O-Ring Selection Guide

Elastomers and Failure Modes

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1 About this guide

This document is divided into the following chapters:

- Chapter 1, “O-Ring Materials” gives an overview of the common oilfield elastomers.
- Chapter 2, “Selection Guide” is a chart used to select the proper material.
- Chapter 3, “Common Failure Modes”, helps you to diagnose and prevent common failures.
- Chapter 4, “Proper Use”, explains the proper use and storage of o-rings.

This guide assumes that you have some down-hole tool knowledge. For more information, contact your local service representative.
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1.1 Disclaimer

This document is intended as a supplement to formal training. DataCan is constantly working to improve its products. We must therefore reserve the right to change designs, materials, specifications and prices without notice. DataCan declines any liability that may arise out of the potential inaccuracies in this guide.

We thank you for any feedback or comments that will help us to continue to improve our products and service.

2 O-Ring Materials

A variety of materials are available for use in O-Rings. The oil field industry has relied on 4 common materials. Nitrile, Viton, Aflas, and Chemraz are all common trade names for popular oil field elastomers.

Generally, as you move from Nitrile to Chemraz you gain chemical resistance and cost, but loose mechanical strength.

Hyrdrogenated Nitrile (HNBR. HSN) Nitrile

Nitrile is a low temperature performer with limited chemical resistance. Superior mechanical characteristics, particularly high strength helps reduce extrusion and wear. Do not use with ketones, esthers, strong acids, or chlorinated hydrocarbons.

Fluorocarbon (FKM) Viton

Has an excellent resistance to high temperatures, ozone, oxygen, mineral oil, synthetic hydraulic fluids, fuels, aromatics and many organic solvents and chemicals. Low temperature resistance is generally not favorable. Do not use with glycol, organic acids, or steam.

Tetrafluoroethylene-Propylene (TFE) Aflas

This elastomer has an excellent chemical resistance across a wide range of aggressive media. Do not use with aromatics, ketones, or chlorides.

Perfluoroelastomer (FFKM) Chemraz

Perfluroelastomer (FFKM) currently offers the highest operating temperature range, the most comprehensive chemical compatibility, and the lowest off-gassing and extractable levels of any rubber material.

3 Selection Guide

Property		Elastomeric Sealing Materials			
Material Code Chemical Nature		HNBR Hydrogenated Nitrile	FKM VF2 Fluoro Elastomer	TFEP TFE/P Fluoro Elastomer	FFKM Perfluoro Elastomer
Common Trade Name		**HSN**	**Viton**	**Aflas**	**Chemraz**
Low Temp Duty (ºC)		-20ºC	-10ºC	30ºC	0ºC
High Temp Duty (ºC)		150ºC	200ºC	220ºC	230ºC
Aliphatic Hydrocarbons		Good	Good	Fair	Good
Aromatic Hydrocarbons		Fair	Good	Fair	Good
Crude Oil @ < 120ºC		Good	Good	Fair	Good
Crude Oil @ > 120ºC		Fair	Fair	Fair	Good
Sour Crude Oil		Good	Fair	Fair	Fair
Sour Natural Gas		Good	Fair	Fair	Fair
Oil Base Mud		Good	Good	Fair	Good
Water Base Mud		Fair	Good	Good	Good
Water		Good	Fair	Good	Good
Steam		Fair	Poor	Good	Good
Amino Corrosion Inhibitors		Fair	Fair	Good	Good
Brines	CaCl2/CaBr2	Good	Good	Good	Good
	$ZnBr_2$	Fair	Good	Good	Good
	Sea Water	Good	Good	Good	Good
Control Fluids	Mineral Oils	Good	Good	Fair	Good
	Glycol Based	Good	Good	Good	Good
	Phosphate Ester	Poor	Good	Good	Good
Methanol		Good	Fair	Good	Good
Acids	HCL (dill)	Fair	Good	Good	Good
	HCL (Conc)	Good	Good	Good	Good
	HF (<65% cold)	Fair	Good	Good	Good
Chlorinated Solvents		Fair	Good	Poor	Good
Methane		Good	Good	Fair	Good
Carbon Dioxide		Good	Fair	Good	Good
H_2S @ < 80ºC < 100ppm		Good	Good	Good	Good
H_2S @ < 150ºC < 15%		Poor	Fair	Fair	Good
Physical Properties					
Tear Resistance		Good	Good	Fair	Fair
Abrasion Resistance		Good	Good	Fair	Fair
Compression Set Resistance		Good	Good	Fair	Poor
Resilience		Fair	Poor	Poor	Poor
Gas Impermeability		Good	V. Good	Good	V. Good

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4 Common Failure Modes

The premature failure of an O-Ring can usually be attributed to a combination of causes and not merely a single failure mode. It is important to maximize sealing life and reliability by reducing the probability of seal failure at the onset by the use proper compound selection, installation and continued education of personnel.

