CAN BATTERY GAS RECOMBINERS IMPROVE BATTERY ROOM SAFETY AND (+) ELIMINATE WATERING REQUIREMENTS FOR VENTED BATTERIES?

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Abstract

The initial objective of the experiment that led to the creation of this paper was for us at BR&T (Battery Research and Testing) to gain an understanding of the differences in the amount of water usage over time in VLA (vented lead acid) batteries, between those that use the manufacturer's standard vent assemblies, and those that use the newer style battery gas recombiners (have two-way valves). We wanted to learn how many water additions might be eliminated over the life of a battery by using recombiners. Our motivator for this experiment was the potential for labor savings with our existing PM contracts.

What we were not thinking about when we started this experiment, was the increase in safety of the battery area because of the reduction in the volume of the off gasses. The potential for **UP TO** a 99% reduction in the amount of hydrogen gas released into the battery area is substantial. Anything that can reduce the hydrogen gas released into the area by a significant amount must be considered beneficial for anyone that uses stationary batteries. That this improvement is gained through a passive means instead of an active/mechanical one is an added benefit.

The battery being utilized in this experiment, is a small three-cell unit. We installed recombiners from two different manufacturers in the end cells, and in the middle cell we left the manufacturer's provided vent assembly. That middle cell is our reference (standard) cell. To accelerate the off gassing, which lowers the electrolyte levels, we raised the average ICVs to a temperature compensated 2.35 VPC. Our goal is to try to keep the current flow through the cells between 1.1 and 1.6 amps in order to accelerate the decomposition of the water in the cells.

On 5/6/21 we performed our **sixth** refill on our reference cell. That was the 128th day since the start of the experiment. It has been taking an average of 21 days for that cell's electrolyte level to go from the high line to the low line. The recombiner equipped cells have lowered @ 3mm (0.118") out of 17.5 mm (0.69"). Based upon this present rate of water loss, we estimate that we are going to have performed over 30 refills of the reference cell before the recombiner equipped cells need to be refilled. If a battery presently needs to have water added once a year, then it is possible that usage of these type recombiners could eliminate over 30 years' worth of the labor required for electrolyte level maintenance.

We started with one battery and two different manufacturers recombiners that have the two-way valves. Because of what we were observing we added more batteries, and additional manufacturers recombiners to the experiment. Included in the additional manufacturers recombiners, were some that did and did not have two-way valve systems in them.

This paper will explain our testing procedure, our observations and measurements, and how we arrived at our conclusions. The intent is to provide you with enough information so that you can come to your own conclusions as to the value of these devices from either a safety standpoint, or a labor savings one.

Introduction

All of the newest design battery gas recombiners that we could find, utilize two-way pressure relief valves and they (European Manufacturers) state that they are either up to 98 or up to 99 percent efficient, which is quite impressive to say the least. We wanted to determine with our own research, if those stated efficiencies were realistic numbers, or if these were exaggerated marketing type statements.

We would be remiss if we did not explain that with the units that use two-way valves that there are significant differences in the designs and functionality of the European manufacturers and the American manufacturer, which resulted in our not being able to properly compare the results of the differing technologies. Because of the limitations of those differences this report will be limited to comparisons between the European technology recombiners and standard vents.

Since we are a stationary battery service company, what we selfishly wanted to get out of this experiment, was to learn approximately how many typical water refills might be able to be eliminated if these new design recombiners were installed at our customers locations. For example, if we normally need to add water to a string once every year, how many of those refills could be eliminated if we had these installed.

Our initially thoughts were that if the watering interval could be extended from once a year to once every five years or longer, that would be an important benefit for our service people. Boy did we get an eye-opening education out of this experiment. As Dr. David Feder once told me, “We do not know what we do not know” and that lack of knowledge really applied to us when we started this experiment.

In order to gain as much information as possible on the subject, we reached out to every manufacturer of recombiners that we could find and requested any product information, historical data, testing data, or proof of performance type documents that they would share with us. Some of the manufacturers were very willing to share their information, and some were not. As far as we have been able to determine, there are three manufacturers of recombiners in Europe, and two here in the US. We believe that the three European manufacturers pretty much produce all of the recombiners sold by the various European battery manufacturers, but to be fair to any other manufacturer that might be out there anywhere, these are the only ones that we could find. It also should be understood that not all manufacturers employ the two-way valves, or have flame arrestors in their units. The three from Europe and one from the US do offer or use the two-way valves. All of the units that we employed initially in this experiment have the two-way valves and flame arrestors.

This paper is limited to reporting on our observations of the differences in the rate of water loss due to off gassing between cells that have recombiners installed, and those that do not, and to the differences in the battery gasses being released into the battery area. These results reflect our observations at the test conditions that we utilized only. At this time, we are not reporting on any other observations, or information gathered.

