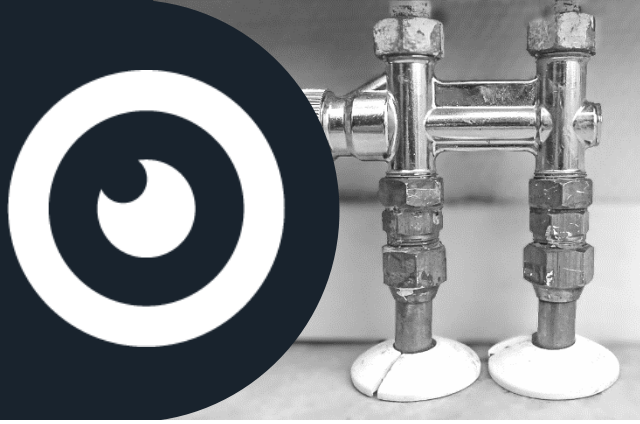
MATERIEX CASE 24-2

LEAKAGE IN RADIATOR FITTINGS

Dezincification and stress corrosion cracking



BACKGROUND

About 3 months after the replacement of a thermostatic radiator valve, a leakage suddenly occurred in one of the two fittings between the thermostat and the connected water pipes (Figure 1). During the valve replacement, the fittings had been loosened but not removed, and then reused. As there was no information of previous work done on the radiators, the fittings were assumed to be from the end of the 1960s, when the house was built.

FINDINGS

- The leakage had occurred due to cracking initiated at the sharp corner on the outer surface of the fitting (Figure 2).
- Investigation in SEM showed that the area adjacent to the fracture surface had suffered from dezincification (Figure 3). The same area in the non-leaking fitting had also suffered from dezincification and smaller cracks (100 µm) were observed (Figure 4). Dezincification is a corrosion process that selectively removes zinc from the brass alloy (if Zn>15%), leaving a porous copper-rich structure with reduced mechanical strength.
- The chemical composition of the fittings was identified as brass CW608N (60% Cu, 38% Zn, 2% Pb).
- The mode of fracture at the crack initiation sites was identified as ductile (Figure 5a). However, the majority of the fracture surface had an intergranular brittle mode of fracture (Figure 5b).

CONCLUSIONS

The fracture had been initiated by brass dezincification resulting in a reduced mechanical strength. As a consequence, the torque used during re-tightening after the thermostat change has probably been sufficient for the crack initiation to occur. However, the fact that the majority of the fracture surface had an intergranular brittle mode of fracture suggests that Stress corrosion cracking (SCC) may have been triggered by the induced stresses caused by the dezincification and the initial stages of cracking.

The leakage could probably have been prevented if fittings in dezincification-resistant brass had been installed during the thermostat change, instead of reusing the old fittings that were made of an alloy that is generally not resistant to corrosive mediums that might be used in the specific environment. Brass is particularly sensitive to ammonia, which is commonly found in some all-purpose cleaning agents.

INVESTIGATION

- On-site inspection and visual examination
- Chemical composition analysis (XRF)
- Fractography (SEM)
- Metallographic preparation and examination (SEM, EDX)

XRF - X-ray fluorescence spectroscopy
SEM - Scanning electron microscopy
EDX - Energy dispersive X-ray spectroscopy

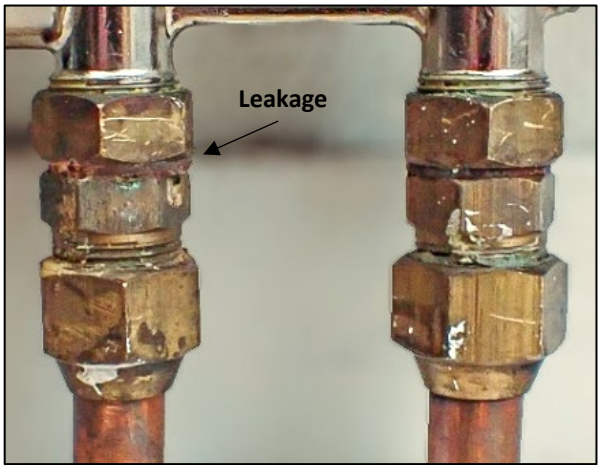


Figure 1. *Leaking vs non leaking fitting.*

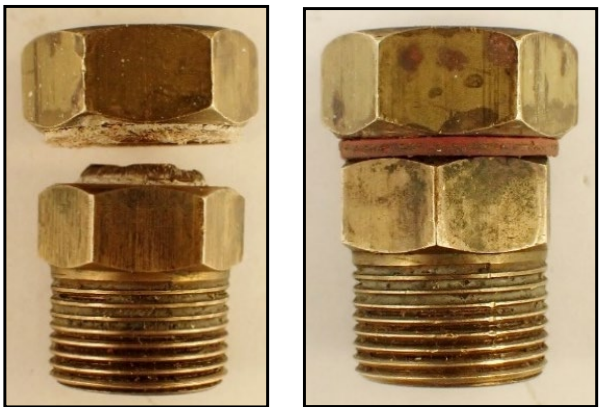


Figure 2. *Leaking (fractured) fitting vs non-leaking fitting.*

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E-mail: info@materiex.com Phone: +46 243-21 33 40 www.materiex.com

