WHAT MAKES A GOOD FE PACKING FOR NEW/USED VALVES?

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Lack of Clear Directions!

• Consult packing manufacturer and/or plant engineering department for guidance on torque (FSA)
• Tighten the gland bolts to the point where heavy resistance to wrenching is felt
• X% of Compression
• FE Emission Labs being Set up
USA announced in 2015 ambitious new goal to cut methane emissions from the oil and gas sector by 40 to 45 percent below 2012 levels by 2025.

Low-E Valve is defined as:
(http://www.epa.gov)

- “Certified Low-Leaking Valve Packing Technology” shall mean valve packing technology for which a manufacturer has issued: (i) a written guarantee that the valve packing technology will not leak above 100 ppm for five (5) years; (ii) a written guarantee, certification or equivalent documentation that the valve packing technology has been tested pursuant to generally-accepted good engineering practices and has been found to be leaking at no greater than 100 ppm.
Installation with Controlled Torque
(ASME PVP Paper 2008-61214)

Optimum Number of rings
(ASME - PVP2009-77467)

Optimization of Corrosion Inhibitors
(VW2010)

Limitation on the Maximum use of PTFE
(ASME – PVP2011-57751)
MINIMUM SEATING STRESS

• Packing:
  • Style A: Flexible Graphite Yarn reinforced with an Inconel wire mesh.
  • Style D: Expanded PTFE filled with Barium Sulphate.
MINIMUM SEATING STRESS

<table>
<thead>
<tr>
<th>Packing Style</th>
<th>$S_{min(0.01)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPa</td>
</tr>
<tr>
<td>A</td>
<td>55</td>
</tr>
<tr>
<td>D</td>
<td>25</td>
</tr>
</tbody>
</table>

Ni-Cr Wire Mesh Reinforced Yarn Flexible Graphite Packing (no impregnation)

Expanded PTFE filled with Barium Sulphate Packing
PACKING DRAG AND FORCE TRANSMISSION

1 - Stem
2 - Gland
3 - Bonnet
4 - Internally Gaged Bolt
5 - Packing
6 - Bushing
7 - Load Cell
8 - Load Cell Base
9 - Electrical Resistance
Results incompatible with the traditionally used Radial Stress Distribution graph for stresses above the MSS.
Friction force difference between Graphite and PTFE packings
COATING

STEM TORQUE
Test at Cycling Conditions
[API 622] 77 Mpa - 260°C - 40bar (Methane)

STYLE 10 and 12 = High Torque
STYLE 5 and 9 = Torque OK!
THERMAL EXPANSION

<table>
<thead>
<tr>
<th>Style</th>
<th>Yarn</th>
<th>Filler</th>
<th>Comparative e-PTFE content</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>e-PTFE</td>
<td>None</td>
<td>100% e-PTFE</td>
</tr>
<tr>
<td>B</td>
<td>e-PTFE</td>
<td>Barium Sulphate</td>
<td>B% &lt; A%</td>
</tr>
<tr>
<td>C</td>
<td>e-PTFE</td>
<td>Barium Sulphate</td>
<td>C% &lt; A% &amp; B%</td>
</tr>
<tr>
<td>D</td>
<td>e-PTFE</td>
<td>Graphite</td>
<td>D% &lt; A%, B% &amp; C%</td>
</tr>
</tbody>
</table>
THERMAL EXPANSION

PTFE Packing Extrusion due to Thermal Expansion

<table>
<thead>
<tr>
<th>Material</th>
<th>(10⁻⁵ K⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>1</td>
</tr>
<tr>
<td>Barium Sulphate</td>
<td>1</td>
</tr>
<tr>
<td>Graphite</td>
<td>1</td>
</tr>
<tr>
<td>PTFE</td>
<td>12</td>
</tr>
</tbody>
</table>
THERMAL RESISTANCE

