



Test Report

Customer: Flexitallic Ltd.
Scandinavia Mill, Hunsworth Lane
UK - Cleckheaton BD19 4LN

Project number (amtec): 302 769
Report number: 302 769 7/-

Test procedure: Packing test according to VDI 2440

Type of packing: Flexitallic 308

Date: January 23rd, 2017
Pages: 5
Appendices: 8

Handwritten signature of F. Herkert in black ink.

Dipl.-Ing. F. Herkert
Head of Laboratory

Handwritten signature of B. Unser in black ink.

Dipl.-Ing. B. Unser
Test Engineer

Test results are only relevant to the test objects submitted.

1. Subject of investigation

The subject of investigation was a set of packing rings for valve stem applications supplied by Flexitallic Ltd. which is named

- **Flexitallic 308**

consisting of 5 rings of graphite material cut from packing cords.

The following geometry of packing rings was tested:

- 56 x 40 x 40 mm.

2. Goal of investigation

The goal of investigation was the determination of the tightness behaviour of the set of packing rings in accordance to the requirements of TA-Luft ("Technical Instructions on Air Quality Control"). According to VDI 2440 (dated November 2000) emission limits are required.

This Technical Instruction serves to protect the general public and the neighbourhood against harmful effects of air pollution on the environment and to provide precautions against harmful effects of air pollution in order to attain a high level of protection for the environment altogether.

Tightening joints can be called high-grade sealing systems for the purposes of TA-Luft, if they fulfill the following requirements:

- The design of the sealing system can be expected to permit normal function in the long term in the given operating conditions.
- The compliance of the specific leakage rate of $1.0 \cdot 10^{-4}$ mbar·l/(s·m) for temperatures lower 250 °C and of $1.0 \cdot 10^{-2}$ mbar·l/(s·m) for temperatures higher or equal to 250 °C will be verified in a first-time test.

The verification of the compliance of the allowable leakage rate was the goal of the study in hand.

3. Testing equipment

The test was performed in the testing equipment TEMES_{stb.freak} 010 206 which was designed for the characterization of stuffing box packing materials, see **appendix 1**.

In this test rig the housing and the stem of a valve is re-built for the examination of friction and tightness behaviour of the stem seals. Up to eight packing rings can be assembled in the test rig.

For the packing geometry which should be tested, the following test housing and stem were used:

- Housing: Inner diameter 56 mm / H8, R_a 1.0 μm ;
- Stem: Outer diameter 40 mm / h7, R_a 1.0 μm , hardened.

The used metallic ring in the bottom of the packing area had a gap of 0.2 mm. The packing set can be heated within this test rig up to temperatures of 400 °C. The internal pressure of the test medium can be set during leakage measurement to a maximum of 200 bars. The stem can be moved in linear direction, the maximum movement of the stem is 100 mm.

Apart from the load of both gland bolts and the stem force, the deformation of the packing set and the movement of the stem are measured. Thermocouples are used at different locations in the equipment, e.g. in the housing, in the gland, at the load transducers and in the supply lines of the test medium. In leakage measurements a pressure transducer is used to measure and control the fluid pressure. The leak rate can be measured either with the pressure drop method with a differential pressure transducer or with a Helium leak detector using the vacuum method, see **appendix 2**.

4. Test procedure

One test with the following boundary conditions was performed:

- Predeforming 70 MPa,
- Prestress 50 MPa,
- 1500 stem cycles,

- Test temperature 200 °C and 300 °C,
- Test medium: Helium (He),
- Test pressure 40 bar.

5. Results

One test was performed with the packing set Flexitallic 308 with the geometry 56 x 40 x 40 mm. The course of test is shown in **appendix 3**.

After the installation of the complete set of packing rings in the housing, all rings were predeformed two times with hydraulic spanners to 70 MPa. The dwell time under maximum load was 5 min. The rings were shifted 90° clockwise. After that the prestress was set to 50 MPa. Afterwards 5 stem cycles were performed. The prestress value was adjusted to 50 MPa, see **appendix 4**; the corresponding bolt force was app. 30 kN. No Belleville Disc Springs were used.

After the assembly procedure a leakage test at ambient temperature was performed. The test pressure was set to 40 bar, the test medium was Helium. The leak rate after 13 hours, which was detected with the leak detector, was $8.6 \cdot 10^{-7}$ mbar·l/(s·m).