Abrasion

The seal or parts of the seal exhibit a flat surface parallel to the direction or motion. Loose particles and scrapes may be found on the seal surface. Rough sealing surfaces, excessive temperatures, environments containing abrasive particles, or poor elastomer surface finish may lead to an abrasion failure.

Use recommended gland surface finishes, consider internally lubricated elastomers or eliminate abrasive components.

Compression Set

The seal exhibits a flat-sided cross-section, the flat sides correspond to the mating seal surfaces. Excessive compression and temperature, excessive volume swell in chemical, and specific elastomers with high compression set lead to this failure mode.

Low compression set elastomers, proper gland design and material compatibility are all suggested solutions to a compression set failure mode.

Chemical Degradation

The seal may exhibit many signs of degradation including blisters, cracks, voids or discoloration. In some cases, the degradation is observable only by measurement of physical properties.

The selection of a more chemically resilient elastomer will prevent degradation.

Explosive Decompression

The seal exhibits blisters, pits, or pockets on its surface. Absorption of gas at high pressure and the subsequent rapid decrease in pressure results is gas that was once trapped inside the elastomer to explosively decompress and exit the seal. The absorbed gas blisters and ruptures the surface as the pressure is rapidly removed.

High modulus or a harder elastomer, as well as a slower decompression rate will prevent this mode of failure.

Extrusion

The seal develops ragged edges (generally on the low pressure side) which appear tattered. Excessive seal clearances, excessive pressure, low modulus or hardness elastomers, or improper sizing will lead to an extruded seal.

Decreasing gland clearances or use of a back-up ring will prevent extrusion.

Installation Damage

The seal or parts of the seal may exhibit small cuts, nicks or gashes. Sharp edges on the glands or components, improper sizing, or a low modulus/hardness elastomer may lead to installation damage.

Remove all sharp edges, and follow the installation guidelines to prevent damage.

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Over-compression

The seal exhibits parallel flat surfaces (corresponding to the contact areas) and may develop circumferential splits within the flattened surface.
Gland design should take into account material responses to chemical and thermal environments.

Spiral Failure

The seal exhibits cuts or marks which spiral around its circumference. Difficult or tight installation clearances with out proper lubrication may lead to this mode of failure. Excessive gland width is also a known cause.

Ensure adequate lubrication, or ensure the back-up ring is installed to reduce gland volume.

Thermal Degradation

The seal may exhibit radial cracks located on the highest temperature surfaces. In addition, certain elastomers may exhibit softening, or a shiny surface as a result of excessive temperatures.

Selection of an elastomer with improved thermal stability is a suggested solution.

5 Proper Use

5.1 Storage

The effective storage life of an O-Ring varies with the inherent resistance of each individual elastomer to normal conditions. The following conditions are suggested for maximum storage life:

- Ambient temperature not exceeding 49ºC (120ºF)
- Exclusion of air (oxygen)
- Exclusion of contamination
- Exclusion of light (particularly sunlight)
- Exclusion of ozone generating electrical devices
- Exclusion of radiation

Generally, sealed polyethylene bags stored in larger cardboard containers ensure optimal storage life.

5.2 O-Ring Removal

DataCan recommends that each O-Ring located on the electronics to batter barrel connection be replaced after every job. In order to maintain a reliable o-ring gland seal structure, the following procedure should be followed:

- Using a soft O-Ring pick, lift the o-ring from the gland
- Cut the O-Ring in half

When lifting the ring, be careful not to scratch the O-Ring gland.



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5.3 O-Ring Installation

DataCan recommends that each O-Ring located on the electronics to battery barrel connection be replaced after every job. To install an O-Ring without damaging the O-Ring or seal gland the following procedure should be followed:

- Cut a 1-2 foot length of wax string (dental floss)
- Place the wax string through the O-Ring
- Use the wax string to “walk” the O-Ring over the threads and into the O-Ring glad
- Ensure that the O-Ring is placed on the pressure side of the Back-Up
- Apply some O-Ring lubrication to the O-Rings. DataCan recommends using Parker® O-Lube or Lubriplate L-461.