Angst+Pfister

Sealing Solutions for Hydrogen Applications

Hydrogen is a highly promising source of energy for the future: its calorific value is greater than oil or natural gas and it combusts with neutral impact on the climate – that is, without releasing CO_2. Hydrogen is known as "green" hydrogen when it is produced from renewable sources: the unstoppable advance of investment in hydrogen technology is massive right now.

Gas is a tricky one for elastomer seals, especially Hydrogen, being the smallest molecule of all. This gas can slowly diffuse through the molecular structure of polymers; although hydrogen itself does not damage elastomers chemically, environmental conditions, such as temperature and pressure, can be an issue. Moreover, not all compounds behave in the same sealing performance with Hydrogen.

Angst+Pfister is currently working on investigating the best elastomeric materials, verifying precisely which elastomer is most suitable for which function. When considering gases in contact with elastomers, permeation is one of the key parameters to be considered: the polymer structure functions as a barrier to gas transport, although gas can slowly diffuse through the molecular structure of the polymer.

A test plan has been established to evaluate compounds performance in terms of permeation, leakage and RGD to ensure that the demanding requirements of sealings in hydrogen applications are met:

- Wide temperature ranges
- High Pressure
- Permeation to gases
- Compound compatibility
- Tight sealing requirements (hydrogen has a very broad flammability range in air)

Contact

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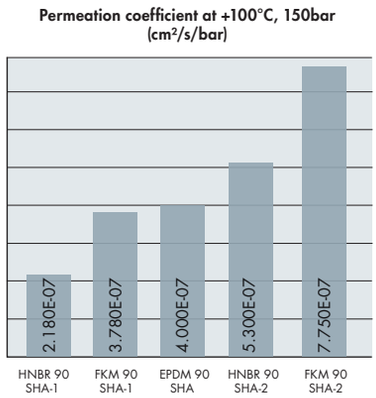
Angst+Pfister tested their 90 Shore A H_2 sealing materials for permeation, leakage and rapid gas decompression in 100% H_2; 70 Shore A materials have been tested for permeation and certified according to DVGW ZP 55101-01.

Testing conditions (90 ShA hardness compounds)

Permeation to gases	**Leakage**	**Rapid gas decompression**
Test acc. to ISO 2782-1: Evaluate compounds in portfolio (effect of polymer type and formulation)	Test acc. to internal method: Measure leakage of O-Rings using H_2 in a pressurised vessel	Test acc. to Norsok M-710 / ISO 23936-2

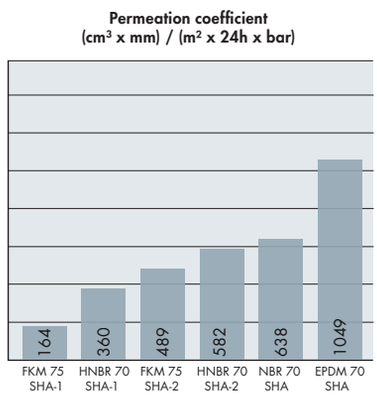
All tests performed at +100°C at 150bar (100% H_2) on HNBR, FKM and EPDM compounds.



Testing conditions (70 ShA hardness compounds)

Permeation to gases	All tests performed at +23°C at 1bar (100% H_2) on HNBR, NBR, FKM and EPDM compounds
Test acc. to ISO 15105-1 (DVGW CERT ZP 5101:2021): Evaluate compounds in portfolio (effect of polymer type and formulation)	

DVGW	Certification program Compatibility and permeation properties of elastomer materials for seals and diaphragms in gas appliances and equipment against hydrogen for a content of up to 100 vol. % H_2 ZP 5101

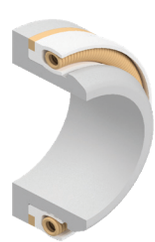


Solution example for sealing a hydrogen storage bottle

Challenge
- +15°C to +50°C
- 1000bar
- Explosive decompression
- Avoid risk for H_2

Solution
- Lip Seal in special PTFE compound
- PEEK spring energizer
- Corner Back-up Ring for extrusion resistance

Added value for customer
- No metals (no H_2 embrittlement)
- No elastomers (no explosive decompression)
- Testing successful
  - Water: 30bar -> 1000bar -> 30bar for 100.000 cycles
  - Hydrogen > 950bar -> 500bar -> >950bar at 10 cycles/min for 60.000 cycles



Solution example for sealings in valves for high-pressure applications

For static sealing applications, rubber O-Rings are used, often with backing washers or molded parts with a special geometry.

For dynamic valve applications spring-energized PTFE seals are the preferred solutions.

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