EXPERT KNOWLEDGE

FAILURE ANALYSIS

OF ELASTOMER COMPONENTS

SHORT VERSION

An offer of

O RING PRÜFLABOR RICHTER

TESTING CONSULTING DEVELOPING

Source: www.o-ring-prueflabor.de
Information as of 02/2018

Explosive Decompression and Overheating –

Strong and Sudden Changes in Pressure or Temperature Can Cause Severe Sealing Damage

Authors:
Dipl.-Ing. Bernhard Richter,
Dipl.-Ing. (FH) Ulrich Blobner,

Elastomers are permeable, in other words gases can infiltrate the rubber material and diffuse out again. The higher a gas is under pressure, the easier it can permeate into an elastomer. If this pressure is suddenly reduced in the sealing system, the permeated gas cannot escape quickly enough. It then creates cracks in the seal core, which propagate to the outside. In other cases, bubbles form on the surface of the seal.
The characteristics of the "explosive decompression" damage pattern are primarily dependent on the level of pressure drop and the ratio of pressures before and after relaxation, in addition to the formula-related resistance of the material. In practical terms, this means that this damage

pattern is most frequently found on O-rings after emergency shutdowns if uncontrolled relaxation to ambient pressure has taken place.
Explosive overheating or evaporation occurs when a medium that has permeated into a seal through swelling is quickly heated above its boiling point. If this diffused fluid suddenly passes from the liquid phase into the vapor phase, small vapor bubbles can form in the O-ring. A sudden transition to the vapor phase can be caused by rapid overheating or a rapid drop in pressure. Here, too, increased temperatures raise the susceptibility to cracking.

Damage Pattern and Problematic Areas

Immediately after the relaxation there are often bubbles on the surface, which usually disappear again. Typical permanent damages are cracks in the core, which in some cases propagate to the surface, see **Figs. 1 and 2**. The damage pattern of explosive evaporation is not fundamentally different from explosive decompression, see **Fig. 3**.

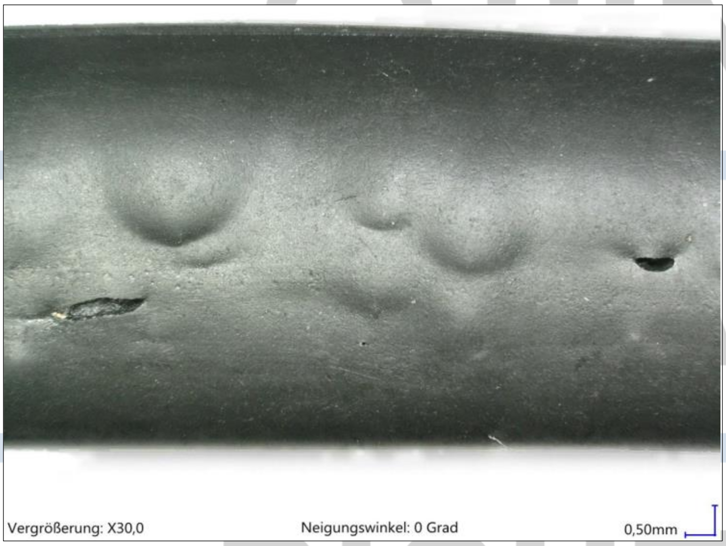

Fig. 1: Bubbles on the surface and cracks in the circumferential direction due to explosive decom-pression

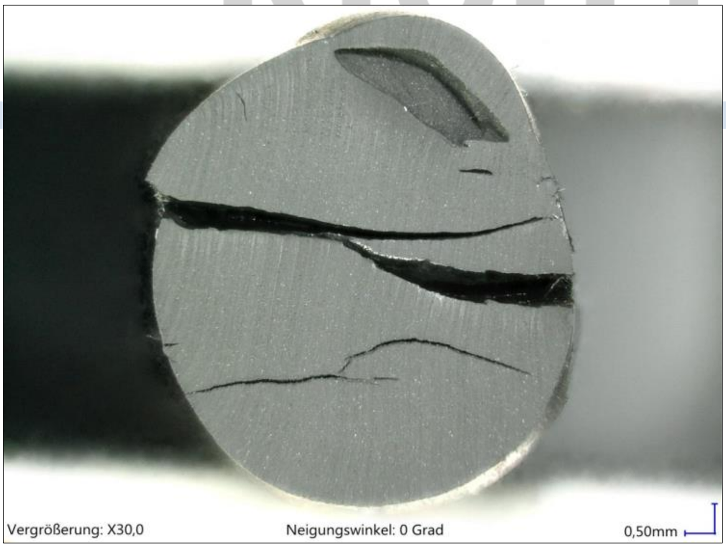

Fig. 2: Cross section cracks due to explosive decompression

Fig. 3: Internal cracks due to explosive overheating or explo-sive evaporation

In many cases in explosive overheating, cracks are more numerous and smaller. The internal crack formation is typical for the damage mechanism of an explosive superheat.

Usually this damage leads to a failure of the sealing system and must be avoided in any case.

Differentiation from Similar Types of Damage

The damage pattern of the internal cracks can also be caused by stress cracks due to excessive deformation and the simultaneous impact of high temperatures, or it can be caused by manufacturing defects at normal degrees of deformation and typical temperature exposure.

Preventative Measures

If an explosive decompression stress occurs cyclically, the usage of elastomers should be avoided altogether. If, however, the number of relief cycles can be limited, the use of special formulations (Norsork M 710 approval) can help. Due to the smaller ratio of free surface to mass, the susceptibility of O-rings increases with increasing cord thickness. Higher temperatures (> 60°C) also increase the risk of cracking as the load limits of elastomers decrease at higher temperatures.

Practical Tips (Testing Possibilities / Standard Recommendations)

Special test methods can be used to compare the resistance of different elastomers to explosive decompression.
While the Norsork M-710 standard and NACE standards are well known, it should be noted that these tests are considered positive, even if there are still considerable cracks and only a very limited number of pressure cycles are tested.

O-Ring Prüflabor Richter GmbH
Kleinbottwarer Str. 1
71723 Großbottwar

Telefon 07148 / 16602-0
Fax 07148 / 16602-299
info@o-ring-prueflabor.de
www.o-ring-prueflabor.de

Geschäftsführer:
Dipl.-Ing. Bernhard Richter
Ust-ID-Nr. DE 277600966
Steuer-Nr. 71342/02407 FA LB

Sitz der Gesellschaft:
Großbottwar
Amtsgericht Stuttgart
HRB 737482

Volksbank Ludwigsburg
IBAN DE96 6049 0150 0820 5810 03
SWIFT GENODES1LBG