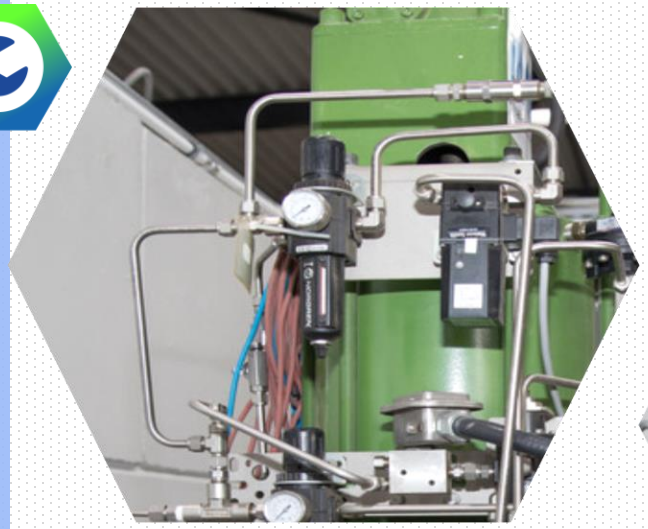
KiK|MPi
Kennis- en innovatiecentrum Maintenance Procesindustrie

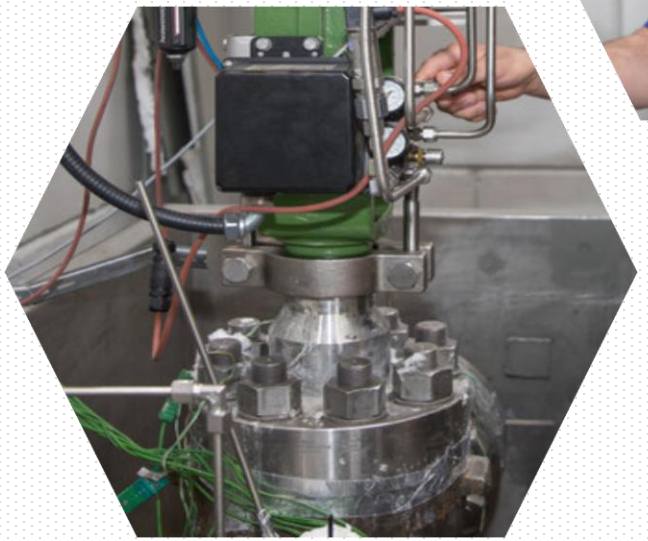
BEMAS

Interreg
EUROPESE UNIE
Vlaanderen-Nederland
Europees Fonds voor Regionale Ontwikkeling

‘Voorkomen van fugitive emissies van afsluiters en regelkleppen’

Slotevent
Circulair Onderhoud
15 november 2022





‘Voorkomen van fugitive emissies van afsluiters en regelkleppen’

Colin Zegers
ITIS (Industrial Testing & Inspection Services)
Goes (NL)

Industrial Testing & Inspection Services

Performance of DVT & Fugitive Emission Testing

Depending valve type and design conditions testing in accordance with standards:

Test Standards for DVT & FE:

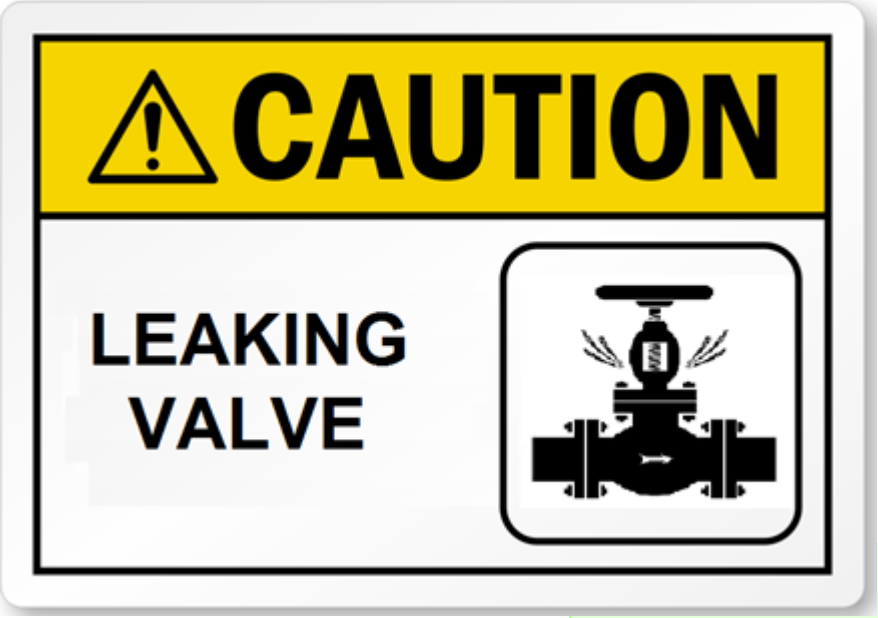
- DVT: Shell SPE 77/300, ISO 23632
- FE: ISO 15848-1 (TA-Luft)
- FE: API 624, 641 (methane)

Test:

- Review of documents
- Visual inspection
- Test set up, Testing in according with test requirements specified in the standard
- Strip down
- Test report (certificate) with covering range

Valves failures during DVT

To prevent failures in practice, major customers already require type tests
Failure percentage is roughly 65%!



