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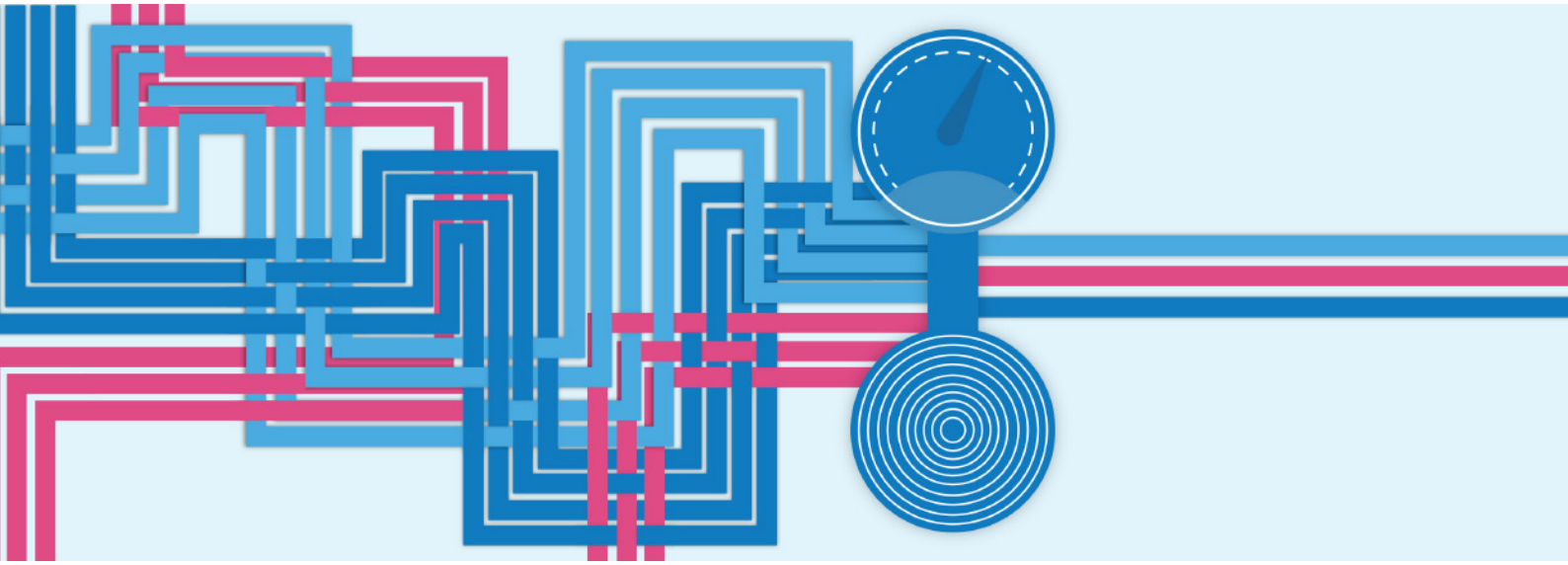


Badotherm: Diaphragm Seal Solutions

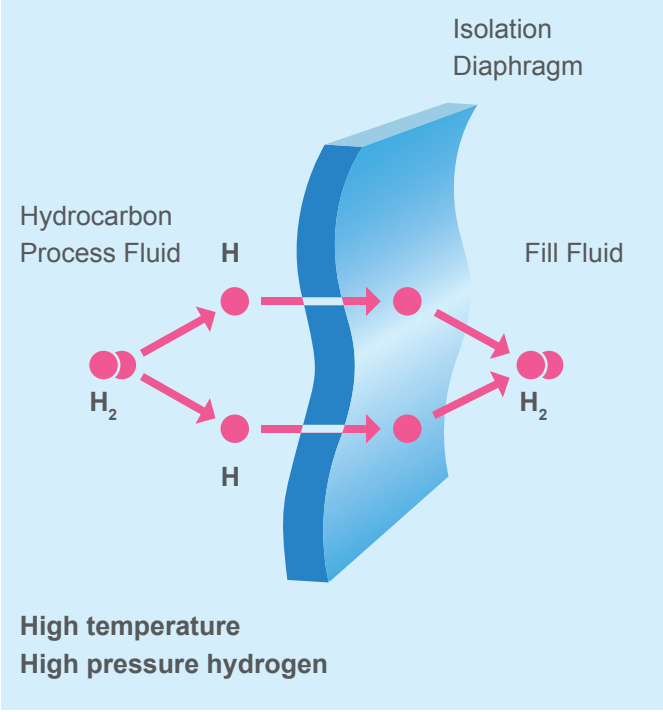
Gold Coating for Diaphragm Seals to protect against hydrogen permeation

