TEADIT®

Sealing for a Safer and Greener Tomorrow

EVALUATION OF PACKING DRAG AND SEALABILITY ON KNIFE VALVES

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Agenda

1. Introduction
2. Objectives
3. Test Rig
4. Preliminary Tests
5. Initial Test Procedure
6. Packing Types and Configurations Tested
7. Testing Procedure
8. Test Results
9. Conclusions

Introduction

- **Knife Gate Valves**
  - **Popular in applications with liquid and solids mixture.**
  - **Widely used in Mining, Pulp and Paper, Chemical and Petro-Chem ...**
- **Gate Sealing**
  - **Usually braided packings.**
  - **Rectangular Packing Chamber.**
  - **Packing must seal under unusual shape.**

At: http://valves.pentair.com

Objectives

- **Develop a testing device and protocol to evaluate braided packings drag and sealability on knife valves**

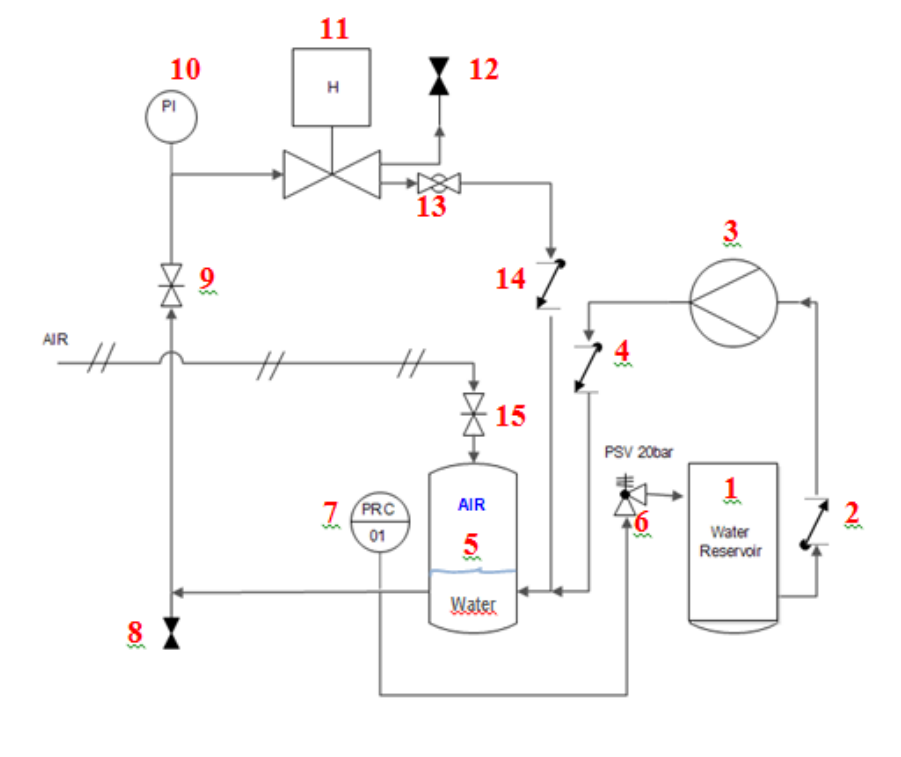
- **Determine correlations between packing materials/number of rings and the results on friction force and sealability**

Test Rig

- **Valve seat removed - Gate contacts exclusively the packing and fluid**

- **Valve/Actuator details**
  - **Size: 6” CL150**
  - **Gate: 6.5” x 0.30” (S_A = 1.95 in²)**
  - **Max Number of Rings: 4**
  - **Packing Length / Cross-section: 15.3” / 3/8”**
  - **Studs: 1/2”**
  - **Actuator:**
    - **2” bore cylinder**
    - **1” Cylinder rod**

Test Rig

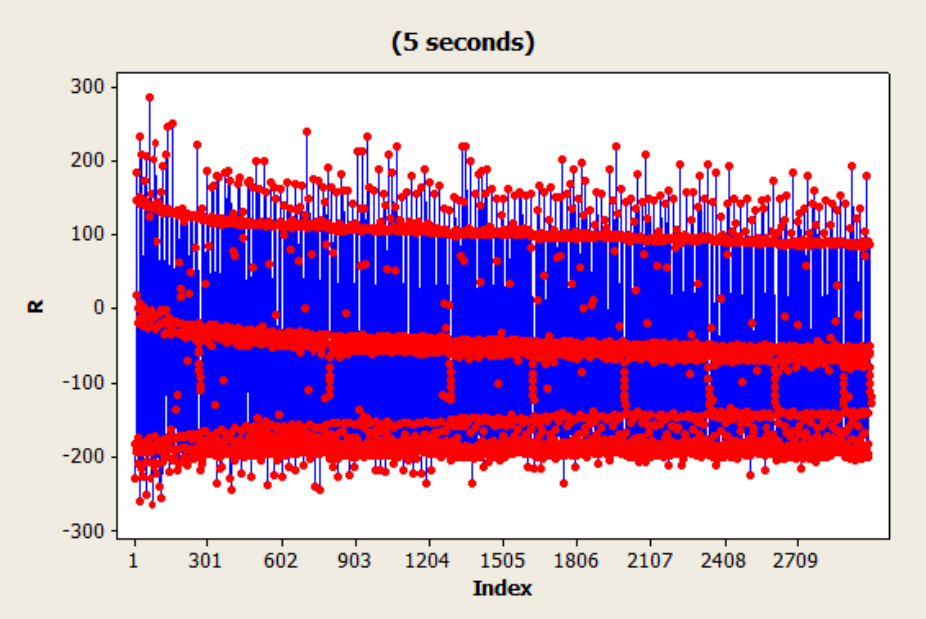


1 - Water Reservoir	6 - Relief Valve	12 - Air Bleed Valve
2 - Check Valve	7 - Pressure Register and Controller	13 - Ball Valve
3 - Alternative Pump	8 - Water Bleed Valve	14 - Check Valve
4 - Check Valve	9 - Needle Valve	15 - Needle Valve
5 - Water/Air Pressure Vessel	10 - Pressure Indicator	16 - Pressure Register
	11 - Pentair Valve/Hidraulic Actuator	17 - Pressure Register