In the next step the test temperature of 200 °C was applied. During heating up the packing stress decreased to 45 MPa. Afterwards 500 stem cycles with a stroke of 40 mm were performed, the stem force during the stem cycles was ± 5 kN, see **appendix 5**.

At the subsequent leakage measurement at 40 bar Helium, the leak rate after 9 hours of measuring was $7.3 \cdot 10^{-6}$ mbar·l/(s·m), see appendix 5 bottom. The measured leak rate after 500 stem cycles at 200 °C is below the limit of $1.0 \cdot 10^{-4}$ mbar·l/(s·m) which is demanded in VDI 2440 for the operational conditions under 250 °C.

The packing type Flexitallic 308 with the packing geometry 56 x 40 x 40 mm can be called **high-grade sealing system for the purposes of TA-Luft** under these operational conditions.

In the next step the test temperature of 300 °C was applied. During heating up the packing stress increased from 42.5 MPa to 45 MPa.

Afterwards another 500 stem cycles with a subsequent leakage measurement were performed, see **appendix 6**. The leak rate after 1000 stem cycles in total after a measuring period of 24 hours was $5.4 \cdot 10^{-5}$ mbar·l/(s·m), see appendix 6 bottom.

After that another 500 stem cycles with a subsequent leakage measurement were performed, see **appendix 7**. The stem force during the stem cycles was between ± 5 kN and ± 10 kN. The leak rate after 1500 stem cycles in total after a measuring period of 24 hours was $2.7 \cdot 10^{-5}$ mbar·l/(s·m), see appendix 7 bottom.

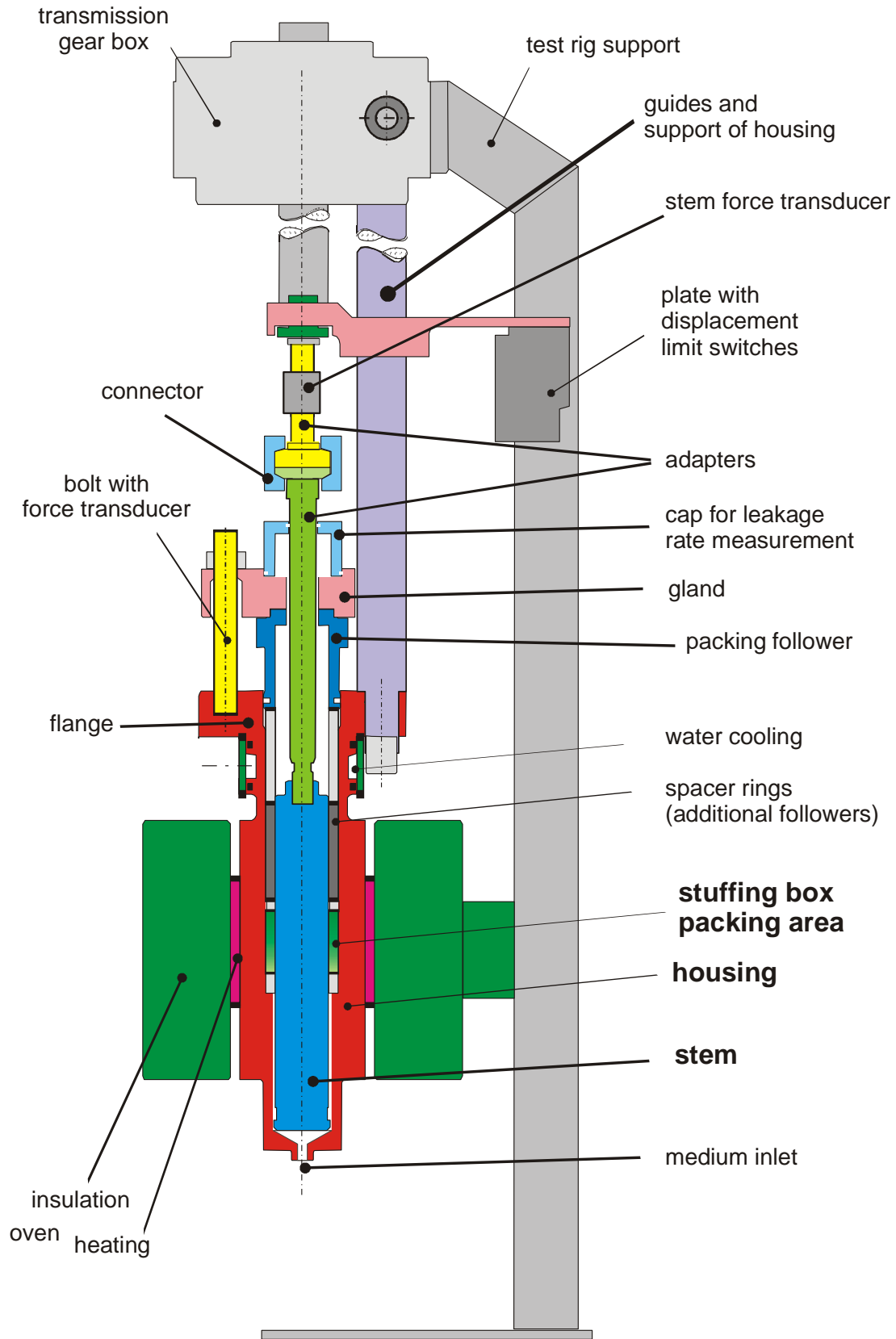
After 1500 stem cycles with a subsequent leakage measurement the test ended. The packing stress at the end of the test was 39 MPa.

