ENERGY
Oil & Gas

DuPont™ Kalrez® and Vespel® Parts

Polymeric solutions for exceptional valve sealing performance in extreme environments

Contents

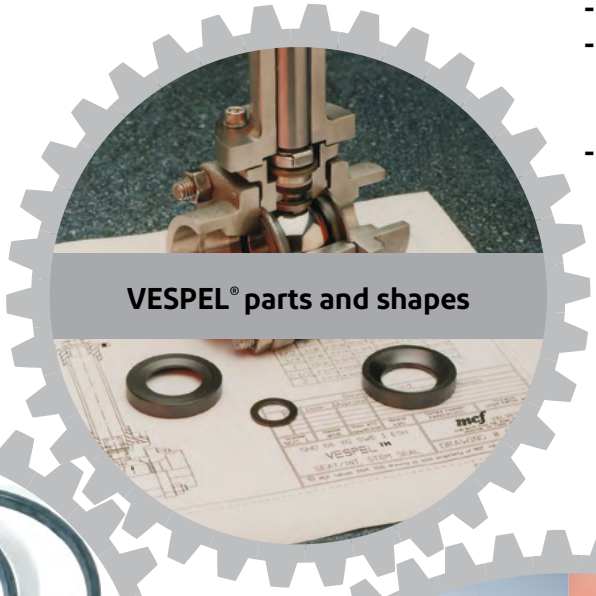
DuPont™ Kalrez® and Vespel® parts deliver performance, reliability and safety where it matters most

Vespel® seats and seals

- Thermal stability
- Low coefficient of friction and wear resistance
- Mechanical strength and low creep

Kalrez® valve seals

- Excellent chemical and thermal resistance
- Exceptional sealing in demanding applications



VESPEL® parts and shapes

KALREZ® perfluoroelastomer parts

RESULTS

- Successful application collaborations
- Proven, trusted solutions
- Increased equipment uptime
- Lower total operating costs for value in use
- Increased operation safety

DuPont™ Kalrez® and Vespel® parts

Testing Capabilities

DuPont has a long history of collaborative innovation in material science to help customers develop solutions that meet the most pressing industry challenges. The DuPont™ Kalrez® and Vespel® portfolio offers a range of high-performance parts and testing capabilities. This can enable customers to meet the most stringent industry standards in terms of reliability, safety, traceability, and efficiency for critical applications in high pressure and high temperature environments.

DuPont's world-class Application Development Centers have a unique combination of global experts and state-of-the-art equipment. Contact your nearest DuPont representative to learn more about our testing capabilities.

DuPont™ Kalrez® Testing Facilities

Sealing Testing
- High pressure high temperature sealing tests using AS568-325 O-rings

RGD **RGD (also available for Vespel®)**
- Rapid gas decompression testing in pure CO_2 gas and liquid up to 250 °C and 350 bars / 5000 psi
- Rapid gas decompression testing for market specifications using automatic cycling with temperatures up to 250 °C and pressures up to 700 bars / 10,000 psi

Chemical Resistance & Aging Tests
- Aging in gases including H_2S, H_2, CH_4, and CO_2
- Aging in fluids including ammonia, ethylene oxide, ammonium hydroxide
- Common air oven aging from 160 °C to 350 °C
- Fluids testing in amines, bases, water, detergents, and solvents

Compression Set Testing
- Compression set testing in various fluids and temperatures
- Compressive stress relaxation testing

Additional testing capabilities
- O-ring stiction testing
- Helium leak testing

DuPont™ Vespel® Testing Facilities

Tribology System Evaluation
- Static and dynamic friction and wear testing through custom tribometers in lubricated and dry environments up to 600 °C
- Broad characterization capabilities for studying material structure and surface chemistry
- Advanced profilometry for surface topography and image analysis

CAE and Custom Modeling
- Design optimization through CAD and FEA

Mechanical Property Testing
- Compression, tensile, flexural, impact, and

Fugitive emissions control: a major opportunity to fight global warming

The oil and gas industry is a large contributor to global methane emissions, which are the second largest driver of global warming. Methane is considered even more dangerous than carbon dioxide, the primary greenhouse gas, because one tonne of methane corresponds to 28 tonnes of carbon dioxide equivalents.

Under the 2050 Net Zero Emissions Scenario, total methane emissions from fossil fuel operations must decrease by 74% by 2030 so that gas can play a supporting role in the energy transition.

Within the natural gas value chain, the majority of all methane fugitive emissions originate from valves.