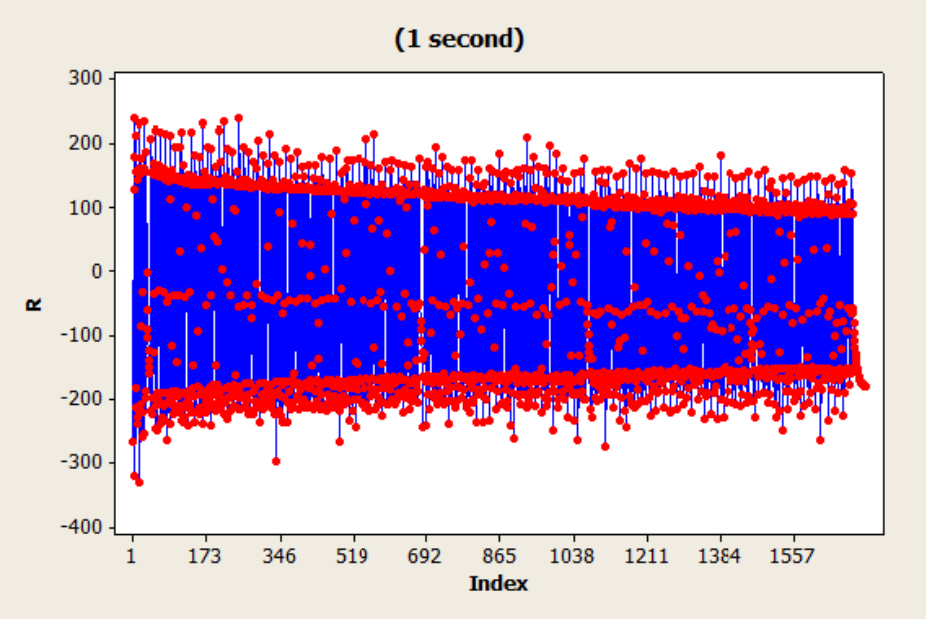
Preliminary Tests

Initial evaluation: Influence of resting time on the results

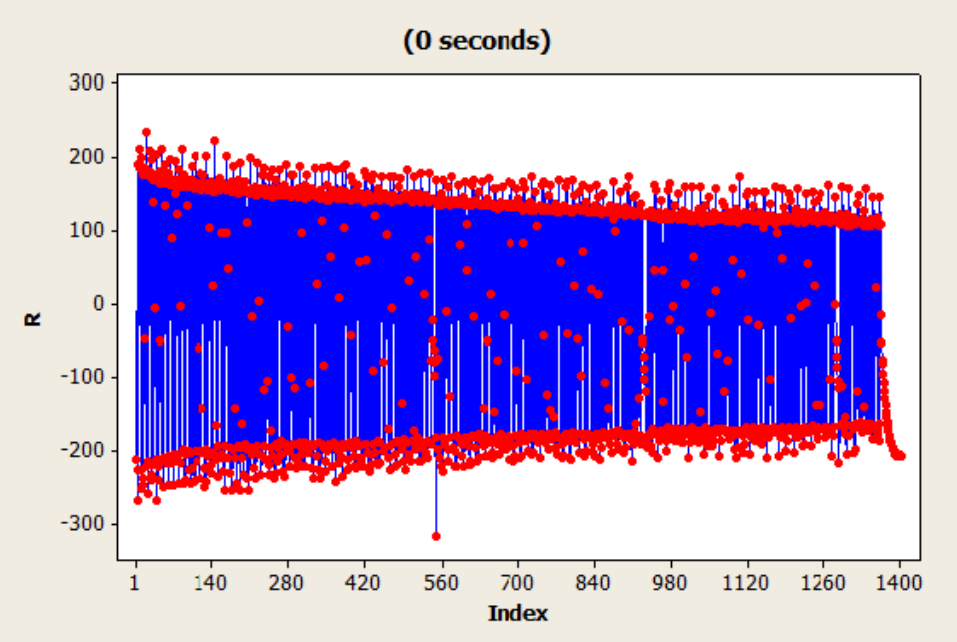
5 seconds



1 second



Preliminary Tests



No difference spotted among the different resting times

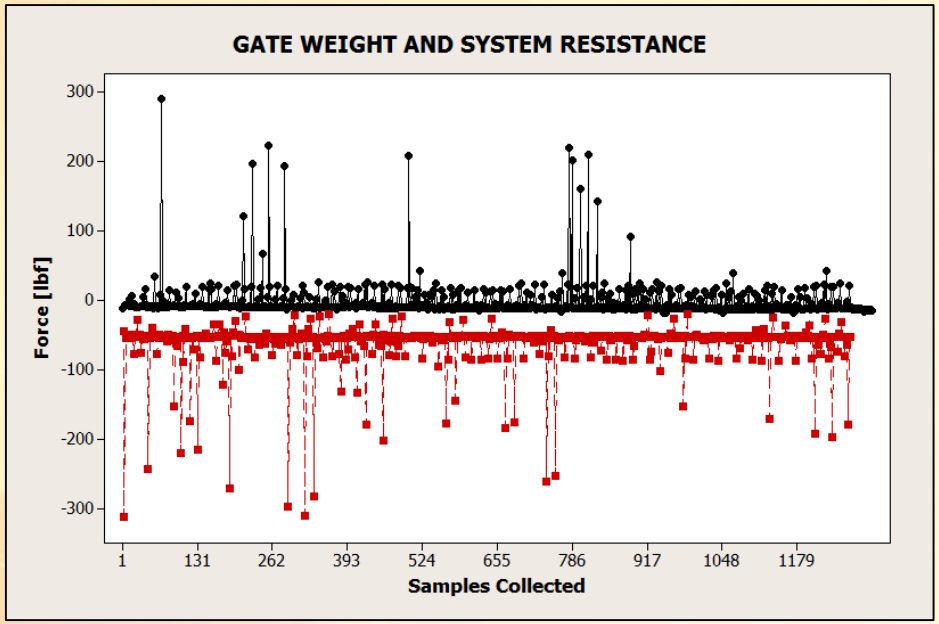
Resting time plays no role on the results

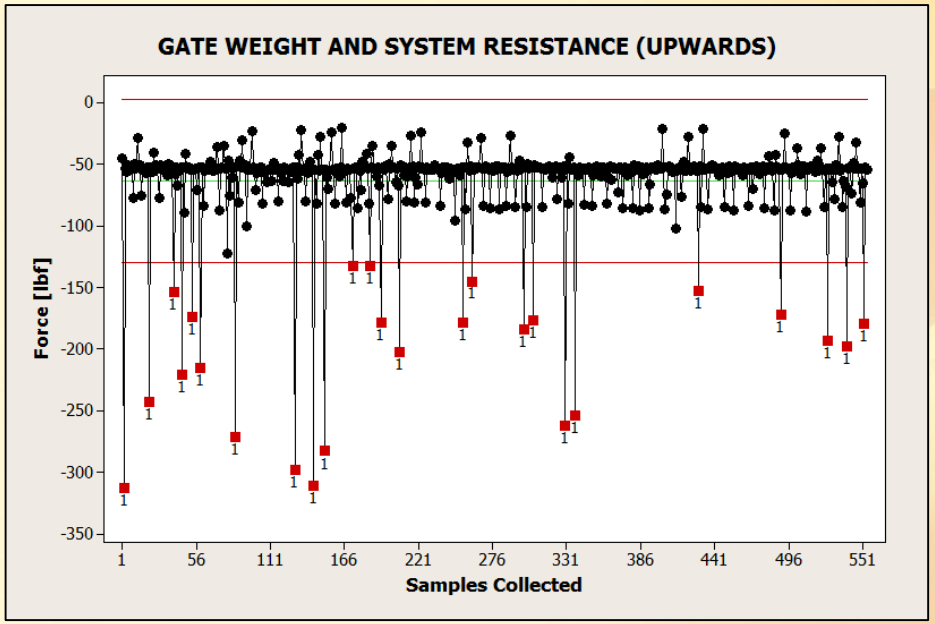
Further Testing performed with 310 mechanical cycles (API 624) and no resting time in between strokes.

