



## Instrumentation for Hydrogen Applications

# Driving Efficiency in Hydrogen



Hydrogen itself is not an aggressive media but it has some characteristics which must be considered when it is being used. It may form an explosive atmosphere and so area classification is a vital consideration

Hydrogen is used in various industries to create diverse products such as fertiliser and ammonia in the chemical industry and the hydrogenation of fatty oils in the food and beverage industry.

It's versatility makes it a useful alternative energy source supporting the energy levels derived from other green sources such as wind or solar. Its ability to be stored and moved from the production site to the user's site, ensures it can fill any energy delta, thereby assisting in the sustainability of the energy required.

Depending upon how the energy is obtained Hydrogen has different names:

- ▶ **Grey:** This is what most of the worlds hydrogen currently is and is produced from natural gas or methane via steam reforming without capturing the CO<sub>2</sub> generated
- ▶ **Blue:** During the steam reforming process, a high proportion of the CO<sub>2</sub> generated is captured and stored this is low carbon hydrogen
- ▶ **Green:** Made using electricity from renewable sources to split water molecules into hydrogen and oxygen – this is carbon free hydrogen and is viewed as the most environmentally friendly

## Collaboration with Us

Accurate measurement and control of pressure, flow, level and temperature are essential to maintaining safety, efficiency and compliance across hydrogen applications.

With over 100 years of engineering expertise, Delta Mobrey designs and manufactures robust process instrumentation built to perform in demanding environments. Engineered to withstand extreme pressures, temperatures and challenging process conditions, our high-performance solutions deliver reliable monitoring and control of fluids and gases - supporting safe and efficient operation throughout the hydrogen value chain.

# Working with Hydrogen

- ▶ It may form an explosive atmosphere and so area classification is a vital consideration
- ▶ Hydrogen atoms can permeate through materials
- ▶ It may lead to the embrittlement of metals

These factors tend to be more prevalent when Hydrogen is working at either high temperatures or high pressures and is in a gaseous state.

## Hydrogen Permeation

This is a simple chemical phenomenon, but its effects are most significant on pressure transmitters, which use metallic diaphragms and diaphragm seals to separate the process from a sensor using oil.

Hydrogen is normally found in its molecular state  $H_2$ , composed of two Hydrogen atoms, but in certain conditions, the molecule splits into two single hydrogen ions  $H^+$ .

Because of the size of these ions, they are able to penetrate through the metal material of a metallic diaphragm of the instrument. Once the ions  $H^+$  pass through the walls of the metallic diaphragm, and are in contact with the filling fluid, which is electrically neutral and very stable, the ions will start to reform  $H_2$  molecules.

The  $H_2$  molecules will then be trapped inside the fill fluid of the transmitter because they are once again too large to pass back through the isolation diaphragm. Gradually over time, the  $H_2$  molecules will dissolve into the fill fluid and generate bubbles, causing an internal overpressure and a continuous drift of the zero of the instrument.

The use of separation diaphragms made in Monel or Hastelloy or other exotic materials, will not solve the problem, but they could make it worse. To avoid this phenomenon, it's highly recommended to use a gold plated separation diaphragm on the process side. This is because the space between the molecules of gold is extremely low and will reduce the possibility of transfer of ions  $H^+$  from the process to the filling fluid.

On mechanical products such as Bourdon tube pressure gauges or Bourdon diaphragm, or bellows actuated pressure switches, this effect is not seen. If we are using (as a minimum) SS316 sensing elements, there is also no effect on the conductive type of instruments in our portfolio, such as Hydratect and Hydrastep.

## Embrittlement

The presence of  $H^+$  ions can cause embrittlement of the metallic material. This is a phenomenon that causes loss of ductility and consequently the brittleness in a material. This is also known as hydrogen-induced cracking or hydrogen attack.

This happens in the presence of both liquid or gasses and involves the ingress of hydrogen into the metal, reducing its ductility and load-bearing capacity.

Due to the small dimensions of the H<sup>+</sup> ions, they can penetrate between the lattice structure of the material and then recombine creating Hydrogen molecules H<sub>2</sub>.

There are several potential sources of hydrogen embrittlement and these be classified into two main types:

**Internal hydrogen embrittlement:** This occurs when the hydrogen enters molten metal which becomes supersaturated with hydrogen immediately after solidification

**Environmental hydrogen embrittlement:** This results from hydrogen being absorbed by solid metals. It can occur during elevated-temperature thermal treatments and in service during electroplating, contact with maintenance chemicals, corrosion reactions, cathodic protection, and operating in high-pressure hydrogen.

This phenomenon has a very low impact on pressure and temperature gauges, switches and also transmitters. On level switches the effect is negligible due to the typical applications of these instruments.

It has no effect at all on the ultrasonic gap sensor instruments when immersed in liquids and also has no effect on the conductive sensors used within our Hydrastep and Hydratect products.