The measured leak rate after 1000 stem cycles at 300 °C is below the limit of $1.0 \cdot 10^{-2}$ mbar·l/(s·m) which is demanded in VDI 2440 for the operational conditions above 250 °C.

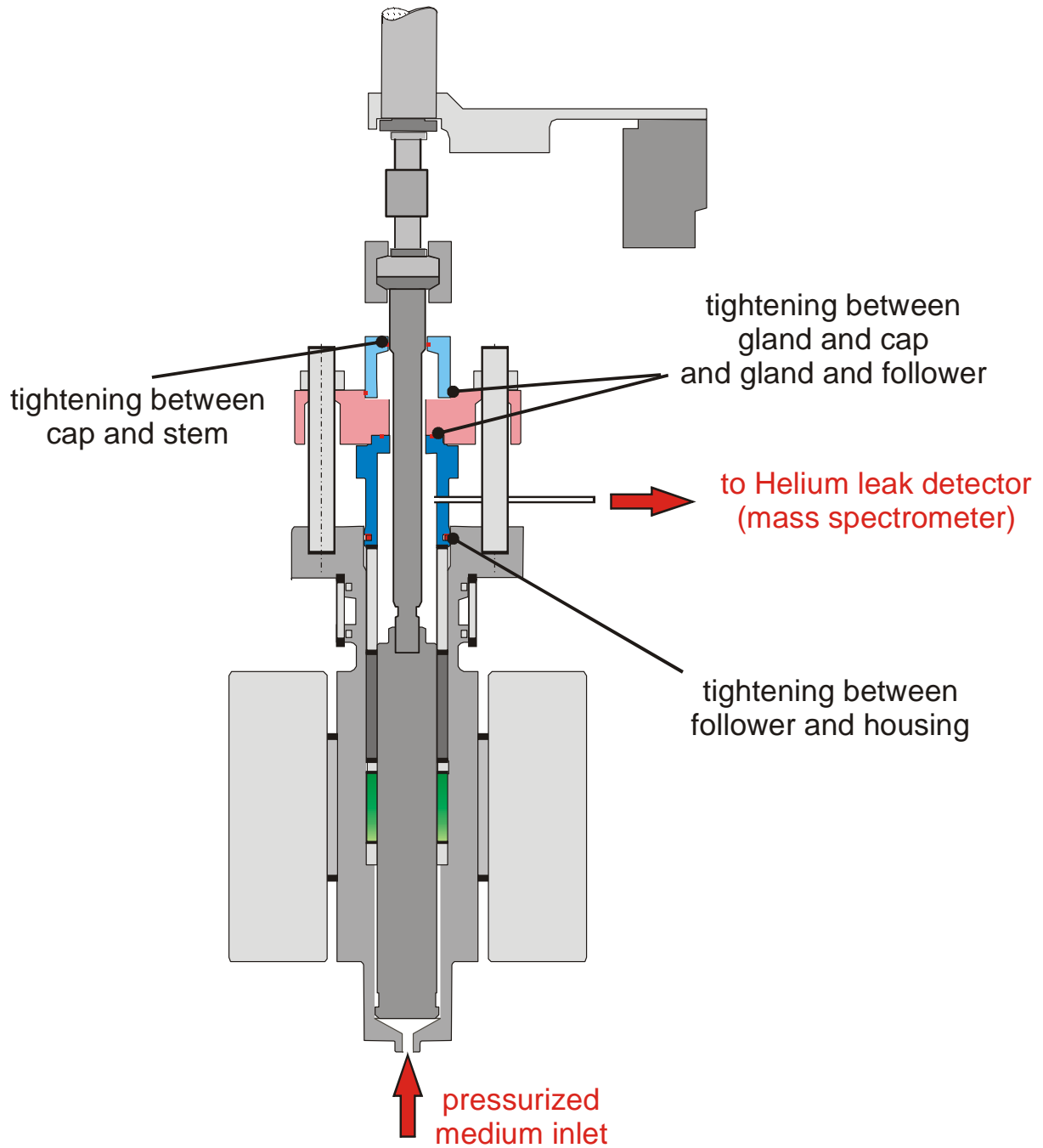
The packing type Burgmann Flexitallic 308 with the packing geometry 56 x 40 x 40 mm can be called **high-grade sealing system for the purposes of TA-Luft** under these operational conditions.