Preliminary Tests

The gate weight and system resistance values need to be subtracted from the resultant values of the testing data – FOCUS ON PACKING DRAG

Tests with no packing and no media to determine those values

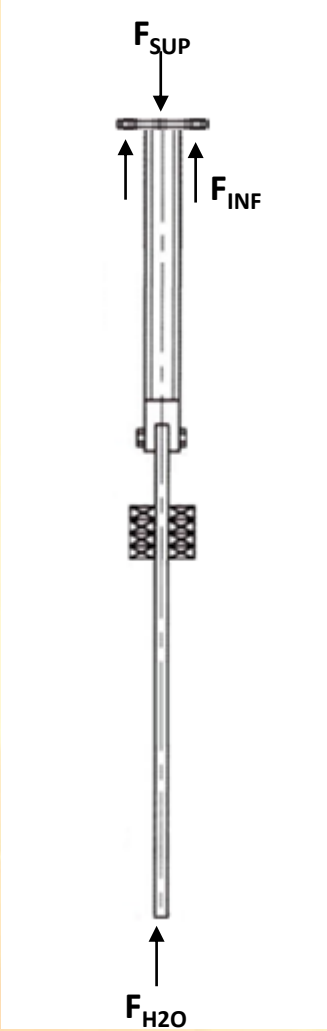




Red = Upwards movement

Black = Downwards movement

Forces Determination



- $F_{SUP} = P_{SUP} \cdot A_{SUP}$
  - $A_{SUP} = \frac{\pi}{4} \cdot (P_D{}^2)$
- $F_{INF} = P_{INF} \cdot A_{INF}$
  - $A_{SUP} = \frac{\pi}{4} \cdot (P_D{}^2 - S_D{}^2)$
- $F_{H2O} = P_{H2O} \cdot (G_L \cdot G_T)$

Where:

$P_D = 2”$
$S_D = 1”$
$G_L = 6.5”$
$G_T = 0.3”$

➢ $F_{DRAG} = F_{SUP} - F_{INF} - F_{H2O}$

The positive values of F_{DRAG} indicate the packing drag while the gate is moving downwards.

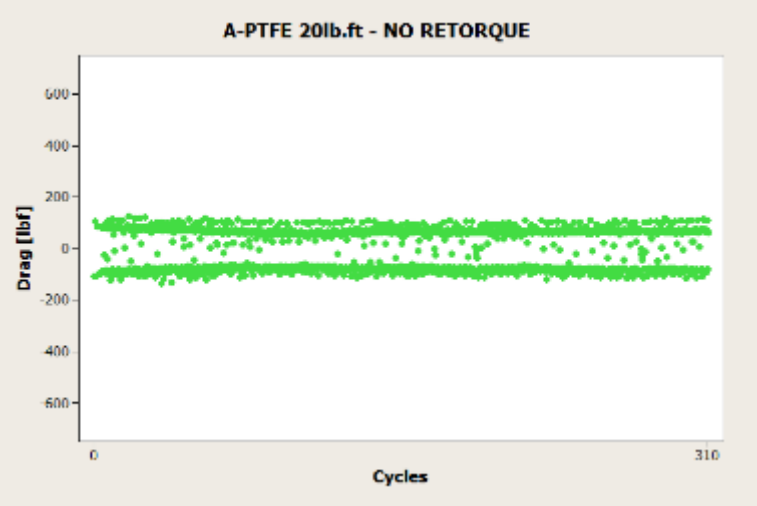
The negative values indicate the packing drag during the upwards movement.

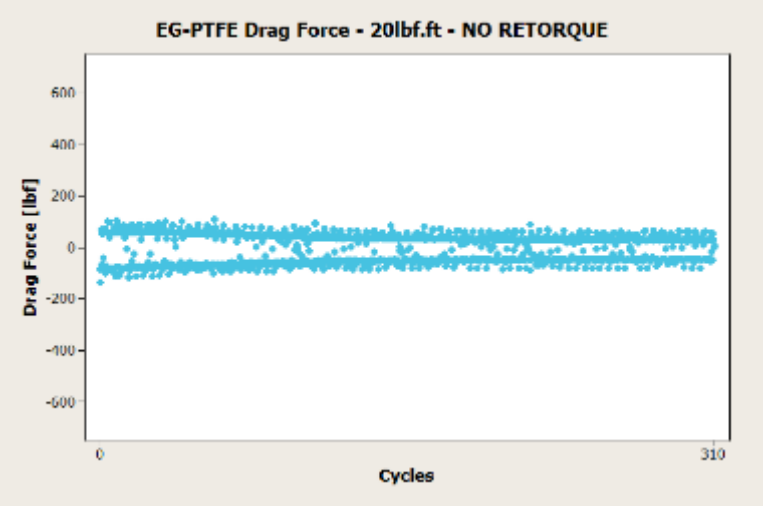
Initial Test Procedure

1. The packing rings are cut with 45 degree angles and installed with the joints of successive rings 180 degrees apart.
2. Install one ring at a time and applying the target load to each of them.
3. 310 cycles are performed with no resting times in between strokes.
4. The pressure to open and close the gate and the media pressure is recorded throughout the whole test.

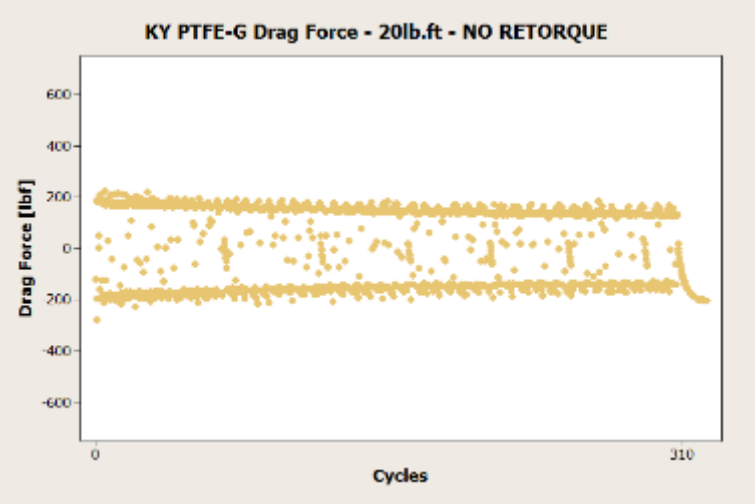
If the system pressure drops by 0.2 bar (2.9 psi) the pressure is restored by the feeder pump. This pressure drop is approximately 100 milliliters leakage.

