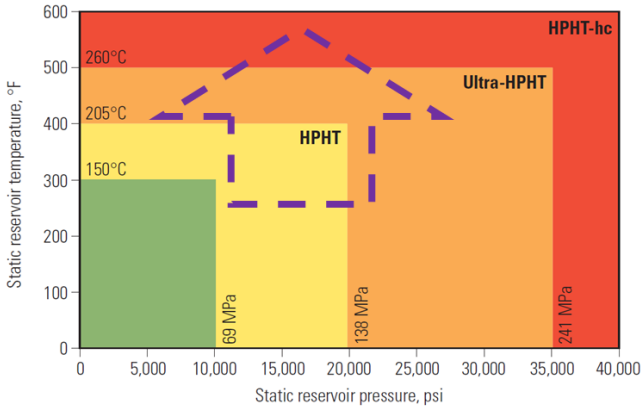
DuPont™ Kalrez®

Oil and Gas Product Selector Guide

Technical Information — April 2017

DuPont has more than 30 years of experience providing Kalrez® perfluoroelastomer seals to the oil and gas industry. Over this time, reservoir pressures and temperatures have both risen while an increased focus on safety margin has driven wider use of this most resilient of elastomeric material classes.



^ HPHT classification system. The classification boundaries represent stability limits of common well-service-tool components—elastomeric seals and electronic devices.

DuPont scientists have developed Kalrez® seals that can offer Rapid Gas Decompression (RGD) resistance to ISO, Norsok and Total industry certifications while resisting the harshest well fluid environments at temperatures that include both arctic surface conditions and high downhole temperatures and pressures. Kalrez® seals deliver proven reliability in extended lifetime services both above and below ground.

Product selector by type of application

Type	Chemical environment	Applications requirements	Suggested products
DRILLING			
Drilling Tools	Aggressive corrosion inhibitors within drilling fluids Sour environment (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam	RGD resistance Extrusion resistance High Pressure up to 309 MPa (45,000 psi) High and low temperature	Kalrez® 0090 Kalrez® Spectrum™ 7090 for short term
Intervention Tools	Aggressive corrosion inhibitors within Drilling fluids, Sour gas (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam Strong acids (Formation opening)	RGD resistance Extrusion resistance High Pressure up to 309 MPa (45,000 psi) High and low temperature	Kalrez® 0090
MWD/LWD	Aggressive corrosion inhibitors within Drilling fluids, Sour gas (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam	RGD resistance Extrusion resistance High Pressure up to 309 MPa (45,000 psi) High and low temperature	Kalrez® 0090 Kalrez® Spectrum™ 6375 if no RGD resistance required
COMPLETION			
Packing Elements	Aggressive corrosion inhibitors within Drilling fluids Sour environment (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam	Extrusion resistance Permanent, moveable or retrievable High Pressure up to 309 MPa (45,000 psi) high and low temperature V-ring sets / chevron sets	Kalrez® 3065
Packers	Aggressive corrosion inhibitors within Drilling fluids Sour environment (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam	Extrusion resistance Permanent, moveable or retrievable High Pressure up to 309 MPa (45,000 psi) High and low temperature	Kalrez® 0090
Formation Evaluation	Aggressive corrosion inhibitors within Drilling fluids Sour environment (H_2S) Hydrocarbons CO_2 Water/steam	RGD resistance Extrusion resistance High Pressure up to 309 MPa (45,000 psi) High and low temperature	Kalrez® 0090

Type	Chemical environment	Applications requirements	Suggested products
PRODUCTION			
Electric Submersible Pump (ESP)	High temperature water and steam Aggressive corrosion inhibitors Sour environment (H_2S) Hydrocarbons CO_2	Extrusion resistance High temperature Maximise pump life	Kalrez® Spectrum™ 6375
Enhanced Oil Recovery (EOR) Water/steam	Water/Steam injection compatibility Biocides Methanol	High temperature steam resistance High Pressure up to 309 MPa (45,000 psi) Extrusion resistance	Kalrez® 0090
Enhanced Oil Recovery (EOR) Carbon dioxide	CO_2 compatibility	High and low temperature RGD resistance Extrusion resistance High Pressure up to 309 MPa (45,000 psi)	Kalrez® 0090
Enhanced Oil Recovery (EOR) Sour gas	Extreme sour gas (H_2S) compatibility	High and low temperature RGD resistance Extrusion resistance High Pressure up to 309 MPa (45,000 psi)	Kalrez® 0090
Christmas Tree	Aggressive corrosion inhibitors Sour environment (H_2S) Hydrocarbons CO_2 Water/steam Control fluids	High and low temperature RGD resistance, Extrusion resistance High Pressure up to 309 MPa (45,000 psi)	Kalrez® 0090 Kalrez® Spectrum™ 0040 if no RGD resistance required
Pipeline Valves Ball valves	Aggressive corrosion inhibitors Sour environment (H_2S) Hydrocarbons CO_2	High and low temperature RGD resistance Extrusion resistance	Kalrez® 0090 Kalrez® Spectrum™ 6375
Subsea Equipment	High pressure water Aggressive corrosion inhibitors Sour environment (H_2S) Hydrocarbons CO_2 Methanol Biocides	Work with high hydrostatic pressures externally as well as internal well bore pressures Low temperature RGD resistance Electrical insulation	Kalrez® 0090 Kalrez® Spectrum™ 0040 if no RGD resistance required
Risers	Aggressive corrosion inhibitors within drilling fluids Sour environment (H_2S) Hydrocarbons CO_2 High pH well kill fluids. Water/steam	RGD resistance Extrusion resistance High Pressure	Kalrez® 0090 Kalrez® Spectrum™0040 if RGD resistance not required.
Monitoring/Logging	Aggressive corrosion inhibitors within drilling fluids Sour gas (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam	High Pressure up to 309 MPa (45,000 psi) High and low temperature	Kalrez® Spectrum™ 0040 Kalrez® 0090 if RGD resistance required