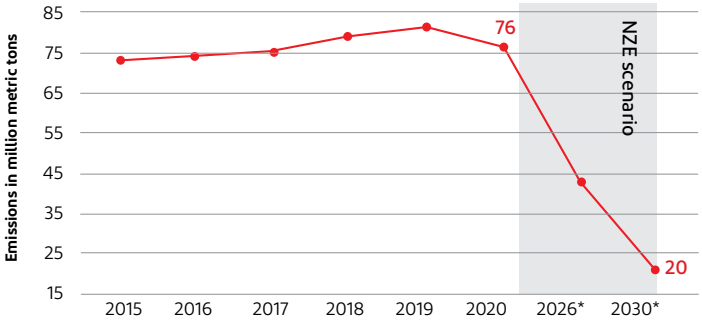
DuPont™ Kalrez® KVSP™ stem packing has the ability to drastically reduce stem-based fugitive emissions of methane and is adequate for handling other gasses including hydrogen.

Methane:
A greenhouse gas 28 times more harmful than CO_2

Source: Greenhouse Gas Protocol

Oil and gas sector methane emissions under the Net Zero Emissions (NZE) Scenario

worldwide from 2000 to 2030 (in million metric tons)

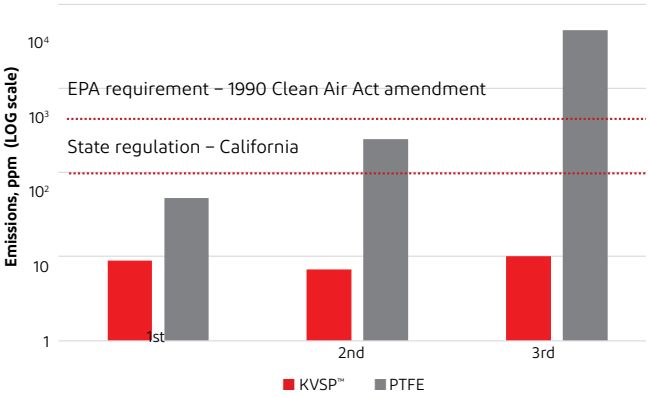


Source: https://www.iea.org/reports/methane-emissions-from-oil-and-gas

DuPont™ Kalrez® KVSP™ parts can help improve your sealing performance and reduce fugitive emissions

DuPont™ Kalrez® KVSP™ - Kalrez® Valve Stem Packing – is a combination of chemically resistant Kalrez® FFKM and Vespel® V-rings which can reduce stem friction and stem-based fugitive emissions and can improve ease of sealing over a long service life.

Controlling Fugitive Emissions: DuPont™ KVSP™ vs PTFE Packing System (EPA Method 21)



Three temperature swings up to 177 °C. 20M–30M full strokes cycles

Test performed three times according to EPA Method 21 for the determination of volatile organic compound leaks. Kalrez® KVSP™ systems provide performance that approaches zero leakage.

DuPont™ Kalrez® KVSP™ kits meet the sizing requirements of standard OEM rising-stem control valves and can include an additional graphite ring for API607 fire safe performance.

Valve Compatibility

- Kalrez® KVSP™ is available in 3- and 5-piece kits to meet the sizing requirements of OEM rising-stem control valves

Service Temperature

- Rated for continuous service from -20 °C to 260 °C (-4 °F to 500 °F)

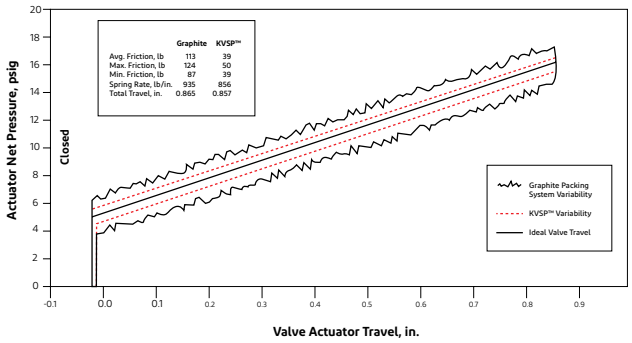
Installation

- Drop-in system with no valve modifications required
- Live loading preferred

Benefits

- Minimization of fugitive emissions over a long service lifetime
- Reduction of actuation force compared to graphite solutions, lowering the cost of the actuator
- Improved process control due to better alignment between the control system and valve response, thanks to low stem friction

Kalrez® KVSP™ Improves Process Control Performance Over Existing Materials



DuPont™ Kalrez® 0090 parts – Best in class for extrusion resistance

Kalrez® 0090

Best extrusion resistance

- 95 Shore A
- Black
- +250 °C*
- Elongation at break: 80%
- Best extrusion resistance
- Resistance to hot water, amines, bases, H_2S

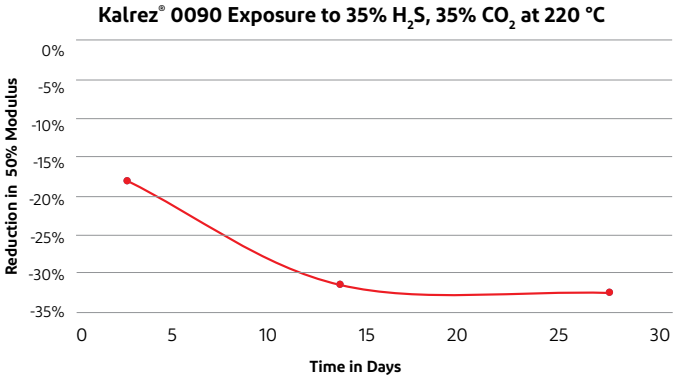
Product meets acceptance criteria for:

