SEC

What is a Catalyst?

All lead acid batteries make poisons in the process of the charge discharge cycle, in flooded vented cells these poisons are vented from the cell but in the sealed VRLA batteries the poison generated in the cells cause the negative plate to become depolarized over time and the cell to become discharged.

When a Catalyst is installed in the head space of a VRLA cell it changes the electrochemical activity within the cell. This causes balance within the cell preventing the negative plate from depolarizing over time and improves cell capacity. A healthy balance in the cell will be immediately obvious by a reduction in the cell's float current by up to 50%. What that means, is a dramatic reduction, by up to 80% in cell gassing, reduced water loss delaying cell dry out, reduced positive plate corrosion, reduced cell heating, reduced risk of thermal runaway and a reduction in the energy required to cool the cells / batteries. The other very important feature of batteries using a Catalyst in the head space is that they can be used in temperature up to 30 C. with out loss of life.

SEC has been putting Catalysts into our range of 2 volt VRLA cells for many years with excellent results. Now with the development of the new smaller Monobloc Catalysts we are fitting Catalysts into our range of 6 and 12 volt Monobloc batteries.

SEC Industrial Battery Company is pleased to announce the addition of a new component in our range of VRLA batteries. The revolutionary Monobloc Catalyst extends battery lfe and operating temperature range of our VRLA batteries and has many other advantage.

? Will reduce float current by up to 50%
? Will reduce gassing by up to 80%
? Reduces cell failure due to dry out
? Will minimise water loss
? Will extend battery float service life due to reduced plate corrosion.
? Batteries will have full design life when use at temperatures up to 30° C.
? Will maintain full cell capacity by preventing depolarization of the negative plate
? Reduces the possibility of thermal runaway.

Monobloc Catalyst now available in SEC range of 12 volt Front Terminal batteries 6 & 12 volt TUA Telecom / UPS batteries and revolutionary Solar Gel TSG range designed to provide full battery life even when used in temperatures up to 30 C.

Taking advantage of this new Catalyst technology, SEC is planning to release several new VRLA battery types over the next few months.

October 2004

Philadelphia Scientific
207 Progress Drive • Montgomeryville, PA 18936

To Whom It May Concern: 21 February 2002

We at Philadelphia Scientific are supplying the Catvent used in the SEC TLA, TLG and FTA cells / batteries.

Philadelphia Scientific is the exclusive manufacturer of this product and has multiple patents (issued and pending) on the use of catalysts in VRLA cells in multiple countries around the world.

We have extensively tested catalysts in numerous battery manufacturers' VRLA cells and have typically found that the float current will be reduced by about 50% and the gassing of the individual cells will be reduced to less than 8.6 ml/100Ah/day at 20 C or 12.2 ml/100Ah/day at 25 C.

These typical results are due to the oxygen scavenging action of the catalyst in the gas headspace of a VRLA cell. Oxygen in the headspace acts to depolarize (discharge) the negative plate of the cell. By recombining a small amount of the oxygen with the hydrogen that is naturally present in the headspace of the cell, the depolarizing (discharging) action is minimized. This allows the negative plate to stay fully charged, thus reducing the amount of charging current required to be supplied by the charger to maintain this full state of charge.

The float current reduction is a leading indicator that the battery has fully charged negative plates and is healthy. The reduction in gas emissions is a direct indication that the catalyst is recombining the oxygen and hydrogen gasses in the cell and that the float current is being reduced.