Failures:

-Visual inspection and NDT
-Operability
-Seat leakage
-Damages during strip down
-Fugitive Emission

Main Cause of Fugitive Emissions: Leakage of Stem Seal

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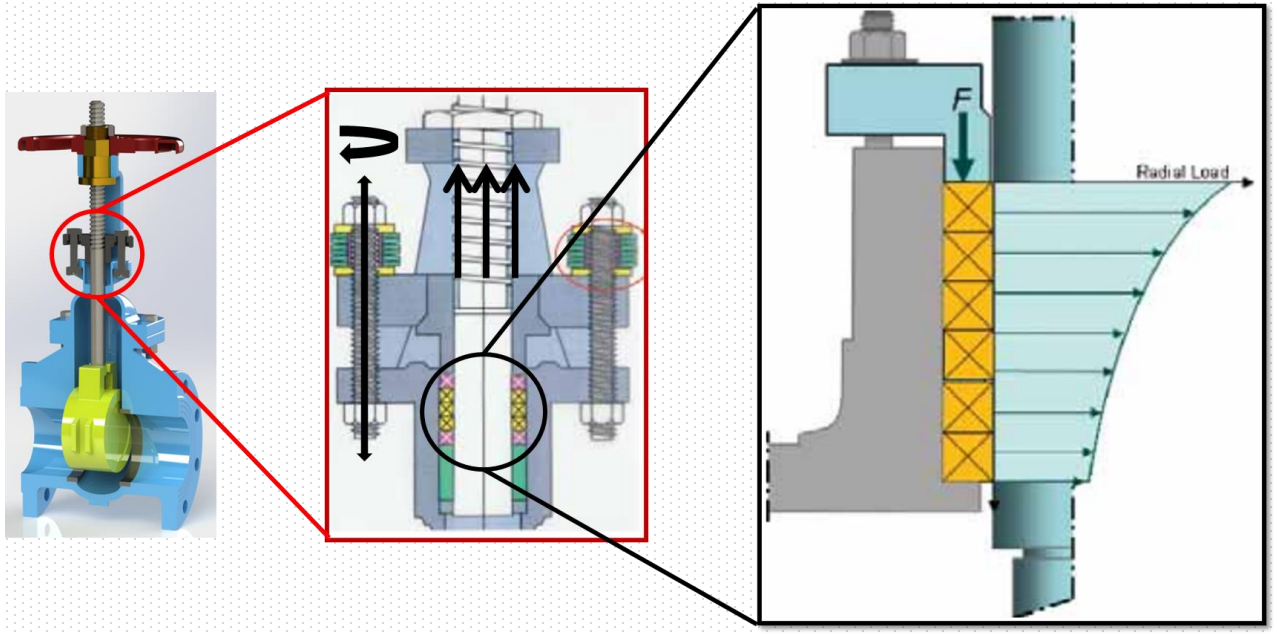
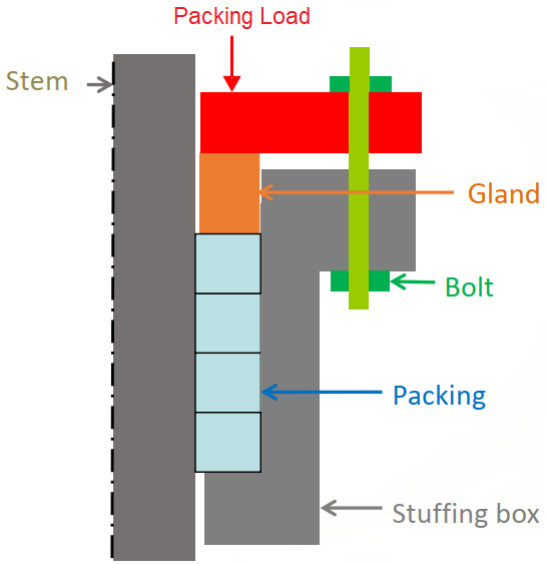
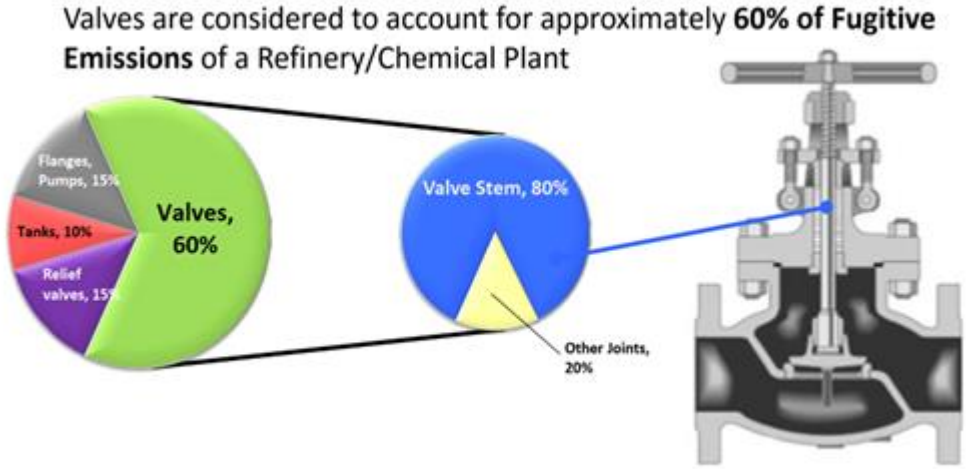
Stem Seal (stopbuspakking)