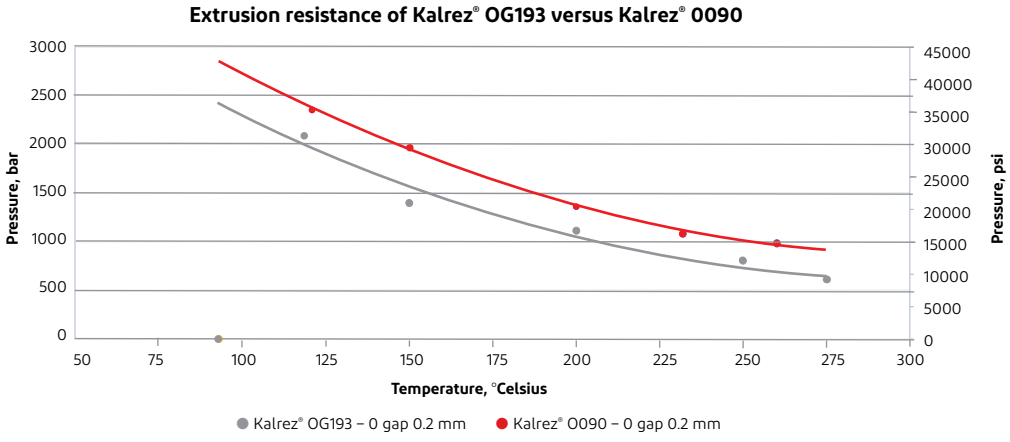
RGD – Total PVV 142
Norsok M710 rev2
ISO 23936-2
Sour aging up to 225 °C – SO23936-2

Excellent properties for oil & gas applications

For the best extrusion resistance combined with excellent performance in rapid gas decompression and resistance to chemicals encountered in the oil and gas industry, Kalrez® 0090 offers durable, reliable sealing solutions for a variety of applications.

Kalrez® 0090 is qualified to ISO 23936- 2:2011 for sour aging of elastomers in 10% H_2S. However, 0090 has shown excellent resistance to concentrations of H_2S up to 65%.





Test details

- Test media: silicone oil
- Diametric extrusion gap 0.2 mm
- Test on AS568-325 O-rings
- No Back Up Ring (BUR)
- Groove type: Piston seal
- Test up to extrusion

DuPont™ Kalrez® OG193 parts – For oil & gas applications requiring rapid gas decompression resistance in a broad range of conditions

Kalrez® OG193

Best RGD resistance

- 95 Shore A
- Black
- +250 °C*
- Elongation at break: 100%
- Best RGD resistance
- Resistance to hot water, amines, bases, H_2S

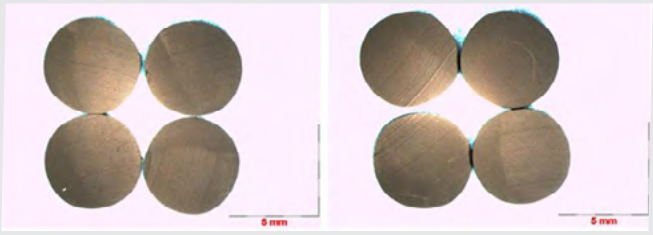
Product meets acceptance criteria for:

RGD – Total PVV 142
Norsok M710 rev2
ISO 23936-2
Sour aging up to 225 °C – SO23936-2

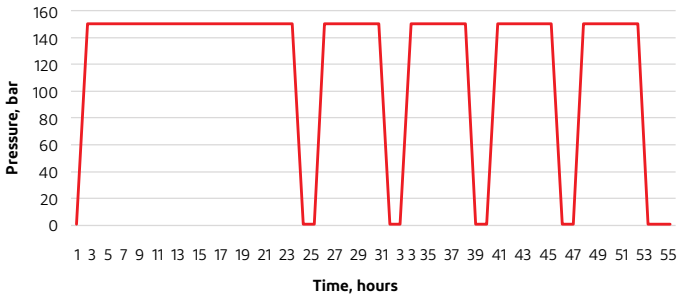
Best in class rapid gas decompression performance

For the best rapid gas decompression performance, excellent chemical resistance, and good low temperature and thermal stability, Kalrez® OG193 offers top performing 90+ durometer (Shore A) to meet the demands of the oil and gas industry.

Kalrez® OG193 parts exhibit high RGD performance even in substantially more aggressive conditions than required by ISO 23936-2 with a "0000 0000" rating. This means that no cracks or blisters were found after in any of the eight cross section samples after testing.



