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Investigations of aged metal seals for transport package safety assessment

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Investigations of Aged Metal Seals for Transport Package Safety Assessment

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Background: To ensure the required tightness for transport and storage cask for high level radioactive material usually metal seals of the Helicoflex® Type are used. The mechanical and thermal loadings associated with the conditions of transport specified in the IAEA-regulations (such as 0.3 and 9 m drop test and 800°C fire test) can have a significant effect on the leak tightness of the sealing system and require potent seals. Due to the long-term use, the seal behavior is influenced by temperature and time.

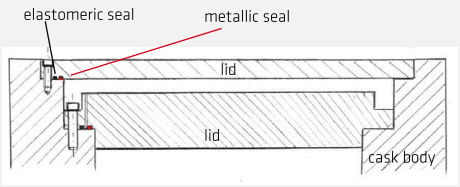

Figure 1: Example for an usual transport cask sealing system

Figure 2: Seal Helicoflex® HN200: spring, inner jacket (stainless steel) and outer jacket (aluminum or silver)

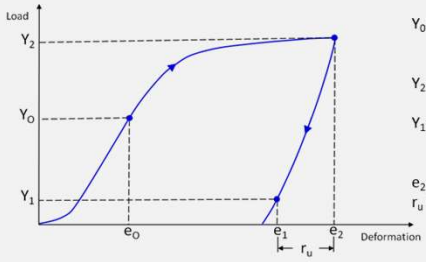

Figure 3: Characteristic curve (load/deformation) of a Helicoflex® HN200 seal

Y_0 = load on the compression curve above which leakage rate is at required level
Y_2 = load required to reach optimum compression e_2
Y_1 = load on the decompression curve below which leakage rate exceeds required level
e_2 = optimum compression *
r_u = useful elastic recovery (e_2-e_1)

*) required He-leakage rate is 10^{-8} Pa m^3 s^{-1}

Question: How does ageing of metal seals influence the sealing efficiency under the special condition, when deformation or short term displacement of cask components made possible a little seal repositioning before compression again?

Test set up and procedure:

1. Compression of flange pairs with metal seals (5 with Al- and 5 with Ag-jacket) in test flanges, measurement of leak tightness,
2. ageing at 125°C for 3 months,
3. flange pair opening, seal repositioning, repeated compression.

Measurement of sealing forces, deformation and leak tightness were performed during all compression and relief cycles.

Figure 5: Temperature chamber

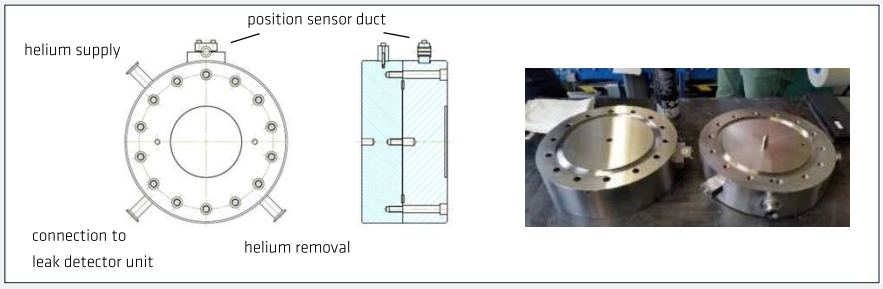

Figure 4: Test flanges

Figure 6: Lifting/repositioning of the seal before repeated compression

First results:

1. With parameters chosen for ageing reliable y_2 reduction is achievable (30 % for Ag-seals, 40 % for Al-seals).
2. Tightness after ageing before flange opening was always better than He-leakage rate 10^{-8} Pa m^3 s^{-1}.
3. After flange opening, seal movement and repeated compression, leakage rate of the Ag-seal was still better than 10^{-8} Pa m^3 s^{-1} but, leakage rate of the Al-seals was significant higher than 10^{-8} Pa m^3 s^{-1}.
4. An influence of the way of seal movement could not be detected.

Next step planned: Variation of ageing conditions

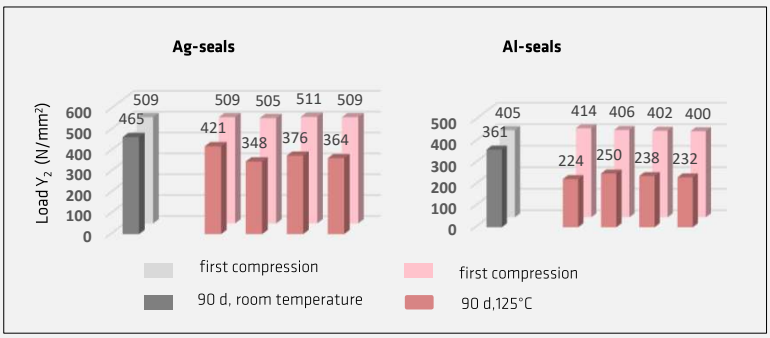

Figure 7: Reduction of Y_2 after ageing (90d, 125°C)

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