Proton® PEM White Papers Series

Up, Up, and Away

A smarter way to reach the air up there

Abstract

Weather balloons are launched around the world on a daily basis to collect atmospheric data such as pressure, temperature, humidity, and wind speed and direction. With approximately 800 different locations in some of the most remote areas of the world, meteorological organizations conducting upper air observation rely on gases such as hydrogen and helium to elevate weather balloons so they can capture data. There has been much recent debate about which type of gas should be used and what to do so that it is readily available when needed.

The hydrogen/helium debate

Many organizations in the weather balloon market, from the military to civil government to meteorological users, typically resort to using helium due to concerns over hydrogen's safety.

However, hydrogen generation has changed dramatically since the advent of Proton Exchange Membrane (PEM) technology. This technology means that pure hydrogen can be produced safely and reliably on-site – using only water and electricity – at an affordable price. The Proton Exchange Membrane electrolyzers that are sold worldwide are used in a variety of applications outside the meteorological field, including heat treating, electronics manufacturing, cooling of power plant turbine generator windings, and gas chromatography. These electrolyzers have demonstrated high reliability in a wide range of environments and duty cycles.

Having used helium for the last 40 years, many meteorological agencies, such as Environment Canada and the US National Weather Service, are now allowing some sites to fill their balloons with hydrogen. These organizations are switching for two main reasons: price and availability.

Many sounding balloon sites are in remote areas where delivering gas is difficult. Additionally, the delivery of either hydrogen or helium in high-pressure cylinders poses certain risks. Through the deployment of on-site hydrogen generation systems, observations in remote locations can be made without the dangers and logistical difficulties associated with the transportation and storage of these gases in high-pressure cylinders.

Helium availability is limited but hydrogen can be made anywhere at any time using only water and electricity. An unreliable supply of helium ties the hands of the organizations in the balloon market and limits their ability to capture data. With their limited budgets, meteorological agencies are not readily willing to risk upper air data collection on an expensive and unreliable supply of helium.

Producing safe, affordable hydrogen

These same organizations recognize value in the price difference between hydrogen and helium. Due to the limited availability of helium, it becomes more expensive to source and more difficult to obtain, two of the problems solved with on-site hydrogen generation.

On-site hydrogen generation eliminates the issues of scarcity, delivery, and cost when compared with helium, and there are several cheap ways of generating the gas: on-site production via a chemical reaction like steam reforming (a process that generates hydrogen from natural gas or other hydrocarbon fossil fuels); using calcium hydroxide cartridges; on-site production via electrolysis with a liquid potassium hydroxide (KOH) electrolyte; or via electrolysis with a solid polymer electrolyte (PEM).

Solid is better

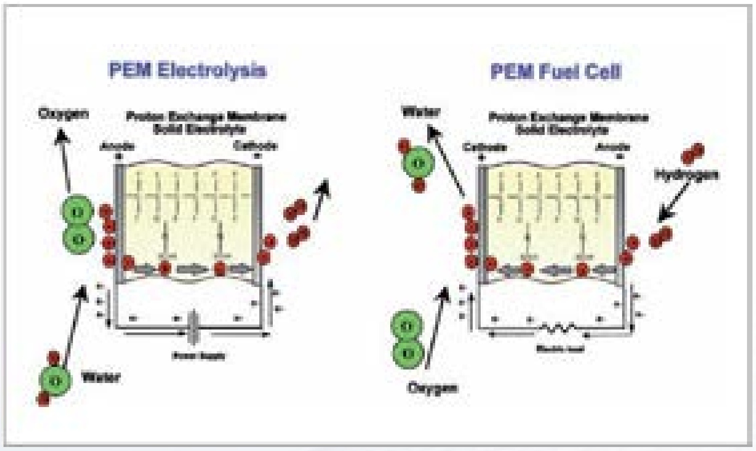
On-site hydrogen generation from fossil fuels is prohibitive for meteorological weather balloons because of the complexity, risks, and fuel costs related with the process.

For the generation systems that produce hydrogen gas from electricity and water, there are two main options: KOH electrolysis and PEM electrolysis, of which the latter uses a solid polymer electrolyte. There are many differences between KOH and PEM electrolysis, with the KOH systems presenting more drawbacks and safety risks. KOH systems, for example, require the use of hazardous, caustic chemicals, including potassium hydroxide. Furthermore, KOH systems typically use a balanced pressure design, which creates a fire/explosion risk when hydrogen and oxygen gases mix.

PEM systems, on the other hand, do not use hazardous chemicals. They also employ a differential pressure design, which eliminates the risks associated with mixing the two gases.

Another benefit of PEM systems is that they do not adversely impact the health and safety of personnel or the environment because there is no need to handle or dispose of hazardous electrolyte chemicals.

Using a solid electrolyte, PEM systems produce hydrogen from pure water and electricity. The latter can be generated by solar panels, making on-site hydrogen generation independent of local power grids and their limitations, which is an important secondary benefit.



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Ease of maintenance

The maintenance needs for KOH and PEM hydrogen generation systems also differ. KOH system components, for example, corrode with every system start up and shut down. KOH systems typically require 40+ hours of maintenance each year, compared with only around four hours for PEM systems.

PEM systems require a much smaller operating footprint; their components are self-contained in smaller cabinets than commercially available KOH systems; and they do not require separate explosionproof rooms. For meteorological teams working with limited budgets in remote locations, hydrogen generation systems with smaller operating footprints are attractive.

As more and more upper air sites turn to on-site hydrogen generators, it is important to consider the most viable option for production of the gas: Proton Exchange Membrane systems.

Nel Hydrogen's Proton PEM S Series

Hydrogen Generation System

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Hydrogen Generation System