Kalrez® OG193 RGD cycling test: 150 °C - 150 bars - 127 bar/min



Test Conditions	
O-Ring dimensions	113.67 x 5.33mm (AS568-349)
Gas	10%/90% – CO2/N2
Pressure	150bar
Temperature	150 °C
Decompression rate	127bar/min
Number of cycles	5 (20hrs + 4x6hrs)
Dwell time	1 hr

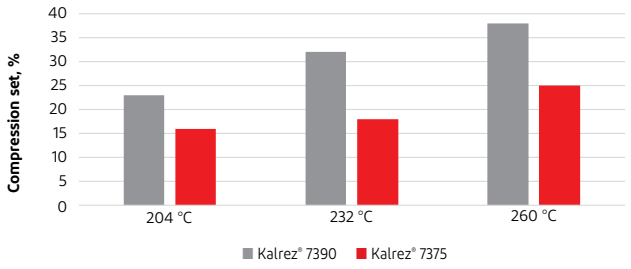
Kalrez® OG193 is ideal for applications where larger cross section thickness combined with chemical resistance, RGD performance, and high strength are a necessity.

DuPont™ Kalrez® Spectrum™ 7375 and 7390 perfluoroelastamer parts

For high temperature, chemical, and water/steam resistance in applications up to 300 °C

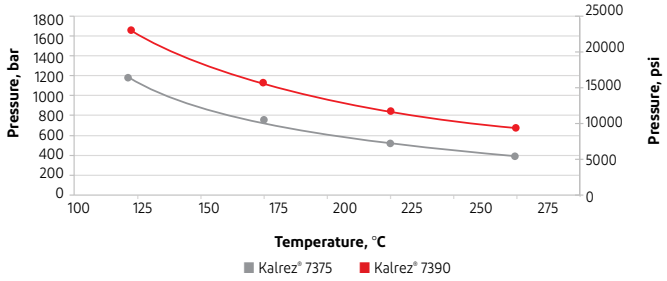
DuPont™ Kalrez® Spectrum™ 7375 and 7390 perfluoroelastomer parts are designed to reliably seal in the most demanding chemical and hot water/steam environments. Thermally stable up to 300 °C, Kalrez® 7375 and 7390 parts can meet your 80 and 90 durometer (Shore A) perfluoro-elastomer (FFKM) specifications, respectively. Numerous shapes and configurations are available to meet your exact needs.

Compression Set, % (with 25% squeeze) of Kalrez® 7390 and Kalrez® 7375 at various temperatures at 672 hours



Both Kalrez® 7375 and Kalrez 7390 have excellent extrusion resistance and compression set performance at elevated temperatures for extended periods of time, which helps provide long term sealing performance.

Extrusion resistance of Kalrez® 7375 versus 7390



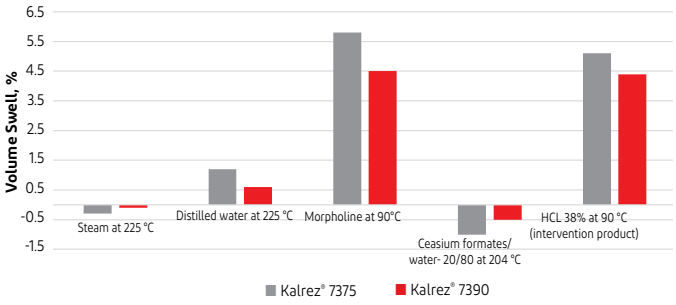
Typical Physical Properties

	Kalrez® 7375	Kalrez® 7390
Color	Black	Black
Hardness, Shore A	79	89
100% Modulus, MPa (psi)	10.2 (1473)	21.3 (3090)
Tensile Strength at Break, MPa (psi)	16.9 (2447)	22.1 (3210)
Elongation at Break, %	128	101
Compression Set, %, 70 hrs. at 204 °C (400 °F)	9	14
Maximum Application Temperature, °C, (°F)	300 (572)	300 (572)

Compatible with fluids commonly used in the O&G industry

Volume swell (%) is a good predictor of performance and low values typically translate to compatibility in the chemical environment. The example below represents typical analogs of fluids and amines found in drilling fluids, corrosion inhibitors, pump oil additives, etc. Test performed with AS-568 K214 O-rings.

