# EXPERT KNOWLEDGE
# FAILURE ANALYSIS
# OF ELASTOMER COMPONENTS

*SHORT VERSION*

An offer of

O RING
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TESTING CONSULTING DEVELOPING

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## Autoxidation –
### Rubber Poisons Can Accelerate Elastomer Aging Rapidly

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Autoxidation is the self-absorption of oxygen from elastomer seals. Even small amounts of oxygen have a detrimental effect on elastomers, which can easily be seen from the strong decrease in tensile strength and elongation at break. The mechanism of oxidation, meaning the destruction of the elastomer network, is usually initiated by radicals, which can form due to high temperatures, mechanical stress, radiation and other causes.

During autoxidation, hardening may occur as a result of tighter post-crosslinking or re-crosslinking (cyclization) as well as softening due to chain splitting.

The term autoxidation is closely associated with the so-called rubber poisons. These are heavy metal compounds that act as catalysts for the relatively slow decomposition of hydroperoxide. This allows complete depolymerization in the typical temperature range of an elastomer to take place within a few months.

Even the smallest amounts of copper and manganese accelerate the autoxidation very strongly and destroy the material in a short time, especially with elastomers made of NR and IR. Most synthetic rubbers are less susceptible to corrosive reactions. Other rubber poisons

are divalent iron salts, cobalt and nickel. However, these are not as harmful as copper and manganese. Rubber poisons can enter the compound either through the natural environment (e.g. manganese-polluted grounds in rubber plantations), through compound components or through sealing applications. Today, autoxidation is a phenomenon that occurs mainly in peroxidically crosslinked EPDM hot water seals. This type of damage only occurs locally, since a certain water quality is required for this, which causes dezincification of the brass fittings, in which the copper of the alloy is excreted as a spongy mass. Certain EPDM formulations and dezincification-resistant brass can prevent this damage.

## Damage Pattern and Problematic Aspects

Damage caused by autoxidation often has a diverse appearance. Elastomeric materials can soften, crack, become sticky or shiny due to this mechanism. The shiny areas are often reminiscent of a melted thermoplastic. These characteristics can occur on the same gasket in different areas. In extreme cases, the seal may be completely depolymerized, resulting in decomposition and even carbon black.


**Fig. 1:** EPDM O-ring, perox. cross-linked after endurance test (cyclic temperature change from 25 to 95° C in water with Cu ions, test duration 4500 h)


**Fig. 2:** EPDM seal damaged by autoxidation (dezincification) with clearly visible fused areas, similar to a thermoplastic or TPE


**Fig. 3:** Seal from **Fig. 2** in cross-section. The left area had contact with rubber poisons, the right area was protected by the housing.

Autoxidative damage in hot water applications leads to leakages.

## Differentiation from Similar Types of Damage

The chemical corrosion of strong cleaning agents (with chlorine) causes sooty surfaces on certain elastomers. This can resemble autoxidative aging.

## Preventive Measures

Contact with critical heavy metals should be avoided in the manufacturing of compounds and in sealing applications. If it cannot be completely avoided, then special materials (e.g. dezincification resistant brass) and rubber formulations that are more stable against autoxidation must be used.

## Practical Tips (Testing Possibilities / Standard Recommendations)

Since there is no national or international standard for testing resistance to rubber poisons, the O-Ring Prüflabor Richter has developed an internal laboratory test procedure. This only deals with the element copper, since the copper compatibility of EPDM in hot water applications in the field of autoxidation is currently the most frequent concern for seal users.



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