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Hydrogenated Nitrile (HNBR, HSN)

HNBR seals have a very good heat resistance, high strength and excellent resistance to oxidized fuels and sour crude. Therefore, HNBR seals should be considered for application generally to severe for standard Nitriles (Buna) and should also be considered for selected applications where fluorocarbon (Viton®) seals are currently being used (applications above 250° F involving high-pressure CO_2, H_2S and corrosion inhibitors). HNBR is also referred to as HSN or Highly Saturated Nitrile.

Hydrogenated nitrile is a synthetic polymer that results from the hydrogenation of nitrile rubber (NBR). In this process the molecular “double bonds” in the NBR primary polymer chain undergo a hydrogenation process and therefore the term “hydrogenated nitrile”.

Hydrogenated nitrile rubbers (HNBR) have proven invaluable in extending the boundaries of elastomeric seals in aggressive environments. These materials have the excellent oil and fuel resistance of conventional Nitrile (NBR) elastomers combined with superior mechanical properties and can sustain higher operating temperatures; up to 356ºF when immersed in oil. They also display superior resistance to aggressive fluids such as sour crude oil or gas, lubricating oil additives and amine corrosion inhibitors. HNBR has been commercially available since 1983. Nippon Zeon Company manufactures HNBR under the trade name Zetpol. Mobay Chemical Corporation markets HNBR under the trade name Therban.

As oil wells become deeper and conditions harsher, the traditionally used nitrile and fluorocarbon elastomers may no longer give the long-term performance required.

Nitriles are often inadequate in terms of both thermal and chemical stability, their maximum service temperature typically is about 250° F (120°C). Temperatures can reach 350° F (180°C) in deeper wells and this, in the presence of crude oil, possibly with hydrogen sulphide and formation water/steam will cause degradation of the elastomer. Injected oil well media such as methanol and amine corrosion inhibitors will accelerate the deterioration of standard nitrile.

Fluorocarbon elastomers exhibit very good thermal and hydrocarbon resistance but unless expensive specialized grades are used, they are attacked by a number of commonly encountered oilfield media: amine corrosion inhibitors will cause embrittlement and hydrogen sulphide, methanol and steam will cause softening with a consequent reduction in mechanical properties.

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Some of the important benefits advantages of HNBR compared to standard Nitrile and Fluorocarbons are listed below.

Benefits

Minimum operating temperature -25ºF (-26°C) special grades –50°F (-45°C).
Maximum operating temperature +356°F (180ºC) in oil +320°F (160ºC) in air.
Excellent aliphatic (not aromatic) hydrocarbon resistance.
High tensile and tear strengths and outstanding abrasion resistance.
Suitable for use with water, steam, amine corrosion inhibitors, brines, drilling muds, etc.
Suitable for use with methanol.
Suitable for use in sour environments, up to 5% Hydrogen Sulfide.

Advantages

- **Resistant to Heat.** Standard nitriles have an upper service temperature rating of between 200° and 300°F—depending on the compound formulation. Fluorocarbons in hot water/steam will soften with a consequent reduction in mechanical properties.

- **Resistance to Compression Set.** The compression-set resistance of HSN at high temperatures (such as 302°F) is much better than standard nitriles. The difference is less pronounced at lower temperatures except for special grades. Fluorocarbons will exhibit compression set at temperatures as low 0°F

- **Resistance to Sour Crude.** Oil and gas that contain hydrogen sulfide (H_2S) can cause a substantial decrease in tensile, elongation and hardness in standard nitrile seals and even fluorocarbon seals. Accelerated aging test show standard nitriles, fluorocarbon (Viton® and Viton® GF) and Aflas lost over 70% of their tensile strength after aging 168 hours at 302°F in the liquid phase of an H_2S test. HNBR lost about 30%. In the liquid phase, the H_2S test solution-contained diesel, water and a corrosion inhibitor. In the vapor phase, the test solution contained 5% H_2S by weight along with carbon dioxide and methane.

- **Resistance to corrosion Inhibitors.** Corrosion inhibitors are often added to oil wells to prolong the serve life of metal parts. With standard nitriles and fluorocarbons, corrosion inhibitors can cause increased elongation and decreased modulus and hardness. However HNBR shows good resistance to a variety of common corrosion inhibitors.

- **Resistance to explosive decompression.** Explosive decompression occurs when gas at high pressure permeates into the elastomer. When the external gas pressure is reduced, absorbed gas expands against the elasticity of the rubber. This can cause severe internal damage, which usually takes the form of swelling with subsequent blisters and splits in the elastomer. HNBR has shown good resistance to high-pressure CO_2 especially when compared to Nitriles and fluorocarbons.