

Fugitive Emissions Reduction Through Valve Packing R&D



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Agenda

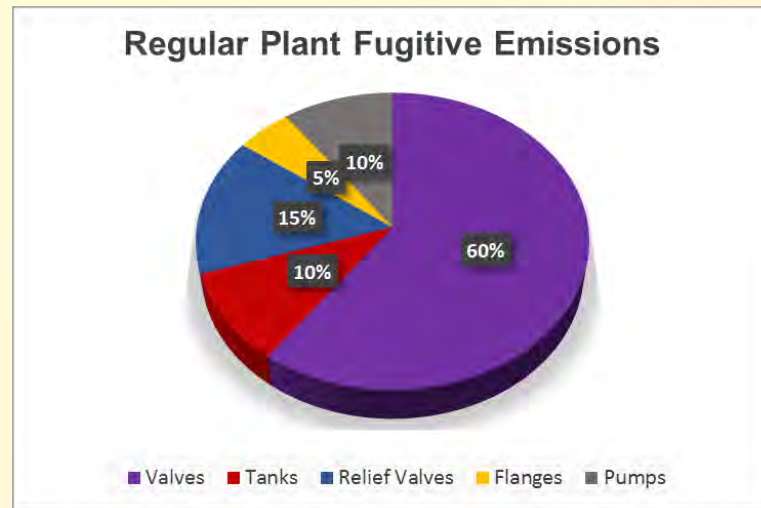
1. Introduction
2. Minimum Seating Stress
3. Stem Torque and Sealability
4. Laboratory Valve Tests
5. Field Results
6. Conclusions

Introduction

Valves account for 60% of Fugitive Emissions in a regular plant

Regulations becoming more strict everyday






- Permitted levels dropping
- 5 years ago: 500 ppmv (API 622 1st Ed.)
- Today: 100 ppmv (API 622 2nd Ed., API 624)



**ESA Sealing Technology - BAT*

How to comply to all these?

Styles Description

Style	Description	Example
A	Flexible Graphite Yarn reinforced with an Inconel wire mesh	
B	Flexible Graphite Yarn reinforced with an Inconel wire mesh with PTFE Impregnation	
C	Flexible Graphite Yarn reinforced with an Inconel wire	
D	Carbon and Flexible Graphite yarn with Graphite Impregnation	
E	Expanded PTFE filled with Barium Sulphate	

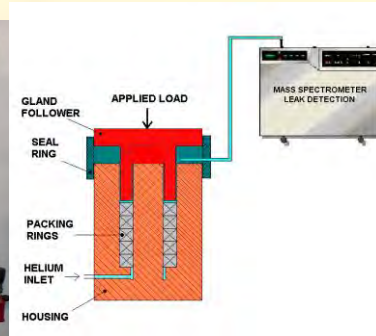
Minimum Packing Seating Stress

Definition

- Minimum stress that should be exerted on the packing at the installation to assure a “leak free” environment at start
- Similar to Gaskets traditional “y” values and the recently introduced Minimum Gasket Seating Stress

Test Rig

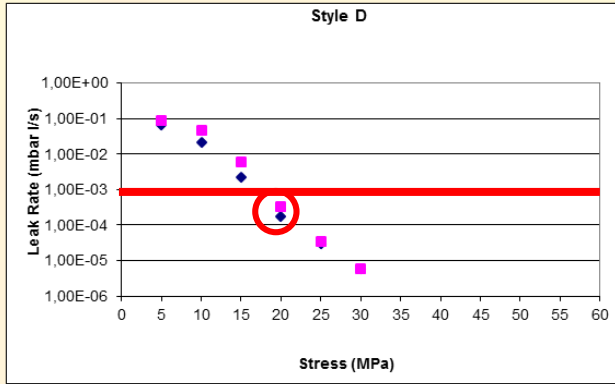
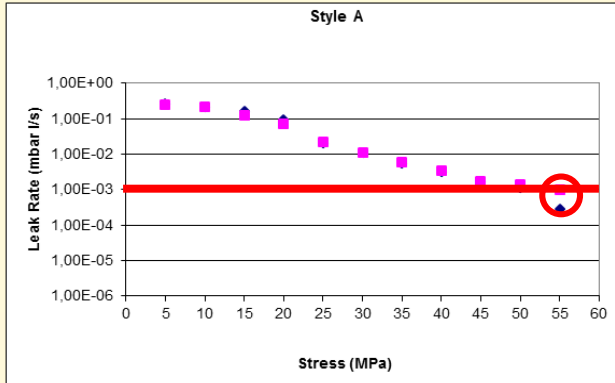
Composed by a hydraulic press equipped with a stem/stuffing box simulation rig.