Type	Chemical environment	Applications requirements	Suggested products
OTHER			
Electrical connectors	Aggressive corrosion inhibitors within drilling fluids, Sour environment (H_2S) Hydrocarbons CO_2 High pH well kill fluids Water/steam	Low electrical conductivity High and low temperatures High Pressure up to 309 MPa (45,000 psi)	Kalrez® Spectrum™ 6375

Product Selector

The following guide provides a quick and easy tool for the selection of Kalrez® products for the oil and gas industry.

	Unit	Kalrez® 0090	Kalrez® 6375	Kalrez® 7090	Kalrez® 0040	Kalrez® 3065
PHYSICAL PROPERTIES						
Maximum Application Temperature[2],	°C °F	250 482	275 527	325 617	220 428	288 550
Hardness[3]	Shore A	95	75	90	70	90
50% Modulus[4]	MPa psi	14.18 2057	- -	15.51 2250	- -	Not applicable
100% Modulus[4]	MPa psi	- -	7.23 1049	- -	6.60 957	- -
Tensile Strength @ Break[4]	MPa psi	19.5 2800	15.1 2200	22.7 3300	13.7 2000	24.1 3500
Elongation @ Break[4]	%	80	170	75	180	30
Compression Set[5], Pellet, 70 hrs. @ 204°C	Pellet AS568-214	19 33	25 30	12 -	- 41	Not applicable
TR-10	°C °F	-7.4 19	-3.8 25	-5 23	-17 1	- -

CERTIFICATIONS		Kalrez® 0090
NORSOK M-710 (Rev. 2)	**Annex A**	√
	Annex B	√
ISO 23939-2	**RGD**	√
	Sour Gas	√
TOTAL GS EP PVV 142 (Rev. 5)	**CSD 5.33**	√
	CSD 6.99	√

SEAL TYPE AVAILABILITY	Kalrez® 0090	Kalrez® 6375	Kalrez® 7090	Kalrez® 0040	Kalrez® 3065
O-ring	√	√	√	√	
Vrings	√	√	√	√	√
Boots		√		√	
T-Seal	√	√	√		
Packers	√				
Seal with embedded anti-extrusion device	√				
Other	Please Contact DuPont for Additional Information				

Special remark on low temperature performance:

The low temperature capabilities depend on the application conditions.
Based on our test results, increasing the pressure improves the low temperature sealing.
Low temperature sealing performance does not correlate with measured values such as Tg, TR-10.

Low Temperature Performance of Kalrez® 0090 Parts

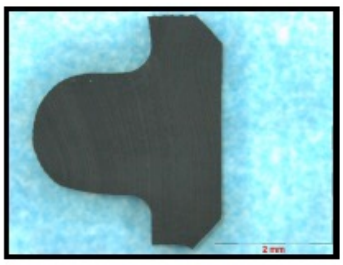
AS568 size	Leak Detection	Gas	Compression	Pressure (MPa)	Low Temp. Sealing (°C)
214	3.0 ccm	Air	16% radial	0.4 (Before cooling)	- 21 *
312	0.1 ccm	Nitrogen	14% vertical	10 (Before cooling)	- 40 **
312	0.1 ccm	Nitrogen	14% vertical	10 (After cooling)	- 25 **

* DuPont proprietary test method (*Thomas, E., "Fluoroelastomer and Perfluoroelastomer Compatibility With Advanced Gas Turbine Lubricants," SAE Technical Paper 2003-01-3029*)
** James Walker & Co proprietary test method

The influence of back up rings on seal performance

Back up rings have long been regarded as a necessary evil to prevent o-ring extrusion at high temperatures and pressures. Back up rings increase part count, make assembly more complex and add significant cost. Kalrez® 0090 changes this paradigm. By having exceptional mechanical strength, even at high temperatures and pressures such as +232°C (450°F) and 150MPa (22,500 psi) Kalrez® 0090 does not extrude. This not only allows the efficiencies described above, but also significantly improves low temperature sealing performance at high and low pressures.