Resistance to fluids commonly used in the O&G industry (after 672 hours)



Test details

- Test media: silicone oil
- Diametric extrusion gap 0.2 mm
- Test on AS568-325 O-rings
- No Back Up Ring (BUR)
- Groove type: Piston seal
- Test up to extrusion

DuPont™ Vespel® polyimide parts and shapes for hydrogen applications

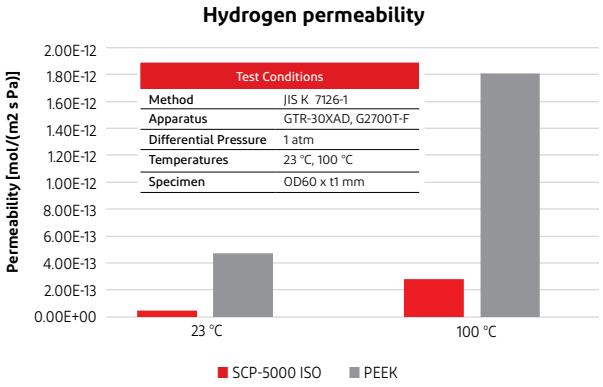
As the world continues to pursue clean energies that do not produce greenhouse gasses, hydrogen is expected to become an important energy source for heating as well as for transportation.

Widespread adaptation of hydrogen as an alternative energy source brings about a unique set of challenges. Hydrogen is commonly stored and transported as a liquid at cryogenic temperatures or as a compressed gas at elevated pressures. Vespel® parts and shapes have several key material properties which make them ideal for hydrogen applications.

Creep performance & low permeability for excellent sealing and storage applications

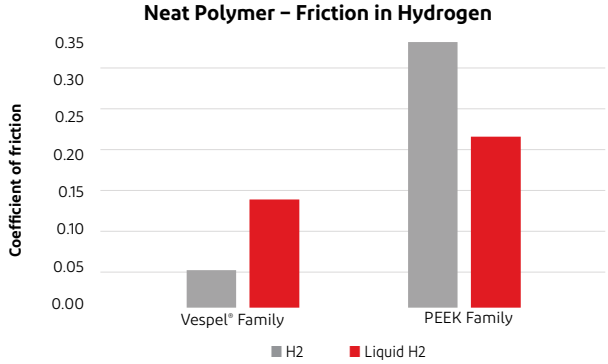
Vespel's® excellent creep performance and low hydrogen permeability are two important properties which demonstrate its ability to properly seal hydrogen and maintain its functionality over a long service lifetime.

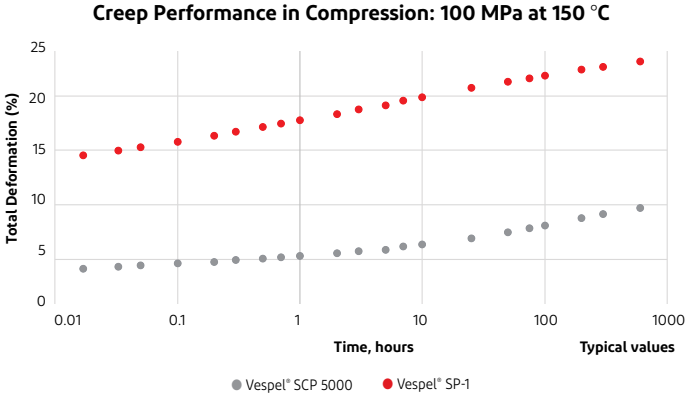
When compared to PEEK, which is also used in valve applications, Vespel® shows significantly lower hydrogen permeability.



Low coefficient of friction for smooth valve actuation

The low coefficient of friction of Vespel® in hydrogen can help reduce actuation force, leading to increased operational efficiency.

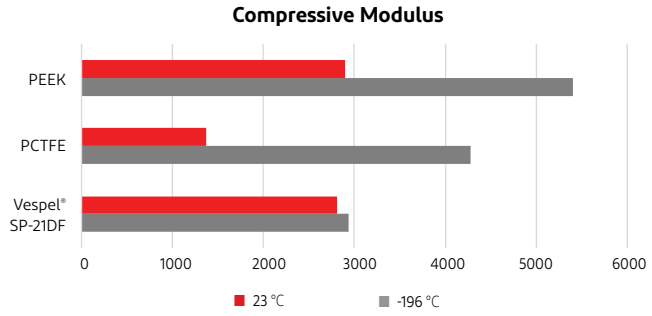




Consistent compressive modulus for low temperature performance

Consistent compressive modulus over a wide range of temperatures is a key advantage in cryogenic valve applications, where it is necessary to maintain sealing performance at low temperatures.

The "soft but strong" behavior of Vespel® is maintained across a wide range of temperatures from cryogenic to ambient.



COF and Wear and friction for Neat polymers of the Vespel® and PEEK Family, data generated by the BAM Bundestanstalt für Materialforschung und –prüfung by Mrs. Theiler, Counterface AISI 304, Ra ~ 0.2 µm, sliding speed v = 0.2 m/s, contact pressure 3 MPa

Vespel® polyimide seats for harsh service ball valves

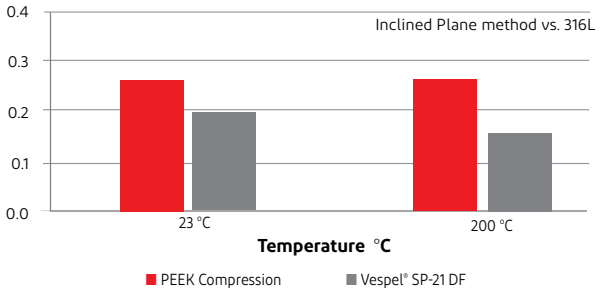
Vespel® for high temperature environments

Vespel® combines better sealing capabilities than PEEK with higher temperature capabilities than tungsten carbide.

