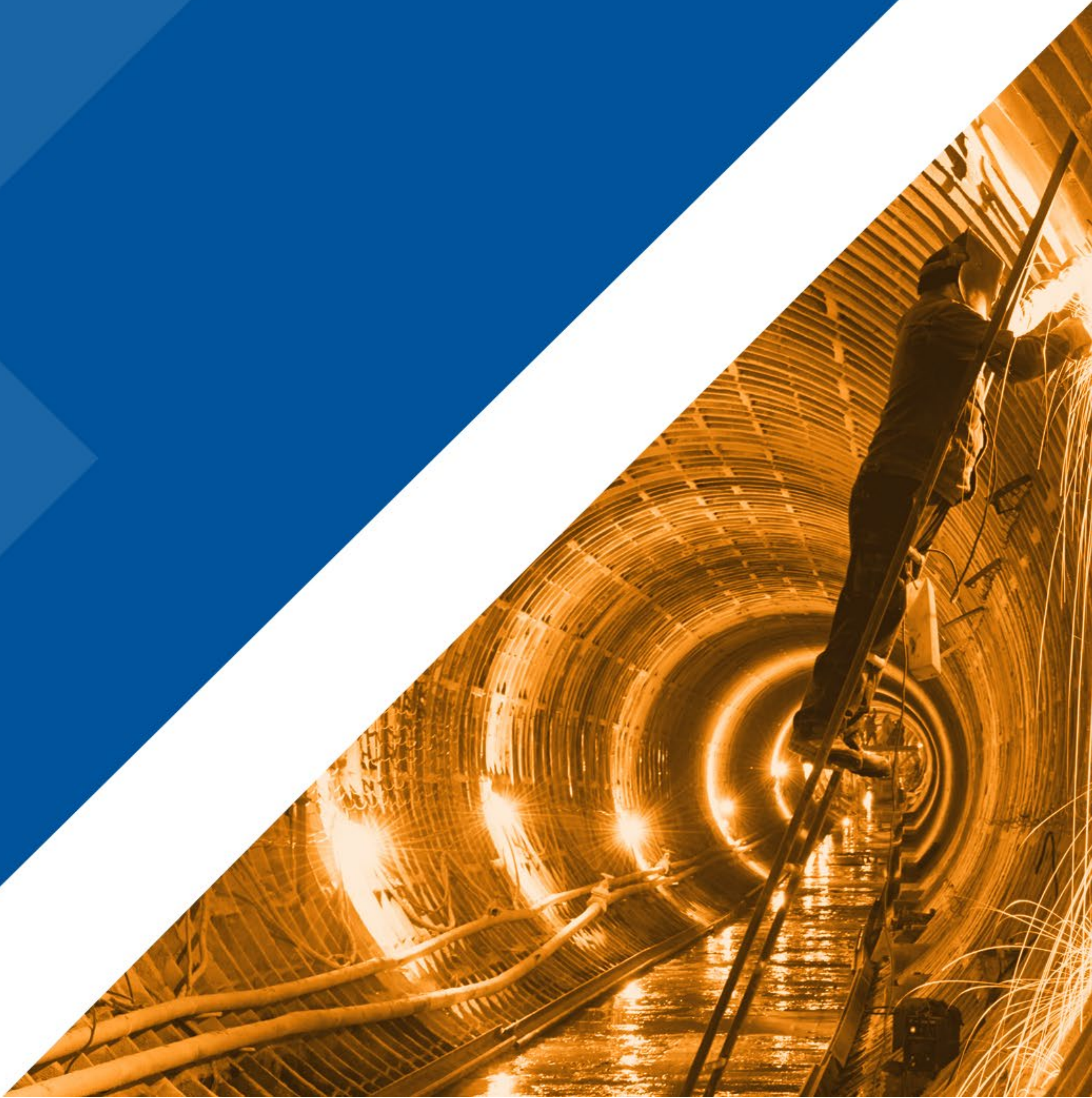
CROWCON
Detecting Gas Saving Lives

Hydrogen Power

Application brief

October 2021

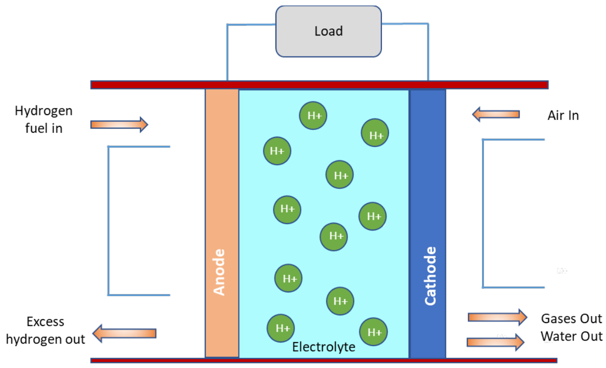


Introduction

Hydrogen has a long history of use as an energy source. Traditionally it has been used as a component of rocket fuel and in gas turbines to produce electricity, or burned to run combustion engines for power generation. In the oil and gas industry, refineries use excess hydrogen generated from the catalytic reforming of naphtha as fuel for other unit processes. In addition, by-product hydrogen is also generated: in the chemical industry, for example, the chloro-alkali industry produces hydrogen as a by-product of chlorine generation and petrochemical plants release hydrogen as a by-product of their olefin production.

Hydrogen is commonly used as a raw material to produce ammonia and methanol for agriculture, mining and marine applications. Pure hydrogen gas is also used as a reducing agent for blast furnaced in steel plants, as part of the industry's effort to reduce CO_2 emissions.

Although hydrogen and energy have a shared history, and the hydrogen fuel cell (where hydrogen and oxygen are mixed in the presence of an electrolyte to produce both electricity and water as by-products) was invented almost 200 years ago, see below schematic of a hydrogen fuel cell. Hydrogen's use as a fuel of choice for vehicles and domestic gas supply in consumer environments is relatively new. Hydrogen burns clean when mixed with oxygen, and is seen as a green fuel alternative in transport, shipping and heating (both domestic and industrial). Read more about hydrogen fuel cells in our application brief here.