Amount of Fugitive Emission:

Fugitive emissions are leaks that occur from process equipment such as valves, pumps, compressors, and flanges. Fugitive emissions account for over 125,000 metric tones of lost product per year in the United States alone [1,2]. The percentage of fugitive emissions that come from valve stems is estimated to be 60% to 85% [1,2] due to the cumulative effects of large numbers of valves in processing plants.



*Source - Monitoring and Containment of Fugitive Emissions from Valve Stems, University of British Columbia, Vancouver

Amount of Fugitive Emission:

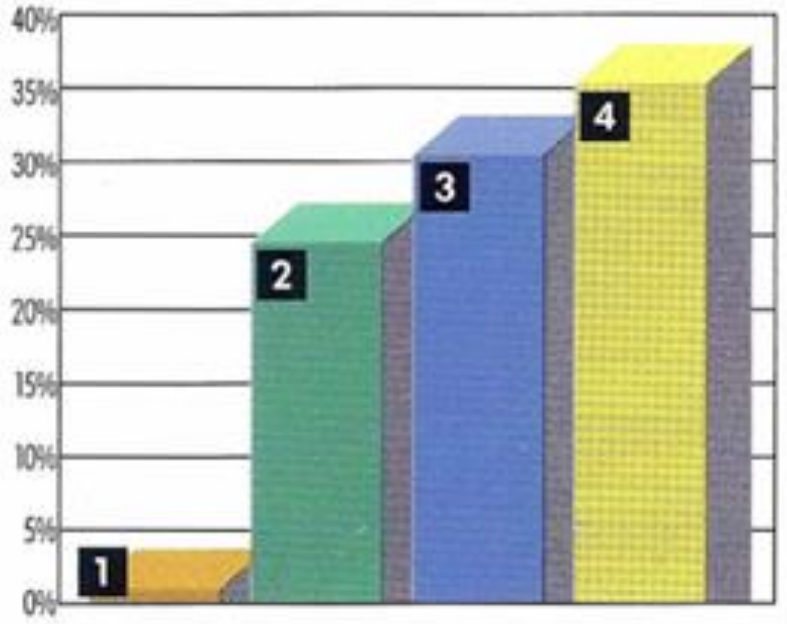
The impact for increased economic efficiency

Important cost saving potential

Various petrochemical companies are committed to improve the environmental performance of their plant and operation. The research and investigation of important petrochemical companies lead to concrete decisions for economical and environmental friendly plants. An emission rate between 10,000 and 100,000 ppm provides up to 1,000 kg of lost product per annum. This number could be caused from a single valve only. E.g. for 500 control valves in an ethylene application with an emission rate above 100,000 ppm a cost saving potential of 1,500 tons or 498,000 Euro has been realised.

Source: Garlock brochure

Percentage of valves with a leakage >10.000 ppm by valve type



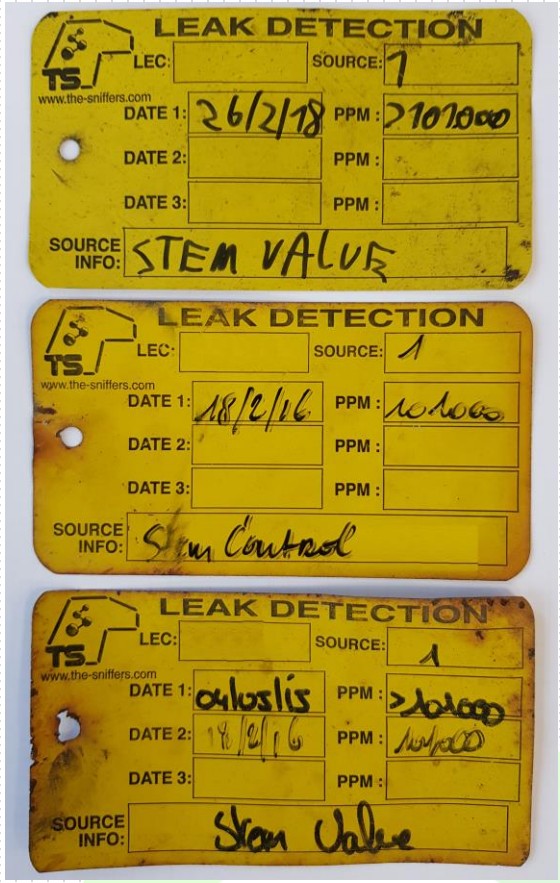
1-Ball valves; 2-Control valves; 3-Gate valves; 4-Globe valves

Regelgeving in Europa, Vlaanderen en Nederland

Europa: PED, RICHTLIJN 2014/68/EU: ontwerp, fabricage, beproeving of samenstellen van drukapparatuur.
Toepassen van materialen die veilig in gebruik zijn.
Green Deal (2030)

Vlaanderen: Vlarem, omgevingsvergunning

Nederland: omgevingsvergunning,
Omgaan met Zeer Zorgwekkende Stoffen (ZZS)
in een Circulaire Economie.
RIVM-briefrapport 2019-0186, coalitieakkoord 2021-2025



Different Standard for Valves
No Standard for Stem Seals!