Given the wide range of process conditions valves must perform in, DuPont supports its customers by generating comparative data for a variety of commonly available materials on the market. For your most extreme applications, DuPont's global technical experts can provide customized product recommendations using state-of-the art testing equipment.

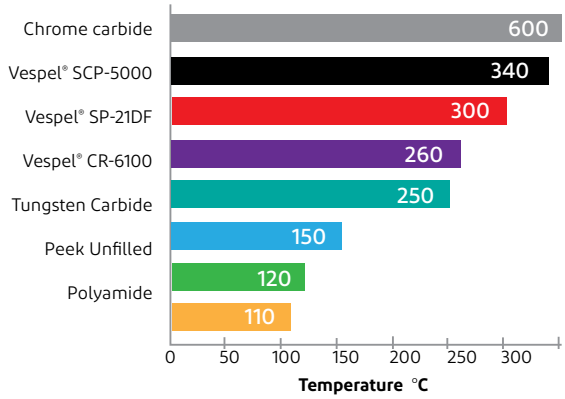
Static friction

Coefficient of static friction



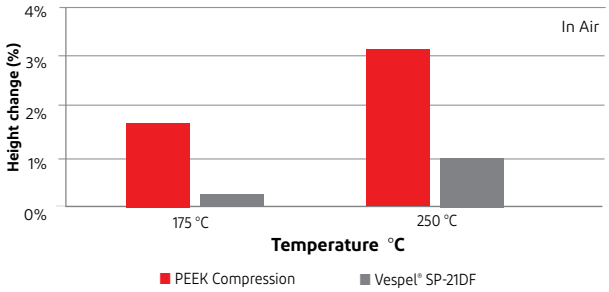
High Temperature Valve Seat Materials

Valve Class 600# typical upper temperature ratings for seats



Creep Resistance

Deformation under load (10 MPa during 1 month)



Vespel® polyimide seats for harsh service ball valves

Vespel® for cryogenic environments

Looking for high performance alternative to PCTFE and Tungsten Carbide?

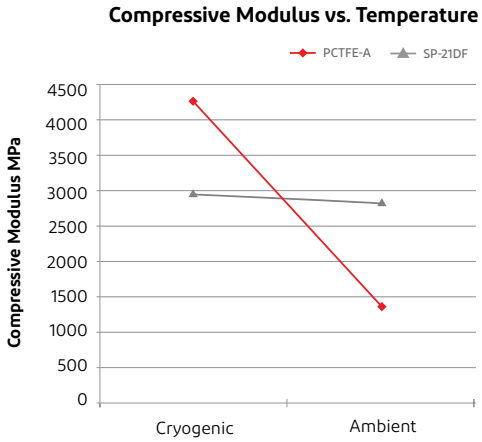
Why does Vespel® add value?

- Improved sealing over a wide range of temperatures
- Simplification of design
- Allows for smaller sized actuator
- Can eliminate scratch damage to the ball
- More reliable sealing. Lasts longer.
- Reduction of total system cost

"Easy to seal" at Lower Temperatures

Compressive modulus (ASTM D695)

Near constant compressive modulus between 2500 and 4200 MPa of all Vespel® parts and shapes within the operating temperature range.

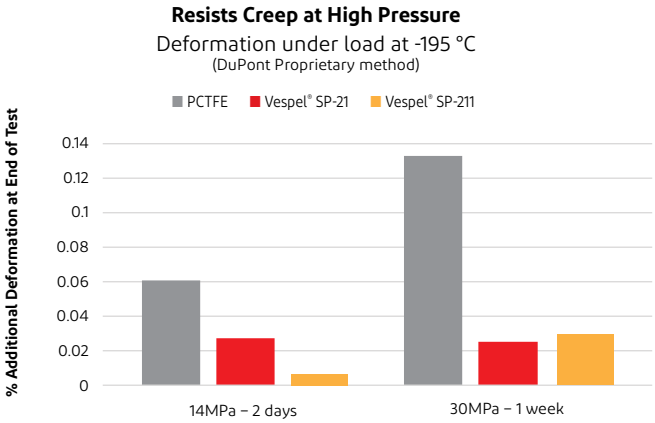


Tungsten carbide is 530-700GPa 100x harder.