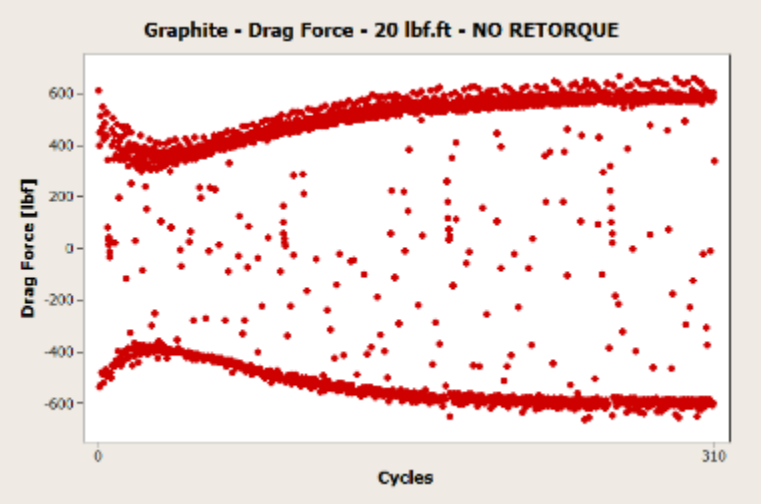
Initial Test Results



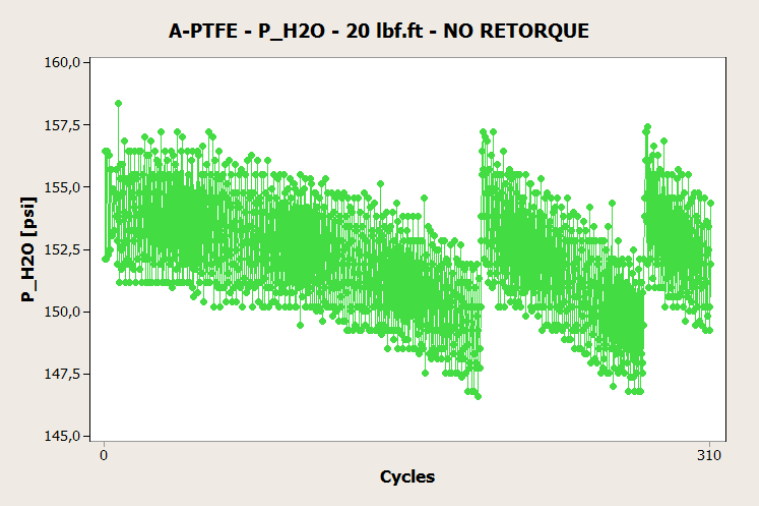


Graphite based packing showed the highest Drag Force values

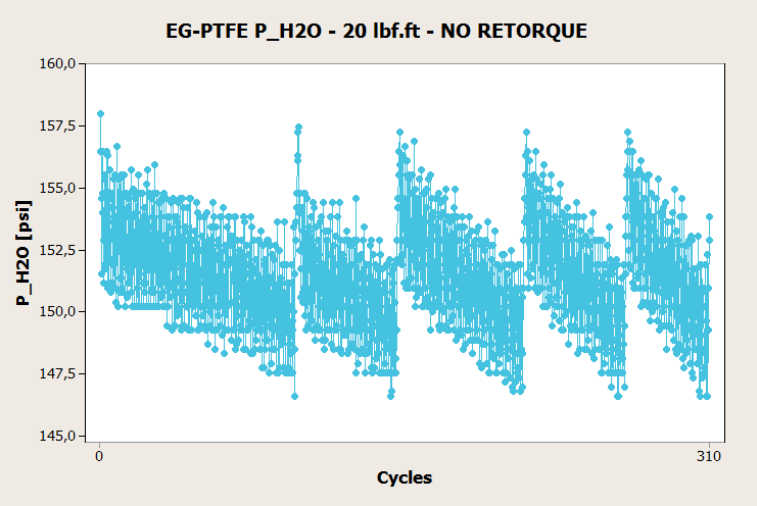




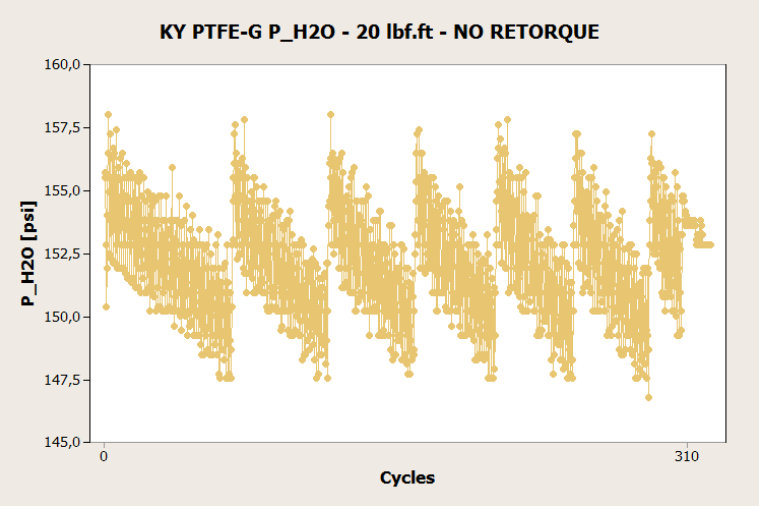
Initial Test Results



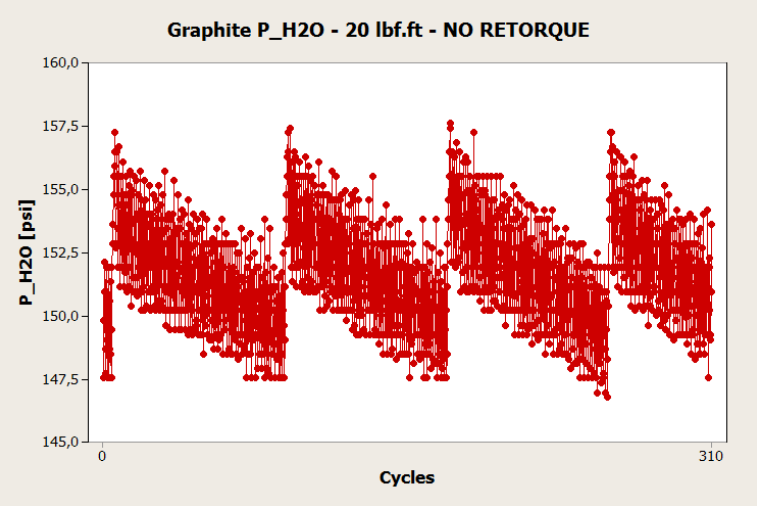
Leakage: >200 mL/h



Leakage: >400 mL/h



Leakage: >600 mL/h



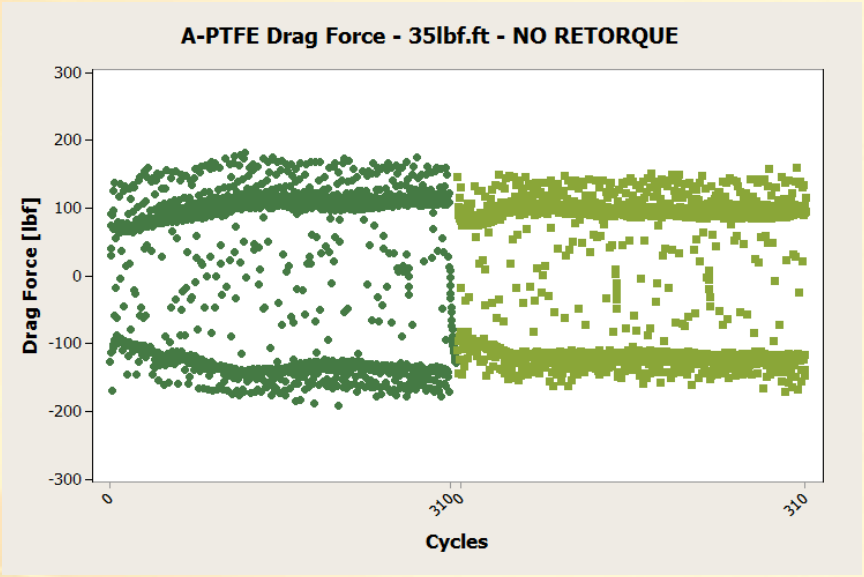
Leakage: >300 mL/h

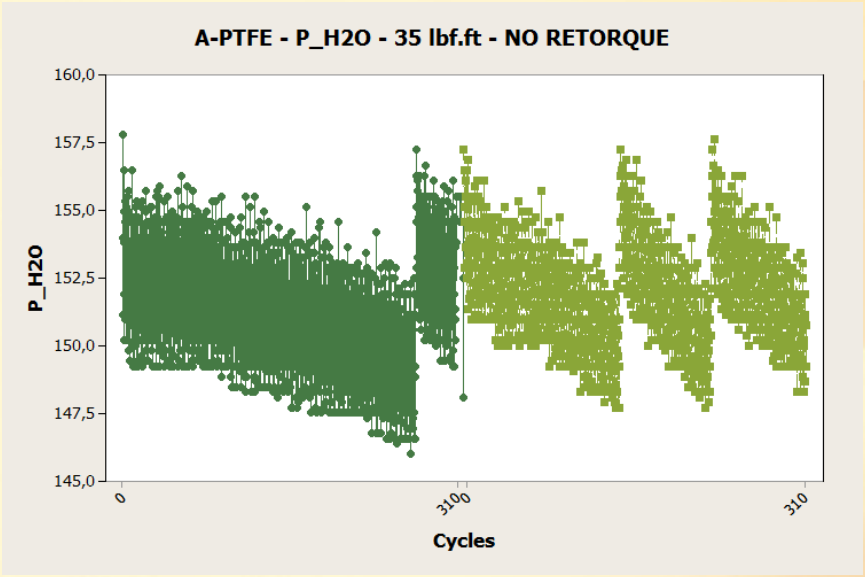
High leakage for all styles tested!