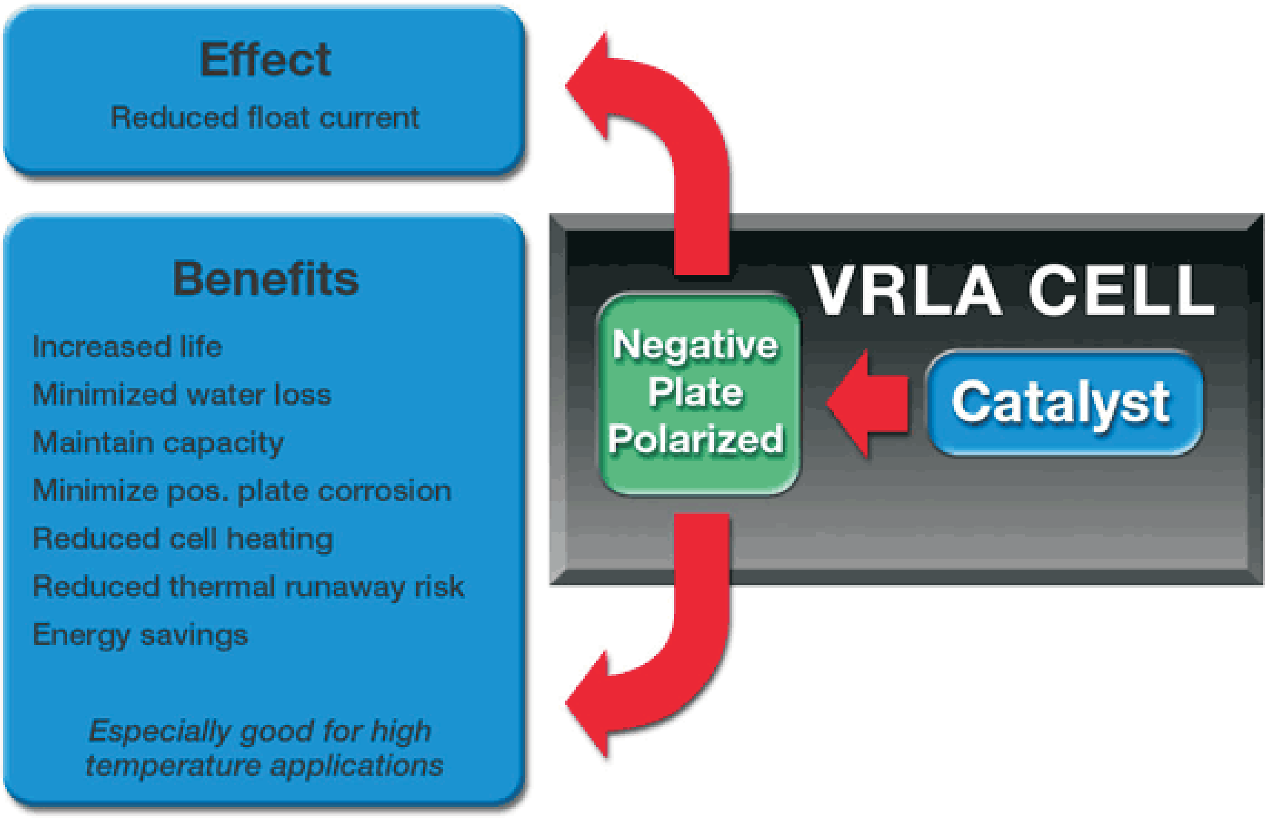
More detailed technical information on this subject is available on our website www.PhiladelphiaScientific.com.