## Material selection and product type

For most industrial instrumentation applications, the permeation of hydrogen atoms is generated in the presence of high pressure and temperature. It also depends on many other conditions like corrosion, catalyst protection, media aggression, process fluid state, but in principle, it is necessary to take action where the process conditions are above 70bar and 170°C.

High-strength and low-alloy steels, nickel and titanium alloys are the most susceptible materials to this phenomenon and some care should be given to the selection of the materials of the wetted parts of the instrument. Monel and Hastelloy in particular, do not offer a great resistance to permeation.

## Area Classification and Product Selection

Within industry, a potentially explosive atmosphere, such as Hydrogen, will be classified according to the frequency and duration of the presence of the gas. Because Hydrogen is a highly combustible media, the area where an instrument may be installed is normally classified as hazardous and the instrument in contact with this process, must be certified for use in such an area and with adequate protection methods.

The problems associated with Hydrogen appear mostly with pressure measuring instruments and with the control instruments equipped with the diaphragm.



Hydrogen is used in multiple industries to produce a diverse range of products; fertilisers, commodities, such as plastics and used to grind metals. Looking at the universal drive to utilise more green energy, Hydrogen looks to be an important aspect within the energy matrix. It's versatility makes it a useful alternative energy source with its ability to be stored ensures it can fill the energy delta, thereby meeting the required levels of energy.

By understanding how this element reacts with differing metals we can really understand what we need to do to make it work better for us.

For ease of understanding we have consolidated which of our products work best within differing classifications of hazardous areas. This information has been condensed into the table below.

Zone 0 and Zone 0/1						
Gauges	Not used in Zone 0					
Switches	Requirement Intrinsically Safe Flameproof	<b>PRESSURE</b> SENTRY INDUSTRIAL COMPACT	<b>DIFFERENTIAL PRESSURE SWITCHES</b> SENTRY INDUSTRIAL	<b>TEMPERATURE</b> SENTRY INDUSTRIAL		
Transmitters	Requirement Intrinsically Safe	<b>ANALOGUE D Series PRESSURE</b> D-SERIES 387 COMPACT	<b>DIFFERENTIAL PRESSURE TRANSMITTERS</b> D-SERIES	<b>DIGITAL HART SMART "HART" PRESSURE</b> D-SERIES 2HT	<b>DIFFERENTIAL PRESSURE TRANSMITTERS</b> D-SERIES	<b>TEMPERATURE</b> D-SERIES
Zone 1						
Gauges	Requirement Assessed for Hazardous Area	<b>PRESSURE- OPEN FRONT</b> Ax 3700	<b>PRESSURE- SOLID FRONT</b> AS	<b>DIFFERENTIAL PRESSURE</b> DA 3700	<b>TEMPERATURE</b> Gx 3700	All with or without electric contacts
Switches	Requirement Intrinsically Safe and Flameproof	<b>PRESSURE</b> SENTRY INDUSTRIAL COMPACT	<b>DIFFERENTIAL PRESSURE</b> COMPACT SENTRY INDUSTRIAL	<b>TEMPERATURE</b> COMPACT SENTRY INDUSTRIAL		
Transmitters	Intrinsically Safe and Flameproof	<b>ANALOGUE PRESSURE</b> D-SERIES 387	<b>DIFFERENTIAL PRESSURE TRANSMITTERS</b> D-SERIES	<b>SMART "HART" PRESSURE</b> D-SERIES 2HT	<b>DIFFERENTIAL PRESSURE TRANSMITTERS</b> D-SERIES	<b>TEMPERATURE</b> D-SERIES
Zone 2						
Gauges	Requirement Assessed for Hazardous Area	<b>PRESSURE- OPEN FRONT</b> Ax 3700	<b>PRESSURE- SOLID FRONT</b> AS	<b>DIFFERENTIAL PRESSURE</b> DA 3700	<b>TEMPERATURE</b> Gx 3700	All with or without contacts
Switches	Intrinsically Safe and Flameproof	<b>PRESSURE</b> SENTRY INDUSTRIAL COMPACT PERFORMANCE	<b>DIFFERENTIAL PRESSURE SWITCHES</b> SENTRY INDUSTRIAL COMPACT PERFORMANCE	<b>TEMPERATURE</b> SENTRY INDUSTRIAL COMPACT PERFORMANCE		
Transmitters	Intrinsically Safe and Flameproof	<b>ANALOGUE PRESSURE</b> D-SERIES 387	<b>ANALOGUE DIFFERENTIAL PRESSURE TRANSMITTERS</b> D-SERIES	<b>SMART "HART" PRESSURE</b> D-SERIES 2HT	<b>SMART "HART" DIFFERENTIAL PRESSURE TRANSMITTERS</b> D-SERIES	<b>TEMPERATURE</b> D-SERIES

# Product Sample

We offer a wide range of configurations for the instruments that need to be used in the presence of Hydrogen. Because of the working principle of the instrument, the main effect of hydrogen permeation is on the pressure transmitters. Some precautions must be taken with these products. For all the other products (mechanical, ultrasonic and conductive type), being aware of the material selection is sufficient.