Initial Test Results - Observations

High leakage values in all tests with different packing styles

The installation torque was then increased from 20lb.ft to 35lb.ft





Leakage: >100mL/h Leakage: >200mL/h

Leakage still above acceptable levels !!!

Test Procedure

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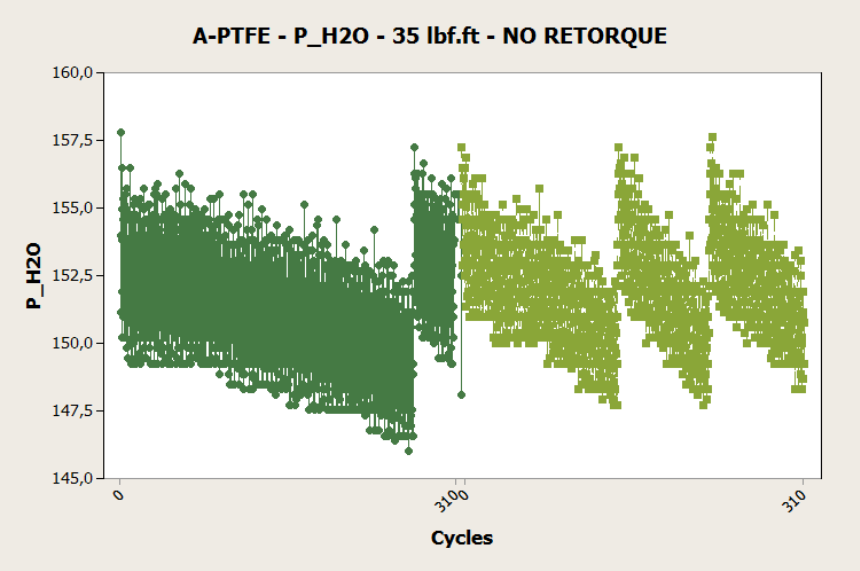
Changes in the installation procedure:

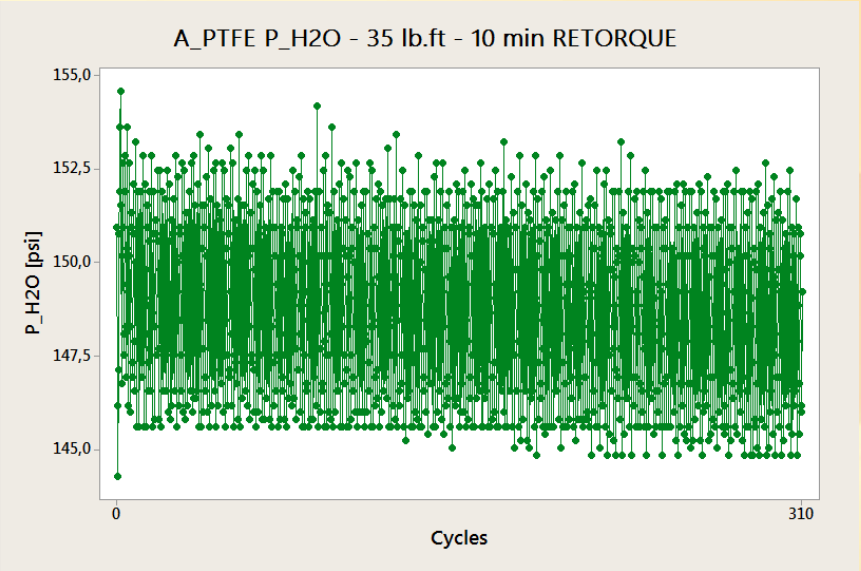
- **Retorque the nuts 10 minutes after the installation**

1. The packing rings are cut with 45 degree angles and installed with the joints of successive rings 180 degrees apart.
2. Install one ring at a time and applying the target load to each of them.
3. Packing target load reapplied after 10 minutes.
4. 310 cycles are performed with no resting time between strokes
5. The pressure to open and close the gate and the media pressure are recorded throughout the whole test.

New Test Procedure Results

Style A-PTFE re-tested with 35 lbf.ft and Retorque 10 minutes after the installation





Leakage: >100mL/h Leakage: >200mL/h

Leakage < 100 mL/h

Adaptations to the procedure effective!!

Packing Types and Configurations Tested

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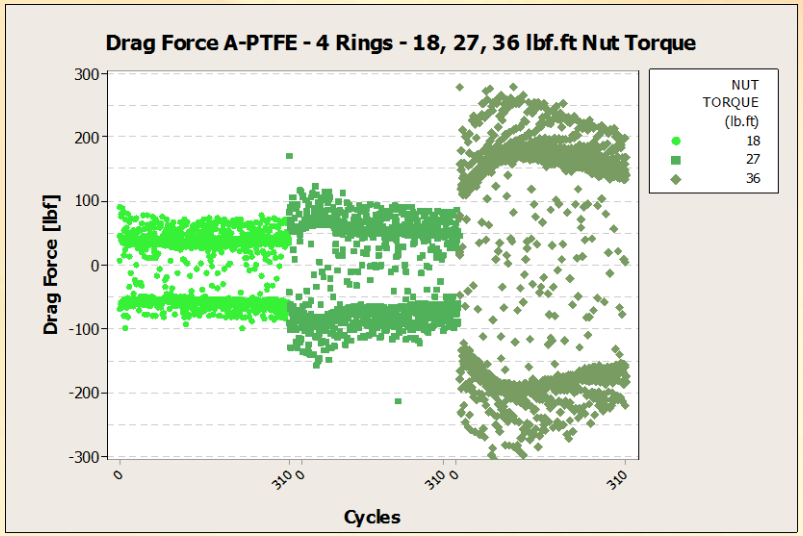
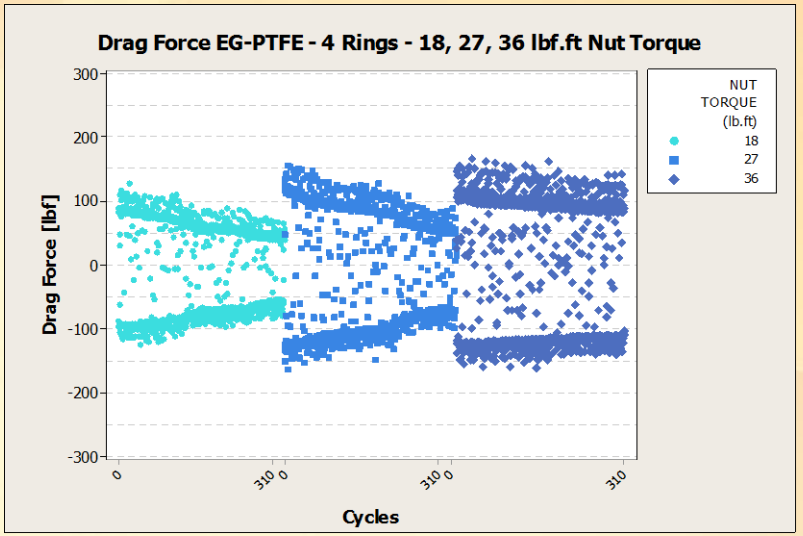
Packing Material	Configuration	Example
A-PTFE Acrylic Fibers + PTFE	1 – 4 rings Applied Torques: 18, 27, 36 lbf.ft	
EG-PTFE Graphite Filled Expanded PTFE		
E-PTFE Expanded PTFE		
E-PTFE R Expanded PTFE with Rubber Core		