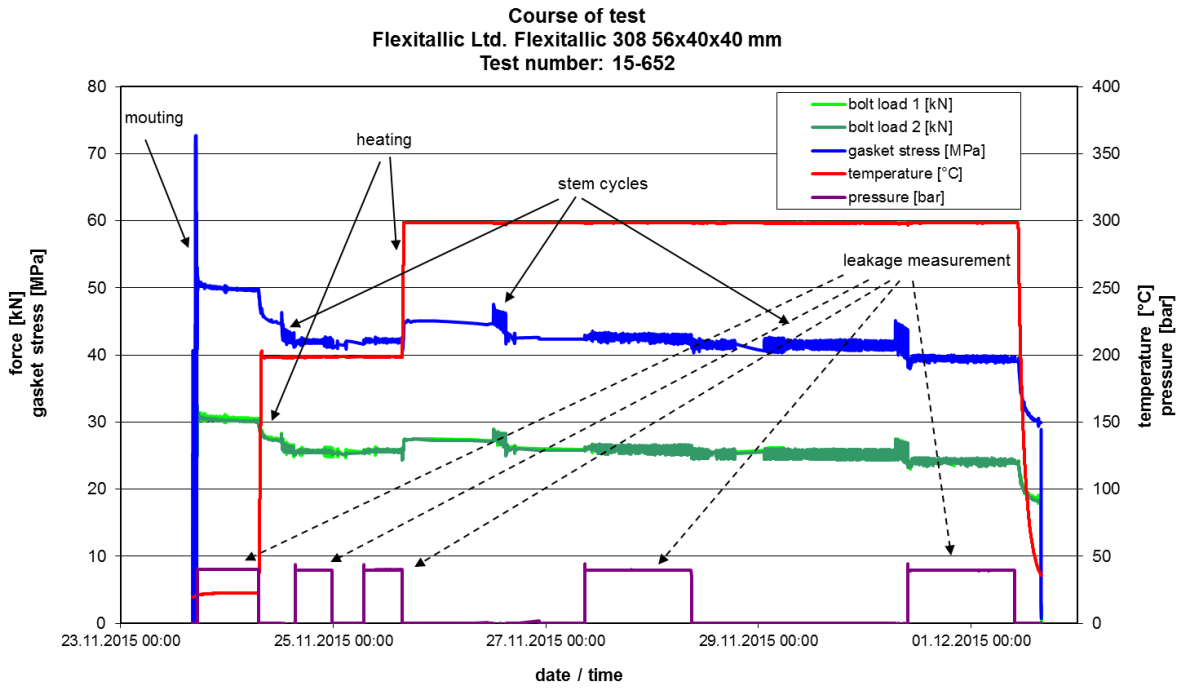
6. Photo documentation

In **appendix 8** a photo of the tested specimen Flexitallic 308 is shown.