Table 3.1 – Thermal properties

<table>
<thead>
<tr>
<th>Style A</th>
<th>LE 1</th>
<th>LE 2</th>
<th>LE 3</th>
<th>LE 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>500°F/1 h (260°C/1 h) [%]</td>
<td>0.8</td>
<td>0.9</td>
<td>1.3</td>
<td>2.6</td>
</tr>
<tr>
<td>900°F/1 h (480°C/1 h) [%]</td>
<td>1.6</td>
<td>11.1</td>
<td>26.5</td>
<td>24.7</td>
</tr>
<tr>
<td>1000°F/1 h (540°C/1 h) [%]</td>
<td>2</td>
<td>12.7</td>
<td>44.1</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Mass Loss

- Style E
- Sample X
GALVANIC CELL - CORROSION

![Graph showing electrical potential difference over time for different inhibitors and a control with no inhibitor.](image_url)
CORROSION INHIBITOR

Average Mass Loss

- Inhibitor 1
- Inhibitor 2
- Inhibitor 3
- Inhibitor 4
- no Inhibitor

Materials: 1010, 304, 410
• Packing Sample P: with Zinc Powder.
• Packing Sample W: with Zinc Wires in the core.
DENSITY CONTROL

• Density Control
• Specially on Molded Rings – Over Compressed rings will NOT be able to fill the voids
FUGITIVE EMISSION TEST RIGS
R&D Results

API Standard 622 2nd Ed. Simulation (4" CL300) Test Report

Static Leakage Chart
Reading

Leakage (PPM)

0 10 20 30 40 50 60 70 80 90 100

Cycle Number

0 250 500 750 1000 1250 1500

Static Leakage Chart
Maximum Reading

Results

Average Test Pressure: 600 psig
Number of Mechanical Cycles Completed: 1510
Number of Thermal Cycles Completed: 0
Number of Packing Adjustments Required: 0
Cycle Number of Packing Adjustments: n/a
Average Leakage Throughout Test: 2 PPM
Maximum Leakage Throughout Test: 22 PPM

Witness

Matthew J. Weisleder, PE
President, Yarmouth Research

Leakage (PPM)

0 10 20 30 40 50 60 70 80 90 100

Cycle Number

0 250 500 750 1000 1250 1500
WHAT MAKES A GOOD FE PACKING FOR NEW/USED VALVES?

• Controlled Packing Density
• Reduced Stem Drag - the least PTFE possible
• Thermal Resistant and Fire Safe
• Corrosion Inhibition
• Designed Assembly Stress
SUCCESS FACTORS - TESTING

API 624 Key Success Factors

• Valve and packing manufacturer relationship
• Quality product and good communication yields good results
• Eyebolt nut / Gland flange torque values
• Machining tolerances (stem, stuffing box, gland, etc.)
• Lubrication
• Third-party tester that is competent – Integrity of test stand (Revolution speed, Safety, etc..)
INSTALLER TRAINING: 3 KEY ELEMENTS

1° PRODUCT

2° TORQUE

3° INSTALLATION
INSTALLATION

- Stuffing Box and Stem finish as per STD
- Tolerances as per best practice as per STD
- Rings with Cuts 90º apart
- 5 Rings = Desirable
- Proper torque (k factor influence)

- Bolt Design

<table>
<thead>
<tr>
<th>Applied Torque N.m (lb. Ft)</th>
<th>Rusted Bolt - Dry</th>
<th>Rusted Bolt - with lubrication</th>
<th>New A193 B7 - Dry</th>
<th>New A193 B7 - Lubricated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friction factor</td>
<td>0.49</td>
<td>0.16</td>
<td>0.17</td>
<td>0.12</td>
</tr>
</tbody>
</table>

![Graph showing stress comparison](image)

- New Hardened G8 Washers
- No Washers
- Carbon Steel Common Washers
API 624 RESULTS

API 624 Type Testing Results

Highest reported value at 12 ppmv
“Since the introduction of LE packing at our TCO Tengiz facility in Kazakhstan four years ago, we have experienced zero leaks on every reconditioned valve we have repacked with…” (Bill Ross)

The financial impact of unscheduled plant shutdown due to Valve Packing Blow out was $50,000,000.

Good Practice: recommend retightening once after initially being put into service.
What makes a good FE packing for new/used valves?

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Thank you!