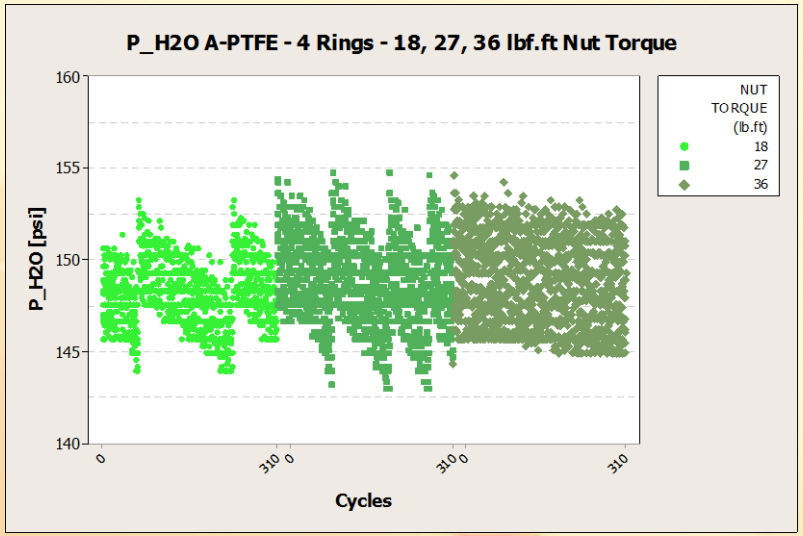
Installation Torque Influence

Same Packing Different Installation Torques

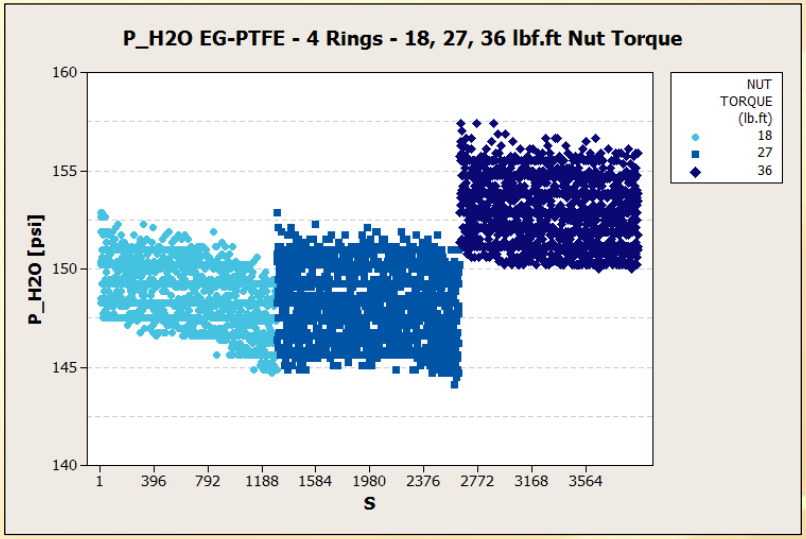




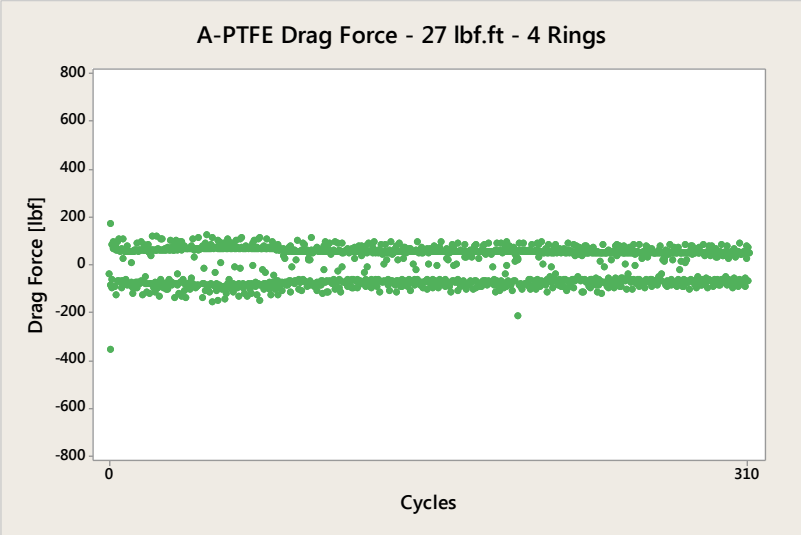
Torque values of 36 lbf.ft granted the sealing