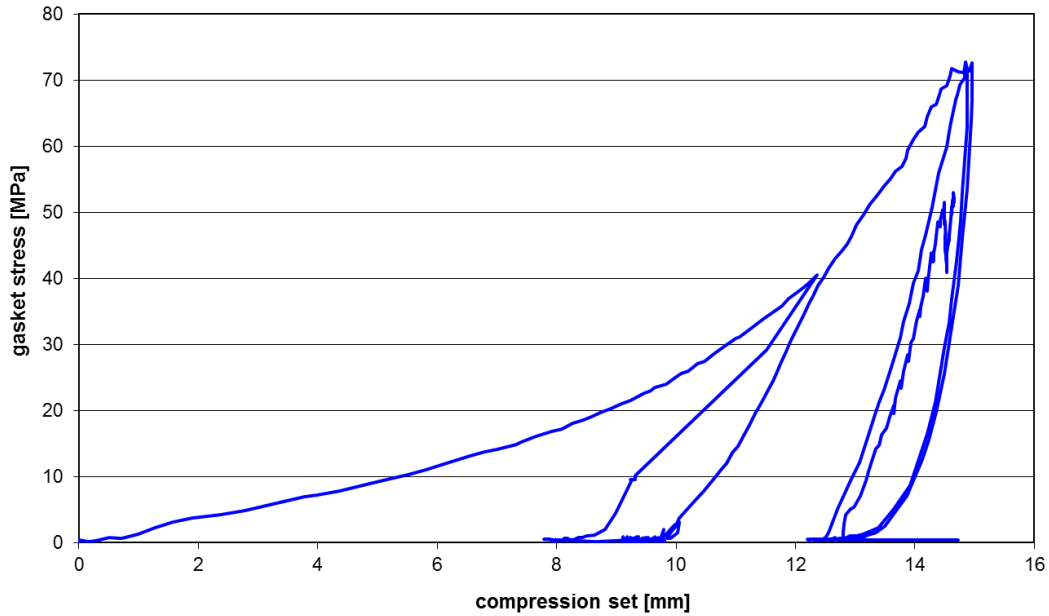
Testing Equipment TEMES_{stb.freak}





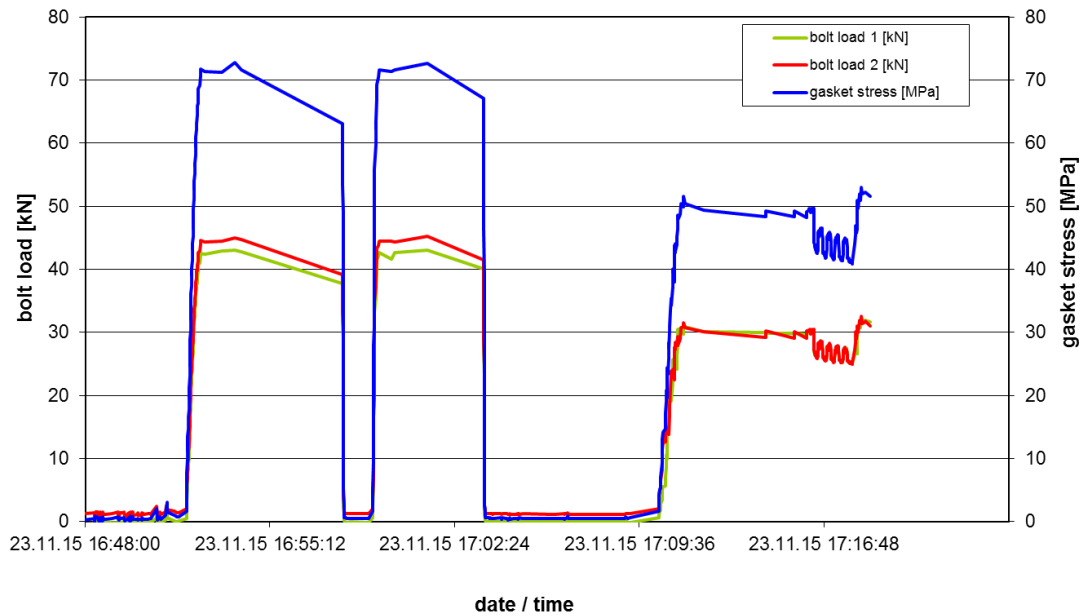
Course of test

Compression curve
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652