In the Spring 2021 issue of BESTMAG, in their "second opinion" section we offered our "opinion" on the value of battery gas recombiners, titled "Battery gas recombiners are they worth the effort" [1]. That article was an explanation on what we observed in the early stages of this experiment.

Procedure

In order to provide consistency and to provide a means for comparing the different recombiners during this experiment, our procedure is as follows.

1. Adjust the charger so that the cells will see a temperature compensated value of approximately 2.35 VPC.
2. Fill the cells to the high line.
3. Continue charging until the cell with the standard vent assembly (the middle cell) reaches the low line.
4. Refill the cell to the high line.
5. Repeat the process until either recombiner equipped cell reaches the low line.

Food For Thought Regarding Efficiencies

A standard vent assembly/flame arrestor, has ZERO % efficiency as they do not recombine any of the gases given off. The only difference between them and a plain shipping plug assembly is that a vent assembly/flame arrestor dissipates the gasses through its walls and those gases rise up into the room or enclosure, and eventually out into the atmosphere. They are primarily a safety device that is there to prevent an outside ignition source from entering the cell and creating an explosion. All of the recombiners that we are testing have flame arrestors in them for that same safety reason.

A recombiner that is functioning at 99% is only allowing 1% of that oxygen and hydrogen gas out of the cell. Even if the recombiner is functioning at some percentage that is lower than 99%, for whatever reason, it is still more efficient than a standard flame arrestor/vent in restricting off gas releases by a substantial amount. Whatever percentage any recombiner is recombining the gasses being generated inside the cell, is the exact value that the gasses are being reduced that would normally be going out into the area. To us it makes sense that any reduction in the explosive gases being released in the room or area is a safety improvement, and any improvement in safety is a positive benefit.

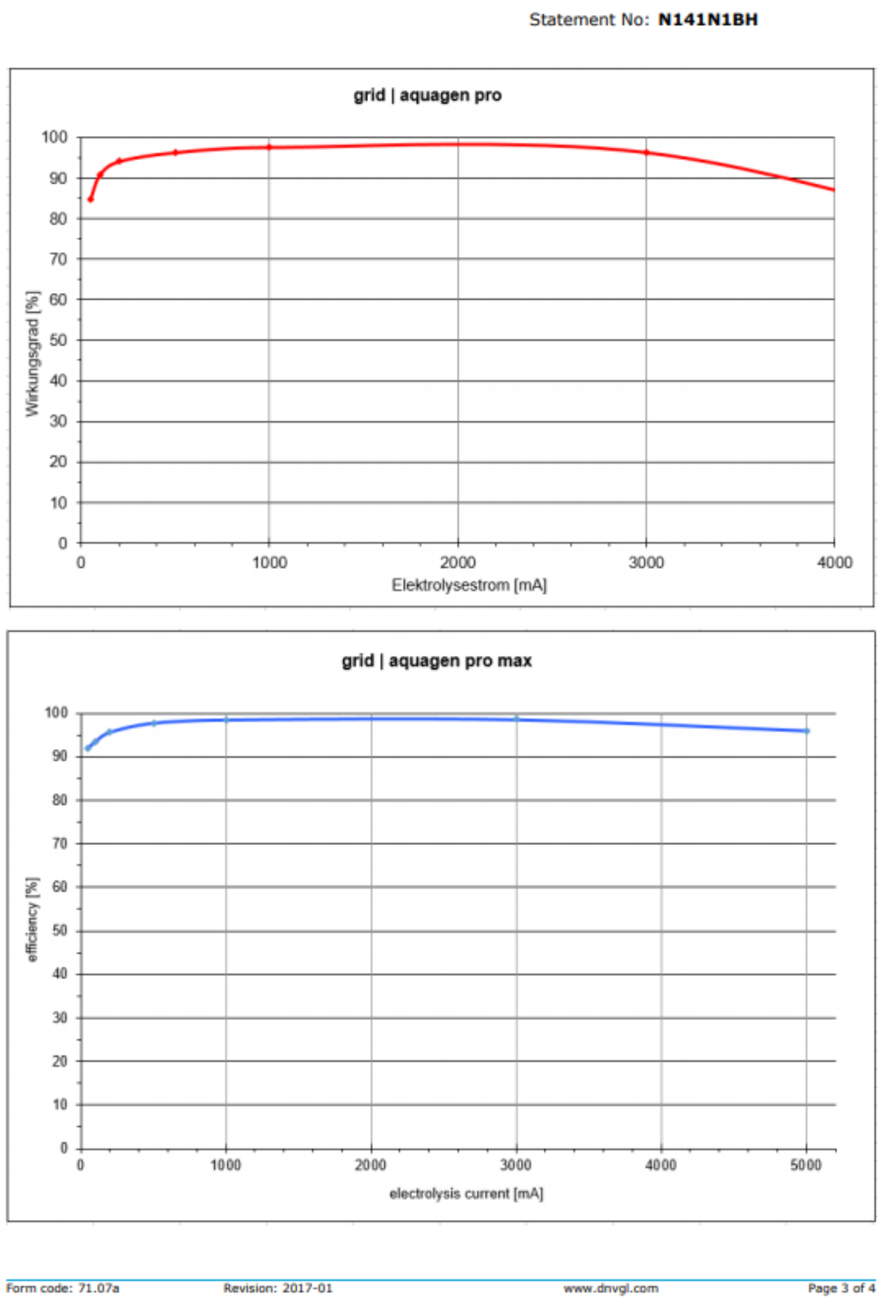
By recombining the oxygen and hydrogen back into water, then the electrolyte level reduction that is normally observed, is reduced by the exact amount of gas that is being recombined. If the Hydrogen and Oxygen are not allowed to leave the cell, the electrolyte levels cannot be reduced. Even if a recombiner is operating at somewhat less than maximum efficiency, there would still be a substantial reduction in the gas being released which improves safety, and provides a labor savings.

