

Measurement of fugitive emissions of industrial valves

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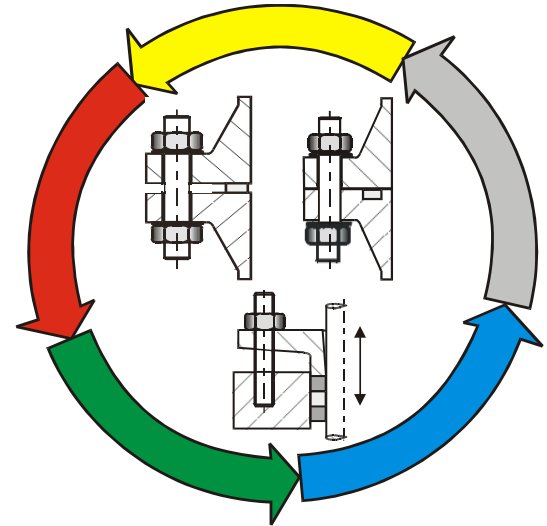
Introduction

Testing Standards

Testing Equipment

Test Results

Summary



Tightness Demands



IED directive [2010/75/EC] Industrial Emission Directive

- energy industries
(incl. oil & gas refineries)
 - production and
processing of metals
 - mineral industries
 - chemical industry
 - waste management
 - other activities
(e.g. pulp & paper ind.)
 - prevent / reduce emissions
to air, water and land
 - reduce generation of waste
 - use energy efficiently
 - prevent accidents
- use **Best Available Technology**
to achieve objectives

German Legislation

- **TA-Luft** (1986/2002)
(general regulations with details regarding bfc and stuffing box packings)
- **VDI 2440** (2000)
(emission control/reduction in mineral oil refineries)

stuffing box packings:

use metallic bellows

or

limit the emission of packing materials under operational conditions in a first-time test

10^{-4} mbar*l/m/s ($T \leq 250$ °C)

10^{-2} mbar*l/m/s ($T > 250$ °C)

International Standard

- **prEN ISO 15848-1 (2014)**

Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves

American Standard

- **API 622 (2011)**

Type testing of process valve packing for fugitive emissions

FAQ's on Testing Standards

- **Is the VDI 2440 test mandatory to fulfill the German legislative requirements?**
- **Or can also one of the other tests be done for this purpose?**
- **What are the differences in these standards?**
- **Which test is the most ambitious one?**
- **Can one procedure cover the results of the others?**
- **Why are the costs of the tests so different?**

Comparison of the Test Standards

- Test item
- Scope
- Test parameters
- Specimen size
- Assembly
- Test duration
- Mechanical cycles
- Temperature cycles
- Test pressure
- Test medium
- Tightness requirements
- Re-adjustment of the bolt load

Comparison – Test Item

	Test Item
VDI 2440	packing
API 622	packing
ISO 15848-1	valve (packing and body seal)

Comparison - Scope

	Scope
VDI 2440	qualification test as a "high-grade sealing system"
API 622	packing performance - fugitive emission - corrosion test - material test (weight loss, density, lubricant content)
ISO 15848-1	classification of the performance of industrial valves ("endurance classes") - CO1, CO2, CO3 (on-off valves) - CC1, CC2, CC3 (control valves)

Comparison – Specimen Size

	Packing size	Gasket size
VDI 2440	individually	- (different test for gaskets)
API 622	1.5 x 1.0 in. (38.1 x 25.4 mm)	-
ISO 15848-1	individually	individually

Comparison – Load Cycles

	Mechanical cycles	Temperature cycles
VDI 2440	<p>individually typical: 500 - 2000 rate: 2 mm/s (only at elevated temperature)</p>	<p>only heating-up to test temperature two levels: < 250 °C, ≥ 250 °C</p>
API 622	<p>1510 (300 per day) rate: 0.12 - 0.2 in./s, 50% at RT, 50% at T</p>	<p>5 (1 per day) 500 °F (260 °C)</p>
ISO 15848-1	<p>- 205, 1500, 2500 (CO1-CO3) - 20000, 60000, 100000 (CC1-CC3) rate 1 - 5 mm/s 50% at RT, 50% at T</p>	<p>2 (CO1/CC1) 3 (CO2/CC2) 4 (CO3/CC3) "temperature classes": -196 °C, -46 °C, RT, 200 °C, 400 °C</p>

Comparison – Leakage Measurement

	Test pressure	Test medium
VDI 2440	individually typical: 40 bar (580 psi) after stem cycles	Helium
API 622	600 psi (41.4 bar) after every 50 stem cycles	Methane
ISO 15848-1	according to p/T-rating of the shell material in every test step (body seal only at the end of each endurance class)	Helium or Methane

Comparison – Tightness Requirements

	Tightness requirements	Re-adjustment
VDI 2440	<p>< 250 °C: 1.0E-04 mbar*I/(s*m) ≥ 250 °C: 1.0E-02 mbar*I/(s*m)</p>	no
API 622	<p>conformity to all local and governmental safety standards</p>	<p>yes (if leak rate exceed 500 ppmv)</p>
ISO 15848-1	<p>"Tightness Classes" for packing: A: ≤ 1.0E-05 mg/(s*m); ≤ 50 ppmv B: ≤ 1.0E-04 mg/(s*m); ≤ 100 ppmv C: ≤ 1.0E-02 mg/(s*m); ≤ 500 ppmv Body seals: ≤ 50 ppmv; ≤ 50 ppmv Helium / Methane</p>	<p>yes 1 for CO1/CC1 2 for CO2/CC2 3 for CO3/CC3</p>