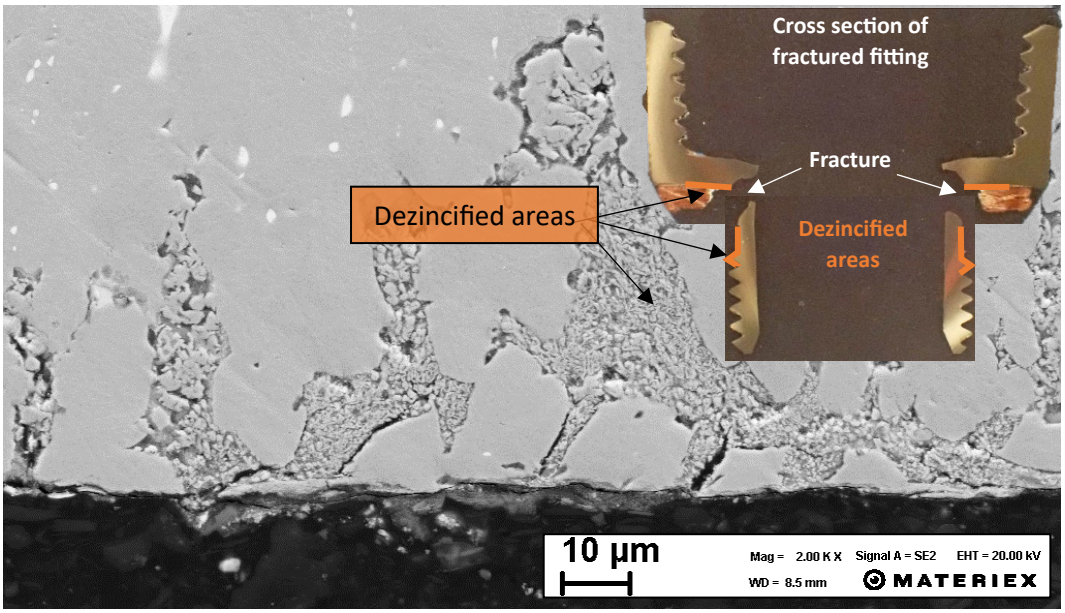

Figure 3. *SEM-image of dezincified surface adjacent to the crack initiation sites (fractured area).*

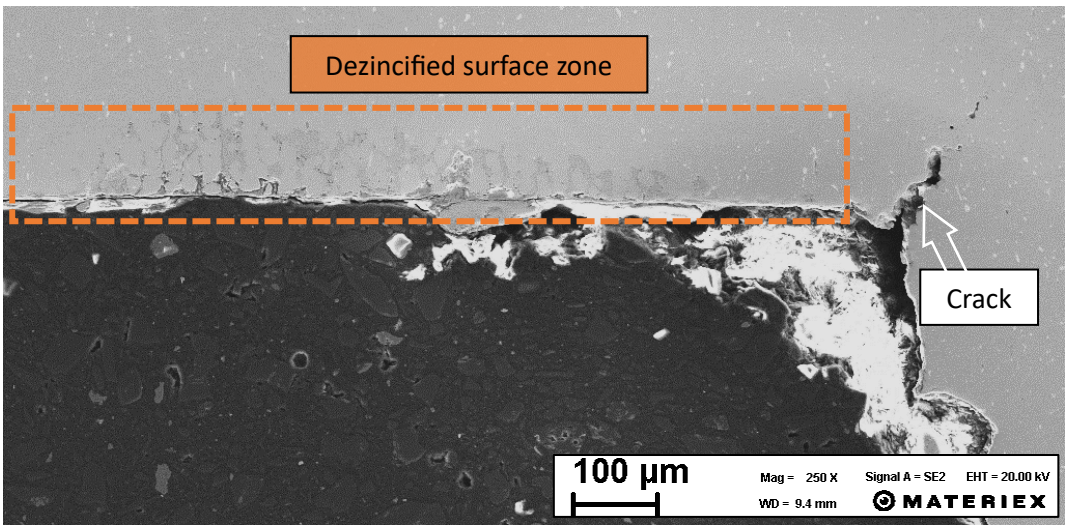

Figure 4*. Non-leaking fitting shows dezincified surface and cracking in the same area as the fractured fitting.*

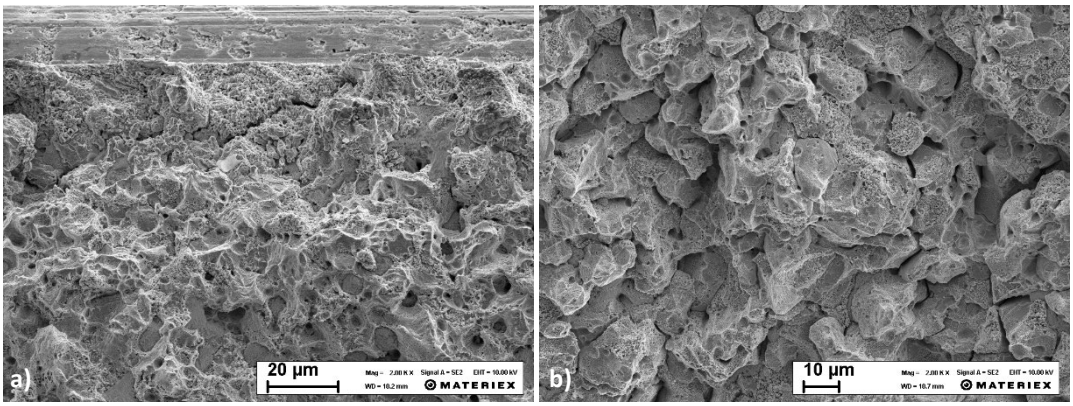

Figure 5. *SEM-images of fracture surface showing a) a ductile mode of fracture at crack initiation site, b) Intergranular brittle mode of fracture at the majority of the fracture surface.*