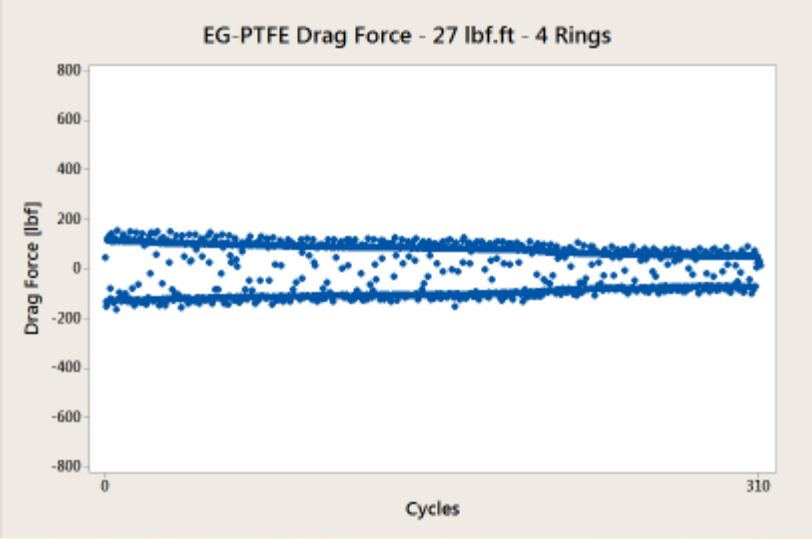


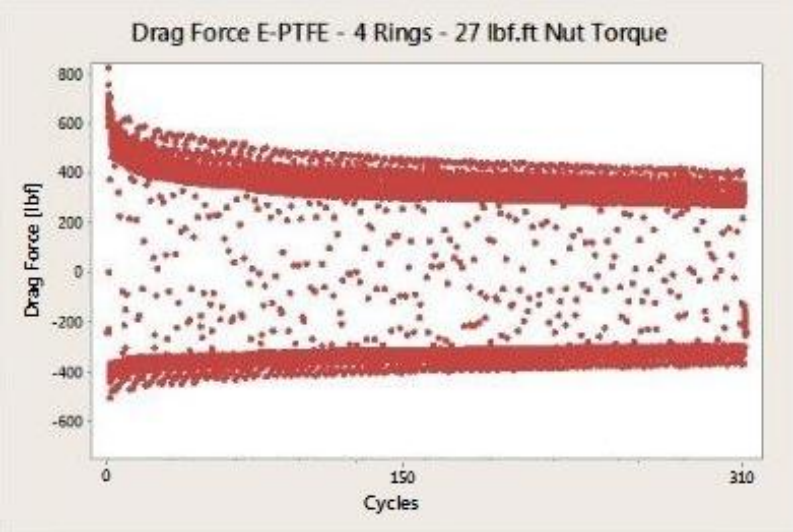
Good sealability for all torques tested



Packing Material

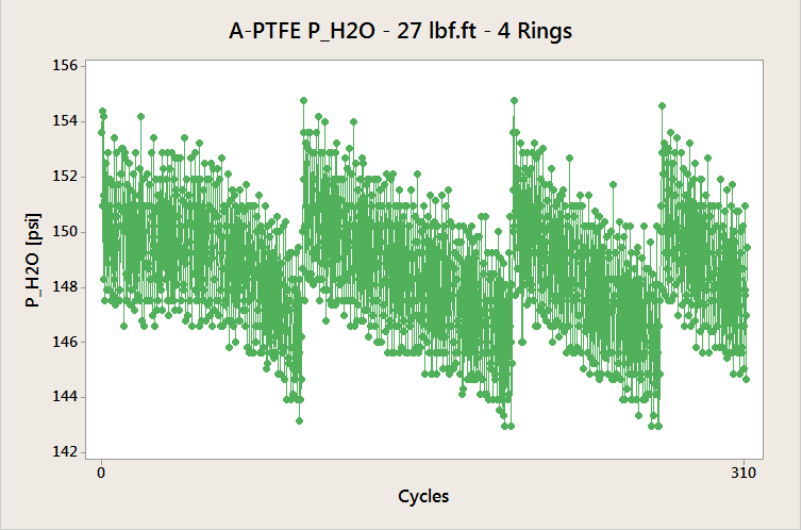


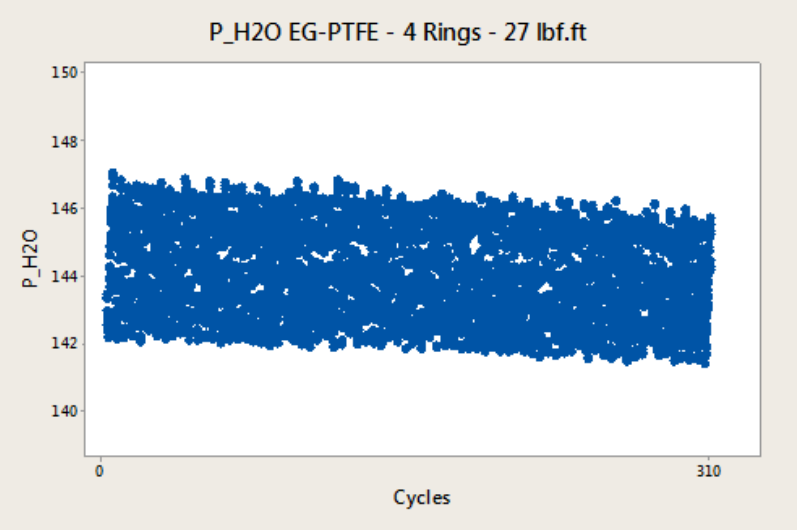


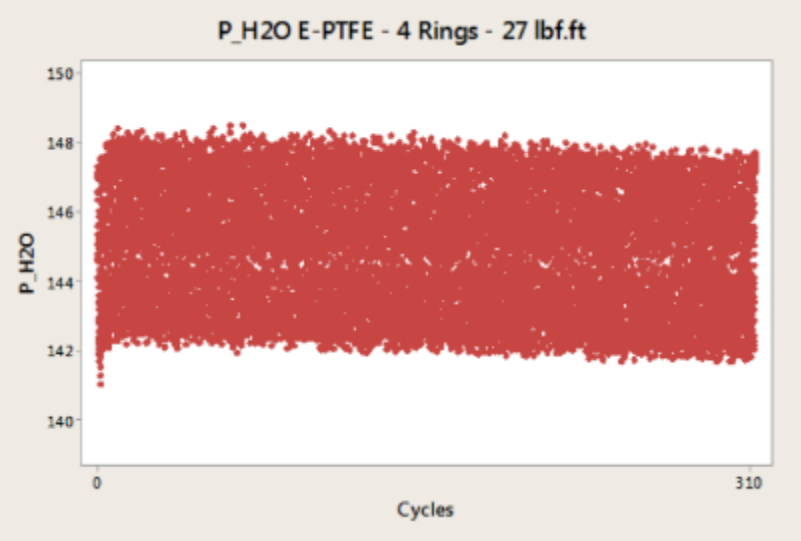


E-PTFE based packing showed friction values 2 times as high as Graphite filled PTFE and Acrylic Fibers with PTFE impregnation.

Packing Material

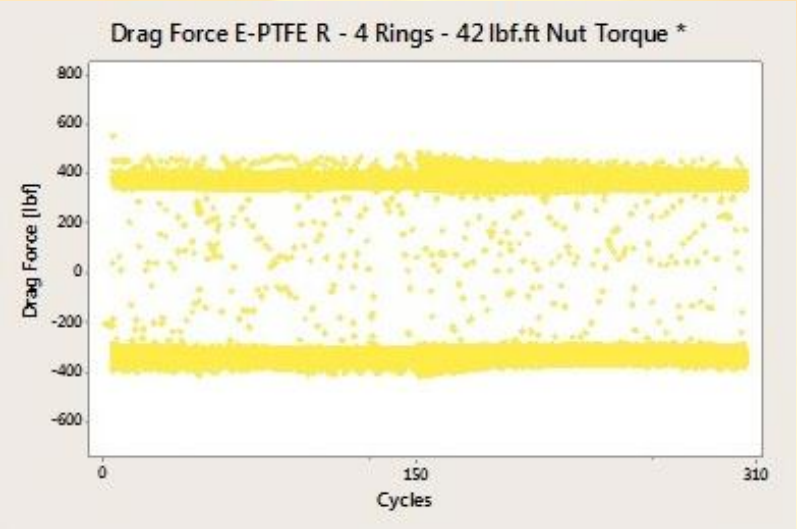


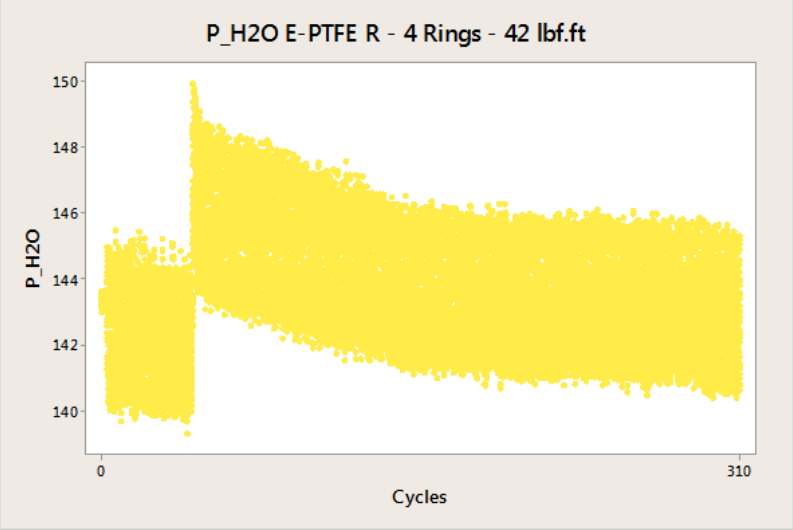




As to sealability, however, A-PTFE showed the poorest results (> 300mL/h)