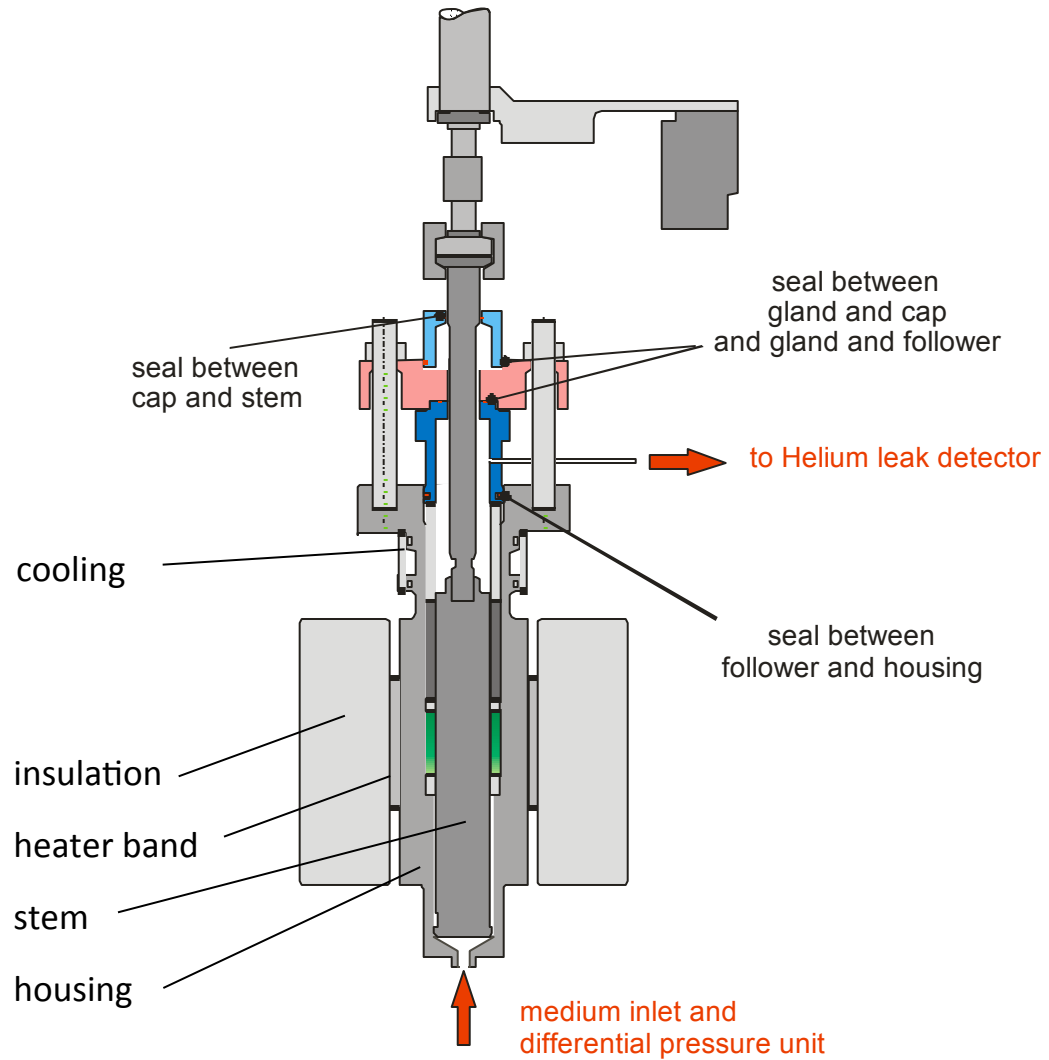
Test Rig for VDI 2440 and API 622

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stb.freak

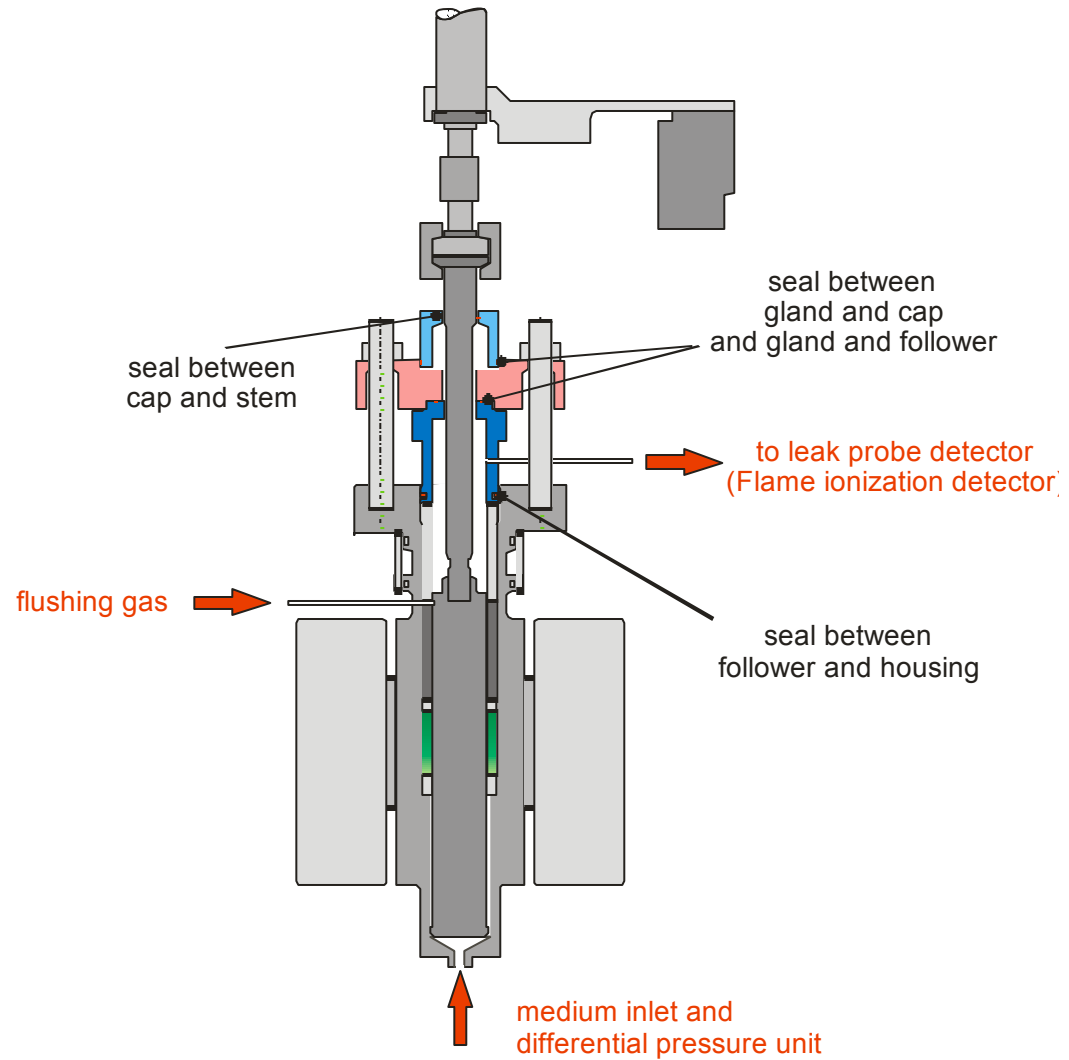


Leakage Measurement (Vacuum Method)