Just like any other device that expends energy to perform its function, think a car engine, recombiners have different efficiencies at different rates of function. With a vehicle engine the efficiencies change throughout its operation. The efficiency of a recombiner also changes, due to the amount of gas needing to be recombined. If the overcharge current is 50mA then depending upon the specific recombiner design/capability the efficiency can be a slow as @ 85% and if the mA is 1000 or higher than those efficiencies can be 98% or higher.

The design (lead antimony, lead selenium, or lead calcium) along with the Ah rating of the cell, has a direct impact on the float current requirement per Ah, with lead antimony being the highest, followed by lead selenium, and then lead calcium with the lowest.

The verification statement document from DNV-GL regarding the Hoppecke grid AquaGen Pro and grid AquaGen Pro Max recombiners provides graphs that show the differing efficiencies at 50 mA, 100mA, 200mA, 500mA, 1000mA, 3000mA, 5000mA, and 10000mA². The following shows the graphs from that report.

Exhibit 1 Recombination Efficiencies at Various Currents from DNVGL Verification Statement



A question that comes to mind is, can it be possible to install this type of a recombiner and never have to add water to the battery over its entire life? For sake of a discussion, let's assume an expected life of twenty years as a goal. Here in the United States, it is normal for VLA (vented lead acid) batteries to last 18 – 22 years, so a 20-year time line is reasonable to use.

A fact to consider that relates to the importance of saving labor is that no companies that I know of are adding service personnel to keep up with the normal required maintenance on any equipment. This is particularly true with those companies that utilize stationary batteries, for whatever application they have. Also, with some applications such as remote communication sites, they can sometimes be very remote and their site visitations can be quite extended between visits.

Another application that comes to mind where the benefit of a reduction in having to replenish the water is important, is with 240 cell UPS systems, especially where there are three tier racks. These systems, because of the operating voltages, coupled with the technician needing to use a step ladder to water the cells makes it riskier than when both feet are on the floor. As with any battery service work the correct PPE for the application needs to be utilized. This benefit could also be considered a safety benefit, but that might be a stretch to prove that.

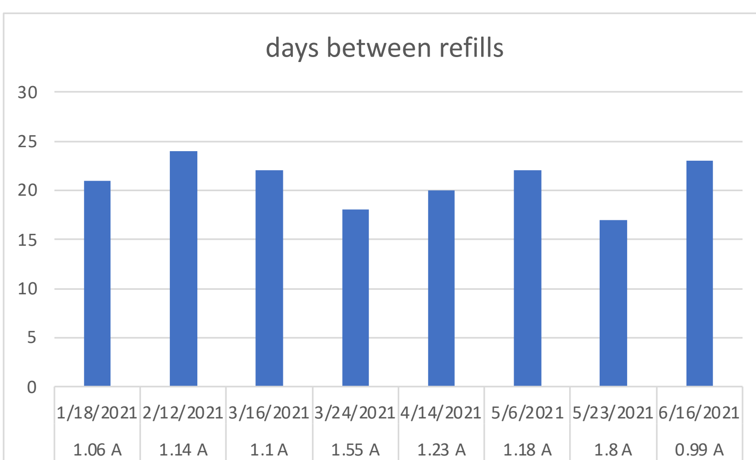
Time Line on Refills of First Reference Cell

By the time this paper is presented in November 2021, we will have over 295 days of data gathered. I will inform everyone during the presentation just how many refills cell 1B which is our reference cell, will have required at that point in time. The eighth refill of cell 1B occurred on June 16 2021 which was 169 days from the start of the experiment. Based upon the average number of days (21) required so far for cell 1B to go from the high to the low line, we are estimating that we will have performed about 14 refills on it by November 2nd.