ANSI / FCI 91-1

ANSI / ISA S93.00.01

TA Luft VDI 2440

15848-1 and -2

Shell SPE 77/300

Shell SPE 77/312

API 624

API 641

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Need for an International Standard: Type Testing of Stem Seals for Valves (ISO 12101)

International Organization for Standardization

Team Leader WG5 TC153: Valves

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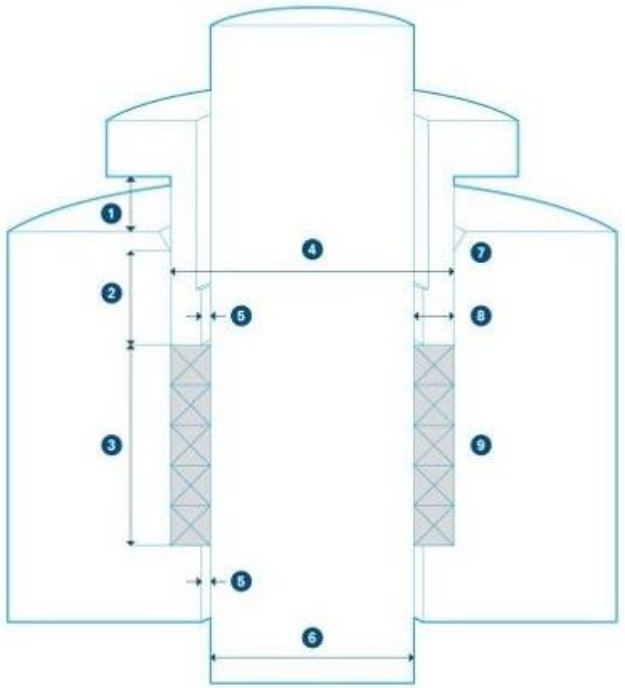
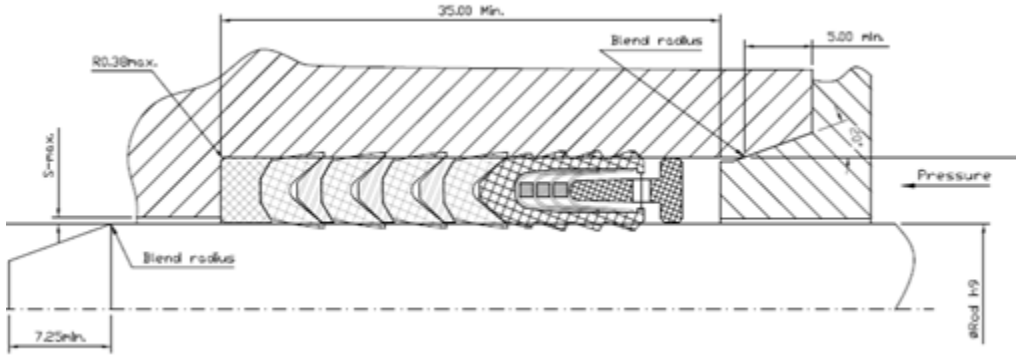
Development of standard ISO 12101 standard:

Measurement, test and qualification procedures for fugitive emissions — Classification system and qualification procedures for type testing of stem seals for valves

- Compressible sealing
- Non-adjustable sealing: spring and pressure energized seals
- Elastomers
- Next TC153 WG5 meeting: 08-12-2022
- Final standard: 2024?





Interreg project
‘Het reduceren van Fugitive Emissions’

- Project gestart met zeer opvallende testresultaten:
- Control valve 700.000 cycles: RT & +200°C, lekwaarde AH
- Zelfde valve, andere stem seal met telkens verlies van vlaktedruk (50% in 24 uur) daardoor zichtbaar lek: tot 9x verlies in vlaktedruk.
- Verder onderzoek welke factoren de relaxatie veroorzaken