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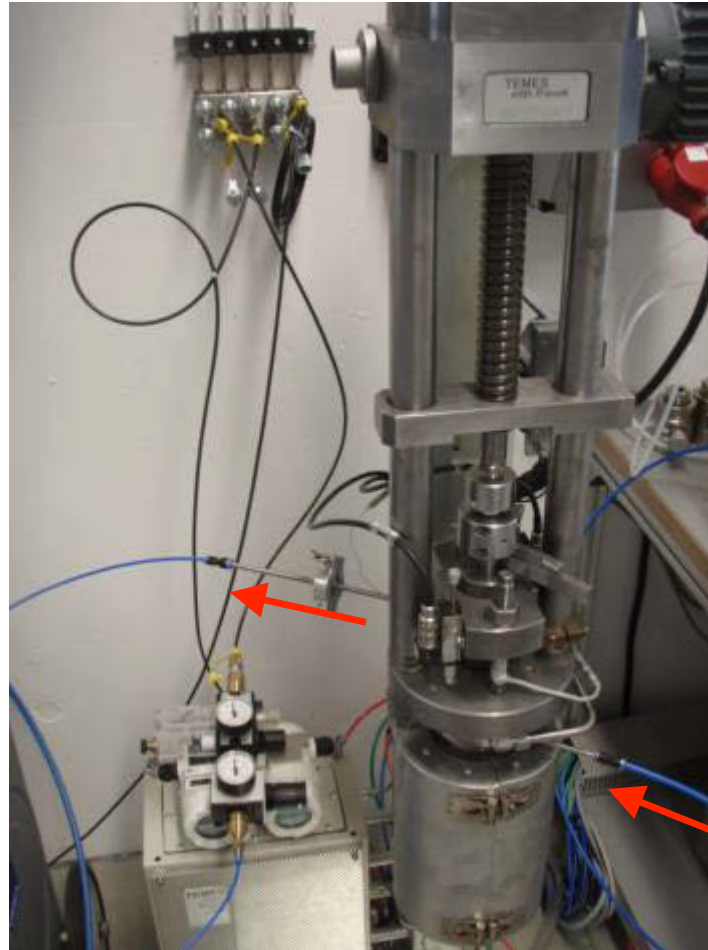


Leakage Measurement (Sniffing Method)



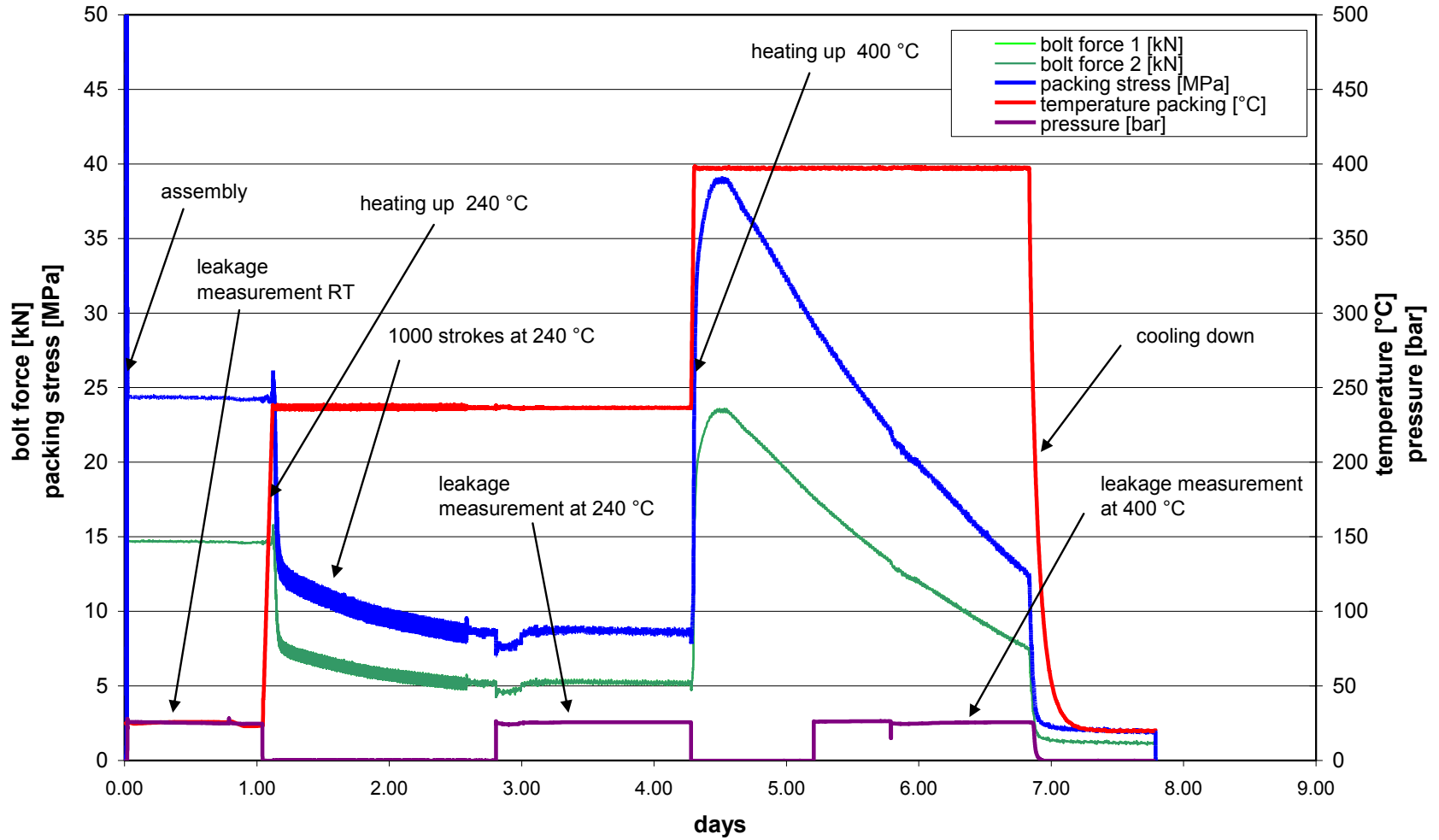
TEMES
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**Outlet
flushing gas &
test gas**