Excellent Wear & Friction Resistance

Coefficient of Static Friction (Break Torque)

- Pressure 25 MPa
- Counter surface SS316
- Ra 0.1
- Fluid: Helium cooled by liquid nitrogen
- Arithmetic mean of 3 samples



Can Reduce Actuator Torque by c. 30%

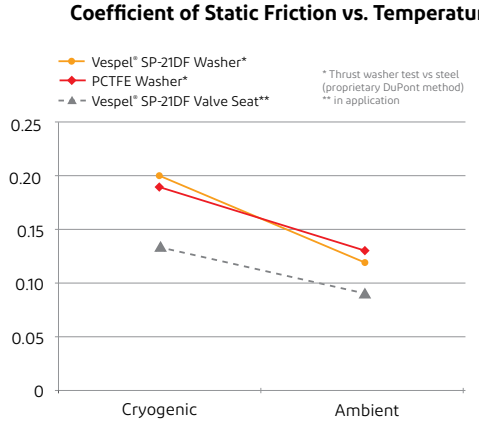
Theorical example of the combined effect of modulus and friction.

Illustration: "Break Torque" reduction - with modest design optimisation.

	PCTFE	Vespel® SP-21DF
Modulus	4275 MPa	2940 MPa
Deformation	1.20%	1.20%
Stress needed	51.30 MPa	35.28 MPa
Typical seat contact area 4"	511 mm^2	511 mm^2
Force needed	26199 N	18017 N
Coefficient of static friction	0.19	0.20
Linear force required	4977.8 N	3603.5 N
Approx Torque	373.3 Nm	270 Nm
Torque reduction changing PCTFE to Vespel®		**28%**

Assumptions:

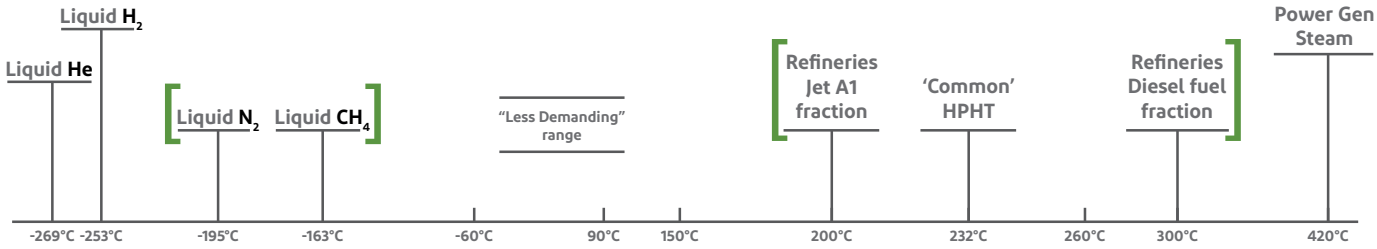
- 4" Trunion ball valve sealing helium at -195°C.
- 1.2% deflection needed to seal.
- Line contact ball to seat of 0.8mm radial
- Design contact force is reduced for Vespel®