Schematic diagram of a hydrogen fuel cell

Demand for hydrogen as an alternative fuel has grown significantly over recent years and is expected to reach 80 million tons/year in 2022 according to report from S&P Global/Platts. For many oil and gas companies aiming to decarbonise, hydrogen is a fuel of choice to comply with climate targets. Hydrogen use is expected to take off in the next 10–20 years, with costs driven down as hydrogen becomes more widely produced. Government support also plays a large part in encouraging investment in hydrogen fuel. Recently, the New South Wales (NSW) government unveiled a A$3 billion (US$2.2 billion) green hydrogen strategy that it hopes will drive more than A$80 billion worth of investment in the Australian state.

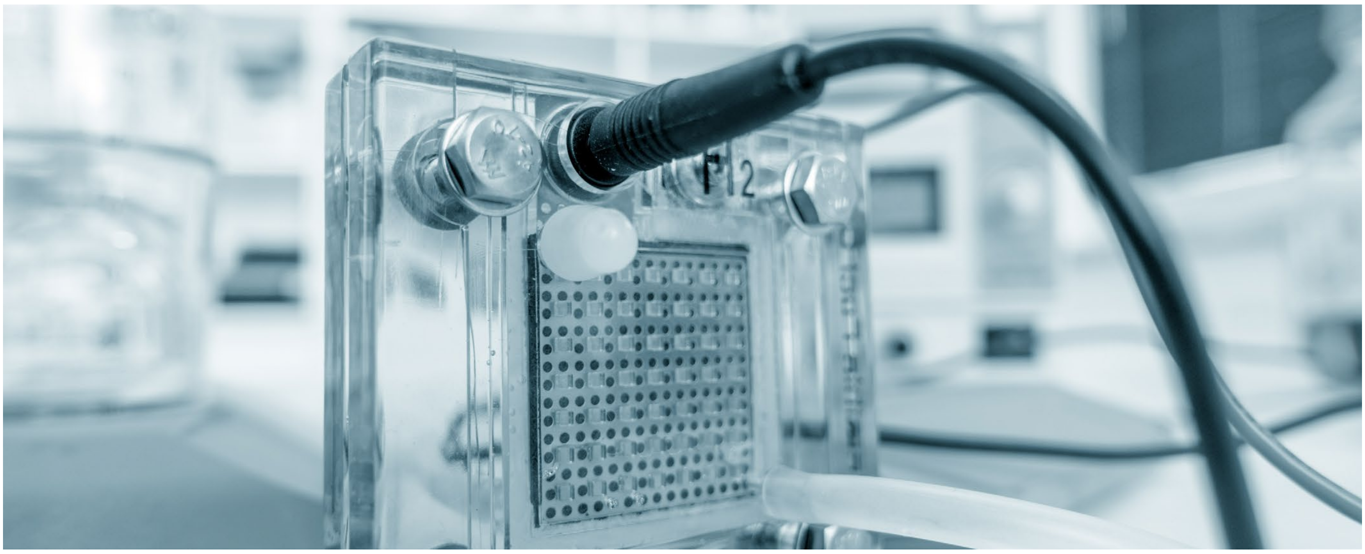
The term 'hydrogen economy' refers to the vision of using hydrogen as a low-carbon energy source, for example, replacing gasoline as a transport fuel or natural gas as a heating fuel. It is expected that the hydrogen economy will contribute to reducing the consumption of carbon-based energy and greenhouse emissions, while stimulating economic growth and job opportunities. For example, Malaysia's state-owned oil company, Petronas (through its subsidiary Petronas Gas & New Energy Sdn Bhd) has signed a memorandum of understanding