Kalrez® shapes O-rings and customer parts



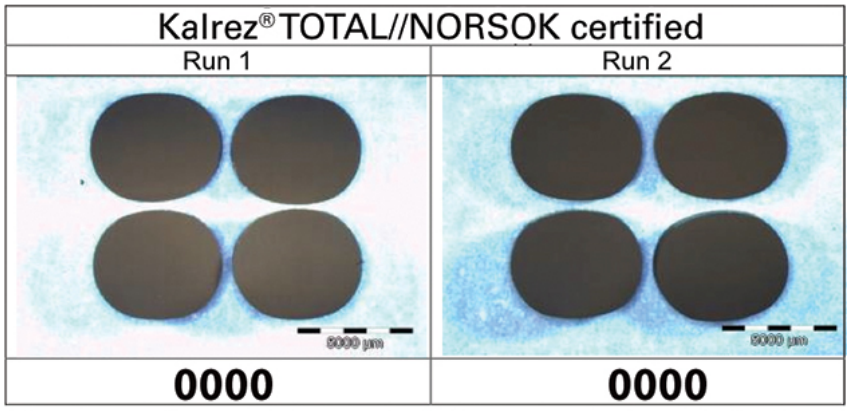
Product Description

Kalrez® 0090

DuPont™ Kalrez® 0090 is an exceptional general purpose compound for use in the oil and gas industry. DuPont™ Kalrez® 0090 perfluoroelastomer parts deliver durable, reliable sealing solutions for applications requiring excellent rapid gas decompression (RGD) properties combined with high hardness and high modulus. Some application areas include downhole equipment such as drilling and completion tools as well as industrial equipment including pumps and valves. Kalrez® 0090 has been certified by two independent labs to meet rigorous requirements for resistance to RGD. In addition to demonstrated RGD resistance, DuPont™ Kalrez® 0090 seals have other chemical and temperature properties that provide superior performance.

• Chemical resistance: Kalrez® 0090 can be resistant to sour multi-phase fluids containing H2S as shown by the external NORSOK M-710 Rev 2 Sour Fluid aging resistance certification provided by MERL (UK).
• Broad temperature capability: Kalrez® 0090 retains high levels of resilience up to temperatures as high as 250 °C (482 °F) and down to –21 °C (–5.8 °F). Under pressurized sealing conditions, Kalrez® 0900 has demonstrated low temperature performance down to –40 °C (–40 °F) in customer laboratory tests.

Highest rating of “0000” in severe test conditions demonstrates outstanding RGD resistance of DuPont™ Kalrez® 0090. (0000 meaning no damage)



Tested according to Norsok M710 rev2 standard (K312 (15.24x5.33mm) O-ring; 67% groove fill; Test gas 10% CO2 in methane)

Kalrez® Spectrum™6375

DuPont™ Kalrez® 6375 perfluoroelastomer parts are designed to give outstanding performance in the widest possible range of chemicals and over a broad range of temperatures. This product is an excellent choice for use in acids, bases, amines, steam, highly alkaline solutions and many other aggressive chemicals. The compound is designed for continuous upper service temperature of 275°C (527°F). This high temperature stability translates into increased chemical resistance and longer life over all temperature ranges, even if high temperature process excursions occur.

Kalrez® Spectrum™ 7090

DuPont™ Kalrez® Spectrum™ 7090 perfluoroelastomer parts are specifically targeted for use in applications requiring high hardness/higher modulus properties. These specialty black parts have excellent mechanical properties including compression set resistance, seal force retention, response to temperature

cycling effects and rapid gas decompression resistance. Kalrez® Spectrum™ 7090 perfluoroelastomer parts are well suited for both static and dynamic sealing applications, especially applications that require extrusion resistance at higher temperatures. They also offer outstanding thermal stability and chemical resistance. A maximum application temperature of 325 °C (617 °F) is suggested. Short excursions to higher temperatures may also be possible.

Kalrez® Spectrum™ 0040

DuPont™ Kalrez® Spectrum™ 0040 perfluoroelastomer parts are specifically designed for low temperature environments where significant chemical resistance is required. Its chemical resistance is close to Kalrez® Spectrum™ 6375 which is the reference in the chemical processing industry. In addition, the proprietary polymer and cure technology enables the low temperature sealing performance (-42°C) of Kalrez® 0040 parts typically unattainable from other perfluoroelastomers parts. Kalrez® Spectrum™ 0040 is an excellent choice in applications for the oil and gas industry, or for other applications, where chemical resistance and elasticity are required in some of the coldest environments. Kalrez® Spectrum™ 0040 can also operate at temperatures up to 220°C.

Kalrez® 3065

DuPont™ Kalrez® 3065 is a long- standing compound that has proved its performance over more than 30 years in the field. It is a highly-filled product containing carbon black and fiber reinforcement, designed to function without extrusion under extreme pressure. It has good all round chemical resistance and excellent resistance to sour oil and amines. Kalrez® 3065 has an upper service temperature of 288 °C (550 °F).
The mechanical properties and chemical resistance of Kalrez® 3065 make it the best choice for many oil and gas well applications. In these applications, it is normally used in the form of V-rings and other custom parts rather than O-rings. With correct design Kalrez® 3065 can remove the need for back-up rings.

Visit us at **kalrez.dupont.com** or **vespel.dupont.com**

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