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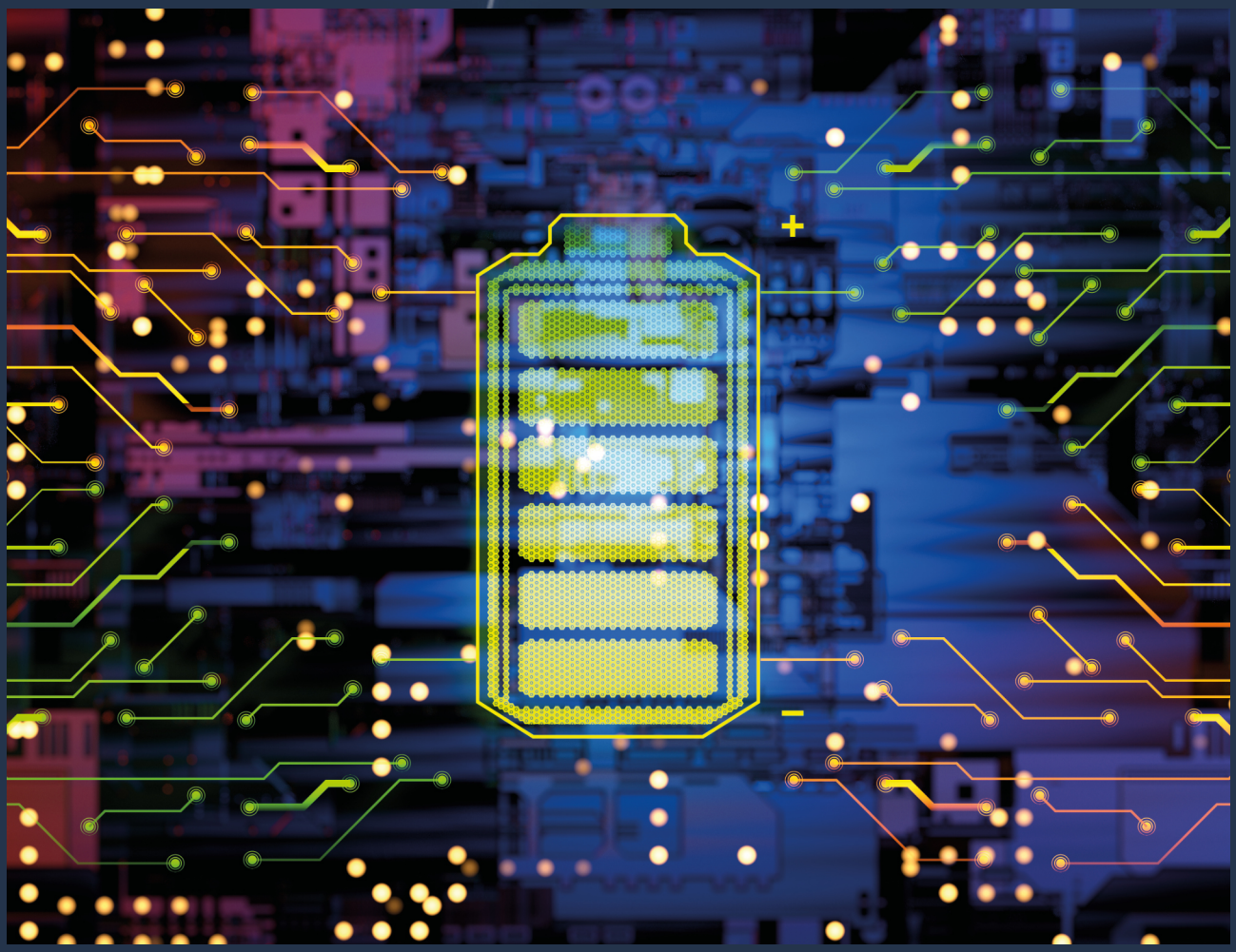


Battery gas recombination in the US and Europe

Is the US finally catching up with the EU regarding the benefits of battery gas recombination devices? Pete DeMar, co-founder of Battery Research and Testing, (BR&T), considers the question and suggests: The answer depends on what you define as 'catching up'.