With the information that we have gathered, we intend to demonstrate that if you know about how long it is between when you need to refill your cells now, that you can use the information from this paper to estimate how long you could possibly go before you needed to add water if you had the new design battery gas recombiners installed in your battery strings.

The current flow has ranged from 0.89 to 1.83 amps with an average of 1.23 amps.

Exhibit 2. Days between refills with dates and current flow values.



Recombiner History

Many of us here in the US think of battery gas recombiner devices as sort of a new thing for vented batteries, but in reality, they are not new. Thomas Edison understood how to recombine hydrogen and oxygen back in the early 1900's (1911?), then Harry A. Guthrie patented his "Self-watering battery" in 1936[3]. In 1949 Dr. Palmer H. Craig patented his STORAGE BATTERY CAP WITH RECOMBINING MEANS[4]. In 1950 a company (Hydro Catylator Corporation) was formed to manufacturer Dr. Craig's invention, which was named a HydroCap. Sometime in the 1970's the company name was changed to HydroCap Corporation which it is currently.

Recombiners have been used in Europe for about 50 years now[5,6,7], and are an industry wide accepted replacement or improvement for standard vent assemblies. Obviously, just like with everything else, there have been a number of lessons learned, changes, modifications, and improvements made to all manufacturer's products over that time period.

Because of their ability to reduce or pretty much eliminate the need for adding water to the cells, these can be a game changer when thinking about what type of battery might be the best choice for differing applications.

The usage of two-way pressure relief valves in a recombiner is a relatively new modification to the previous recombiner designs. We believe that they were first introduced in 2015 but are not sure exactly when that did occur. These valves were added to the previous designs in order to hold the gasses in the recombination chamber longer so that they cannot escape out into the air before they can be recombined. By forcing the gasses to remain in the chamber longer it provides more time for the catalyst material to react with those gasses and return them to water vapor. With the previous designs, the catalyst material was only able to react with the gases as they were passing by the catalyst on the way out of the cell and into the environment. Though two-way valves can improve the efficiency of the gas recombination process, there are some potential down-sides that need to be understood and considered, because of the pressure being created inside the headspace of the cell.

Before we go further, it is important that everyone understands that all any battery gas recombiner does is recombine the hydrogen and oxygen gasses back into water. It does not care if the gasses it recombines are from a lead acid or a nickel cadmium cell. They work the same in both technologies, so please do not think that these will only benefit lead acid batteries. It is also important to understand that it does not make any difference what manufacturer's cell the recombiner is in, it recombines the gasses equally well.

Explanation Of Experiment Process

For our testing we wanted to use a small multi cell Lead Antimony design unit for two primary reasons.

The first reason is that an Antimony design cell has the highest float current requirement of the different lead acid technologies, and therefore has the highest off gassing rate. The order of float current requirements for the four basic lead acid designs from highest requirement to the lowest is Lead Antimony first, Lead Selenium second, Lead Calcium third, and finally Plante[8]. And yes, Lead Selenium is a lead antimony design which utilizes a very low antimony content.

The second reason is that we wanted to be able to take pictures that would allow us see all three cell's levels in the same picture, so a small three cell unit would meet our requirements.

We selected a three-cell 3CA-05M unit from Enersys, which is a 100AH model. This is ideal for our experiment, as it accomplished both of our desires.

Because the unit that we are using is a three cell one, and we had decided that we wanted to use recombiners from different manufacturers in this experiment, this left us with one cell to use as our "standard" cell. The recombiners went in the end cells, and the middle cell kept its standard vent. We chose the middle cell as the "standard" cell so that we could simply look to the left or right to observe the differences in the levels during the process. The following picture is the unit with its standard vents in place.

Exhibit 3. Test unit.

This experiment actually came about because one of our technicians asked a question about how do you know how much gas is coming out of the cells when they are in a high-rate charge situation. This was a good question and we were clueless as to an answer. It is not like you can put food dye in the electrolyte, then see the colored gases in the air. So, we decided that we would try to capture the gasses in balloons, and see what that might show us. What we observed in those balloon experiments made us realize that we really had very little knowledge about this subject, which made us want to understand a lot more, and from that desire came this experiment, or education. After all, it is an experiment that ended up giving us an education.

We mounted balloons onto the vent and recombiners in order to be able to capture the gasses leaving each cell. In our first two attempts at this, within 24 hours the balloon on the standard vent cell increased in size to the point that we halted the experiment because we were afraid that the balloon would burst, while the ones on the recombiners did not inflate at all during these initial tests. These observations showed us that there was a substantial difference in the gasses being released and that there was something to be understood here that we needed to learn more about.

