Kalrez® 0090 perfluoroelastomers parts for RGD and extrusion resistance

ELASTOMERS USED IN THE OIL & GAS SECTOR
RIEG OF IOM3
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William Braule, Kalrez® Application Engineer
William.braule@dupont.com
ABSTRACT

Kalrez® 0090 perfluoroelastomers parts for oil and gas downhole equipment with the need for RGD and extrusion resistance

DuPont™ Kalrez® 0090 perfluoroelastomer parts deliver durable, reliable sealing solutions for applications requiring excellent rapid gas decompression (RGD) properties as well as high hardness and high modulus. Some application areas include downhole equipment such as drilling and completion tools as well as industrial equipment like pumps and valves.

Recent studies have demonstrated the excellent extrusion resistance of Kalrez® 0090. This presentation will cover into more details the impact of the parameters such as high and low temperature and diametral clearance over this property.
Kalrez® in Oil & Gas (O&G)

Main challenges for seals in Oil & Gas

- High chemical resistance
- High thermal resistance
- High pressure resistance
- High resistance to Rapid Gas Decompression (RGD)
- Low temperature performance (surface tools)
Kalrez® in Oil & Gas (O&G)
Excellent match for Kalrez® highly specialized products

**UPSTREAM**
- Kalrez® 0090 for High Pressure High Temperature
- Kalrez® 3065 for V rings in packing
- Kalrez® 0040 for low temperature sealing with broad chemical resistance

**DOWNSTREAM**
- Kalrez® Spectrum™ 6375 for general applications
- Kalrez® Spectrum™ 6380 for amine, oxidizers
- Kalrez® Spectrum™ 7375 for high temperature and steam
- Kalrez® 0090 for Ball Valve with TOTAL/Norsok® certification

Kalrez® parts can increase process reliability in the Oil & Gas industry
## Kalrez® in Oil & Gas (O&G)

### Kalrez® 0090

#### Typical Physical Properties

<table>
<thead>
<tr>
<th>Kalrez® 0090</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Black</td>
</tr>
<tr>
<td>Maximum Application Temperature</td>
<td>250 (482)</td>
</tr>
<tr>
<td>Durometer, Shore A</td>
<td>95</td>
</tr>
<tr>
<td>50% Modulus, MPa (psi)</td>
<td>14.2 (2057)</td>
</tr>
<tr>
<td>Tensile Strength at Break, MPa (psi)</td>
<td>19.5 (2827)</td>
</tr>
<tr>
<td>Elongation at Break, %</td>
<td>80</td>
</tr>
<tr>
<td>Compression Set, 70 hours at 204°C (400°F), %</td>
<td>33</td>
</tr>
</tbody>
</table>

1. Not to be used for specification purposes
2. DuPont proprietary test method
3. ASTM D2240 (pellet test specimens)
4. ASTM D412 (AS568 K214 O-Ring test specimens)
5. ASTM D395B (AS568-214 O-Ring)

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### Volume Swell after 672 hrs. exposure:

<table>
<thead>
<tr>
<th>Chemical/Product</th>
<th>Temperature [°C]</th>
<th>Kalrez® 0090</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam</td>
<td>225</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>Ethylenediamine</td>
<td>90</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>H₂S/CO₂ (65% / 35%)</td>
<td>220</td>
<td>&lt; 5%</td>
</tr>
</tbody>
</table>

6. ASTM D471 (AS568 K214 O-Ring test specimens)
Kalrez® in Oil & Gas (O&G)

Kalrez® 0090

RGD comparison

- Kalrez® 0090
  NORSOK M-710 rating of 0000

- FFKM (O&G benchmark)
  NORSOK M-710 rating of 3332

Test conditions*:

- Gas composition: 100% CO₂
- Samples**: AS568 K312 O-Rings
- Pressure: 15 MPa
- Temperature: 100°C
- Soak time: 24 hours
- Decompression rate: 12 MPa/min
- Sample compression: 20%

* DuPont Proprietary Test Method
** Samples are cut to ensure that gas is on both sides.
Chemical resistance

Volume Swell- AS568-214 / ASTM D1414

- 90°C (194°F) Ethylene diamine 672 hours
- 200°C (392°F) water 672 hours
- 225°C (437°F) steam 70 hours
- 225°C (437°F) steam 672 hours
- 220°C (428°F) 65% H2S 672 hours
Kalrez® in Oil & Gas (O&G)
Kalrez® 0090

Volume swell in water and ethylene diamine*
AS568-214 O-Rings / ASTM D1414

Source: Element Oilfield Engineering with Polymers 2014

* 225°C = 437°F
FFKM-F40 and FFKM-A34 : O&G benchmark
Kalrez® in Oil & Gas (O&G)

Kalrez® 0090

Custom parts examples

T-Seals

Packers

Diameter up to 260mm
Length up to 150mm

Boots
High Pressure High Temperature (HPHT) testing

Extrusion resistance
Kalrez® in Oil & Gas (O&G)
High Pressure / High Temperature Test rig

Testing conditions:

- Temperature: 232°C
- Pressure: From 0 up to 1500 bar (ramp: 10 bar/min)

Up to extrusion...
Kalrez® in Oil & Gas (O&G)

Kalrez® 0090 high pressure sealing performances

Maximum pressure function of the temperature and the diametric extrusion gap before seal extrusion.

Tests details*

- Test media: silicone oil
- Diametric extrusion gap
- Test on AS568-325 O-Rings
- Test up to extrusion
- No Back-up Ring
- Piston seal

* Tests performed on DuPont HPHT bench
Test in gas / low temperature

- **Test conditions:**
  - Pressurise first – then cool: method used in this study
  - Static test
  - Diametrical extrusion gap: 0.2 mm
  - Gas: 90% nitrogen; 10% carbon dioxide
  - Temperature: from room temperature down to -54°C max
  - Compression: 18 %
  - Test with and without unfilled poly ether ether ketone (PEEK) back up ring
  - Test at 7 bar, 150 bar and 1,000 bar pressure. (~ 0.1 Ksi, 2 Ksi, 15Ksi)
Low temperature test results Kalrez® 0090

Gas mixture (90% N2/10%CO2)

- Low temperature performance of Kalrez® 0090 is improved when removing back-up rings.
- Higher pressure tends to energies the seal in place and lowering sealing temperature.

Minimum sealing temperature with varying pressure. With and Without BUR

<table>
<thead>
<tr>
<th>Pressure</th>
<th>With BUR</th>
<th>Without BUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 bar (101psi)</td>
<td>-18</td>
<td>-18</td>
</tr>
<tr>
<td>150 bar (2175psi)</td>
<td>-23</td>
<td>-40</td>
</tr>
<tr>
<td>1000 bar (14500psi)</td>
<td>-23</td>
<td>-55</td>
</tr>
</tbody>
</table>

Reach equipment low temp limit.
Executive summary

This discussion describes the performance of Kalrez® 0090 in high pressure testing on laboratory equipment.

Kalrez® 0090 can:

✓ Withstand peak pressure > 2000 bars at 150°C without back-up ring when assembled in a system with tight clearance

✓ Can resist continuous pressure such as 900 bars at 200°C for longer period of time

✓ Seal at low temperature under pressure and without back-up ring

✓ Pass RGD test with section up to 6.99mm according to Total standard (PVV142 rev9)
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