Best Regards,

Harold A. Van

Harold A. Vanasse
Technical Director

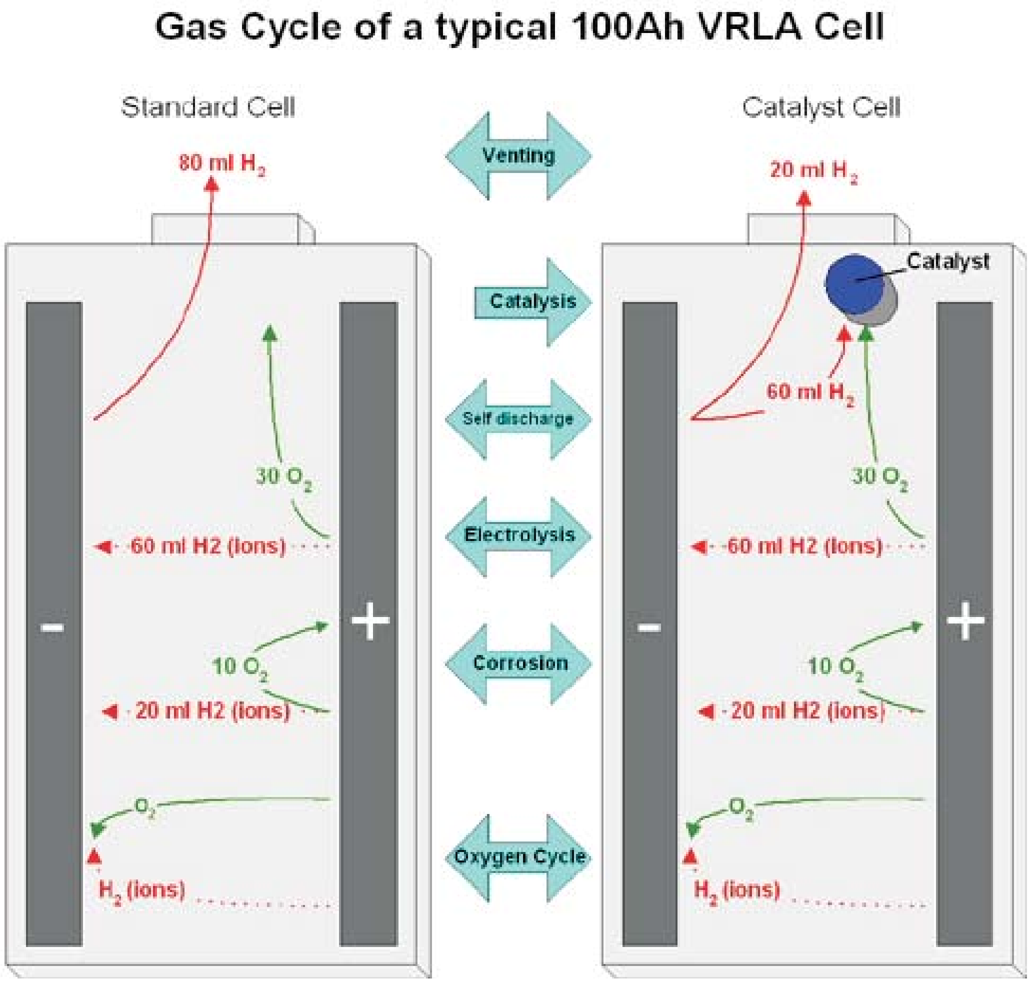
VRLA Catalyst - Optional



When a catalyst is installed into a VRLA battery cell it changes the electrochemical actions within the cell. This causes balance within the cell preventing the negative plate from depolarizing over time. A healthy balance in the cell will be immediately obvious by a reduction in the cell's float current. The reduction in float current translates into: increased life, minimized water loss, maintained capacity, minimized positive plate corrosion, reduced cell heating, reduced risk of thermal runaway, and energy savings. All these benefits are enhanced in more demanding high temperature applications.

Benefits
Background - A brief history of the development of VRLA technology and a description of some of the limitations of the current state of the art.
Anatomy of a Microcat
Catvent! - Our complete vent plug with built in catalyst
How it works - Explanation of the electrochemical reactions inside a VRLA cell equipped with a catalyst.
Library - Technical papers and articles for reference

How It Works



Gas Cycle of a typical 100Ah VRLA Cell

The VRLA cell was designed to correct all the problems of flooded technology. All the gas produced inside the cell was intended to recombine back into water on the negative plate in a very efficient oxygen cycle. In an ideal world there would be no negative plate self discharge, no positive plate corrosion and no excess charge current needed. Batteries would last forever and no gas would be released from the cell.

In the real world, chemistry dictates that negative plates do self-discharge and they do this more when impurities are present in higher quantities. In our experience the typical high quality, long life (20 yr) VRLA cell has a self discharge rate equivalent to 80 ml of Hydrogen gas per day per 100 Ah. Oxygen, produced from a variety of processes on the positive plate, will recombine with this hydrogen on the negative plate and cause it to depolarize.