Procedure

1. Install the five rings and install the Test Rig in the Hydraulic Press;
2. Apply an initial seating stress;
3. Pressurize the Test Rig and raise the packing stress in 5 MPa increments recording the leakage rate at each step;
4. If the leakage rate is equal or less than 0.001mbar-l/sec record the seating stress and finish the test.

Minimum Seating Stress Results



Packing Style	$S_{\min(0,01)}$	
	MPa	Psi
A	55	7975
B	30	4350
C	35	5075
D	20	2900
E	25	3625

Installation Stress Tests

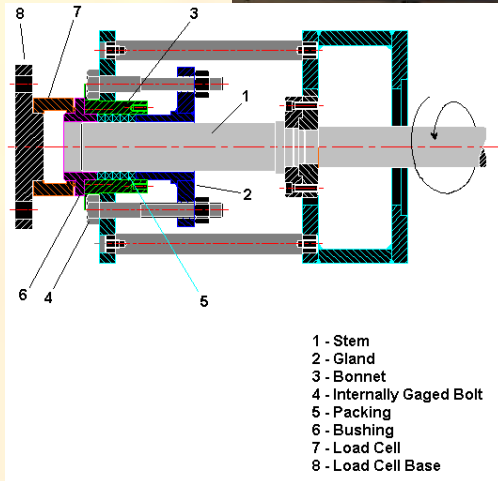
- Further testing was performed with different approaches:
 - Constant Packing Stress ($S_{\min(0,01)}$) : Minimum seating stress is applied and kept constant as the Helium pressure is increased;
 - Constant Leakage Rate: The packing stress is increased as the Helium pressure is increased in order to keep the leakage rate constant.
 - Variable Stress: Minimum seating stress ($S_{\min(0,01)}$) is applied and raised by the same value of the Test Media.



Number of Rings Influence on Torque and Sealability

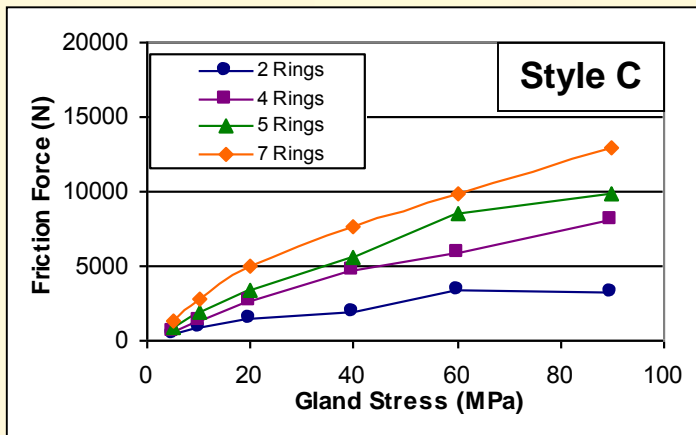


1. Install the packing rings with a seating load of 1MPa (145psi);
2. Apply the load (5, 10, 20, 40, 60, 90MPa);
3. Allow the packing to relax for 10 minutes;



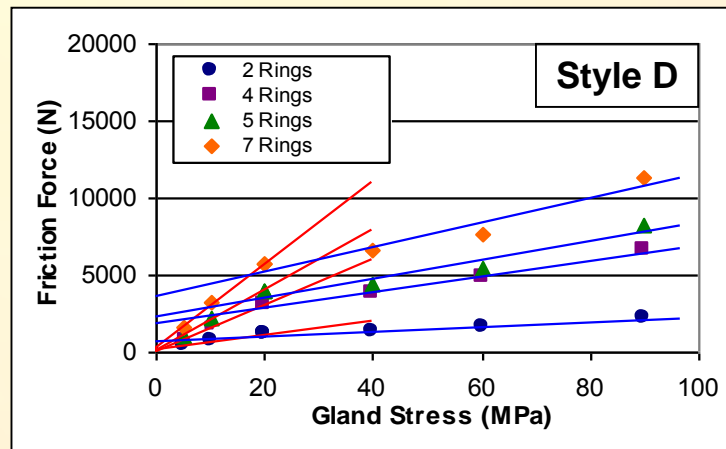
4. Re-apply the load;
5. Turn the stem;
6. After the two stem turns, register readings;
7. Repeat 2-7.

