EXPERT KNOWLEDGE

FAILURE ANALYSIS

OF ELASTOMER COMPONENTS

SHORT VERSION

An offer of

O-RING PRÜFLABOR RICHTER

TESTING CONSULTING DEVELOPING

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Cracks Due to Manufacturing Problems –

Serious Defects Often Leading to Seal Failures

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Seals must not show any cracks. As ISO 3601-3 (August 2010) states: "In the non-stretched state, the surface of the O-ring shall be free from cracks (...) at twice magnification under appropriate lighting."[1]
Since cracks in elastomer parts can have a variety of causes, this article is limited to manufacturing defects only.
There are four common causes of cracks:

[1] translated from DIN ISO 3601-3 (August 2010): Fluidtechnik – O-Ringe – Teil 3: Form- und Oberflächenabweichungen (ISO 3601-3:2005), S.7

- Incorrect vulcanization
- Superimposed compound (already started to scorch)
- Cracks due to impurities
- Demolding cracks

Damage Pattern and Problematic Areas

While a layman can easily recognize the damage pattern of relatively large cracks, microcracks require the eye of an expert together with the appropriate technology (e.g. magnifying glass or digital surface microscope) or a stretched test.

Damage Pattern "Cracks Due to Incorrect Vulcanization or Superimposed Compound"
If vulcanization is faulty or a superimposed compound is used, flow lines may appear on the seal in addition to the inhomogeneous fracture surface. Cracks caused by flow lines are often parabolic and symmetrical to the parting line. In the case of faulty vulcanization, the structure of the fracture surface is usually inhomogeneous (see **Fig. 1**), in some cases there are also conspicuously smooth areas in the fracture surface. It is typical for cracks caused by vulcanization defects to have a rounded transition from the surface to the crack in comparison to a case of damage caused by cuts.

Fig. 1: Cracked O-ring caused by a vulcanization defect

Damage Pattern "Cracks Due to Impurities"
The fracture surface clearly shows the area of pollution (see **Fig. 2**) where insufficient vulcanization has occurred and the area of crack propagation (regular, slightly roughened structure, stress driven, meaning usually radial crack propagation).

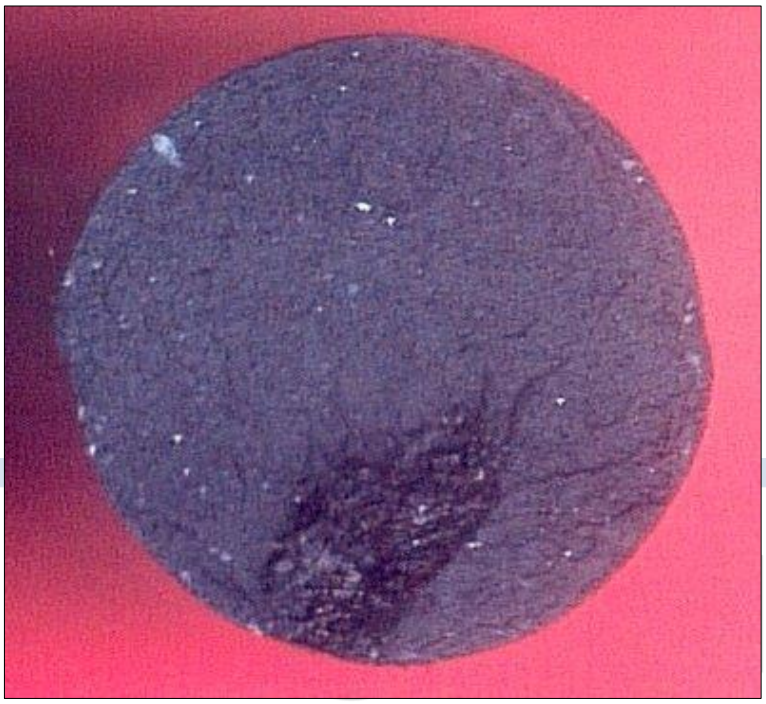

Fig. 2: Crack triggered by ingress of foreign material

Damage Pattern "Demolding Cracks"

These often occur at sharp transitions, edges (see **Fig. 3**) or undercuts. Demolding cracks originate from the parting plane or another tool edge and then propagate perpendicular to the demolding stress.

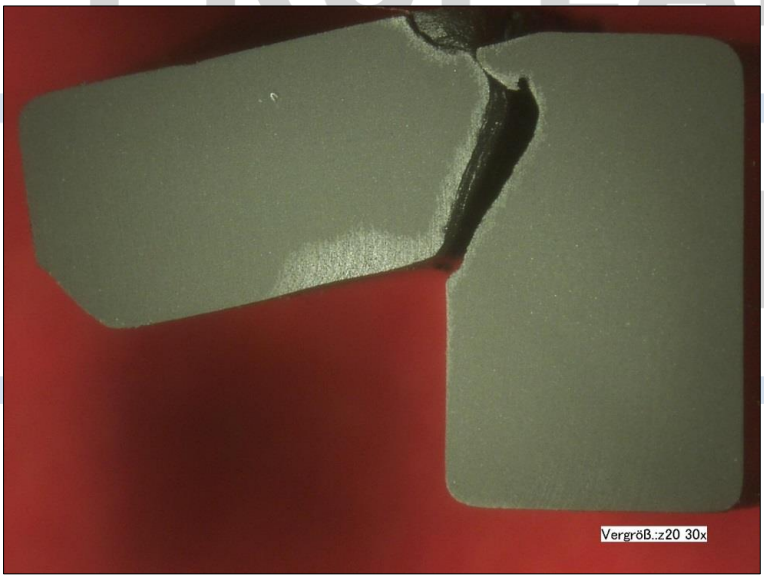

Fig. 3: Demolding crack at a sealing element

Differentiation from Similar Types of Damage

Since cracks can be caused by a variety of other causes and since they usually lead to a total failure of the gasket, it is very important to make a precise distinction from similar damage

patterns. They can be confused with ozone cracks, fatigue cracks, cracks due to aging by heat and oxygen, assembly cracks or cracks caused by chemical degradation.

Preventive Measures

The manufacturing process of a rubber part is very complex and therefore requires sufficient competence and care on the part of the manufacturer. This means that the purchase of a highly stressed gasket always requires a certain amount of trust towards the supplier. As a user it makes sense to visit the supplier to get a first-hand impression of his possibilities. If the assessment is then positive, appropriate incoming goods inspections should be defined with regard to shape and surface defects of the seals used.

Practical Tips

If a crack is discovered in a delivery lot, the whole delivery lot should be inspected. For better detection of cracks in incoming inspection, seals should be slightly stretched manually (10-30%) and inspected under a well-lit magnifying glass with at least 2x magnification.

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