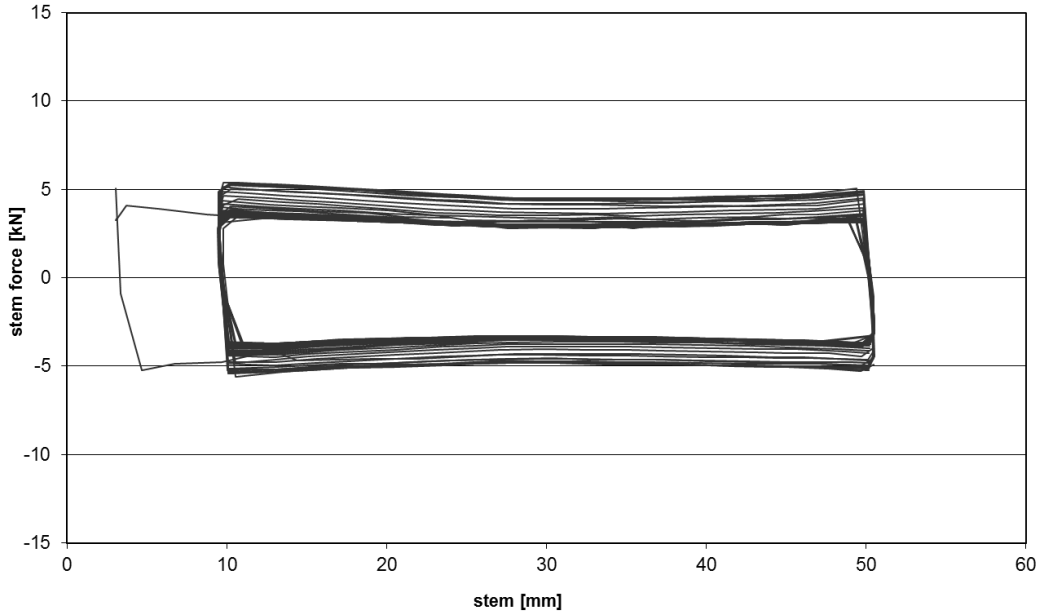
Assembly - Compression curve

Course of assembly
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652

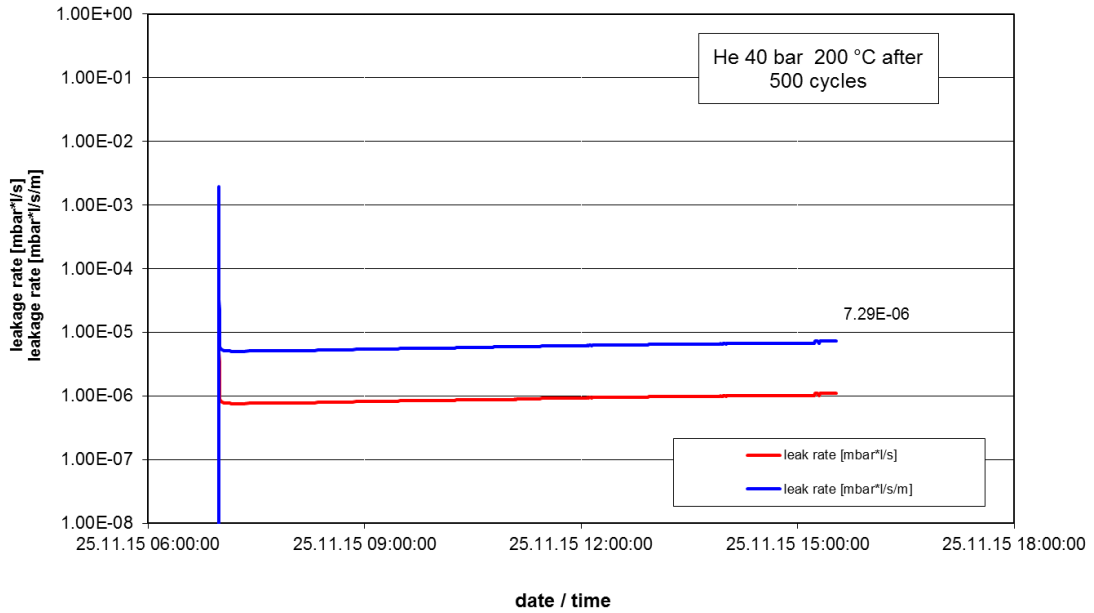


Assembly of 5 rings

