EXPERT KNOWLEDGE

FAILURE ANALYSIS

OF ELASTOMER COMPONENTS

SHORT VERSION

An offer of

O-RING PRÜFLABOR RICHTER

TESTING CONSULTING DEVELOPING

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Chemical Erosion –

Destruction of the Network Structure by a Contact Medium

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Elastomer compounds for almost every contact medium are available to today's practitioner. Despite a very extensive knowledge of chemical resistance, seal failures due to chemical erosion frequently occur, as these are often complex processes with some interactions.

The following compound components have an influence on the resistance to chemical erosion[1]:

[1] Cf. NAGDI, K.: Gummi-Werkstoffe - Ein Ratgeber für Anwender, Ratingen, ²2002, chapter 17, P. 345 and RÖTHEMEYER, F. und SOMMER, F.: Kautschuktechnologie, München, 2001, P.38f.

1. Base polymer (e.g. EPDM, NBR etc.)
2. Polymer architecture (e.g. diene content for EPDM, ACN content for NBR)
3. Cross-linking system (e.g. bisphenolic or peroxidic for FKM)
4. Fillers (e.g. carbon black)
5. Other mixture components (e.g. acid acceptor system for FKM (e.g. MgO), antioxidant for NBR, plasticizer)

Chemical erosion is an irreversible process that cannot be partially reversed like excessive bulking by re-drying. The medium first erodes the contact surface of the seal and then spreads - driven by the diffusion of the medium - into the interior of the seal. This interacts with the network structure of the polymer material and crosslinking bridges, which leads to post-crosslinking and/or destruction of the crosslinking bridges and/or segmentation of the long polymer chains.

Damage Pattern and Problematic Areas

Chemical erosion can, but must not, leave traces on the surface in the contact area. It can also lead to a high permanent deformation. Signs of chemical erosion that has occurred can be found below (see **Fig. 1-3**):

- Tears towards the medium can occur before the material loses its elasticity.
- Strong setting behavior of the seal
- Sticky surface and strong softening (polymer degradation), partly also sooty surface
- Hardening and loss of elasticity, meaning breakage of the seal after slight bending or tensile stress.

Fig. 1: EPDM seal destroyed by disinfectant

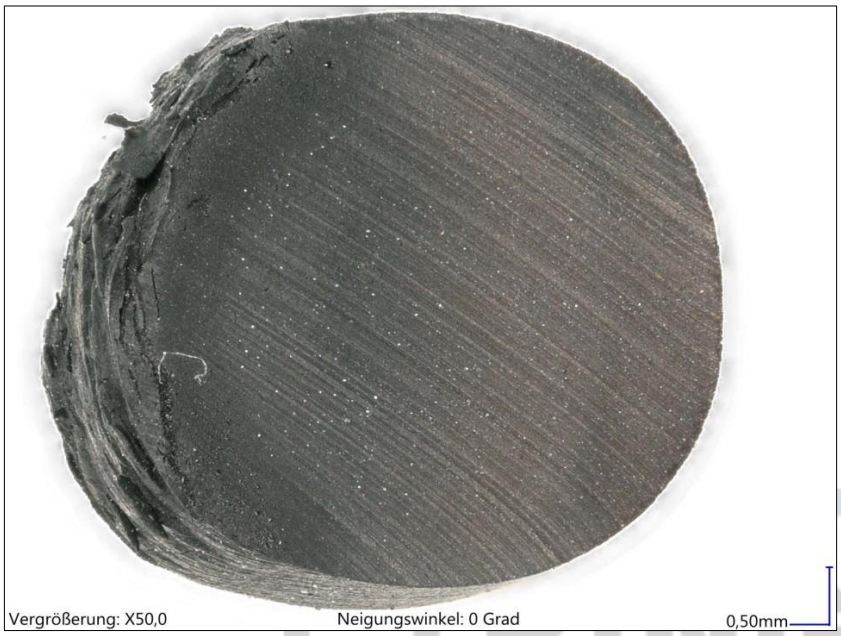

Fig. 2: Chemical erosion of an FKM material by an inorganic acid

Fig. 3: Hydrolysis (= chemical erosion by water) of a polyurethane seal

The damage pattern of the chemical erosion is very similar to the damage pattern of aging by thermal overloading, see DICHT! 2/2017. In order to clearly distinguish chemical erosion from other damage mechanisms and determine the eroding medium, various analytical detection methods are available to the user today (e.g. GC-MS, FTIR analysis).

Prevention

The following questions can help the practitioner avoid this damage:

- Are all mediums with which the component comes into contact actually known?
- Are there any preceding or subsequent processing, cleaning or assembly steps involving critical contact mediums?
- Are the actual temperature loads and the contact duration with critical mediums known?
- Is there a state-of-the-art standard for a sealing material? (e.g. in comparison to ISO 3601-5)
- Are formulation-specific test results available from the seal supplier? If not, check (risk assessment) whether compatibility tests are still necessary.

Practical Tips

In a first step to clarify the elastomer resistance, medium resistance tables can help.
Particularly when used with oils, it is not only the compatibility with the base oil itself that matters, but also the additive properties of the oil.
Particular care must be taken when using FKM materials in acids, hot water and steam.
Last but not least, it is always good to call on the assistance of a specialist, whether from a seal supplier or a specialist service provider.