The following picture shows the balloons after a 24-hour period on charge at 2.35VPC.

Exhibit 4. Difference in off gas volumes.

We selected 2.35 VPC as our desired volts per cell because that voltage is above what anyone typically charges their cells at. And for some applications such as load leveling, cycling, or intermittent charging, the recharge voltages which the batteries might be seeing on a daily basis could be at this voltage, or even higher. It should be mentioned that the two European recombiner manufacturers that did communicate with us use 2.40 VPC as their voltage limit for normal operation or testing. They both have run tests at much higher voltages, but use 2.40 as their allowable operational voltage. Some manufacturers have recommended that their recombiners be removed during high-rate charging.

Another reason that we selected that temperature adjusted voltage is that we wanted to raise the voltage of the cells to a point where we were forcing over one amp of current through the cells. The formula from Faradays Laws of electrolysis is that 1 Ah of overcharge decomposes 0.3361g H2O and generates 0.449 liter of hydrogen at 20˚C (68˚F)[9]. We were able to use this formula to estimate how long it would be between refills, based upon the current flow during that period, and it was quite predictable. Thanks to Jim McDowall and Volen Nikolov for advice regarding this formula and other technology specific issues.

Before we started this experiment, we needed to know how much electrolyte volume space there is between the high and low lines in each cell, so we reached out to Enersys to learn what that volume is for the 3CA-05M cell. I want to thank Jason Wallis and Christopher Gendron for providing us with that information, and much more. The volume from the high line to the low line in one of those cells is

12.759 cubic inches (0.05533 gallon which is 7.08 ounces). The distance between the bottom of the high-level line and the top of the low-level line is 17.5 mm (0.69").

By setting the voltage at a temperature compensated value of 2.35 VPC we are able to pretty much keep the current flow between 0.9 and 1.8 amps through the unit. The majority of the time the flow was between 1.1 and 1.4 amps. The current flow changes as the room temperature changes, but we have been able to stay within that current range most of the time. Obviously, one would not want their batteries to be charged continuously at that value, but this is what we are using to accelerate the off gassing, and to try and limit this experiment to a single year's time period or close to that. By the time that this paper will be presented in November 2021 we are estimating that based upon our experience so far, that we will have performed about 14 refills on the standard cell, and the recombiner equipped cells will still be well above the mid points in those cells. Updated info on refills is that on 9/30/21 we performed the 11th refill, and will have performed 12 (not 14) refills by the time this is presented at Battcon 2021.

Sanity Check

In the initial stages of this experiment, we were so surprised at what we were seeing, that we reached out to a number individuals in the industry that we have known for a number of years for sanity checks on what we were doing and seeing. Tom Carpenter from the TVA questioned if possibly the results that we were seeing might have been because of a defect in that middle "standard" cell (1B) which could be causing it to off gas as much as it was as compared to the other two cells. A good thought, and we had not considered that possibility. Thanks Tom.

To answer Tom's question, we waited until the refence cell next needed to be refilled, and then we swapped positions. We added water to the middle cell (1B) until it was at the same level as the water was in the cell that the recombiner was previously in (1A) and installed the recombiner in that cell. We filled cell 1A to the high line and reinstalled the standard flame arrestor in it, and then continued charging at 2.35 VPC. The time required for cell 1A to reach the low line was approximately the same as when cell 1B had been the reference cell. This assured us that our initial reference cell 1B was not a problem cell. Upon the next refill we moved the recombiner back to cell 1A and the flame arrestor back to cell 1B.

At a later date, as a follow up to the above explained recombiner repositioning test, we started another test unit (unit 2) where we charged another 3CA-05M unit at the same voltage. To begin, we filled all three cells to the high lines with their standard vent assemblies installed, and then let all cells go down to their low lines, then we refilled them. Next, we installed a recombiner in the first cell (2A) in the unit and again charged the unit until the two cells with standard vents reached the low line, then filled them again and moved the recombiner to the middle cell (2B), then refilled them again and moved the recombiner to the end cell (2C). With each top to bottom water loss in the two cells that had the standard vents, the recombiner equipped cell always remained at or near the high line. These results validated what we were observing with cell 1B.

Reductions In Gas Releases = Improvement in Safety

Some people might not consider the value of the improvement in the safety of the battery area that results from the reduction in the amount of gas being released into the battery area as an important issue, because of the ventilation equipment that is presently installed to control those gasses. However, I think that any reduction in those gasses being released in the area is a good thing. One should consider that if the existing active ventilation equipment ceases to function, that if recombiners are installed the length of time before an explosive environment could be reached would be quite substantial.