Number of Rings Influence on Torque and Sealability

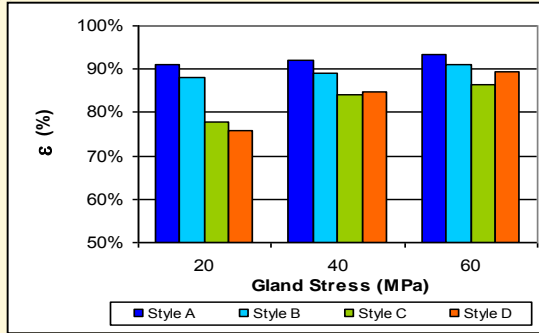


More Rings = higher torque

Change in the packing behavior after the minimum seating stress is reached.

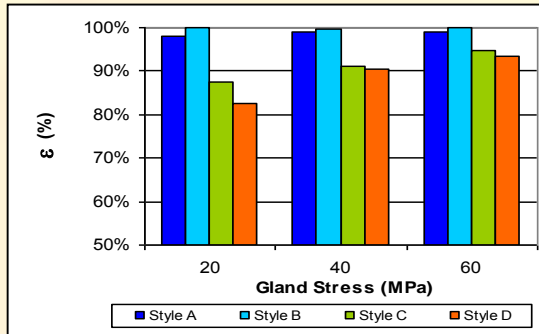


Packing Relaxation



RELAXATION AT GLAND

(5 RINGS)



RELAXATION AT THE BOTTOM OF THE STUFFING BOX

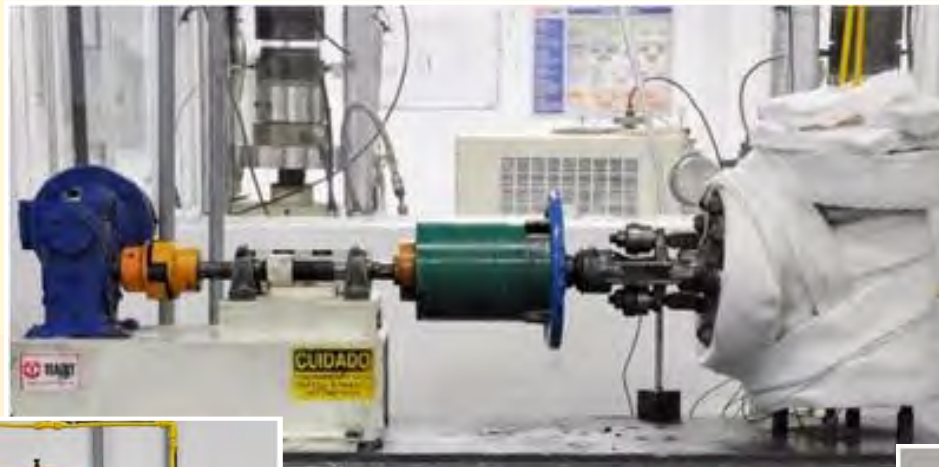
(5 RINGS)

- Relaxation is higher closer to the gland
- Higher Stress = Lower Relaxation
- Graphite Packings relaxed less than PTFE Packings