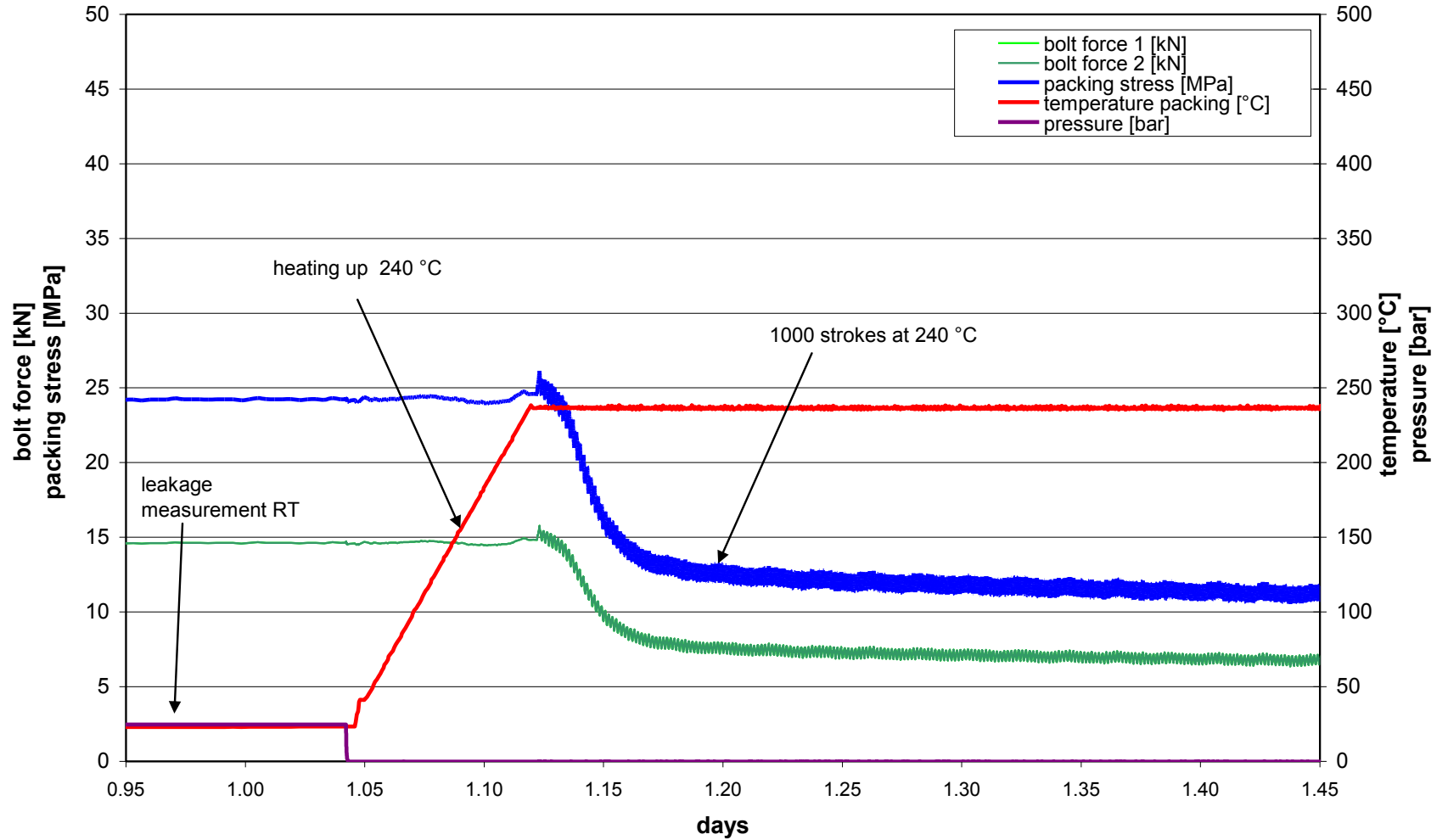
**Inlet
flushing gas**

Typical Test Result (VDI 2440)