Regarding ventilation requirements for battery rooms, in Europe for some years now they have understood the reduced volume of gas release that occurs when recombiners are installed. In Europe there presently is allowed a 50% reduction in ventilation required if battery gas recombiners are installed in the cells in place of the standard vent assemblies[10]. That statement is on Page 21 in the Ventilation requirements section of that standard. I believe that allowance was written based upon the older style recombiners, prior to the development and the introduction of the two-way pressure relief valves which has increased their efficiency.

I would expect that they selected 50% as the allowable reduction to their ventilation requirement with that percentage being a conservative number as compared to the actual data that they utilized to arrive at their recommendation. I do not know that as a fact but my experiences has shown that any group with that type of responsibility, prefers to provide very conservative estimates when it comes to safety issues.

Here in the US, it might be beneficial for users, if the IEEE ESSB group, or another group such as ASHRAE looked into this difference in ventilation needs, and included this information in the applicable documents when they are next updated.

Observations So Far

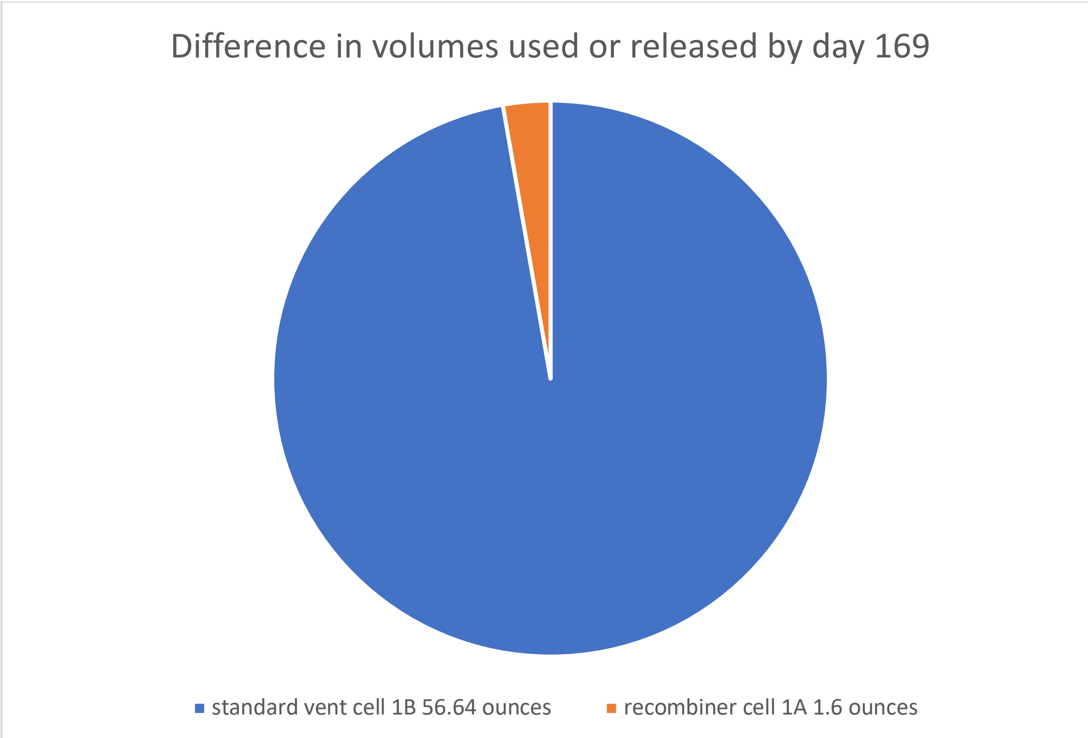
The volume from the high line to the low line in the 3CA-05M cell is 12.759 cubic inches (0.05533 gallon which is 7.08 ounces). The distance between the bottom of the high-level line and the top of the low-level line is 17.5 mm (0.69”). 7.08 oz divided by 17.5mm =0.4 oz per mm. 4mm times 0.4 oz = 1.6 oz. Cell 1A has used @ 1.6 oz. Cell 1B has been refilled 8 times. 7.08 oz times 8 refills = 56.64 oz.

As of today, 6/25/21 (which is the last day that this paper needs to be submitted by) this test has been going on for 178 days. The most recent refill of the reference cell (1B), which was its eight refill, was on 6/16/21 which was 169 days into the experiment. The time it takes for the reference cell to go from the high to the low line has ranged from as low as 17 days to as much as 24 days, with an average of 21 days. The differences in the time required is impacted by the current flow, which is impacted by the charge voltage, and changes in the cell temperature, which is impacted by the ambient temperature.

