

SEALING SOLUTIONS FOR HYDROGEN SERVICES

evolution

For the highest rated, safest solution on the market, look no further than the **EVOLUTION**[®] gasket.

Due to its unrivalled sealing performance, **EVOLUTION**[®] is a gasket designed for hydrogen applications. Hydrogen provides a number of unique challenges which have a direct impact on sealing, and the materials used in these applications must be suitable for the challenge.

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THE CHALLENGES SPECIFIC TO HYDROGEN INCLUDE:

Sealing Capabilities – Hydrogen has a high propensity to leak. The reason for this is because of its

- Low viscosity
- Very high diffusivity
- Likelihood of embrittlement
- Smallest molecule gas

- Hydrogen gas could potentially permeate all the way through the material itself, leading to leaks. So even if the seals are doing their job, emissions can still occur through the material.

- Permeation is what can lead to embrittlement. Embrittlement can cause:
 - Mechanical Stress Cracking
 - Hydrogen Induced Cracking
 - Stress oriented hydrogen induced cracking.
 - High temperature hydrogen damage
 - All of these crackings take place within a metal substrate. The rub lies in that metallic seals are likely to be used to avoid leaks from permeation, as gas will not permeate all the way through the material. However, these metals are now susceptible to embrittlement. Essentially, hydrogen is absorbed by the metal, which reduces yield strength and leads to premature failure.

Propensity to Ignite and Consequences of Fire and Explosion

- Wide flammability range
- Very low ignition energy
- Spontaneous ignition

Chemical Compatibility

- Hydrogen soaking can reduce functional strength of materials
- Other medias can be present in hydrogen lines that a seal needs to be chemically compatible with such as CO², amines, steam, H₂S

Overall Safety

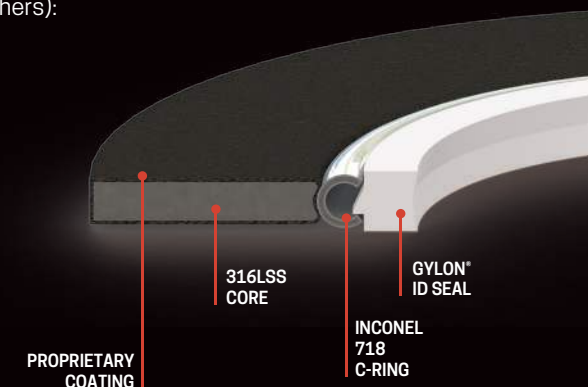
- Limited regulations to date
- Limited testing to date
- There are real and perceived dangers to hydrogen, and if something were to happen this would have a huge impact. Sealing plays a major role in this function.

SEALING SOLUTIONS FOR HYDROGEN SERVICES:

GPT's Evolution gasket brings a sealing solution to hydrogen service by mitigating each of these challenges:

- Evolution is the lowest emission gasket in the industry. The sealing of Evolution utilizes a dual seal design, with both seals, a Gylon ID seal and Inconel C-Ring, being top of their class in sealing. These seals work independently, creating a level of redundancy to create top level sealing, even in small molecule gases such as hydrogen. This has been shown in Shell TAT testing, Chevron CFET testing, API PR2 testing, and more.
- The Evolution gasket has been testing to over 120,000 psi without leakage.
- Evolution utilizes a metal core and metal secondary C-Ring seal. As a result of these, there is no permeation that can occur through the gasket itself.
- Even though these metallic elements are present, there is no exposed metal to the media. Both the metal core and C-Ring seal are completely encapsulated in coating. In addition, sealing will occur inboard of by the Gylon ID seal, protecting the metallic elements from seeing the media.
- GYLON 3510 is a recommended ID seal option as this material is designed to provide the less permeation than elastomer-bound seals.
- Evolution is inherently a fire safe gasket.
- Successfully passed the API 6FB fire test in sizes 6" 300#, 2" 2500#, 12" 600#, and 24" 300#.
- Due to utilizing a Gylon ID seal, Evolution provides chemical compatibility beyond typical metallic and elastomeric gaskets.
- Chemical compatibility for (among others):
 - Hydrogen
 - CO²
 - Amines
 - Steam
 - H₂S
 - Ammonia
- Gylon 3510 has been BAM tested for storage in Hydrogen

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