## D Series Pressure and Temperature Transmitters:

The D Series offers a wide range of transmitters, that are available in IECEx or ATEX with intrinsically safe or flameproof protection mode, making them a perfect option when dealing with potentially volatile environments.

This robust and comprehensive product range is easily configured and can communicate with HART protocols with Handheld Communicators or our D-soft software. The SMART HART instruments have a high standard of accuracy of 0.075%, and higher accuracy 0.04% is available as option. The availability of SIL certified versions makes the instrument suitable for Emergency Shutdown (ESD) systems.



## Sentry Series:



Offers exceptional performance and high build quality in a simple, safe and cost-effective package. Recently been redesigned into a simple one-piece enclosure, so we use 70% less material in the manufacturing process without compromising on the quality or the performance of the product.

Safety is maintained by a vent that stops the enclosure becoming pressurised should a sensor be damaged. By keeping a selection of common standards, we can maintain the costs associated with the manufacture of this product, although as with all our products, there are a variety of optional extras available upon request. The availability of SIL certified versions are suitable for ESD systems.

## Industrial Range:

Our robust range of Industrial switches use diaphragm based sensors and a more traditional in-line force balance mechanism to transfer movement from the sensor to the microswitch, these switches are suitable for a wide range of industrial applications.

Various international approvals make the Industrial Series suitable for use in both safe and hazardous areas in Europe, North America and throughout the world. Also, SIL certified versions are available making the instrument suitable for ESD systems.



## Compact Series:



These pressure switches provide users with a compact, robust and hermetically sealed switch for use in Safe and Hazardous Areas. All housed in a compact and rugged enclosure making them particularly suitable for panel mounting in harsh environments. All models in the Compact Series come with hermetically sealed switch contacts and flying leads as standard. The series can be used in ESD systems with SIL certified versions.

## Horizontal and Vertical Level Switches

Our range of Vertical and Horizontal level switches are one of our best sellers for a reason. They have been engineered to be fault resistant and to continually give confidence wherever they are utilised. Our float level switches are rugged, robust, and trusted globally for their long-term reliability in the harshest of environments and the most hazardous areas. Ideal for industrial applications such as pump control and high or low alarm duty on tanks and pressure vessels, making them ideal for hydrogen production from biogas. These are suitable for ESD systems when the instrument is specifically SIL certified.



## Transmitters



Pressure transmitters are the most susceptible instruments to hydrogen permeation, because of the necessity for a thin diaphragm, the presence of silicone oil as filling fluid and the high performance of this type of instrument. For both types, analogue or SMART HART, the sensors are manufactured in the same manner; they are a welded configuration, and we strongly suggest the selection of the SS316L process connection with gold plating on the diaphragm as a minimum to avoid product degradation.

## Switches

For all the range of pressure and temperature switches we suggest the selection of SS316L material for the process connection and for the sensing element. For the design of the sensing element, it is suggested in all welded configurations, to avoid leakages and that there is O-ring or gasket compatibility. This is the same, for the mechanical level switches, where float and all the wetted parts should be in SS316.



## Gauges



No particular precautions are required for the use of Bourdon tube, diaphragm and capsule type pressure gauges. The sensing element of our instruments are made in SS316 as standard, so these are suitable for use with Hydrogen. This is the same for bimetallic type or gas expansion temperature gauges. It is recommended that the use of SS316 in the product construction as a minimum. Gold plating of the diaphragm will ensure safety in the presence of both high pressure and temperature.

## Conductive Type Products

No specific precautions need to be taken. The standard construction does not show any problems in presence of H<sup>+</sup> ions.





The hydrogen sector presents unique challenges, including high pressures, extreme temperatures and material compatibility. Reliable measurement and control are essential to maintaining safety, efficiency and compliance across production, storage and distribution.

With over 100 years of engineering expertise, Delta Mobrey designs and manufactures high-quality process instrumentation trusted across industry. Our solutions support safe, efficient operations and protect critical assets across hydrogen applications.

### **Trusted Quality. Reliable Dependence**

Quality and reliability have always formed the cornerstone of our success, we are recognised by industry with international approvals covering every aspect of our manufacturing, test and product portfolio.

Certifications span all areas of hazardous and regulated environments, and include: ATEX, ICEx, EXd, EXia, NEMA, SIL, IS, PED, NEC 500 and 505, with new certifications being gained.

### **Proven Value**

Performance and value are the reasons why so many customers return and continue to place their trust in us and our products. With continual investment in innovative manufacturing solutions, customers can be confident we can deliver the highest value solutions, without ever compromising on quality.

### **Bespoke Solutions**

We're proud to be able to provide custom engineered solutions to meet your exact requirements.

The complexity of special engineering can vary from a simple change in process connection, or to a completely redesigned product to meet specific operational /performance criteria; available as one-offs through to large volume requirements.

### **Global Presence**

To ensure our customers have immediate and continuous access to our staff and support, we have several strategically placed offices around the globe. For more information, please visit the Contact Us page on our website - [www.delta-mobrey.com](http://www.delta-mobrey.com)



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