SUPPLEMENT

Hydrogen

Why selecting the right type can make a 'world' of differance

By David Bow, Nel ASA and Proton OnSite

Not all hydrogen is created equal. There are two general types of hydrogen available in today's commercial marketplace: 'brown' hydrogen and 'Green' hydrogen. Brown hydrogen, referring to hydrogen that is produced from hydrocarbon-rich feedstock, is by far the most widely available hydrogen used by the world's industrial markets and has a very large carbon footprint. Green hydrogen refers to hydrogen that is produced by renewable energy and water using a process called electrolysis.

Green hydrogen is getting a lot of attention from both environmentally conscious businesses and government legislators. It has been more expensive due to high electricity pricing, but the costs have been dramatically improved by the growing renewable energy assets operating in major developed economies. The overwhelming positive impact green hydrogen has on the environment is paramount due to its extremely low carbon footprint.

The 'Green Movement' is on the rise. Concerns over global warming, climate change and air pollution-related health issues have placed increasing pressure on the world's business and government leaders to take action to reduce their carbon footprints. Whether it's transportation, electricity being used, or the paper they print on, most are considering options for sourcing materials for processes that help to minimise the amount of greenhouse gases they put into the atmosphere.

There are limited laws requiring businesses to make these changes, but they act because their customers and shareholders appreciate the fact that they are making an effort to reduce their impact on the environment. Hydrogen gas is required in many industrial processes such as chemical manufacturing, oil refining, material processing, hydrogenation of pharmaceuticals, oil and food products, semiconductor fabrication, power plant generator cooling, crystal growth, and float glass manufacturing. Hydrogen is a vital part of these operations, so it is understandable why companies would like to source hydrogen that has a reduced carbon footprint.

Although hydrogen is the most abundant element in the universe, it is largely present on Earth locked up in hydrocarbons and water molecules. The primary hydrocarbons used to generate hydrogen are natural gas, coal and petcoke. As an example, China produces 22 million tonnes per year (tpy) of hydrogen using coal and petcoke. At 17 tonnes of carbon dioxide (CO_2) per tonne of hydrogen, this equates to 373 million tonnes of CO_2 – this is equivalent to the annual carbon emissions of 93 million cars.

HYDROGEN PRODUCTION MEANS AND VALUES

Hydrocarbon	CO_2 Emitted per Tonne of Hydrogen Produced
Natural gas	10 – 12 tonnes
Coal	17 – 19 tonnes
Petcoke	17 – 19 tonnes

The electrolysis process of extracting hydrogen from water uses a DC-driven electrical potential to break the bonds of water molecules. Using renewable electricity, the electrolysis process does not emit any CO_2. There are two main types of commercial electrolysis: Proton Exchange Membrane (PEM) and Alkaline electrolysis. PEM technology utilises a solid polymer electrolyte membrane and an applied current to separate hydrogen (via protons) and oxygen from water. The electrons are then transported from the anode electrode to the cathode electrode via the electrical circuit. The electrons combine with protons to create hydrogen molecules. PEM technology has a fast response ramp-up and ramp down capability and a wide dynamic operating range of 0-100%, making it ideal for generating hydrogen using excess renewable energy. PEM technology is also compact, reliable, and low maintenance; suitable for small-to-medium industrial applications. Alkaline electrolysers use a liquid electrolyte (potassium hydroxide solution in most cases) with a porous separator between the anode and cathode. In this case, hydroxide ions cross the separator via the liquid solution to form oxygen and water. At the other electrode, hydrogen is co-generated with hydroxide ions. Modern alkaline technology is extremely efficient, reliable, and cost-effective.

Onsite gas generation or local gas generation via electrolysis are great alternatives to the current gas distribution model. Traditionally, hydrogen gas needs to be transported long distances from major petrochemical facilities to local distribution centres or direct to large consumers in gas or liquid form. For small-to-medium-size consumers, the hydrogen is transferred into pressurised tubes or cylinders at local distribution centres and delivered to customer sites. This carbon intensive distribution process can be replaced by local gas generation and distribution, or on-site gas generation. Gas suppliers can lease or sell gas generation equipment to customers, or reduce their own carbon footprint by offering green hydrogen options to their customers. End-users may also opt for on-site hydrogen generation to reduce their carbon footprint, minimise site hydrogen storage, improve facility safety conditions and reduce cost.

Adding up the pros and cons, it quickly becomes obvious that the world will be a better place by selecting ‘green’ hydrogen over the costly and polluting ‘brown’ alternative. In most cases, hydrogen users have a choice between the two and it is hoped that, once educated, these users will consider their options and make the ‘Green Choice’.

ABOUT THE AUTHOR

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