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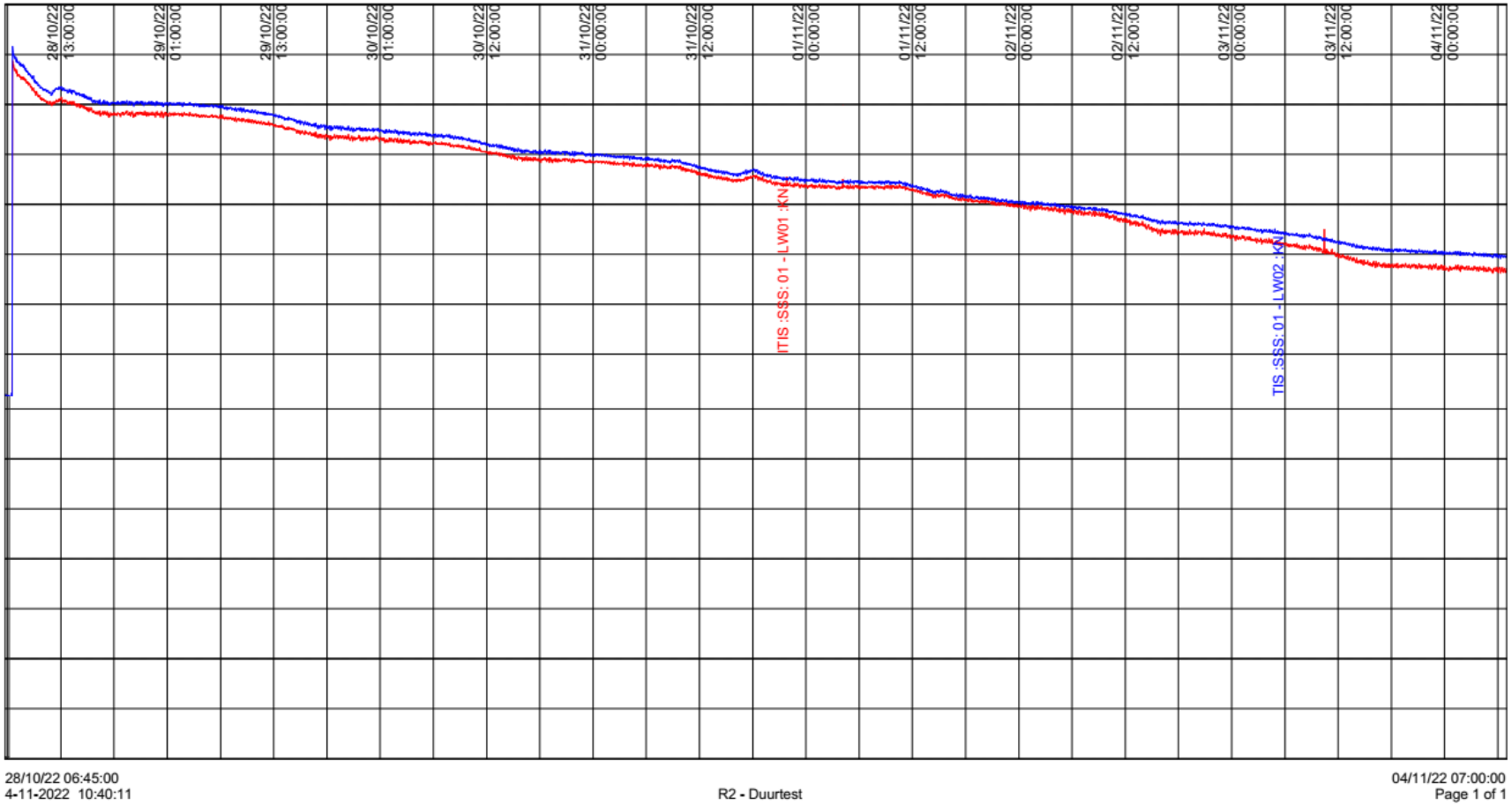
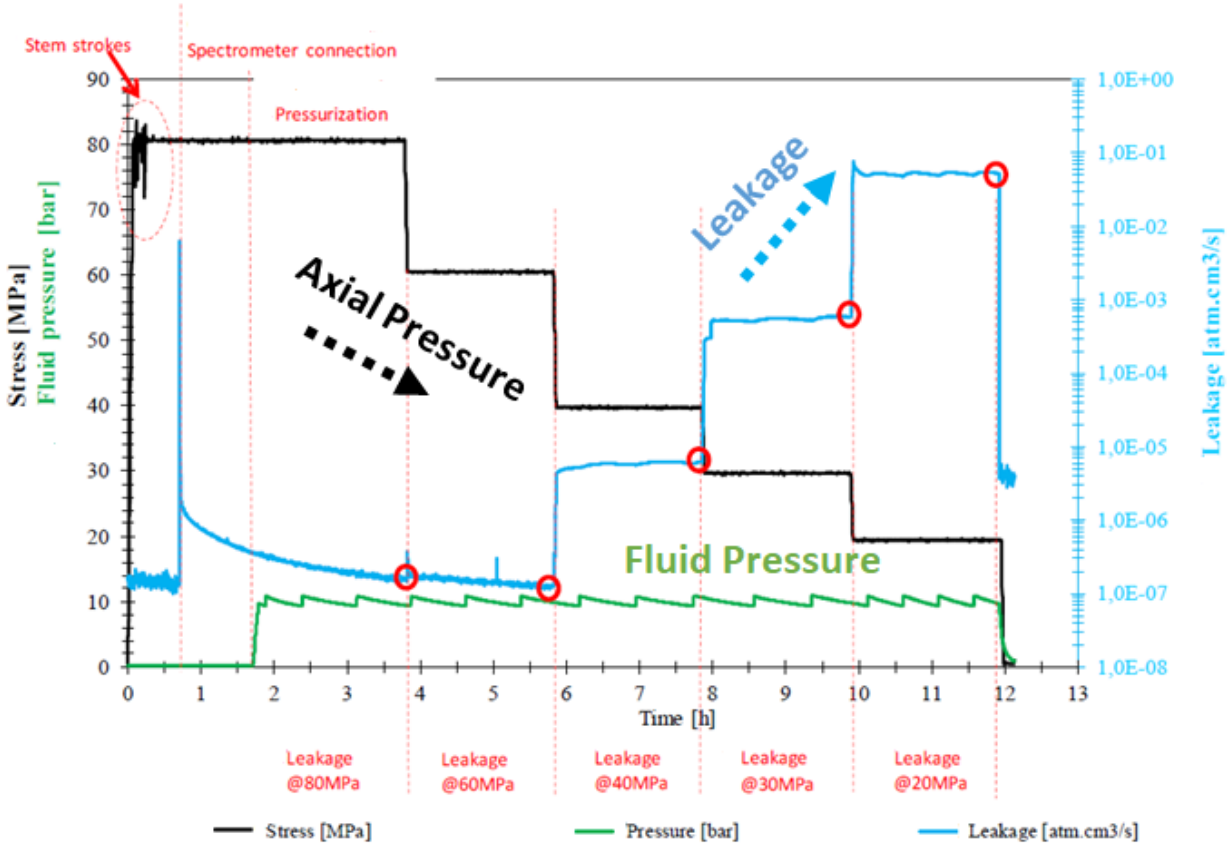
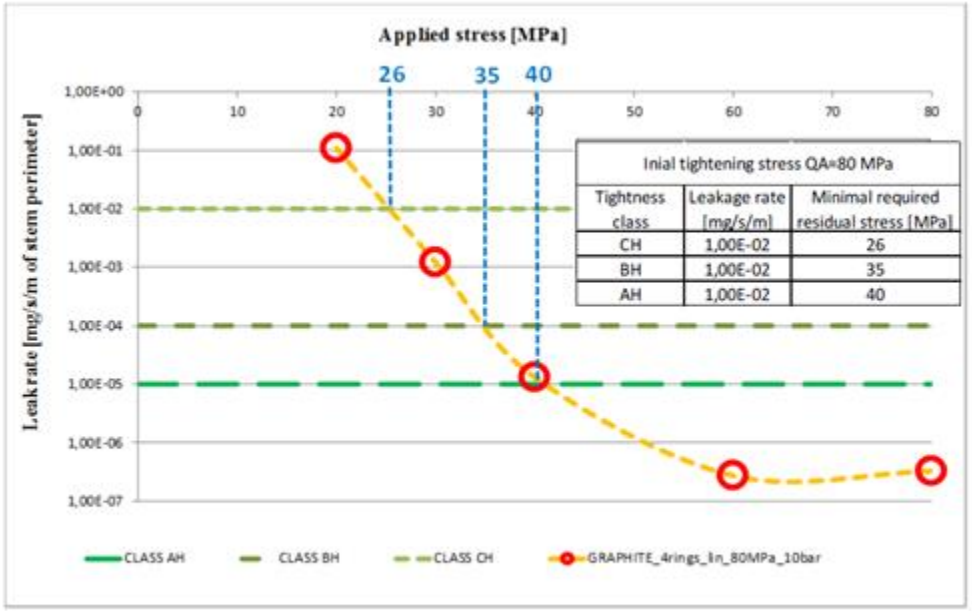
Verlies in vlaktedruk tijdens duurtesten



