of rejuvenated batteries will continue to rise for up to 9 months. This is because the catalyst causes gradual re-polarization of the negative plates – a good thing. We expect that the capacity of this battery string now is at least **80% of design capacity** and it should remain at close to that capacity for many years.

Conclusion: US Air Force forecasts millions in savings

The US Air Force now requires catalyst caps in all new-purchase telephone switch batteries and we are working to rejuvenate and/or install catalyst caps in all other telephone switch batteries. The catalyst caps will probably make these "20 year" batteries actually last 20

years. It is a certainty that the use of this new technology (catalyst caps) and process (battery rejuvenation or IOVR+) will, in the future, save the Air Force millions of dollars in telecom battery costs.

About Battery Research and Testing

Battery Research and Testing delivers a full range of proven stationary power services for telecommunications, power generation, computer data centers, manufacturing and military installations. Our DC system expertise includes site evaluation and installation, preventative maintenance, green technology for battery capacity recovery / rejuvenation, load and capacity testing, removal and recycling / disposal, and temporary battery back-up systems. Additional services include thermographic inspection, facility audits, engineering consultation and training in DC systems. We meet or exceed all applicable IEEE standards, Telcordia practices and battery manufacturer requirements. Founded in 1982 by Peter DeMar, a longtime member of the IEEE Battery Working Group and member of the Battcon Hall of Fame, Battery Research and Testing is a WBE enterprise and a veteran-owned business. Contact us at +1 (800) 221-7123 or visit www.batteryresearch.com.