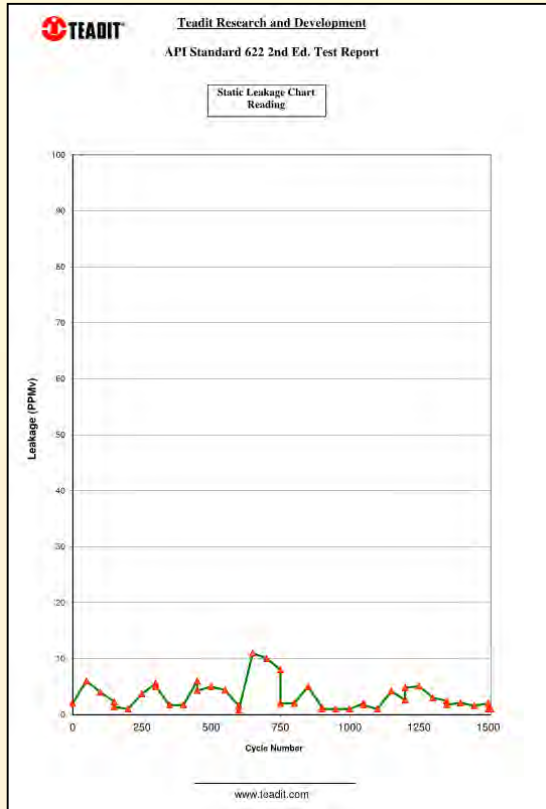
Number of Rings vs Sealability

- Minimum Seating Stress applied for two and seven rings
- Leakage rate equal or less than 0.001mbar-l/sec for all the styles tested – 7 bar - He
- No influence of the number of rings on the sealability results

Laboratory Valve Tests



Laboratory Valve Tests



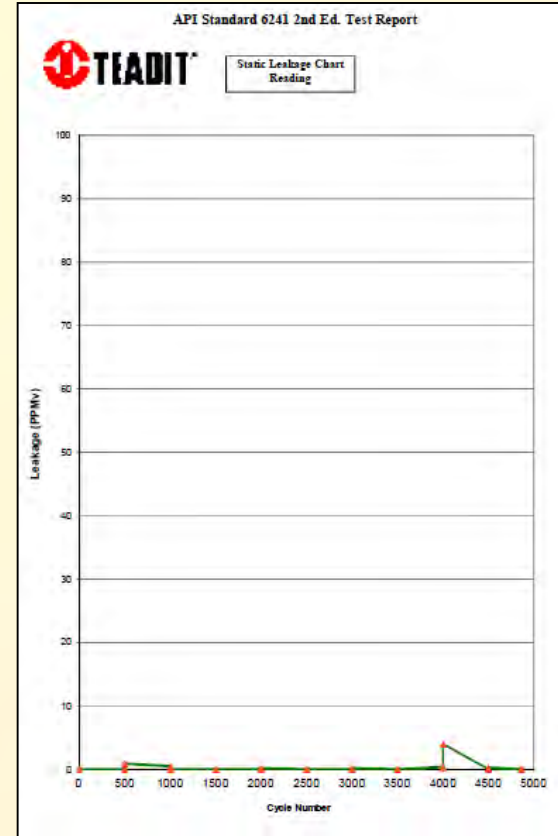
Style B Fugitive Emissions

- API 622 2nd Ed. Simulation
 - 1510 mechanical cycles
 - 5 thermal cycles – RT to 260°C
 - Average Leakage: **2 ppmv**
 - Maximum Leakage: **11 ppmv**
- API 624 1st Ed. Certification
 - 310 cycles
 - 3 thermal cycles - RT to 260°C
 - Valves approved – NPS ½, ¾, 4, 12, 20”
 - Maximum Leakage: **8 ppmv**

Quarter Turn Valve Tests

Style D Fugitive Emissions

- API 641 Simulation
 - 5010 mechanical cycles
 - 5 thermal cycles – RT to 205°C
 - Average Leakage: 0 ppmv
 - Maximum Leakage: 4 ppmv
 - **Using Spring Loads**