(MoU) with ENEOS Corporation to jointly develop a competitive, clean hydrogen supply chain between Malaysia and Japan, and to explore other hydrogen opportunities.

An overview of hydrogen production

We know that hydrogen is a good choice of fuel for industries looking to decarbonise, but not all hydrogens are created equal. Hydrogen does not exist naturally, it must be produced from other compounds such as natural gas, biomass, alcohols or water. More than 70% of the world's hydrogen supply currently comes from steam methane reforming (SMR), and if this hydrogen were to be produced via the SMR pathway but without coupling this with carbon capture and storage (CCS) technology, it would generate a significant increase in total emissions, a net increase in natural gas demand and significantly increased costs. For this reason, hydrogen's contribution to carbon neutrality and climate change largely depends on how it is produced, and hydrogen is described in terms of different colours, according to the production methods involved. You can read about the different colours of hydrogen in our blog.

Regulations and requirements in the hydrogen industry



Currently ISO 22734-1:2019, *hydrogen generators using water electrolysis* is available for hydrogen generators that use electrolysis of water to produce hydrogen and oxygen gas. This ISO standard specifies that a hydrogen gas detection system that initiates ventilation at 0.4%v/v (100%LEL) hydrogen must be installed close to the hydrogen generator. Hence, a gas detector should ideally come with relay output to trigger a ventilation system when the hydrogen level exceeds 0.4% v/v in air. The ISO standard also specifies that gas detectors should be installed at optimal locations, i.e., those that permit the earliest possible detection of hydrogen gas.

Gas detection in the hydrogen industry

Hydrogen has a wide flammable range (4%–74% vol in air), so even small quantities of H_2 can cause explosions when mixed with atmospheric air. Just a spark of static electricity from a person's finger is enough to trigger an explosion when hydrogen is present, and in many locations where hydrogen is used, spark ignition from electrical components or maintenance activities is an ever-present risk.

However, with appropriate measures such as risk assessment, hazard and operability (HAZOP) analysis and the implementation of appropriate mitigating actions (such as gas detection being linked to the ventilation system), the risks associated with hydrogen production, storage, distribution and use can be minimised. Appropriate gas detection systems play a major role in optimising safety across the full hydrogen value chain.

Flammability Risks

Hydrogen has many unique properties that make the deployment of a gas detection system significantly more challenging than is the case for other flammable gases. Hydrogen is the lightest gas compound and tends to leak, due to its very small size and low density (0.09 g/L at NTP of 0°C/1 atm) which corresponds to a high buoyancy. Hydrogen is odourless, colourless and tasteless, so leaks are hard to detect using human senses alone.

Hydrogen is non-toxic, but in indoor environments like battery storage rooms, hydrogen may build up and cause asphyxiation by displacing oxygen. In fuel cell stacks, hydrogen is prone to leak from seals present at process connections near the H_2 storage cylinders. There is more information in our factsheet.