During this same time period of 169 days the level of cell 1A has lowered @ 4mm. If we take the distance that cell 1A has lowered so far of @ 4mm, and divide that into the distance from the high to the low line of 17.5mm we arrive at a value of 4.375. If we use that multiplier of 4.375 and multiply it times 8 (the number of refills of cell 1B to date) we arrive at a value of 35. This means that there will be @ 35 refills performed in cell 1B before cell 1A will need to have water added.

The following graph shows the differences in water usage, by day 169 into the test. Cell 1A has used @ 1.6 oz and cell 1B has used @ 56.64 ounces of water.

Exhibit 5. Differences in water usage and off gassing.



At the present rate of water loss from our reference cell 1B as compared to our primary recombiner cell 1A, we are estimating that to get to the point where we will have performed a total of 20 refills (using the assumption that water would need to be added once a year), that the experiment could go on for a little over 400 days from the start. This will mean that we should be making the 20th refill of cell 1B about the beginning of March 2022. Of course, before we can actually report with accuracy on just how many refills can be eliminated by using these recombiners, we need to get to the end of the project.

VLA or VRLA

These results of this experiment do present an interesting issue. As everyone remembers VRLA (Valve-Regulated Lead-Acid) batteries when first introduced were advertised as "maintenance free". What was intended to be conveyed was that there was no need to repeatedly add water to the cells as there is with VLA cells. This was indeed true, but it was soon realized that there was a need to understand what was going on inside the VRLA cells and that understanding was not capable with the normal inspection checks that were being performed. Initially the same maintenance checks that had been used for VLA batteries were being performed on VRLA ones, with the exception of specific gravities of course.

Equipment was soon developed to measure the internal ohmic values, which added to the maintenance requirements, and as time went on it was learned that many of those cells did indeed need to have water added to re-saturate the AGM to maintain contact between the plates, in order to restore lost capacity and extend their useful life. We all learned that these were a completely different animal than we were familiar with back then.

VRLA batteries were also designed to provide less off gassing, which is a safety benefit. However, they do off gas, and when they off gas to the extent that they are "dried out" their float current increases, and their off-gassing rate and volume increases, and they suffer from PCL (pre-mature capacity loss). A number of VRLA manufacturers now add catalysts to their VRLA cells as a part of the manufacturing process to help recombine the gasses inside the cells in order to delay or prevent this drying out and excessive off gassing of the cells.

Going Forward

Because of what we were observing in the early stages of this experiment, we decided that we wanted to understand even more about these devices and therefore needed more observation points (cells). Because of this need, we added two more 3CA-05M units to the first 3CA-05M unit to create a 9 cell (18-volt) battery. We connected these new units in series with our first unit, so that we could compare different recombiners performance while having the exact same current flow through all of the cells. We installed recombiners from a number of different manufacturers in the different cells, and are following the same general procedures as in the test that this paper is following, with some exceptions. In order to have another reference cell, we have one cell in jar # 2 that also has a standard flame arrestor installed. In the third unit in this 9-cell battery, we have recombiners in all the cells.

We also have started an experiment on one three cell C&D 3DCU-09 lead-calcium unit and are running that with recombiners in all three cells. This unit is on its own charger and is not in series with the other cells due to the lower current requirements of lead calcium as to lead antimony.

In addition, because of observances in the testing, plus our trying to understand the difference between a recombiner without the two-way valves as compared to an identical one that does have the two-way valves, we obtained recombiners that do not use two-way valves. We are running tests on both designs now. We decided to do this because of observations made on certain design cells, that were the result of the internal pressure created by the two-way valves. We want to determine if the exact same recombiner, with the only difference being the two-way valves, provides a different result, or much of one. By including recombiners that do not use the two-way valves has allowed us to run tests on units from the oldest manufacturer of these devices that we could find. Anyone interested in the results of that this ongoing experiment just contact me and we will keep you abreast of our findings.

Exhibit 6 is a picture that shows all of the different recombiners that were tested, that have two-way valves at one point in the testing. Exhibit 7 is a picture of an arrangement that has recombiners that have two-way valves and ones that do not have the two-way valves.

Exhibit 6. Picture of test arrangement with two-way valve equipped units.

Exhibit 7. Picture of test arrangement with units with and without two-way valves.

Conclusion And Thoughts

The results of this experiment demonstrates that battery gas recombiners that utilize the two- way pressure relief valves have the ability to recombine enough of the gases generated within the cell, back into water in a sufficient volume, that in standard operating conditions it is possible to install these recombiners, with the electrolyte levels at the high line and never have to add water again over the life of the battery.

That fact could be a game changer for many users, as it allows them to make choices that they may not have had the freedom or ability to make previously, when selecting a battery system.

What is not explained in this report is that it is our belief that recombiners that do not have the two-way valves, also have the ability to provide the same or very close to the same benefits as those that do.