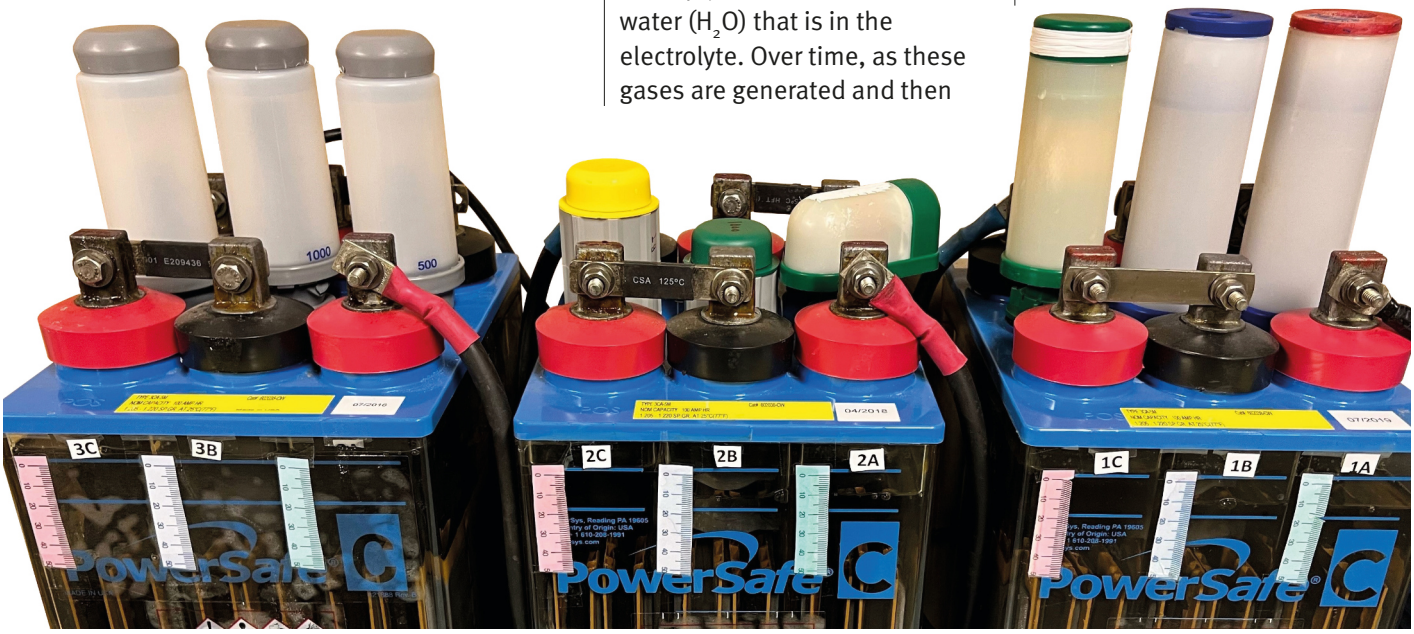
If your definition of catching up on battery gas recombination in the US is that the powers-that-be (standards writers and standards documents) define recombination vents/plugs, explain what they do and acknowledge their benefits and value, then the answer is 'yes'. That recently occurred in the US with the newest revision/update to the IEEE1635/ASHRAE21 document.

If you define catching up as the majority of the US end-users actually understanding how these devices function and the benefits they can provide, the answer might be 'not quite yet'.

Fig 1: A selection of battery gas recombination devices from different manufacturers mounted on batteries

The need to recombine

To explain this, it needs to be understood that the process required to recombine the gases (hydrogen and oxygen) that are generated during charging, of stationary batteries, has been understood since Thomas Edison's time. All vented lead-acid and vented nickel-cadmium batteries give off hydrogen and oxygen when being charged. This is simply the breakdown of the water (H_2O) that is in the electrolyte. Over time, as these gases are generated and then released from the cells, the electrolyte levels in the cells lower, which eventually requires the addition of water to keep the levels within an acceptable range. This is a normal and ongoing maintenance requirement. The interval between those required water replenishments is influenced by a variety of issues, such as the cell design, the average individual cell voltage setting, the average electrolyte temperature, and in particular the float current of the specific battery string.