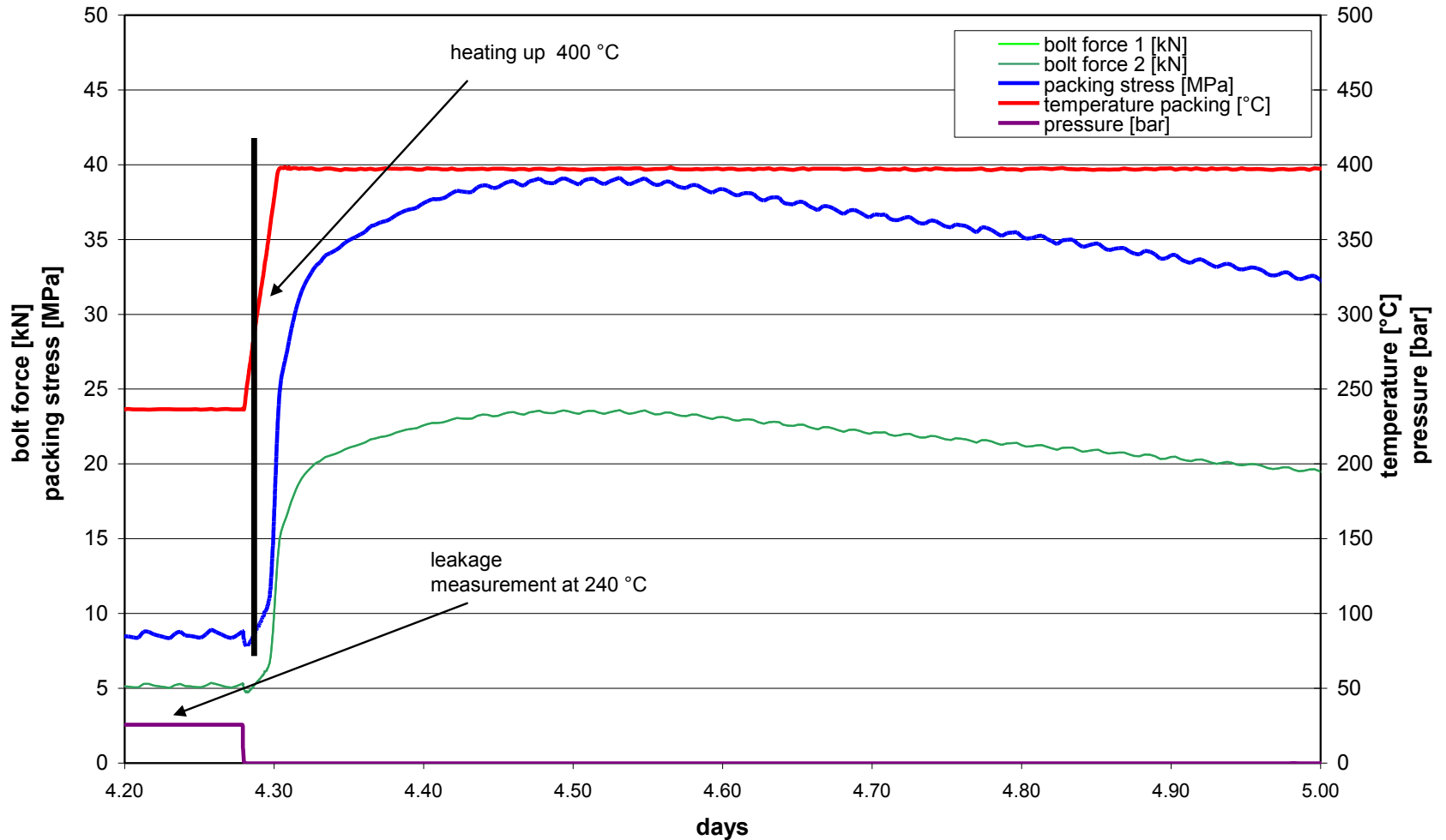
Typical Test Result (VDI 2440)