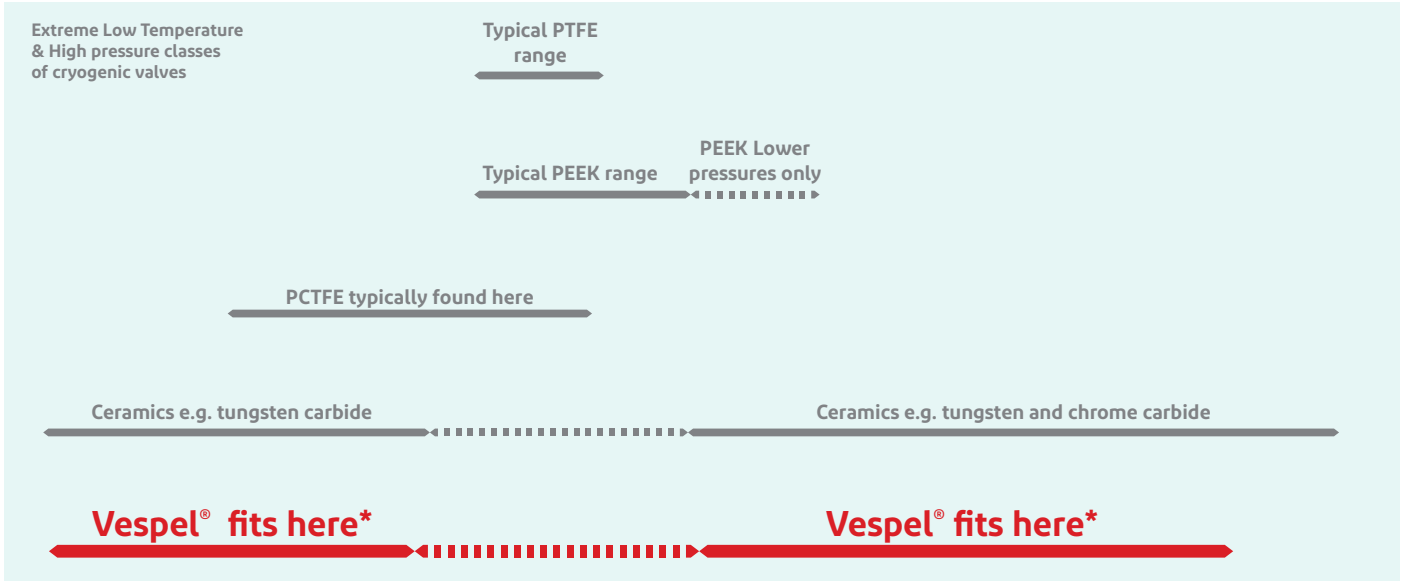


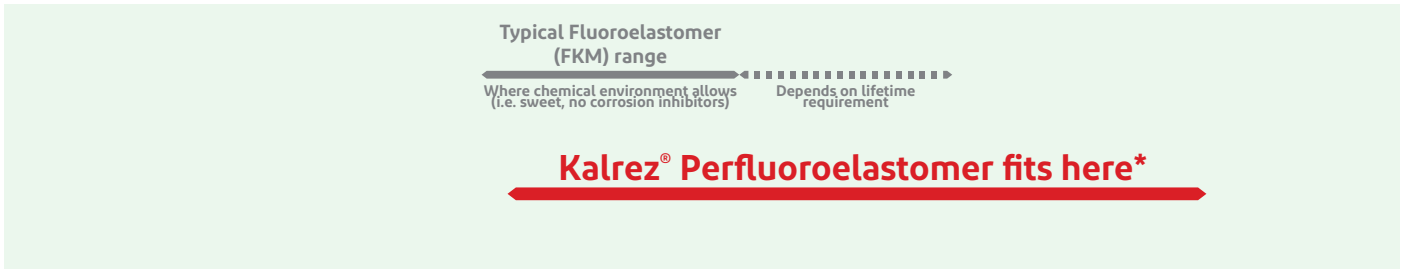
DuPont™ Kalrez® and Vespel® valve seals and seats in extreme temperature and pressure conditions

Oil & Gas ball valve industry solution mapping

TEMPERATURE RANGES WHERE KALREZ® AND VESPEL® CAN GIVE YOU ADVANTAGE
Class 600 and above (e.g. 900, 1500, 2500)







Kalrez® 0090 is very resistant to chemical change according to the NORSOK M-710 Rev 3 standard certification for sour fluid ageing resistance.

Vespel® SP-21 is listed in the TOTAL Spec GS PVV 142 for the -200°C/+260°C temperature range.

Highest NORSOK and TOTAL Rating Demonstrates Outstanding RGD Resistance of Karlez® 0090.

* Grade dependant and subject to a suitable chemical environment.

Discover the Kalrez® and Vespel® product range

Our technical support team are here to answer your questions and find the best Kalrez® and Vespel® products to meet your most stringent requirements.

Kalrez® products for valves in energy and industrial

High service temperature	Special performances	High hardness & modulus
Kalrez® Spectrum™ 6375 Black, +275 °C Broad chemical and temperature, multi-purpose	**Kalrez® Spectrum™ 6380** Cream, +225 °C Hot amines (>80°C), chlorine dioxide, ethylene dioxide	**Kalrez® OG193** Black, +250 °C Best RGD resistance, custom parts, chemical resistance
Kalrez® Spectrum™ 7075 Black, +327 °C Highest temperature, low compression set	**Kalrez® Spectrum™ 0040** Black, +220 °C Lowest service temperature, O-rings	**Kalrez® 0090** Black, +250 °C Best extrusion resistance, good RGD resistance, hot water, amines, bases
Kalrez® 4079 Black, +316 °C Low compression set	**Kalrez® Spectrum™ 7275** Light brown, +300 °C Ethylene oxide, acrylic acid, chlorosilanes	**Kalrez® Spectrum™ 7090** Black, +325 °C Low compression set, high temperature
Kalrez® Spectrum™ 7375 Black, +300 °C Broad chemical and water/steam resistance		**Kalrez® 7390** Black, +300 °C Broad chemical and temperature, multi-purpose

Vespel® products for valves in energy and industrial

Vespel® SP-21 is a graphite-filled polymer with exceptional high temperature performance, low wear and friction for dynamic seals, ball valve seats, and stem sealing. It is tested at temperatures from near absolute zero to 350 °C.

Vespel® CR-6100 provides excellent widespread chemical resistance for applications in refineries or chemical processing.

Vespel® SCP-5000 is a recently introduced unfilled polyimide that offers very low hydrogen permeation, high compressive strength for high pressure hydrogen applications, and very low wear and friction in hydrogen atmospheres.

Vespel® SCP 5050 has low hydrogen permeation and its coefficient of thermal expansion is matched to SS 316L at high and at cryogenic temperatures. It also offers excellent wear and friction properties at liquid hydrogen temperatures.

Form No. KZE-A40130-00-A0523 CDP