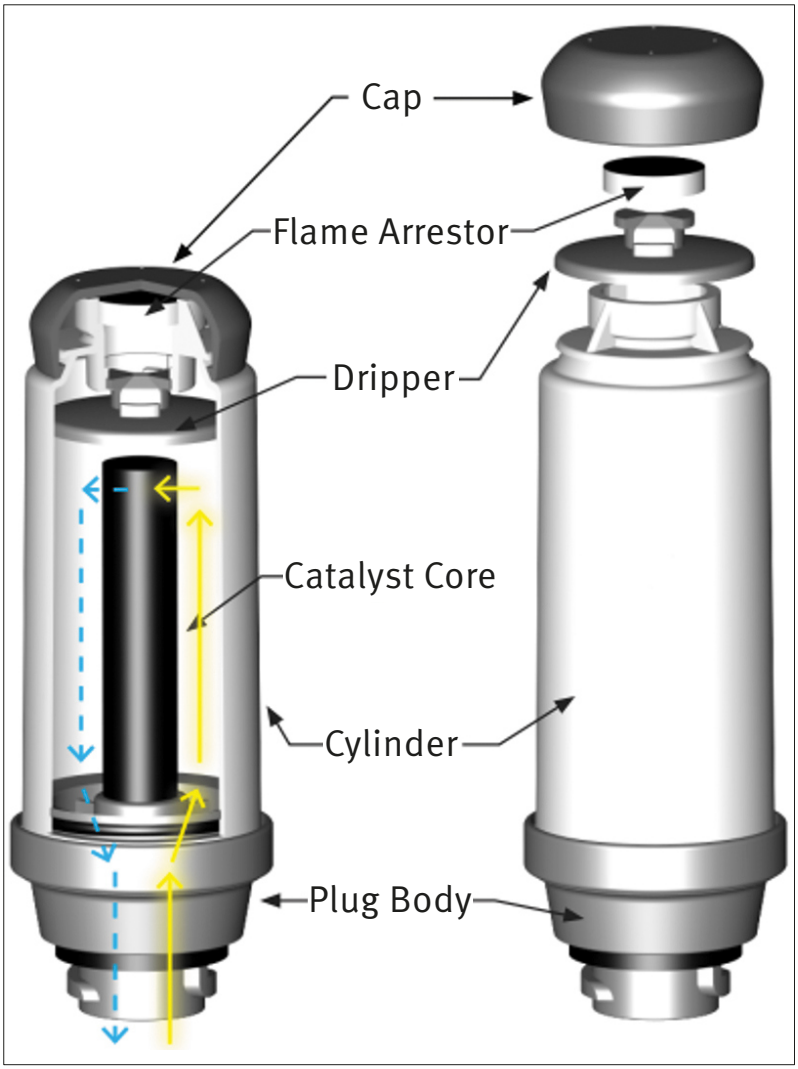


Fig 2: Standard recombination vent

Battery gas recombination has been known about since the early 1900s, with some early devices patented to perform this process. The earliest unit that I consider of a modern type design was patented in 1949 by Dr Palmer H Craig and entitled 'Storage battery cap with recombining means'. It was not until the late 1960s that a concentrated effort was made to create a modern-day type of recombiner.

In 1971 Hoppecke introduced the AquaGen plug, which made them the first battery manufacturer in Europe to offer recombiners to purchasers of their batteries – as far as I am aware. These were created with the main objective of extending the time interval when water would need to be added to the cells.

> "Everyone reading this must know that a Class 1E battery is the one responsible for the safe shutdown of nuclear reactors – the most important battery function anywhere"

Savings and safety

As users recognised the labour savings, and these devices proved their value, other manufacturers entered the market with their own recombiners. Obviously, as time went on, there have been changes and improvements made to recombination vents due to the knowledge gained through both research and that which came from actual users' experiences and feedback.

That these devices have proven their benefits, one only needs to understand that some Nuclear Class 1E batteries in Europe have them installed in their cells. Everyone reading this must know that a Class 1E battery is the one responsible for the safe shutdown of nuclear reactors – the most important battery function anywhere.

I personally do not know of a single battery manufacturer in the EU or the US that objects to a user installing recombination vents in their cells. After all, why would any manufacturer object to a user of their batteries wanting to make their battery rooms safer or wanting to reduce their maintenance costs?

These devices are often advertised as being up to 98 or 99% efficient. Even if the devices were only 90% efficient, that is a substantial benefit over any standard vent or flame arrestor, which is 0% efficient. Testing has proven that these devices make a substantial reduction to the volume of hydrogen and oxygen that is released from the cells. As all understand, it is critically important that the hydrogen and oxygen content in

a room or area is not allowed to reach an explosive value. Vents and flame arrestors do not prevent the gases or moisture from leaving the cells.

All recombiners perform the same function. They recombine those gases (hydrogen and oxygen) back into water. Some designs utilise a pressure relief valve internally, and some do not. The difference in efficiency is typically less than an estimated 2-3%. The upside of a pressure relief valve is a slight improvement in efficiency, but the potential downside is that by increasing the pressure in the headspace of the cell, if there are sample tubes in the cells this increase in pressure can cause an overflow of electrolyte from the tubes. Or if there are defective post seals, then the wicking of electrolyte, caused by that increase in internal pressure, can be accelerated. Some designs such as the Flux units also incorporate a condensate control method to capture evaporation. This also acts as a barrier to prevent electrolyte mist from exiting the cells.

