INTRODUCTION HYDROGEN PERMEATION

Hydrogen is the lightest and most abundant chemical element. Hydrogen is not considered to be corrosive, still problems with Diaphragm Seals can occur under specific circumstances. These can be with high process temperature in combination with high process pressure, a galvanic reaction, or with high temperature steam.

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 diaphragm. However, if the hydrogen splits into two H^+ atoms, it can permeate the diaphragm as H^+ ions are smaller than the space between molecules of the diaphragm material.

After permeation through the diaphragm, H^+ ions can unite into H^2 molecules which become trapped inside the Diaphragm Seal. H^2 will dissolve into the Diaphragm Seal fill fluid and over time the seal fill fluid will become saturated, a hydrogen bubble will appear, and the measurement will fail.

When the process pressure drops, the trapped H^2 ions are not able to permeate back and remain in the Diaphragm Seal system. With the H^2 molecules in the system the pressure within the Diaphragm Seal could remain as high as the original process pressure. The result is that the diaphragm will bulge, which leads to a zero and span shift and reduces the performance of the Diaphragm Seal system.

SOLUTION DEVELOPED

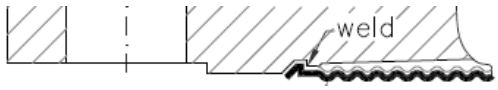
To protect the diaphragm seal diaphragm against the H^+ ions permeation a Gold Coating is advised. Badotherm offers a 40µm and 25µm thickness for Gold Coating on Diaphragm Seals.

Normally, the temperature limit of Gold Coating is 280°C, because of by the intermediate layer of nickel. Above this limit a normal Gold Coating will be damaged or even detached from the diaphragm. Together with TNO Delft, which is an independent Dutch Research Organisation, Badotherm developed a new procedure to plate 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.

The 40µm Gold Coating thickness was engineered and designed specifically for the Hycon project in The Netherlands. Because in this project the operating temperatures (320°C) and pressures (180 bar) were extreme, additional tests on various thicknesses were executed by TNO. The result was that only a 40µm thickness could warrant the non porosity for H^+ ions.

CHEMICAL RESISTANCE

As the Gold Coating protects the diaphragm to even the smallest molecules it is also very suitable to increase the Chemical Resistance of the Diaphragm Seal. For protection against Hydrogen Permeation the diaphragm only is coated, but to ensure Chemical Resistance the Gold Coating is extended to the outside diameter of the gasket surface.



Hydrogen Permeation

Hydrogen Permeation and Chemical Resistance

TECHNICAL SPECIFICATIONS

The table below presents the technical specifications of the Gold Coating for Diaphragm Seals.

	25µm HP	25µm HP+CR	40µm HP	40µm HP+CR
Maximum temp.	400°C	400°C	400°C	400°C
Diaphragm Seal type				
BF	•	•	•	•
BRF	-	•	-	•
BC	•	•	•	•
BRC	-	•	-	•
US	-	•	-	•
USL	-	•	-	•
BHS	-	•	-	•
Diaphragm Material				
AISI 316(L)	•	•	•	•
Monel 400*	•	•	•	•
Hastelloy C276*	•	•	•	•

HP = Hydrogen Permeation; CR = Chemical Resistance

* Maximum temperature 200°C

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