Onderzoek minimum Vlaktedruk per merk/type

Test curve voor stem seal met grafiet ringen en een liniaire beweging, 80 MPa vlaktedruk en 10 bar helium druk





Sealing diagram and table example (graphite packing)

Vervolg onderzoek en testen

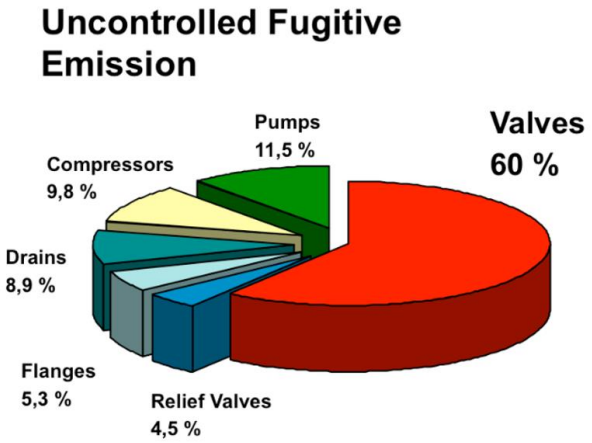

Ventilspindel Packungen

> Zurück zur Produkteübersicht

Technische Daten

Material: reines Graphitexpandat	Imprägnierung: PTFE Filcoat-Verfahren
Temperatur: - 0°C bis + 450°C	Druck: 0 bis 450 bar
Geschwindigkeit:	pH-Wert: 0 - 14
Zulassungen: ISO 15848-3	Abmessungen: vorgepr. auf Anforderung

- Interreg project eindigt najaar 2022
- Verder ontwikkelen van norm ISO 12101
- Budget voor onderzoek en testen?
- Onderzoek naar factoren die zorgen voor relaxatie en daardoor falen van stem sealing:
- Testen van diverse merken en materialen stem seals
- Functie ‘live loading’
- Ontwikkeling Emissie Monitoring System