In the real world positive grids also corrode. When a positive grid corrodes at a relatively high rate, it absorbs the oxygen produced as the lead grid turns into lead dioxide; leaving no oxygen to depolarize the negative plate. In this case, the negative plate stays polarized and all the hydrogen will vent. Unfortunately, a positive grid that corrodes at the required rate will last much less than 20 years. Designers have done what is typically done on flooded designs for long life and reduced the corrosion rate of the positive grid. Typical state of the art design will only absorb 10 ml of oxygen on the positive plate instead of the 40 ml needed to counter act the hydrogen generated on the negative. This is the paradox of VRLA design. A "better" positive grid can actually impair the life of the design.

This leaves an unbalanced situation with a strongly depolarized negative plate. The charging system will compensate with more current which will lead to excessively high polarization on the positive plate and damaging effects on the cell due to the excess current. Electrolysis will generate high amounts of gas leading to water loss.

The dilemma for the battery designer is in achieving perfect balance in the cell. If the positive plate corrosion rate doesn't correspond exactly to the self discharge rate of the negative, then negative plate depolarization becomes an issue. To achieve balance, one can either make an extremely pure negative or have a relatively high corrosion rate on the positive. The purity required may be prohibitively expensive, and a high corrosion rate precludes a long life design.

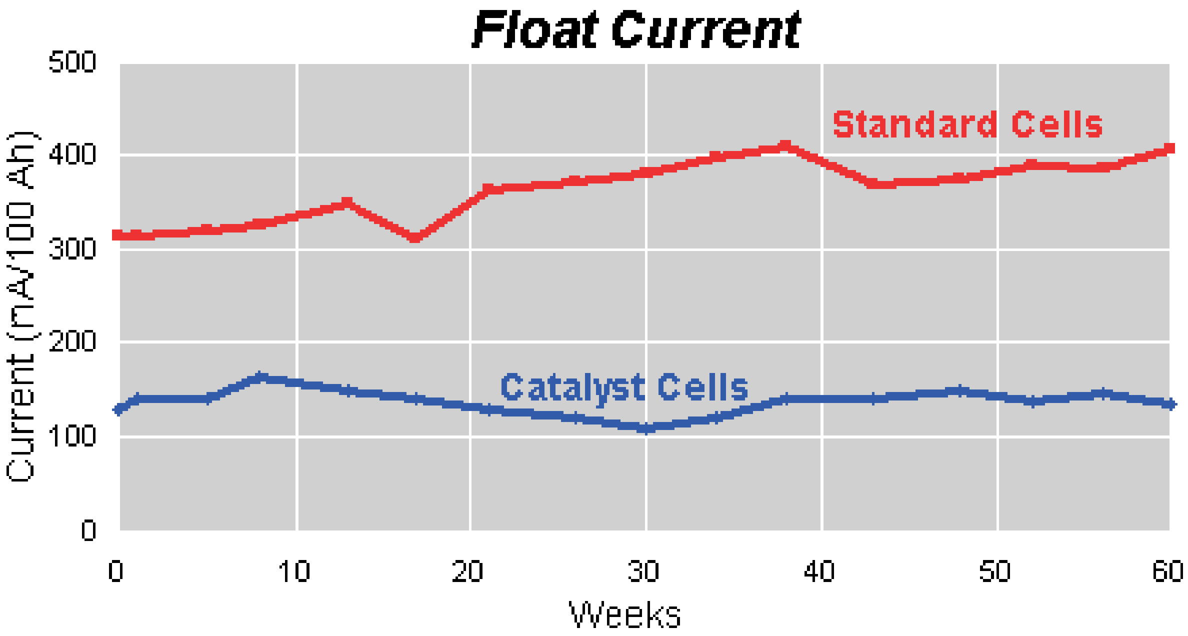
Adding a Microcat™ to the cell gives the battery designer a new tool to break out of the deadlock. The catalyst will absorb free oxygen in the headspace and recombine it with the abundant hydrogen always present in the cell. This drastically reduces the amount of gas venting from the cell, but most importantly this prevents oxygen from reaching the negative plate and buffers the negative plate self discharge reaction from the positive plate corrosion reaction. Now that the cell is in balance the negative remains charged. The charging system responds by only sending the small amount of current needed to keep the cell charged.