Hydrogen is the lightest and most abundant chemical element. Water, acids, bases, and the related family of organic compounds all contain hydrogen. Although hydrogen is not considered to be corrosive, problems with pressure transmitters mounted with Diaphragm Seals can still occur under specific circumstances. For example, a situation in which either high process pressure, a galvanic reaction or high temperature steam occurs in combination with high process temperatures, could result in Hydrogen Permeation of the into H+ splitted H^2 molecules. For this situation, Badotherm offers a solution with the use of a special material on the Diaphragm Seals: a layer of gold coating.

Gold Coating for Diaphragm Seals to protect against hydrogen permeation

Introduction to Hydrogen Permeation

Hydrogen is normally found in a diatomic state, H^2 molecules, composed of two hydrogen atoms. In a diatomic state, molecules will not permeate the thin diaphragm, with a typical thickness of 75µm, of the Diaphragm Seal. However, if the hydrogen splits into two H+ atoms, it can permeate the diaphragm. This occurs because H+ ions are smaller than the space between molecules of the diaphragm material.



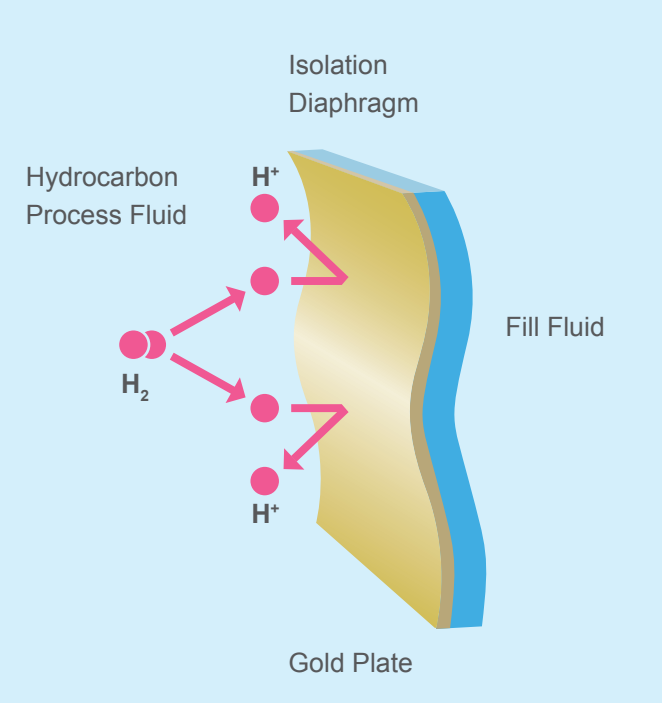
H+ ions permeate the diaphragm and re-unite behind the diaphragm.

Once they have permeated the diaphragm, H+ ions can unite into H^2 molecules that become trapped inside the Diaphragm Seal. The H^2 will then dissolve into the Diaphragm Seal fill fluid and, over time, cause the Diaphragm Seal fill fluid to become saturated, and hydrogen bubbles to appear. The presence of the hydrogen gas bubbles can alter the performance of the transmitter with Diaphragm Seals and thus the measurement to fail.

When the process pressure drops, the trapped H^2 ions are not able to permeate back through the Diaphragm Seal and remain in the system. With the H^2 molecules still in the system, the pressure within the Diaphragm Seal can remain as high as the original process pressure. This will cause the diaphragm to bulge, which leads to a zero reading and span shift, and reduces the performance of the Diaphragm Seal system.