Vervolg onderzoek en testen

- Verder ontwikkelen van norm ISO 12101
- Onderzoek naar factoren die zorgen voor relaxatie en lekken van stem sealing
- Budget voor onderzoek en testen?
- Testen van diverse type en materialen stem seals
- Ontwikkeling Emissie Monitoring System

PACKING: Relaxation

Experiment vs Simulation

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Creep Constitutive Law of Packing Materials Based on Relaxation Tests

The tightness of valves, compressors and pumps is ensured by superposed braided rings installed in a stuffing-box system. The nature of the packing material and structure, which is like a rectangular braided cord, influences the proper stuffing-box assembly behavior. During installation, a minimum compressive load is required to ensure a min-

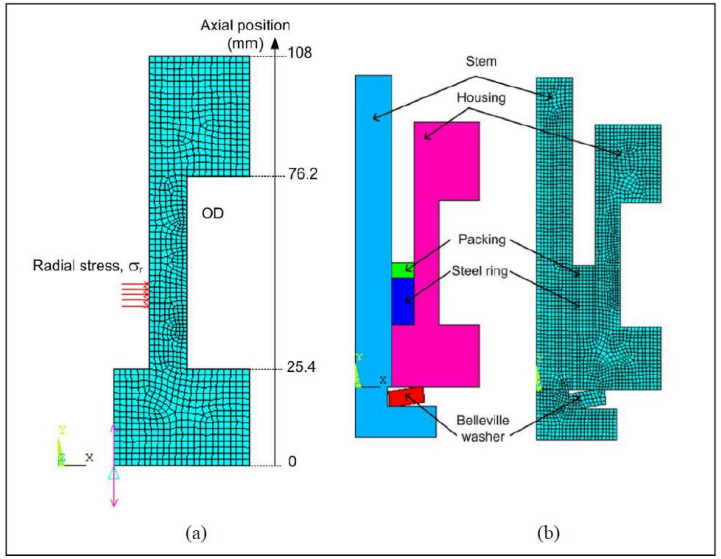


Figure 1.15 Finite element models to study the creep characterization of packing element (Diany and Bouzid, 2012)

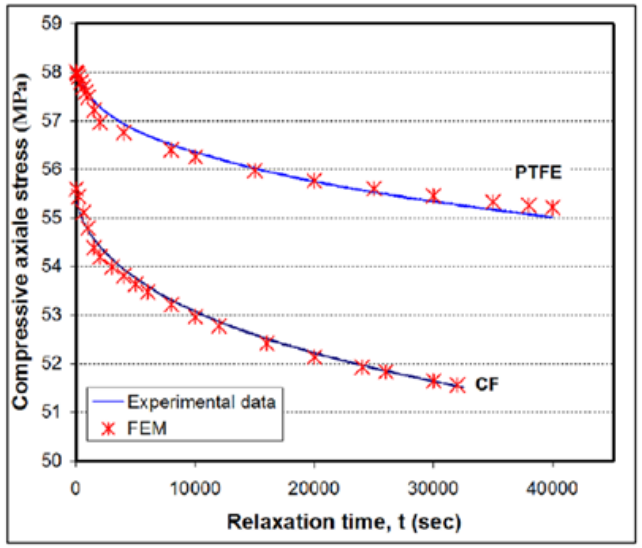


Figure 1.16 The relaxation curve from experiment and characterizing packing (Diany and Bouzid, 2012)

Table 1 Relaxation moduli of the material tested

	κ_0	κ_∞	μ_0	μ_∞
FG	118	105.7	88.5	79.3
CF	82.3	27.4	61.7	20.5
PTFE	144.8	74.2	107.9	55.5