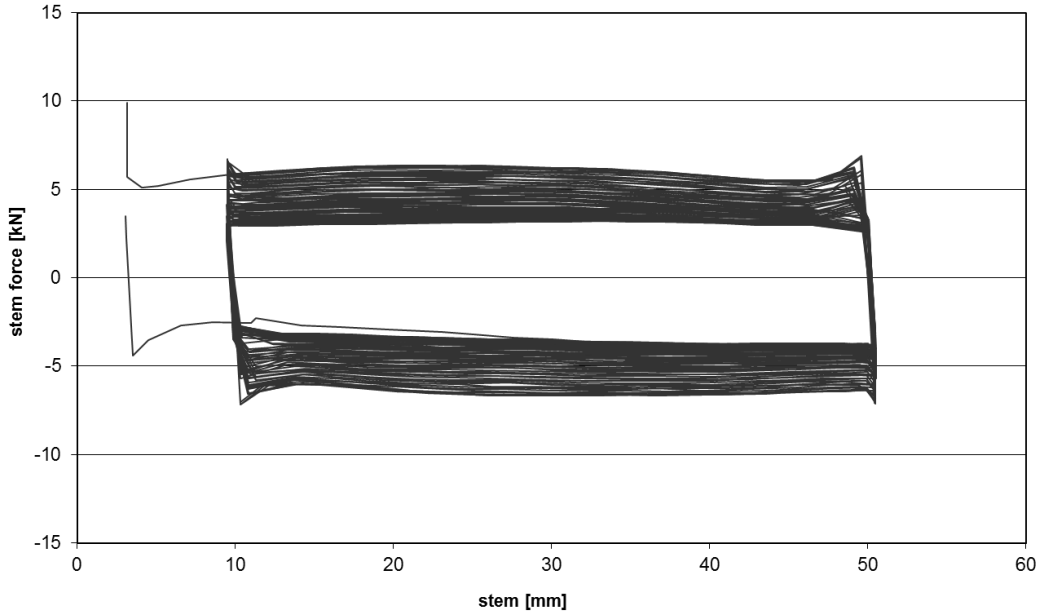
Stem cycles 1-500
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652



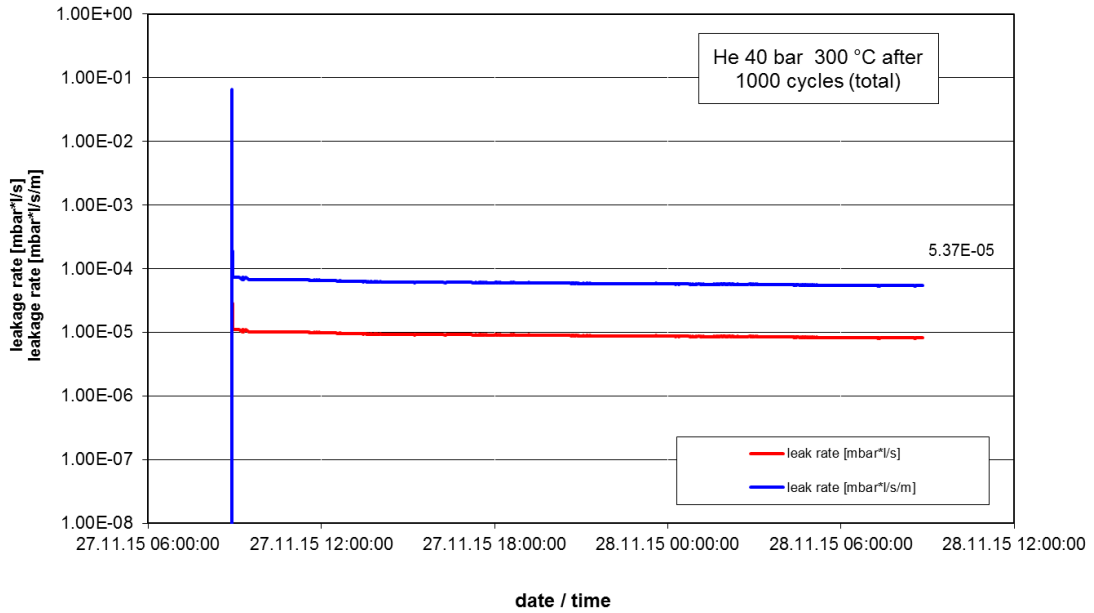
leakage curve
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652