Solution Developed

Gold is one of the noblest materials. As such, providing a thin layer of gold to a base metal will provide protection against hydrogen permeation. To protect the Diaphragm Seal against the permeation of H+ ions through the diaphragm foil, Badotherm offers a layer of 25µm or even 40µm a thickness of gold.



A layer of gold coating protects the H+ ions from permeation through the diaphragm.

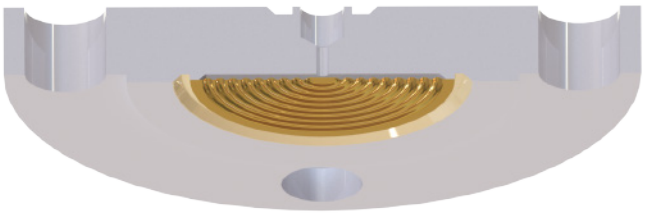
Due to the intermediate layer of nickel, the temperature limit of Gold Coating is normally 280°C. Above this limit a normal Gold Coating will be damaged or even detached from the diaphragm. Together with TNO Delft, an independent Dutch Research Organisation, Badotherm developed a new procedure to attach the gold directly to the diaphragm without any intermediate layer. With this new type of procedure the temperature limit on Gold Coating is increased to 400°C.

Whereas a layer of 25 µm is often considered the market standard and offers sufficient protection, the 40 µm thickness offers increased security at extreme conditions. The 40µm Gold Coating thickness was engineered and designed specifically for the Hycon project for one of the largest refineries in the world, located in The Netherlands. Because the operating temperatures (320°C) and pressures (180 bar) in this project were extreme, additional tests on various thicknesses were executed by TNO. The result was that only a 40µm thickness offered the required additional warrantees for the non-porosity for H+ ions.

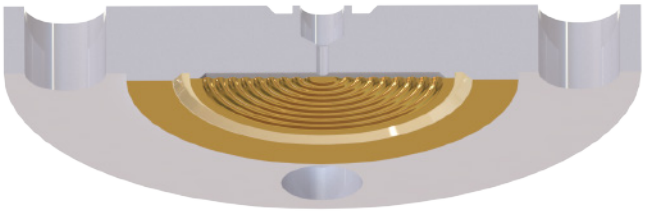
Gold Coating for Chemical Resistance

As stated before, gold is one of the noblest materials available. The Gold Coating protects the diaphragm from the permeation of even the smallest molecules; it is also very suitable for increasing the chemical resistance of the Diaphragm Seal materials.

- To protect against hydrogen permeation (HP) only the diaphragm is coated.
- To ensure chemical resistance (CR), the Gold Coating is extended to the outside diameter of the gasket surface.



Diaphragm only for the protection against hydrogen permeation (HP).



Diaphragm + raised face protection against hydrogen permeation AND for corrosion protection (HP+CR).

Temperature Limits

Gold coating in combination with 316(L) material have a temperature limit up to 400°C, in combination with Monel or Hastelloy C276 the temperature limit is 200°C.

	25µm HP	25µm HP+CR	40µm HP	40µm HP+CR
Diaphragm Material				
AISI 316(L)	•	•	•	•
Monel 400	•	•	•	•
Hastelloy C276	•	•	•	•

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Technical Specifications

The table below presents the technical specifications of the Gold Coating for Diaphragm Seals. Gold coating is suggested in applications where atomic hydrogen is present. However, it is not necessary for all hydrogen service applications. Every application is different and the materials should be selected carefully. It remains the end user responsibility to select the appropriate materials suitable for the process conditions.

	25µm HP	25µm HP+CR	40µm HP	40µm HP+CR
Diaphragm Seal type				
BF	•	•	•	•
BC	•	•	•	•
US*		•		•
USL*		•		•
BHS	•		•	
PTH*		•		•

HP = Hydrogen Permeation; CR = Chemical Resistance

** Lower part is not gold coated.*