Heating-up to 240 °C



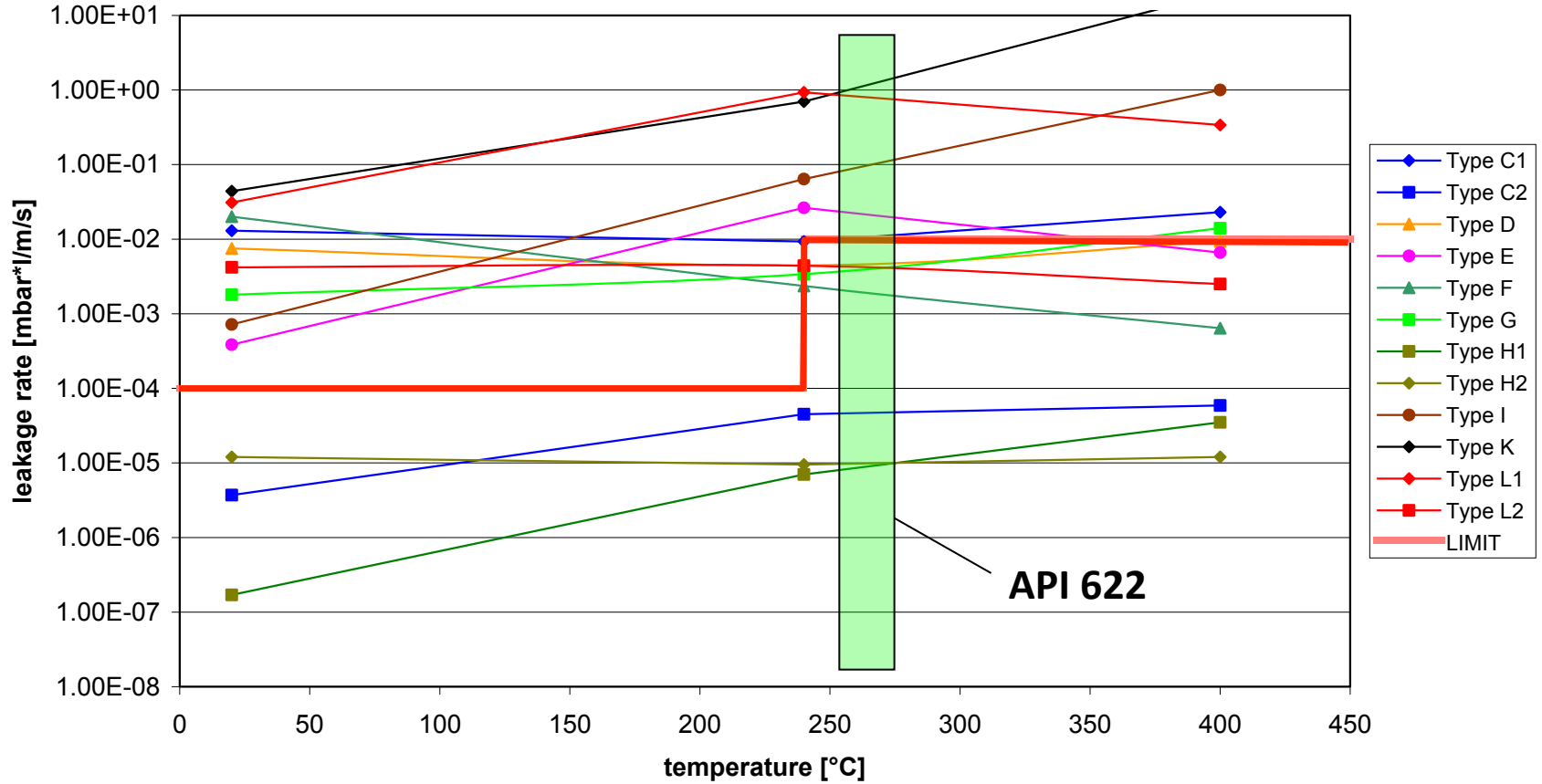
Typical Test Result (VDI 2440)

Heating-up to 400 °C



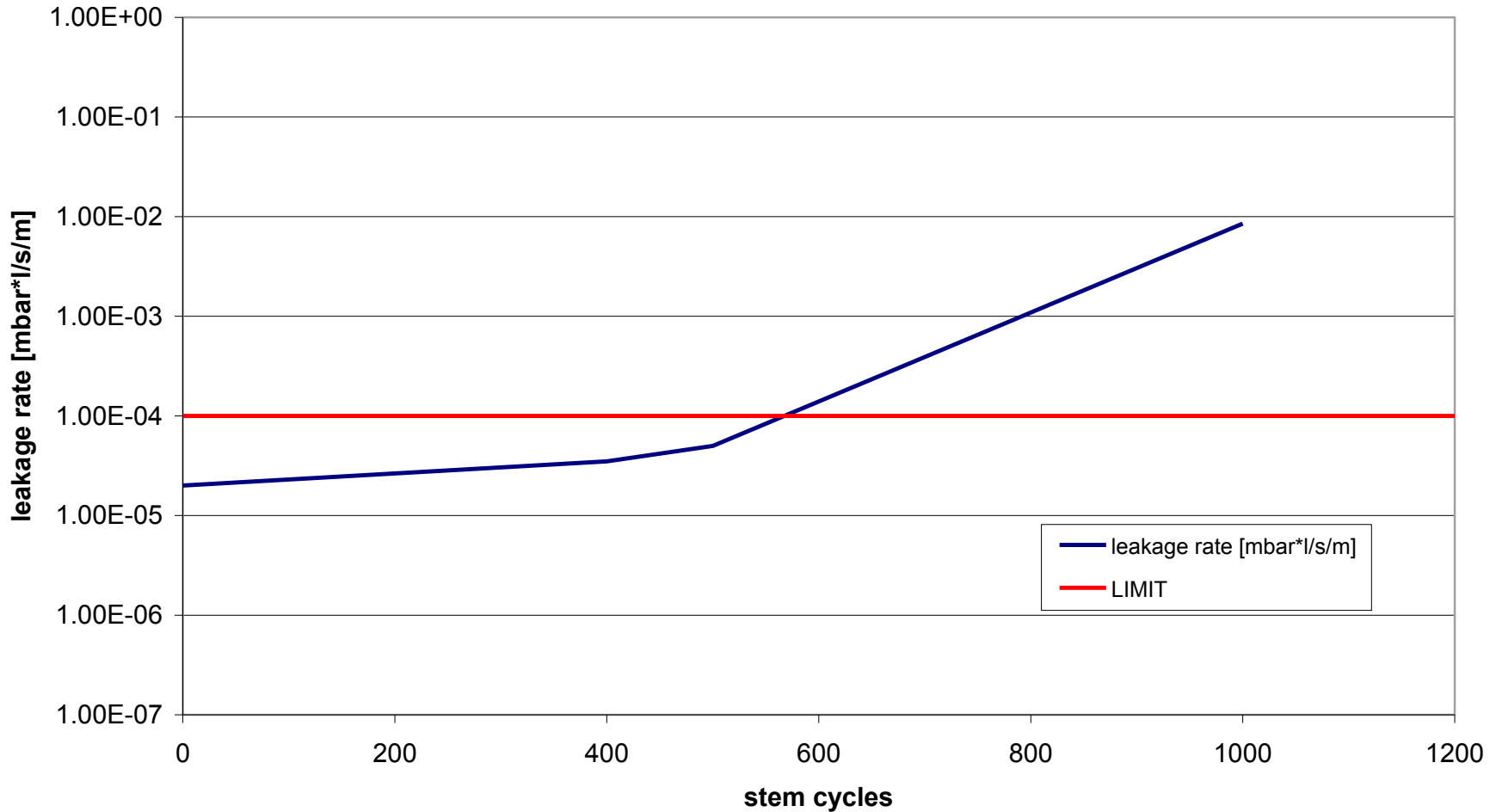
Tightness Behavior of Packing Sets

VDI 2440 Test
25 bar He - 240 °C / 400 °C - 1000 stem cycles
Geometry: 56 x 40 mm



Influence of Stem Cycles

VDI 2440 TEST
Packing Type B
Geometry: 28.25 x 19.05 mm



VDI 2440 vs. API 622

Leakage rates of Helium (VDI 2440) and Methane (API 622) are in the same order of magnitude, the results are comparable. But the measurement technique for Methane has some limits.