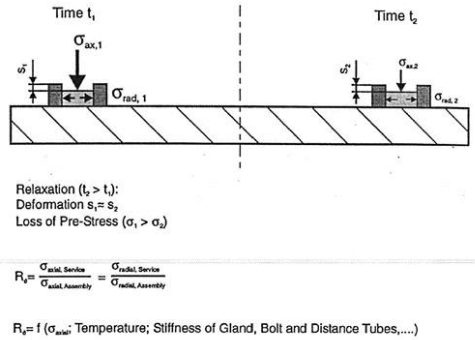


Fig. 7: Principle of the relaxation test

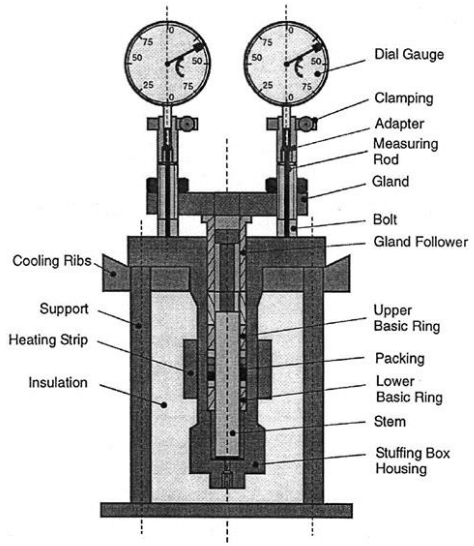
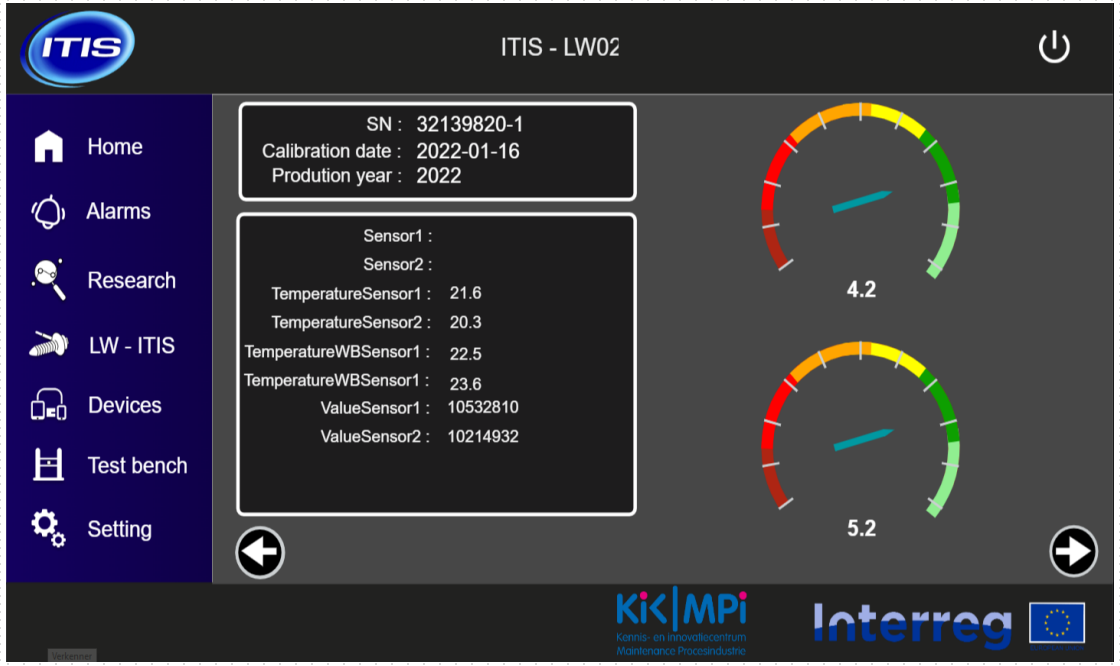
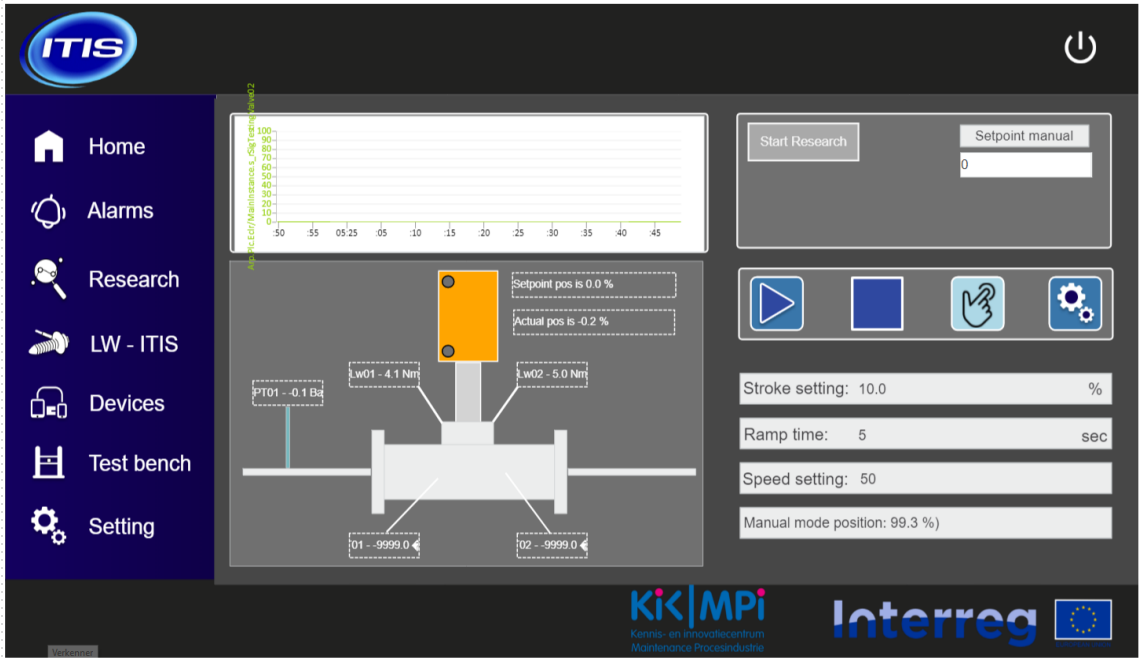


Fig. 8: Test equipment for the relaxation test (schematic)

Monitoring System Fugitive Emissions:





Werkend proto type
Aanvraag patent (2022/begin 2023)
Budget zoeken voor doorontwikkeling systeem
Testen in praktijksituaties

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Thank you for listening!

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