Module 14:
Explosive Decompression

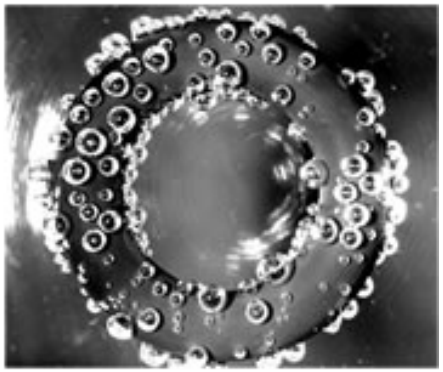
MADE WITH GENUINE VITON
DuPont Performance Elastomers
Viton® fluoroelastomer

Viton® fluoroelastomer
From DuPont Performance Elastomers

Definition

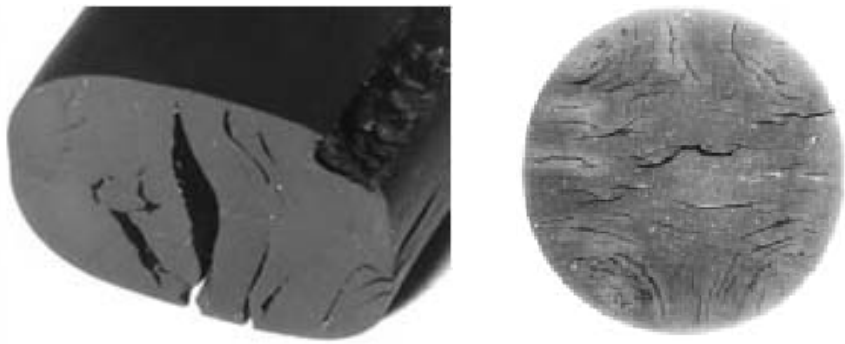
Explosive Decompression (ED) or **Rapid Gas Decompression** (RGD) is a structural failure, a condition that occurs due to gas permeation or dissolution into the seal material. When the system pressure decays quickly, the entrapped gas expands, rupturing the o-ring.

Explosive decompression may cause the form of blistering, internal cracking and splitting of parts.(e.g. Oil and Gas field)



Picture from 2006 MERL Ltd.

Gas escaping
from a rubber O-ring



Internal failure is observed

Testing Equipment

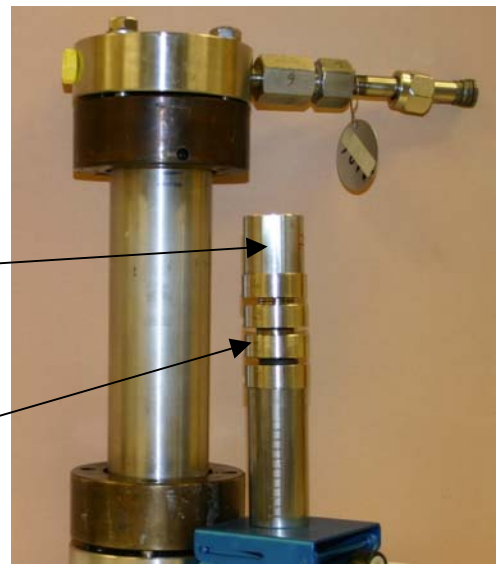
Equipment at DuPont Performance Elastomers European Technical Center in Geneva - Switzerland

- Autoclave (volume 330 cm^3)
- 100% CO_2 environment
- State of the art software developed internally for data acquisition and pressure release control.

Testing Equipment

Uncompressed
(smaller piece)

To be compressed
(larger piece)



Testing Conditions for FKM

- 24 hour exposure
- Temperature: Room Temperature, 100°C, 150°C, 200°C
- Pressure: 50 bars, 100 bars, 150 bars
- Decompression rate: 20 bar/min
- 1 decompression cycle
- Uncompressed and compressed K-325 o-rings

  (3 specimens per condition)

ED Testing-Sample Analysis

- Samples are analyzed based on the **Norsok M-710[a]** visual inspection method.
- Each specimen is cut into four equal sections.
- The four sections are examined for cracks and rated [see table below]
- Overall rating is <u>the highest</u> of the individual ratings [i.e. the worst ED performance]

	Description	Rating*
Pass	No internal cracks, holes or blisters of any size	0
	Less than 4 internal cracks, each shorter than 50% of cross-section, with a total crack length less than cross-section	1
	Less than 6 internal cracks, each shorter than 50% of cross-section, with a total crack length of less than 2.5 times cross-section	2
	Less than 9 internal cracks, of which 2 cracks can have length between 50% and 80% of cross-section	3
Fail	**More than 8 internal cracks, or one or more cracks longer than 80% of seal section**	4
	Crack or cracks going through cross-section or complete separation of the seal into fragments	5

Seals with ratings 4 or 5 are not acceptable** [[a]Norsok Standard M-710, ***Qualification of non-metallic sealing materials and manufacturers, Rev. 2, October 2001]

ED Testing Results [100% CO_2 Environment]

[performance of Viton® types is dependant on formulations]

condition[a]	state[b]	ETP-S	GF-S	GBL-S	A-HV	TFE/P	B type industry standard	HNBR industry reference
24h/50bar/rt	U							
24h/50bar/rt	C							
24h/50bar/100C	U							
24h/50bar/100C	C							
24h/50bar/150C	U							
24h/50bar/150C	C							
24h/100bar/150C	U							
24h/100bar/150C	C							
24h/150bar/150C	U							
24h/150bar/150C	C							
24h/150bar/200C	U							
24h/150bar/200C	C							

Color code following Norsok M-710 rating

0,1,2	4	
3	5	
passed	**failed**	**not tested**

[a] 100% CO2 environment

[b] U stands for uncompressed, C for compressed

Conclusion

- ED testing in 100% CO_2 might be considered as an aggressive condition due to the polarity of the gas. However, results are relevant to the industry as seen in various publications. [e.g. proceeding of MERL/Rapra Oil Field Engineering 2006]
- Our work indicates that compounds based on Viton® Extreme™ETP-S and Viton® GF-S show the best ED performance in 100% CO_2 environment, followed by compounds based on Viton® GBL-S and Viton® A-HV.
- Based on our data, we conclude that it is difficult to predict ED performance from room temperature stress strain data. ED appears to be a complex function of strength and solubility.

Controlling Parameters as Described in the Literature

ED damage is expected to decrease by:

- Low gas pressure
- High seal constraints
- High gas diffusion rates
- High modulus & high tear strength
- High compound hardness
- Homogeneous rubber part

ED damage is expected to increase by:

- High gas pressure
- High solubility in the polymer
- Fast decompression rates
- High temperature
- Multiple cycles

ED Resistance of FKM Fluoroelastomer Selection Guide For Oil & Gas

Fluoroelastomer Selection Guide

	Polymer				
Requirement	**A-HV**	**GBL-S**	**GF-S**	**ETP-S**	**TFE/P**
Strength at High Temperature	++	++	+	NR	NR
Methanol Resistance	NR	NR	+	++	+
Amine Corrosion Inhibitor Resistance	NR	NR	NR	++	++
Formate Fluid Resistance	NR	NR	NR	++	na
Ester Based Fluid Resistance	+	na	NR	NR	NR
ED Resistance (100% CO_2)	**+**	**+**	**++**	**++**	**NR**
Compression Set Resistance	++	+	++	+	NR
Low Temperature Flexibility	++	++	+	+	NR

++	Definitely should be considered
+	Should be considered
NR	Not Recommended for this service
na	Not tested

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