**In API 622 the test parameters are defined unambiguously, the test results can not cover several industrial applications.
Tests acc. VDI 2440 can be defined more use-oriented.**

**The critical test temperature for a lot of packing materials (270 – 300 °C) is above the test temperature level of API 622 (260 °C).
Otherwise, the thermal cycles of API 622 imply an intensification of the test conditions.**

API 622 test results can be used for the qualification in respect of TA-Luft requirements, but only for the specified test conditions.

Test Rig for ISO 15848-1

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valve.teq

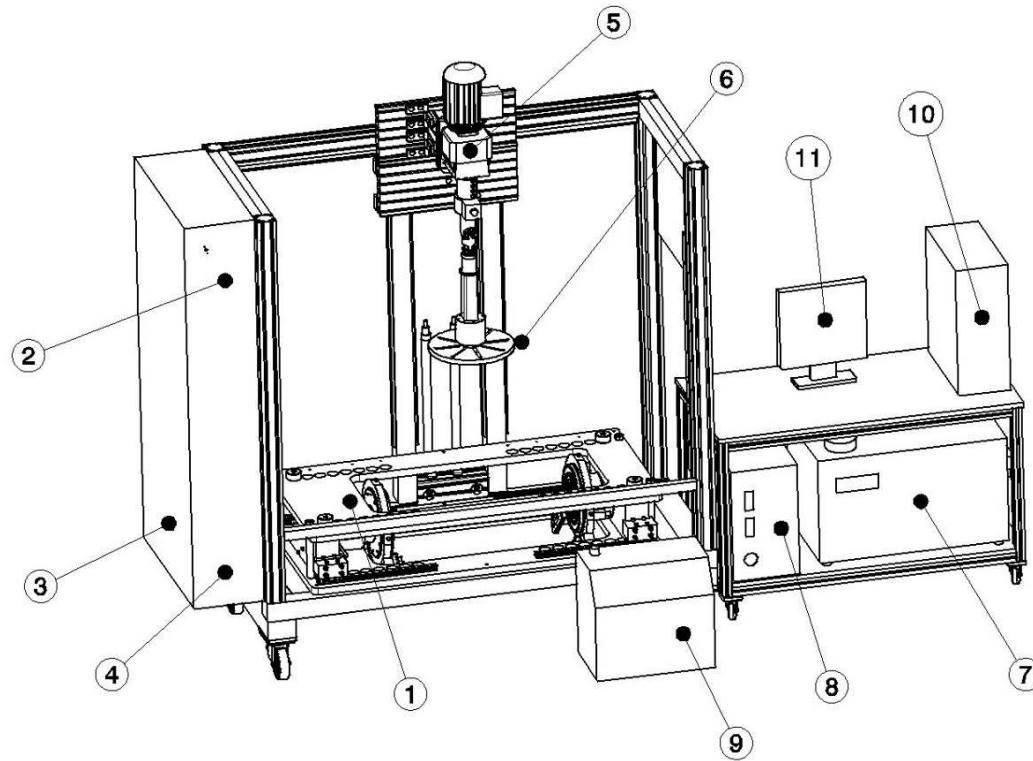
Technical Specification:

Valve Size:	max. DN150/PN250 or DN250/PN25
Temperature:	max. 400 °C
Pressure:	max. 200 bar
Test Medium:	e. g. He, N ₂ , CH ₄
Clamping Load:	max. 1450 kN
Actuator:	max. 120 Nm