The results can clearly be seen when reference electrodes are used in experimental cells with and without catalyst. As seen in the table, the catalyst equipped cell has a healthy set of polarizations while the non catalyst cell does not. The reward for this balance is that the float current drops dramatically, usually by half or more.

Plate Polarizations		
	Control Cell	Catalyst Cell
Negative Plate	0 mV	30 mV
Positive Plate	100 mV	70 mV

Note: For a more in-depth technical description of the reactions see the Telescon '97 paper

Benefits of Catalyst in VRLA Batteries

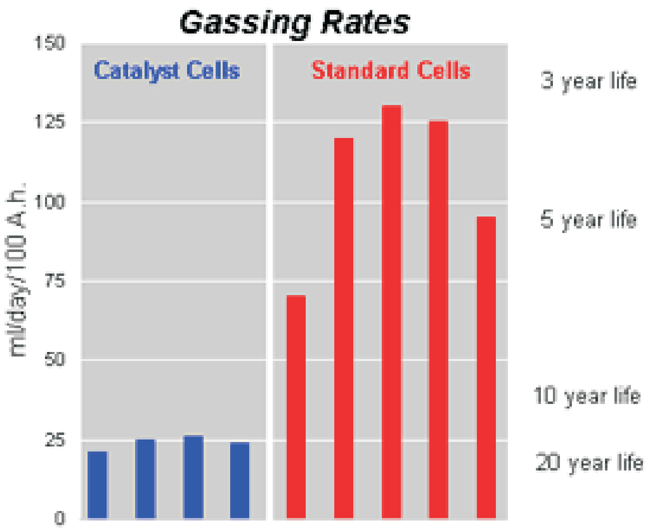


Catalyst Reduces Float Current

One of the most immediate, observable effects of installing a catalyst in a VRLA cell is a sudden drop in the float current. Typically float currents are one half or less when a catalyst is installed.

A quick explanation of how this happens: In a VRLA cell, the negative plate does double duty compared with a flooded cell. In addition to normal negative plate functions, it also is the site where oxygen and hydrogen are recombined into water, making the cell maintenance free. When this process is too efficient, excess oxygen reaching the negative plate causes it to become depolarized. When the negative plate is depolarized, the charging system will supply more current in effort to bring the cell voltage up. The additional current becomes excessive overcharge on the positive plate, which has many damaging effects on the cell. (See How it works for a more in-depth technical explanation)

Adding a catalyst to the cell prevents some of the oxygen reaching the negative plate and allows the negative plate to stay polarized. This means that less current needs to be supplied to the cell from the charging system, manifesting itself as lower float current, leading to the following benefits:



? Minimize water loss - Gasses are recombined into water inside the cell rather than exiting the cell. Too much gas leaving the cell can lead to premature dry-out and cell failure. Cell dryout has been the predominant cause of customer dissatisfaction with VRLA technology.

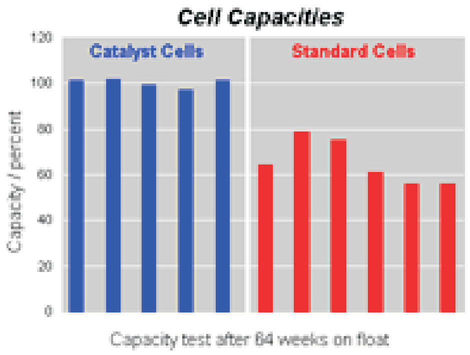
? Increased life - There are many potential failure modes of VRLA cells. A number of these failure modes can be mitigated by the catalyst technology such as: Cell dry out, positive plate corrosion, thermal runaway, capacity loss due to negative plate depolarization.