European safety standards

The European Union's standards writing organisation has published standard 62485-2 IEC:2010. In *table 1*, which is used to determine ventilation requirement needs, *note 2* states: "In case of use of recombination vent plugs, the gas producing current/gas can be reduced to 50% of the values for vented cells." They realise that these devices are in the high 90% efficiency range, but I believe they used a lower value

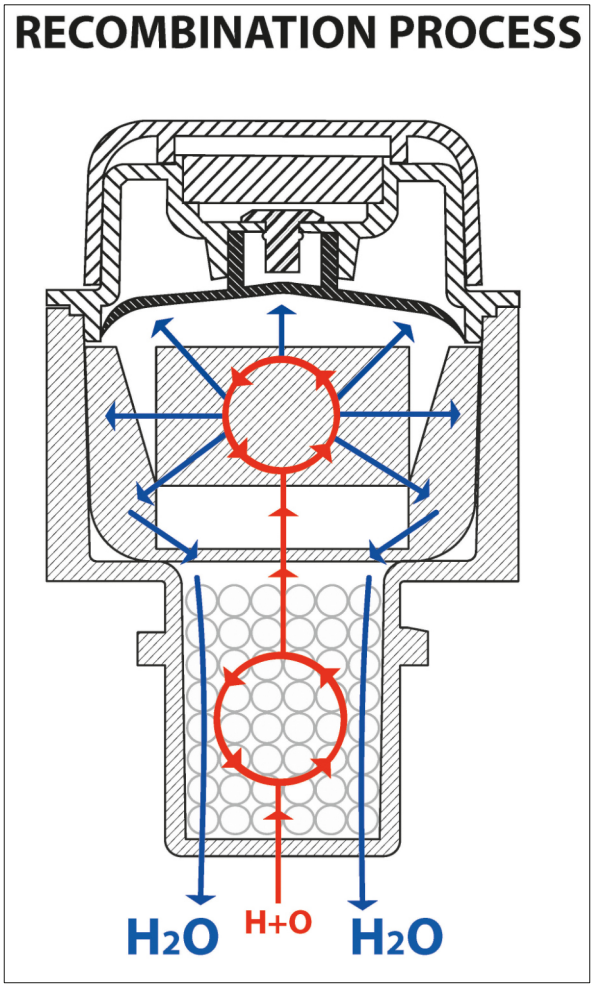


Fig 3: Diagram showing how all recombiners work. Hydrogen and oxygen gas rise up and interact with the catalyst material, and then condenses on the walls of the device and flow back down into the cell as water.

(50%) as a 'safe' specific value that they could include. This standard is titled *Safety requirements for secondary batteries and battery installations. Part 2: Stationary batteries*. The date indicates this standard has been around for a number of years.

Updated US safety document

The American equivalent to that safety document is the IEEE1635/ASHRAE21 *Guide for the ventilation and thermal management of batteries for stationary applications*. In previous versions of this safety document, there had been no mention of recombination devices. But the newest revision just updated (2022) now includes information regarding recombination vents. I believe that the fact that there had been no mention of these devices in any of the previous versions of this document was because, in the US, the majority of the stationary batteries installed are of the lead-calcium design – these normally require a lower float current for equivalent amp hour than a lead antimony or lead selenium – so no-one involved years ago was thinking about battery gas reductions. A lower float current equals less off-gas being generated. A simple oversight in my opinion. This has now changed.

The changes to the document start with the addition of a definition of what these devices are and what they do. That definition is as follows: "Recombination vent: An assembly on a vented cell in which most of the hydrogen and oxygen gases escaping from the head space of a cell are catalytically recombined and returned to the cell as water." As can be seen from this definition, it is understood that the majority of the hydrogen and oxygen is prevented from leaving the cells. It does not say "some" of the gases, it states that "most" of the gases are recombined into water and returned to the cells.

Later in the document, in *section 5.1.1.2* on vented lead-acid (VLA) batteries, and in *section 5.1.2* on nickel-cadmium (Ni-Cd) batteries, it states the following: "In some cases, recombination vents may be used to reduce maintenance.