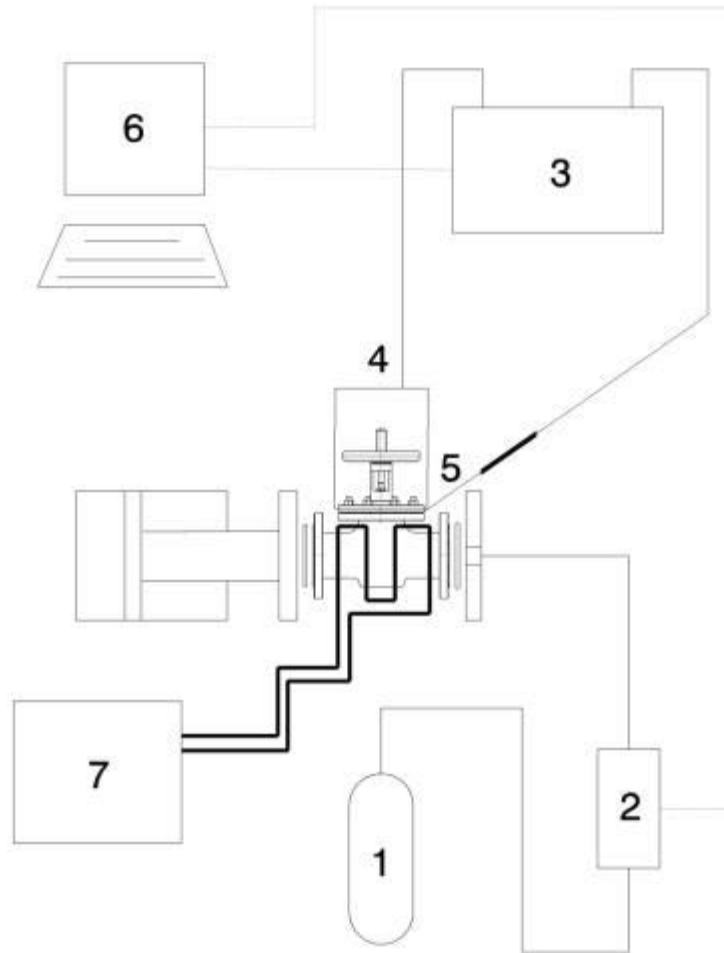
General View

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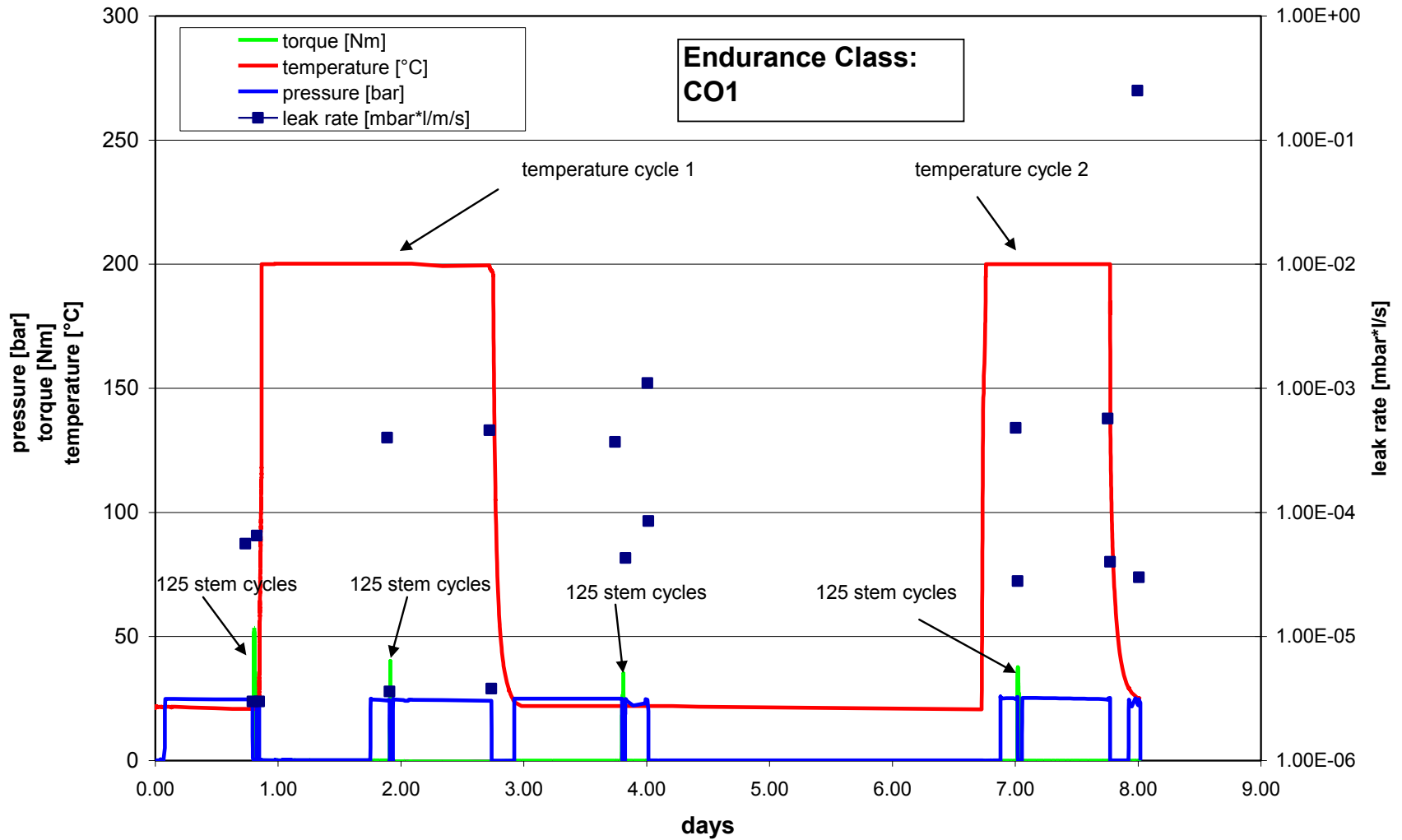
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|---|-------------------------------------|----|---------------|
| 1 | Tensioning device | 7 | Cooling unit |
| 2 | Instrumentation and Control cabinet | 8 | Heating unit |
| 3 | Hydraulic unit | 9 | Leak detector |
| 4 | Leakage unit | 10 | PC |
| 5 | Actuator | 11 | Monitor |
| 6 | Clutch | | |

Leakage Measurement (ISO 15848-1)



- 1 Gas medium
- 2 Leakage unit
- 3 Leak detector
- 4 Vacuum chamber
- 5 Sniffing pipe
- 6 Data acquisition
- 7 Heating unit

Typical Test Results (ISO 15848-1)



Summary

ISO 15848-1 is a classification system and a qualification procedure for type testing of valve fugitive emissions. The classification system includes

- **tightness classes,**
- **endurance classes, and**
- **temperature classes.**

The successful test result of VDI 2440 is no guarantee for a good performance of the packing in the ISO 15848-1 procedure. The reason for this behavior is assumed to be caused by

- **the roughness of the surfaces (housing, stem) of the valves,**
- **the tolerances in the production of the valves,**
- **the thermal cycles in the test procedure of ISO 15848-1, and**
- **the unknown assembly procedure of the packings.**

But at least, the capability for a positive ISO 15848-1 can be derived from the VDI 2440 or the API 622 test results.

Thank you for your attention!

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