? Minimize positive plate corrosion - A reduction in float current reduces the amount of overcharge on the positive plate which directly impacts the corrosion rate. The design life of a lead acid cell is based on the corrosion of the plate barring any other unforeseen failure modes.

? Reduced cell heating - Any excess current above that needed to charge the cell is converted directly into heat. A reduction in float current means less heat produced. This can result in a cooler environment for batteries and electronics or a reduced load on HVAC systems.

? Reduced risk of thermal runaway - Since heating is reduced and float current minimized there is less risk of thermal runaway.

? Direct energy savings - Reduced float current directly translates into less power purchased.



Maintain cell capacity - Many VRLA cells in service are failing capacity tests because their negative plates are depolarized. In fact significant capacity increases have been seen on some cells just by installing a catalyst.

Note: Graphs taken from Intellec 1998 paper

Background: History and Limitations of VRLA Technology

VRLA technology was launched as an improvement over standard flooded technology which had been extensively proven in long term service. As with any new technology there were inevitable problems as the technology evolved. A brief history of the development milestones will aid in understanding why many current VRLA designs can be improved with a catalyst.

1982: Stationary VRLA born
The large Valve Regulated Lead Acid (VRLA) battery was launched by GNB (now part Exide Technologies) in 1985. Telecom customers immediately liked the new design because it was maintenance-free, safer, and compact. Over the next decade, all the major manufacturers in the US, Europe and Asia were making and selling VRLA batteries into the Stationary/Standby market.

1995: Fundamental problem comes to light.
Dr. David Feder presented a controversial paper (Intelec1995) on the results of a study of 24,000 cells that ranged from one to nine years old. The cells were produced by nine different manufacturers from around the world and were in service in benign temperature controlled environments. It was found that 68% of these cells failed to meet their capacity requirements. More alarmingly, cells that were three years old had a failure rate of 35%. Also this year, Philadelphia Scientific presented a paper that established a water loss standard for VRLA cells to meet in order to achieve 20 years of life.

1995-1996: Field complaints rising
By the mid 90's, there were an increasing number of complaints from users regarding the unreliability of VRLA batteries. Defects reported included high float currents, positive grid corrosion, negative strap corrosion, capacity loss, thermal runaway and dryout. Though not understood at the time, all these disparate defects were actually closely related.

At Intellec '96 a paper was presented that continued the tests from the 1995 paper and for the first time, identified that the central lingering problem with VRLA technology was negative plate depolarization. It also announced the beneficial effect of a catalyst on negative plate polarization.

1997: Understanding the problem
At the Telescon conference in Budapest in 1997, the entire problem was brought to light, defined and experimentally demonstrated (see paper). A serious problem lay concealed in the electrochemistry of the VRLA design. Many of these batteries were predisposed to an unexpected failure mode of negative plate self-discharge. The same oxygen cycle that provided the maintenance-free benefit was causing self-discharge and loss of capacity.

Most of the battery industry was unaware of the problem at this time. It was presented by comparison to the well-known flooded cell design where virtually all of the float current charges the negative plates so that they always stay fully charged. In VRLA cells, almost none of the current goes to charging the negative plates. Therefore, the negative plates self-discharge slowly on float, even when the exact same pure materials are used.

At the conference, three solutions to the problem were also proposed:

1. Improve the purity of the negative plate and otherwise minimize its self-discharge rate. This requires the use of extremely pure lead, which may be cost prohibitive and may run counter to the imperative to recycle.

2. Increase the corrosion rate of the positive. This was an acceptable approach on short life batteries but obviously not on long-life ones.

3. Use a small internal catalyst to remove excess oxygen and permit the negative plate to recharge naturally.

1998: VRLA catalyst product launch

In 1998 Philadelphia Scientific began the manufacture of catalyst devices for VRLA batteries. One large manufacturer of VRLA batteries incorporated catalysts into one of their product lines.