With this knowledge regarding the extension of the time periods required for the electrolyte levels to be lowered, it would seem that any governing body or organization that has the authority to require any user to perform electrolyte level maintenance checks on specific intervals should consider this information and extend that requirement to reflect batteries with recombiners installed. Presently NERC with PRC-005 requires that the electrolyte levels be inspected on a four-month interval[11]. I believe that this requirement should either be removed completely, or at least extended to reflect the reality of the differences between batteries with standard vents and those that have recombiners installed. While some could argue that it is desirable to verify that cells have not cracked and leaked out their electrolyte, it can also be argued that verifying battery continuity is only required on an 18-month interval and that is possibly even more important than electrolyte levels. This is a discussion for another day but it should be considered.

Earlier in this document it was mentioned that in Europe that when calculating ventilation requirements that there is a 50% reduction in the ventilation requirement when recombiners are installed. Since the European Standards organization have verified the benefit of the reduction in gas releases when recombiners are installed, it would seem to make sense that going forward the IEEE ESSB group would include that information in the next update of the IEEE 1635.

It is well accepted in the industry that a VLA battery will typically provide a substantially longer useful life than a like size VRLA battery. With that understanding, does it make sense to install a VRLA battery in any location where there is sufficient space to install a like sized VLA battery? With sites that are extremely remote which do not receive regular visits, or which have extended periods of elevated temperatures, or both, then eliminating the need to replenish the water in the cells makes those sites candidates for VLA cells, when previously it was predominantly VRLA models that were initially installed because of the perceived reduced need for maintenance and no need for water additions.

Now that it is possible to eliminate the labor requirement for additions of water over the years, plus the reduction in the volume of gasses being released into the room or enclosure, a person could arrive at the conclusion that for maximum life, and ROI, that a VLA battery with recombiners would be a first choice when making a purchase decision.

Here in the US, there appears to be a movement with utilities to reduce head count, in order to reduce overhead and maximize profits, which often ends up with the employees that remain having to perform their normal tasks plus the tasks of those that have departed. Since adding water is time consuming, by reducing or eliminating that task, it must be beneficial to the organization.

I hope that you have enjoyed this presentation, and thank you for your attention. Please feel free to contact me at any time at info@batteryresearch.com for a more in-depth discussion. For those of you that were not in attendance at BATTCON 2021, and are reading this from the paper archive section of the BATTCON website, you can contact us at this address and we will send that to you for your watching.

Special Call Out Thank You

As anyone that has ever dug into a subject that they did not understand, there is a world of difference if you have to learn it all on your own as you go along, or if you are able to obtain information and knowledge from others that have that knowledge or are performing or have already performed testing of the same subject. Any time that you can review data from others research, testing, or experiences on the same subject, makes it much easier to understand what you are observing.

We were fortunate that Mirko Annovazzi of CT Sistemi Plastici SRL, Nick Fortune of Hoppecke USA, Mike Nispel of Philadelphia Scientific, Carey O'Donnell of Mesa Tech, and Mark Peroni of HydroCap were willing to share their information, knowledge and experiences, and to offer suggestions or comments on what we are doing. Thanks everyone, much appreciated.

And last but by far not least. I want to say a special thank you to Ryan Munger who has been helping me with this experiment from the beginning and whom took over all experiment related activities when I physically moved from Oswego NY to Sarasota FL in June. Without someone to continue the activities required, this experiment would not have been able to be continued into next year.

References

1. www.bestmag.co.uk/emags/BESTMAG72-Spring2021/index.htmp page 14
2. DNVGL verification statement
3. US patent number 2.051,039 Self-watering battery – Harry A. Guthrie – issued 8/18/36
4. US patent number 2,615,062 STORAGE BATTERY CAP WITH GAS RECOMBINING MEANS – Palmer H. Craig – issued 5/3/49
5. Carey O'Donnell and Charles Finin "A COMPARISON OF LEAD CALCIUM AND LEAD SELENIUM ALLOYS: SEPARATING FACT FROM FICTION" BATTCON 2004
6. Carey O'Donnell and Michael Schiemann "HYDROGEN GAS MANAGEMENT FOR FLOODED LEAD ACID BATTERIES" BATTCON 2008
7. https://www.hoppecke-history.de/en/ - 1971
8. IEEE 1635/ASHRAE 21 (Guide for the ventilation and Thermal Management of Batteries for Stationary Applications)
9. Faradays Laws of Electrolysis.
10. UNE-EN IEC 62485-2 Safety requirements for secondary batteries and battery installations. Part 2: Stationary Batteries. 7.2 Ventilation requirements Note 2.
11. PRC-005-06 Table 1-4(a) Component Type – Protection Supply System dc Supply Using Vented Lead-Acid (VLA) Batteries – 4 Calendar Month interval – Inspect the Electrolyte Level