Hydrogen gas leak detection relies on sensors that detect the gas and indicate the concentration (%LEL or ppm) through local display or signal output. These signals can be used to trigger alarms and initiate other safety measures, such as ventilation systems. The ideal hydrogen gas leak detection sensor should have fast response time (expressed as t90), be able to detect a low concentration of hydrogen accurately and be able to detect the target gas when it is mixed with other gases. Repeatability, a long service life and the ability to operate with minimal maintenance are also key considerations, because hydrogen detectors are generally installed at height (for example, on the ceiling), where leaking hydrogen is likely to pool.

Flammable Gas Detection

Until very recently, the detection of hydrogen was restricted to pellistor sensor technology. However, pellistor sensors are prone to poisoning and require regular calibration to verify performance. However, the recent introduction of MPS™ sensor technology to detect flammable gases (including hydrogen) has changed the landscape entirely. The MPS™ sensor is an extended-life sensor for multiple flammable gases, which does not require calibration at any point in its lifecycle, resists sensor poisoning and minimises the risk of false alarms. As well as driving up safety in areas where flammable gases pose a risk, MPS™ technology generates significant savings on total cost of ownership, and reduced interaction with the unit drives down occupational risk for operators. Please see our webpage to learn more.

The use of personal detectors to monitor hydrogen must be tailored to the situation involved; users must determine whether they need %LEL detection in a potentially explosive atmosphere, and/or ppm level detection to identify leaks.

In addition to pellistor and MPS™ technology for %LEL range, an electrochemical sensor is often used where early detection of any leak is required, for example in battery charging facilities. Crowcon has a wide range of detectors available for low range (0–1000ppm) to %LEL range detection.

Flame Detection

Another concern around hydrogen flammability and detection is that hydrogen flames are pale blue in colour and nearly invisible to the human eye. Hydrogen flames also emit low radiant heat, so people may not feel that heat until they are very close to the flame. Flame detectors are therefore used to complement point gas detectors, as they cover a wide area. Hydrogen flame can be detected using multi-spectrum infrared detectors.

In summary, gas detection represents the first line of defence against hydrogen leaks. Actions should be taken to prevent hydrogen release before a flame or explosion can occur. Flame detectors are used as perimeter monitoring to ensure that any hydrogen flame is detected and appropriate alert/ alarm signals are given to make operators aware.

Do you have any questions about the issues raised in this document? Please contact Crowcon if you have any questions on hydrogen gas detection.

Sources

- Injecting hydrogen in natural gas grids could provide steady demand the sector needs to develop (S&P Global, 14 May 2020)
- After 2020 global hydrogen demand decline, market could rebound by 2022 (S&P Global, 21 Jan 2021)
- The Future of Hydrogen – seizing today's opportunities (IEA Technology report, June 2019)
- PETRONAS and ENEOS Expand Energy Partnership to Include Hydrogen Business (Petronas media release, 10 Sep 2021)
- Australian state unveils 'world leading' green hydrogen strategy to drive $58.7bn investment (Upstream News, 13 Oct 2021)

Portable monitors

T4

- Easy to use one-button functionality
- TWA resume function
- Easy servicing and quick turnaround
- Bump test station available

Gas-Pro

- Integrated pump (up to 30 m sampling)
- One-button operation
- IR sensor for wide range of hydrocarbons
- Confined space entry (CSE) kit available
- Bump test station available

Gasman

- Easy to use one-button functionality
- TWA resume function
- Easy servicing and quick turnaround
- Industry's first 5-year warranty Oxygen sensor
- Next generation flammable gas sensor with MPS technology

Fixed monitors and controllers

Xgard

- Rugged reliable detector
- Available in various gases and material
- mA or mV output

Xgard Bright

- Modbus or Hart output
- Local display
- Non-intrusive calibration
- Modbus or Hart output
- Now available with MPS™ (molecular property spectrometer) sensor for calibration-free detection of 19 flammable gases simultaneously

XgardIQ

- Universal transmitter for all sensor types
- Hot swap sensor module – no special tools required
- Non-intrusive calibration
- Modbus or Hart output
- SIL2 rated
- Remote sensor option available

Vortex

- Up to 12 configurable channels
- Modbus compatibility
- SIL 1 (IEC 61508) validated

GM Controllers

- Up to 128 channel inputs
- Modular configuration
- Touch screen display