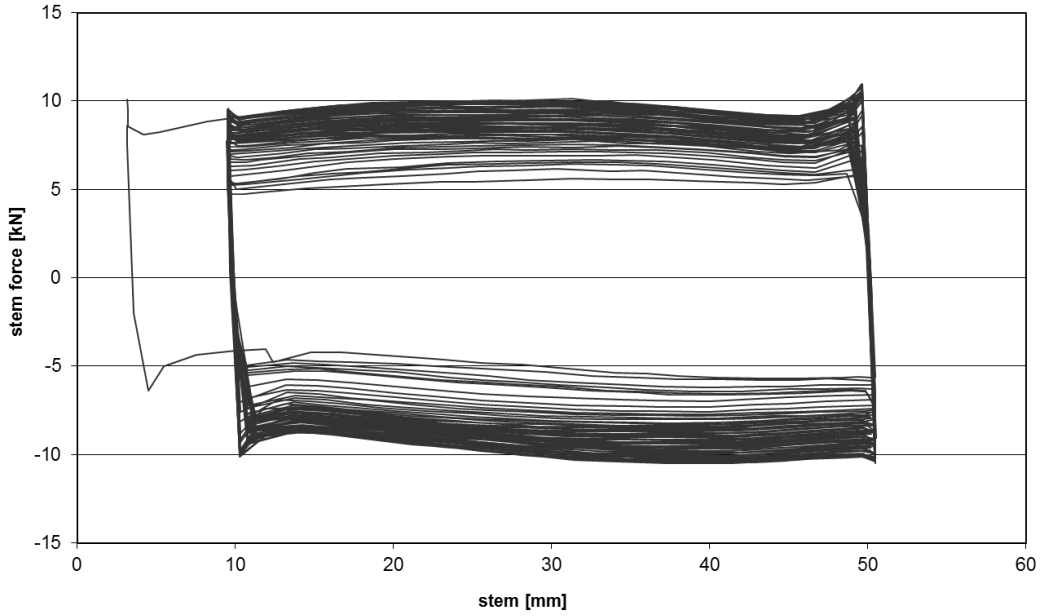
Stem cycles 500-1000
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652



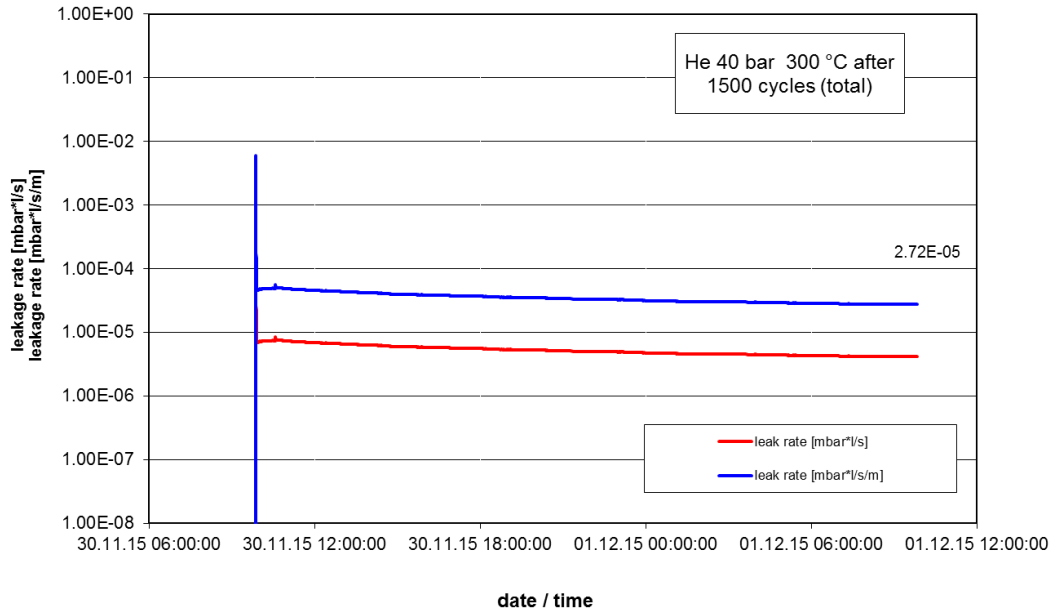
leakage curve
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652



Stem cycles 1000-1500
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652



leakage curve
Flexitallic Ltd. Flexitallic 308 56x40x40 mm
Test number: 15-652





Flexitallic 308 – 15-652