At the 1998 INTELEC conference Philadelphia Scientific published the results of a definitive test showing dramatically how premium VRLA cells suffered almost 50% loss of capacity in a period of less than 2 years. The cells with catalysts installed maintained 100% capacity and had much healthier negative polarizations. (See paper)

2000: Next generation catalyst designs

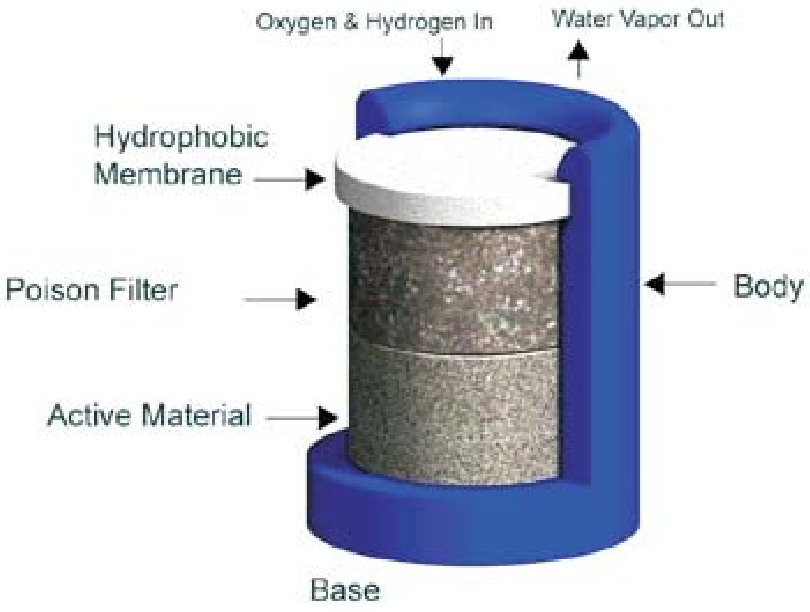
The second generation catalyst design called the Microcat™ was launched (Anatomy of a Microcat). This significant advance in the catalyst technology added poison filtering and temperature limiting features along with a more robust construction.

At INTELEC 2000, Philadelphia Scientific presented a paper that defined the standard of purity required for a high quality VRLA cell. (see paper) Since normal spectrographic tests were not adequate to measure such low levels of impurities, the standard was based on a test method developed by Chloride in the 1980's. It gave manufacturers a simple, reliable and low cost method of measuring the purity of their final products.