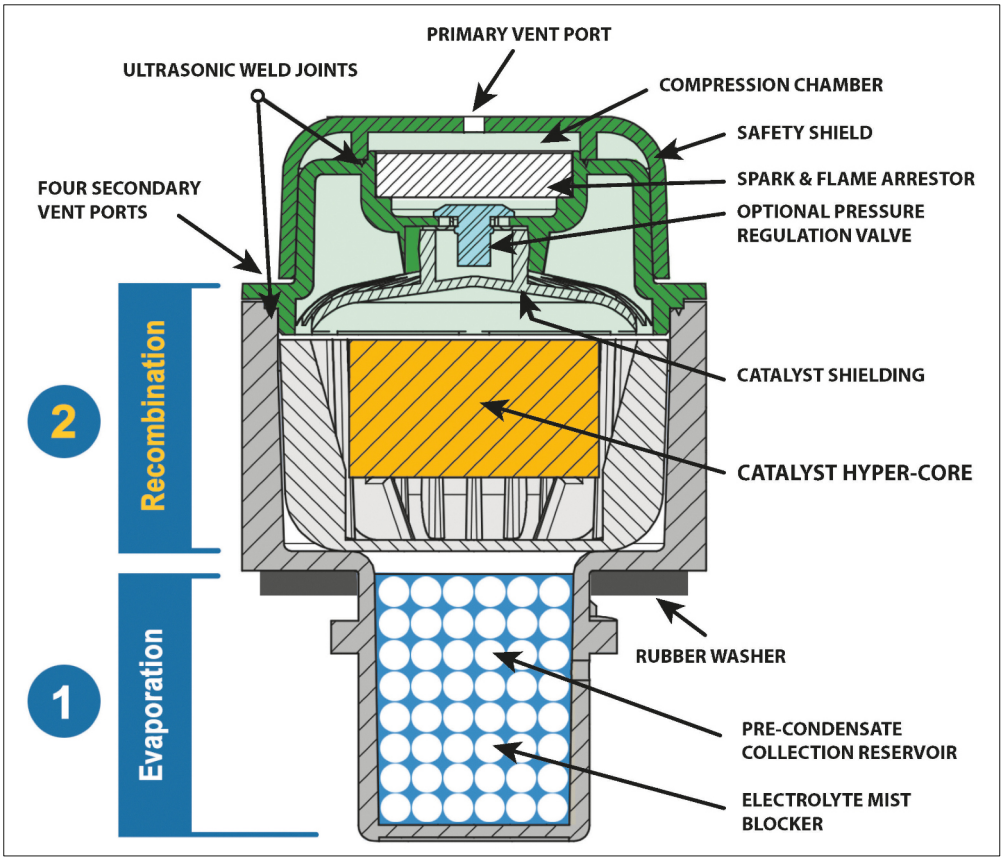


Fig 4: Short recombiner with condensate and mist capture

See 7.2.1 for recommendations for ventilation calculations when such vents are used."

In *section 7.2.1 General*, it states that recombination vents catalytically recombine most of the charge gases from vented cells, providing a significant maintenance benefit.

Based upon the present inclusion regarding information on the function and benefits of recombination vents, I believe that here in the US we have now caught up with the EU in terms of standards – providing valuable information for the battery users, as it relates to these devices.

Safety first

It is not mentioned in any documents, but there is one benefit that is normally overlooked when discussing recombination vents. That is their ability to prevent an explosive gas build-up in the battery room/area even if the HVAC ceases to function. Recombiners will continuously recombine those gases for as long as they are being generated. In other words, if the charger is functioning, the gases will be recombined back into water. If the charging source is not functioning, then no gases are being generated.

While every battery manufacturer and user in the EU understands and accepts these devices, in the US it is different, as they are sort of 'new'. In the US, Enersys has been the only American manufacturer offering recombination vents as an optional item for many years now. It was not until quite recently that other US manufacturers have developed an interest in these devices. There are some stationary battery sales agencies promoting and selling these devices for usage in all different battery manufacturers' models.

How long it takes for users in the Americas to actually experience the benefits of these devices is going to depend upon a number of things, such as, but not limited to:

- How soon they learn about them and come to understand the financial savings possible
- How much value the user assigns to increased safety in the battery room/area
- How the American battery manufacturers endorse and promote them
- How rapidly the insurance companies acknowledge the benefit of the reduced hydrogen releases and share that with their insured – some are already doing this
- The AHJs (authorities having jurisdiction) learn about and endorse them
- How quickly the stationary battery sales organisations realise that these devices are a profit centre, and they start promoting them to their customers. Profit is a strong motivator.

As for 'catching up' I believe that America is getting there, but only time will determine if I am right or wrong.