

DuPont™ Kalrez® Perfluoroelastomer Parts

Rapid Gas Decompression Tests in Hydrogen

Hydrogen demand reached 94 million tons (Mt) in 2021, surpassing pre-pandemic levels (91 Mt in 2019), and containing energy equal to about 2.5% of global final energy consumption. Most of the increase came from traditional uses in refining and industry, though demand for new applications grew to approximately 40 thousand tons (up 60% from 2020, albeit from a low base) (source IEA.org). The broader production, use and new application of dihydrogen is leading to the creation and development of new standards and customer requirements. When it comes to elastomers two main questions are surfacing:

1. Can elastomer seals resist rapid gas decompression (RGD) with dihydrogen?
2. What is the permeation level of elastomers seals?

This technical report aims at providing some preliminary information on the RGD performance of Kalrez® perfluoroelastomer parts. The target of this test is to evaluate the RGD resistance of three Kalrez® grades in hydrogen gas (H₂) at high pressure and high temperature.

Rapid Gas Decompression Test Procedure

The test set up uses a “scouting test fixture” where several O-rings are piled up and compressed homogeneously whereas having an important contact surface with the gas as shown on the pictures on the right-hand side.

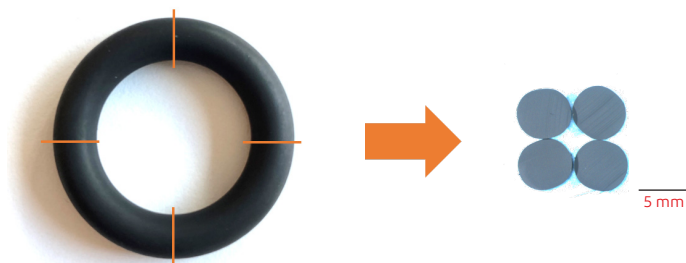
After assembling the O-rings, the whole test fixture is positioned into a pressure vessel which is then closed, heated up and pressurized.

Tested materials:

- Kalrez® 0090: 95 Shore A grade
- Kalrez® OG193: 95 Shore A RGD grade
- FFKM: 90 Shore A – non RGD formulation

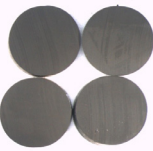
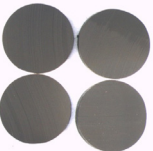
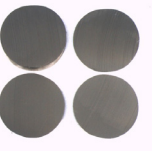
Specimen:

- Two O-rings per tested material
 - Kalrez® 0090 - Specimen reference: A1 & A2
 - Kalrez® OG193 - Specimen reference: B1 & B2
 - 90 Shore FFKM - non RGD formulation - Specimen reference: C1 & C2
- Specimen size: AS568-315 (ID = 19.99 mm, CSD 5.33 mm)
- Four cuts per O-ring were made, according to the ISO 23936-2



Test Conditions	
Grades	0090, OG193, FFKM non RGD
Gas	H ₂
Seal Compression	13%
Pressure	200 bar / 2,900 psi
Temperature	150 °C / 302 °F
Specimen	O-ring K-315 (19.99 x 5.33mm)
Hold time	72 hrs
Cycle	1
Decompression Rate	120 bar/min

RGD rating analysis and pictures

H ₂ RGD tests - Picture rating					
Kalrez® 0090		Kalrez® OG193		FFKM (non RGD)	
A1	A2	B1	B2	C1	C2
					
Rating: 0000 Pass	Rating: 0000 Pass	Rating: 0000 Pass	Rating: 0000 Pass	Rating: 4444 Fail	Rating: 4444 Fail

Conclusion

The overall conclusion of this study is that both Kalrez® 0090 and Kalrez® OG193 have passed rapid gas decompression test using 100% dihydrogen gas based on the specific conditions used. A non RGD FFKM with 90 Shore A formulation might not be able to pass a rapid gas decompression event with dihydrogen.

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