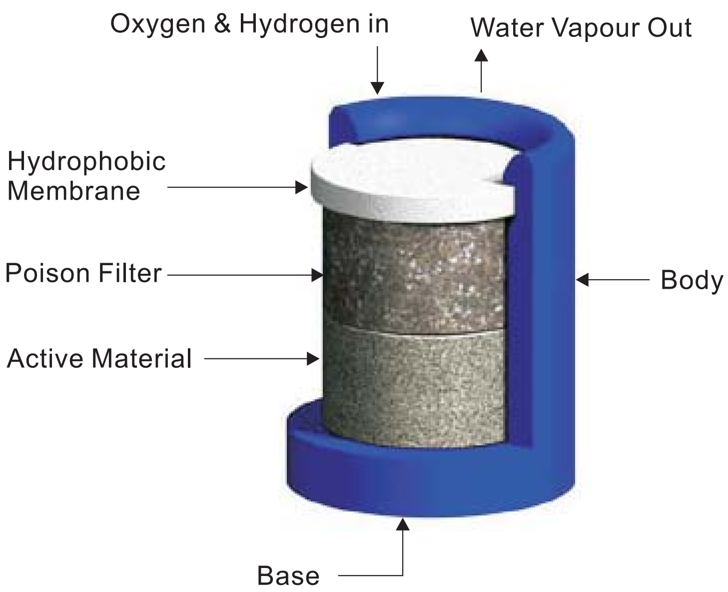
Summary

Flooded lead-acid batteries have been with us for over 100 years. VRLA technology was born in the early 1980's and was not well understood. The new technology was prone to unique failure modes, which had to be diagnosed and corrected. (It is especially difficult to prove a 20 year design when the oldest cells are only now just approaching their twentieth birthday.) Many improvements have been made to VRLA technology to get better jar to cover seals, improved post seals, an end to strap corrosion, improved cell compression, etc. When these more immediate failure modes were addressed it then became possible to discover a major root cause of shorter life - negative plate self discharge. As noted, this was and is a failure mode specific to VRLA battery designs due to the gas management issues inside the cell. The catalyst was shown to be one of the three fundamental solutions and for many

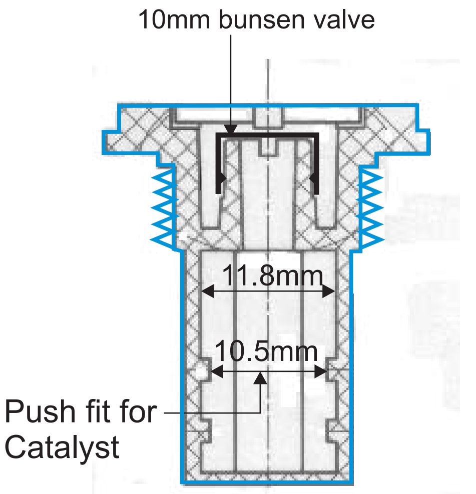
Anatomy of a *MICROCAT*™



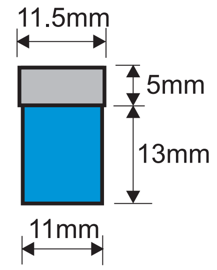
- Body - Engineered high temperature plastic outer housing. Can withstand temperatures up to 500°F (260°C). Chemically resistant to sulfuric acid.
- Hydrophobic membrane - Microporous barrier allows cell gasses to enter catalytic chamber and water vapor to return to the cell. This acts as a barrier to keep acid spray outside the microcat. This also regulates the rate of gas diffusion so that the temperature of the microcat never exceeds 200°F (93°C).
- Poison filter - Guard layer of a dual acting filter material protects the active material from poisonous gasses found inside VRLA cells.
- Active material - Precious metal catalyst dispersed on a granular substrate, which recombines Hydrogen and Oxygen into water vapor.
- Base - Can be custom molded with a variety of different attachment methods for easy mounting on customer vent cap



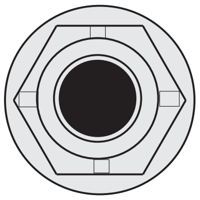
2 Volt “MICROCAT” Catalyst CTL-018 (1Amp)

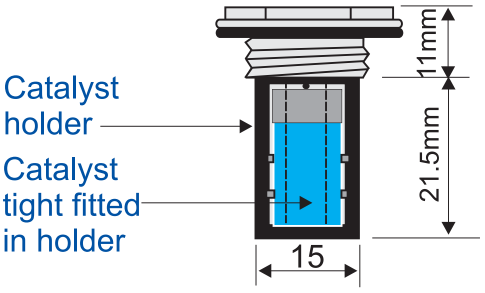


Typical Cross Sectional View



Full Size
New Catalyst





Full Size

SEC

TITLE TYPICAL “MICROCAT” CATALYST & HOLDER DETAIL

DRAWING NO. SEC-5294

CUSTOMER

SCALE A.S.

DATE 08/08/07

DRAWN J.F.X.M.

APP.

DIMENSIONS IN MM

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Catvent™

Microcats are typically attached to the vent cap of the cell. Philadelphia Scientific also makes complete vent cap assemblies The Catvent includes:

- Precision pressure relief valve
- Flame arresting disk
- Built in Microcat
- Custom design capability - We can design a vent especially for your battery.
- Two standard versions currently available including 35mm standard DIN push fit with o-ring seal.