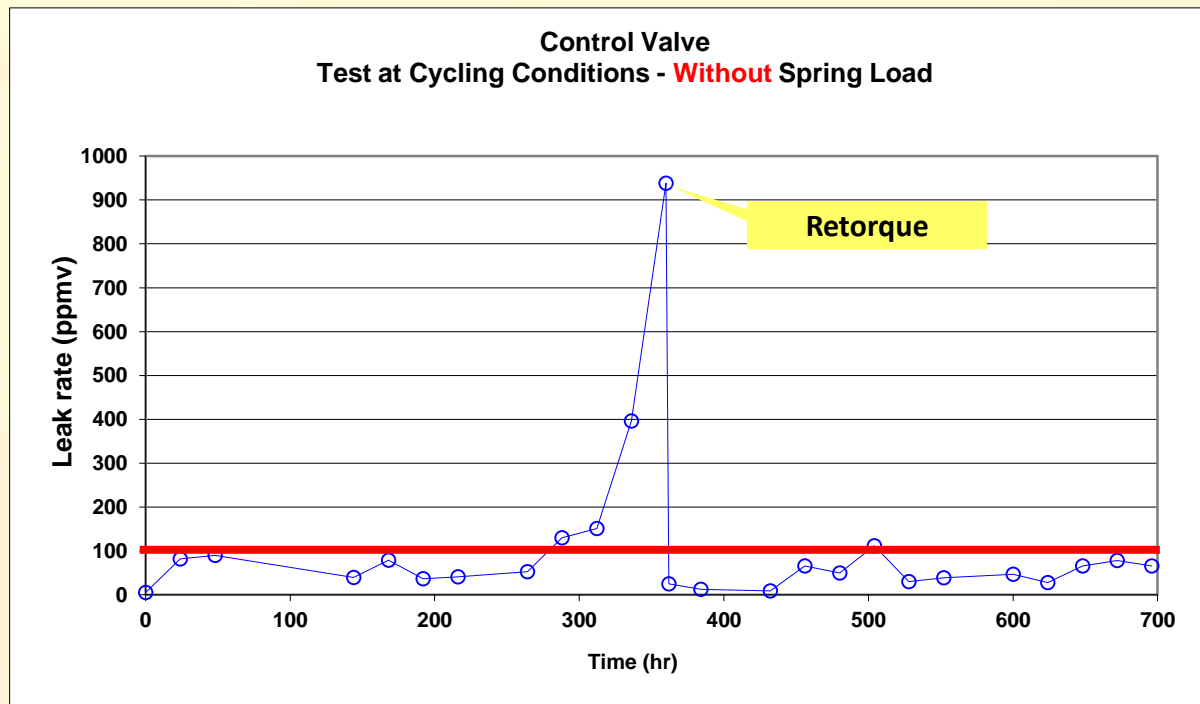


Control Valve Tests

- Style D installed with the S_s
- 700 hours cycling

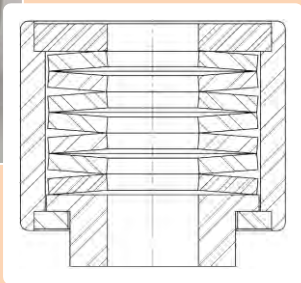
Result:

Retorque required to keep leakage rate in low levels



Control Valve Tests

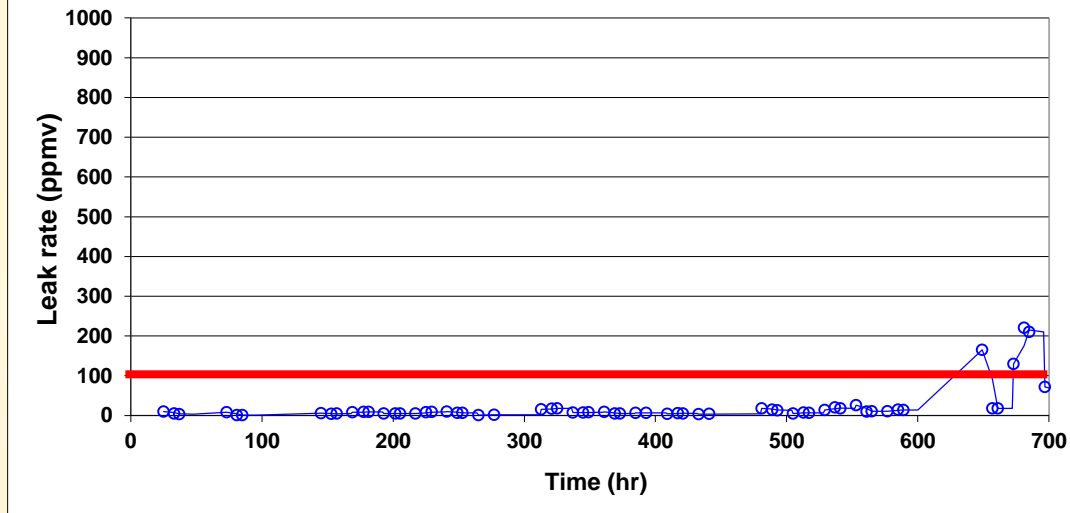
**Dynamic Load System
developed to ensure the S_S**



DLS

- Style D installed with S_S and DLS
- 700 hours cycling

**Control Valve
Test at Cycling Conditions - With DLS**



Style D kept the system leakage below 100ppmv for the first 600h of testing **with DLS**

Braskem Plant

Initial Conditions:

- High pressure steam and hydrocarbon lines.
- Pressures of 140bar (2030psi) under temperatures as high as 550°C (1022°F).
- Constant history of high leaks (up to 2.000 tons of steam/year).
- Several interventions to inject sealant.
- 54% of the 17.474 hydrocarbon valves presented leakage values higher than 500ppmv

Steam Lines

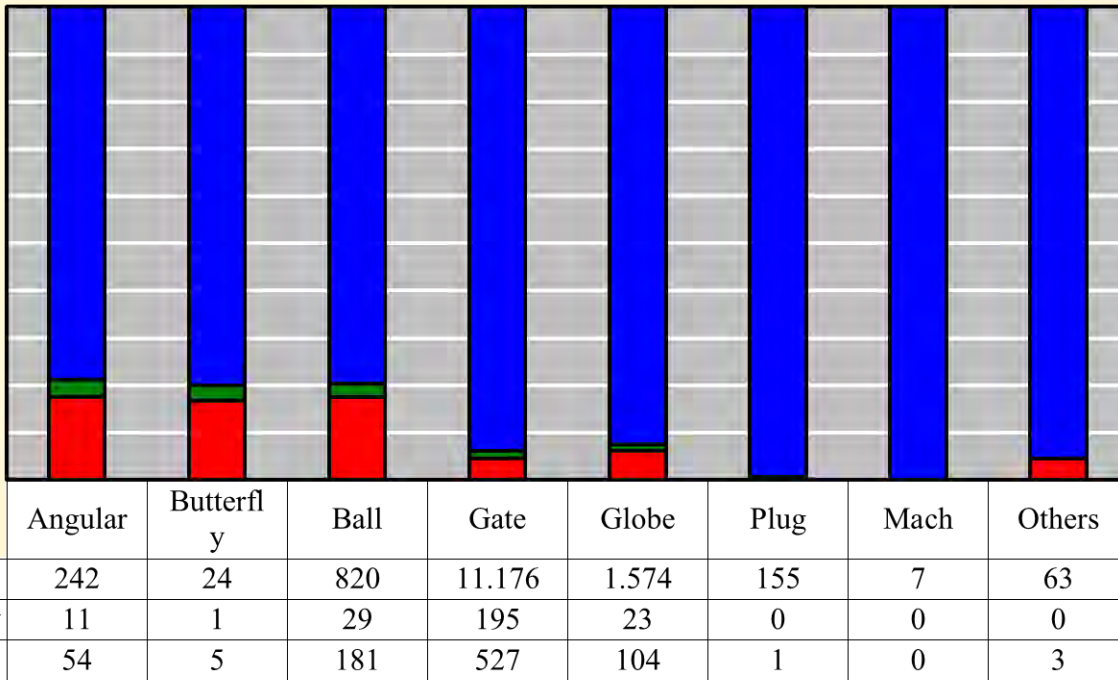
- **46 valves packed with Style A**
- **Sizes from 1/2” to 16”**
- **No leaks after 36 months**

- **Seating Stress:**
 - $S_s = S_{\min(0,01)} + P = 69 \text{ Mpa}$
 - $S_{\min(0,01)} = 55 \text{ MPa (8000 psi)}$
 - $P = 140 \text{ bar (2000 psi)}$



Field Tests

- >90% of the valves with leakage levels below 250 ppmv
- Only 5% above 500 ppmv



Conclusions

- The Experimental determination of minimum installation stresses is successful in granting Low Emission rates
- Sealability can be achieved without the need of several packing rings.
- Low Emission rates can be achieved using PTFE packings and Spring Loads combined.
- Lowest emission levels can be achieved through R&D
- Proper installation calculation and procedures can prevent leakage on the long run

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Thank You!

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