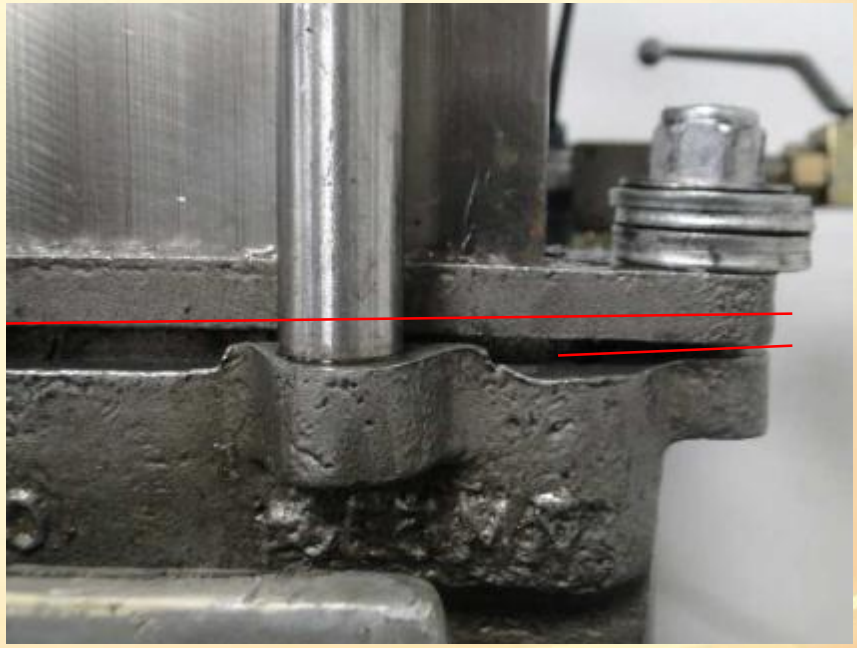
Packing Material



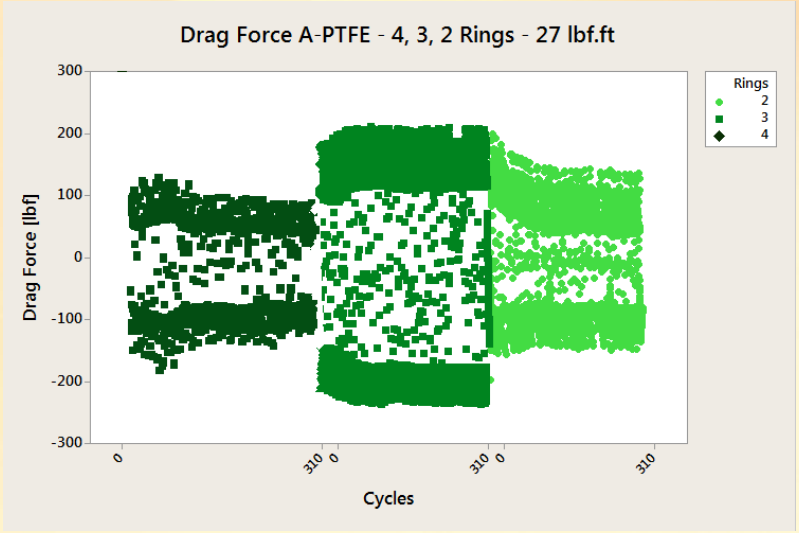


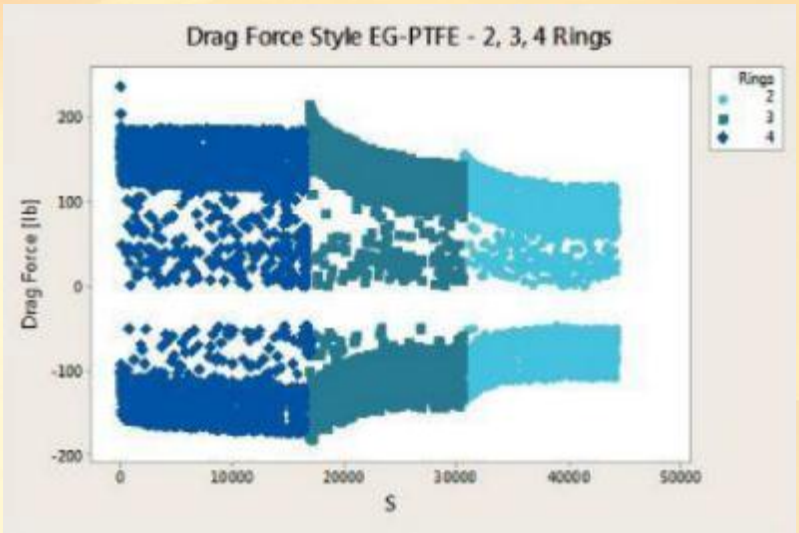
Style E-PTFE required a much higher initial torque to grant no visual leakage before test start – 42 lbf.ft

The high torque value lead the gland follower to bending:

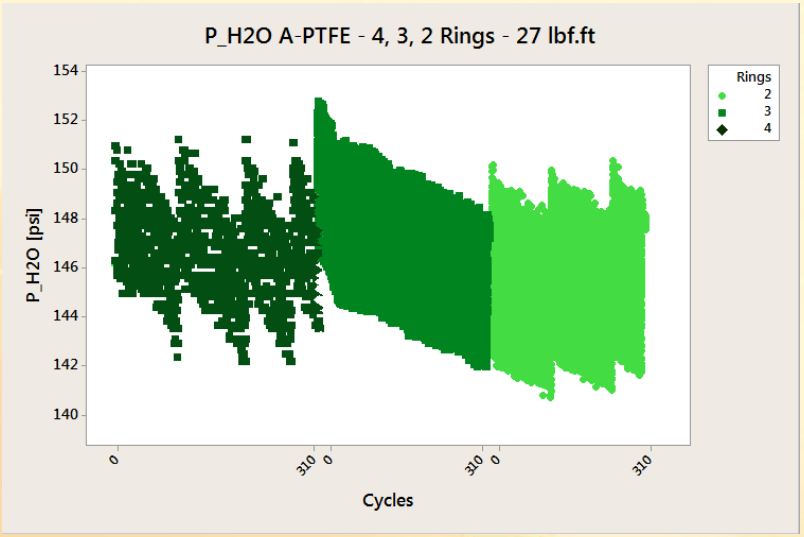


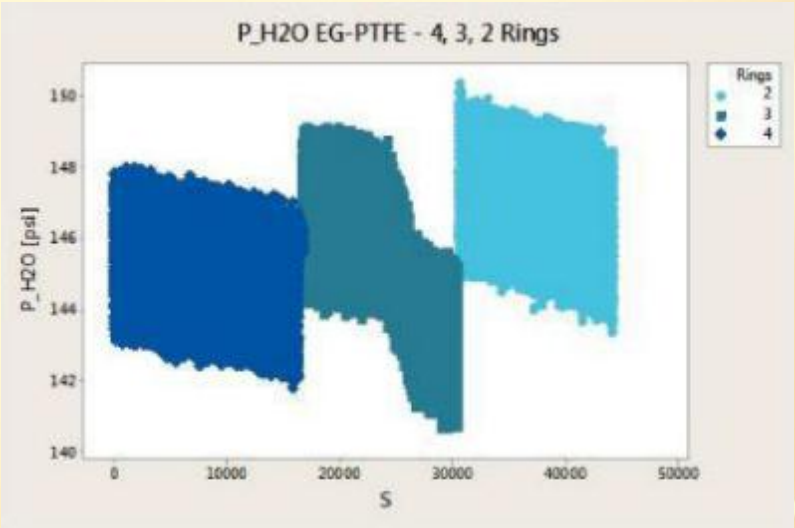
Number of Rings





No significant difference between the number of packing rings

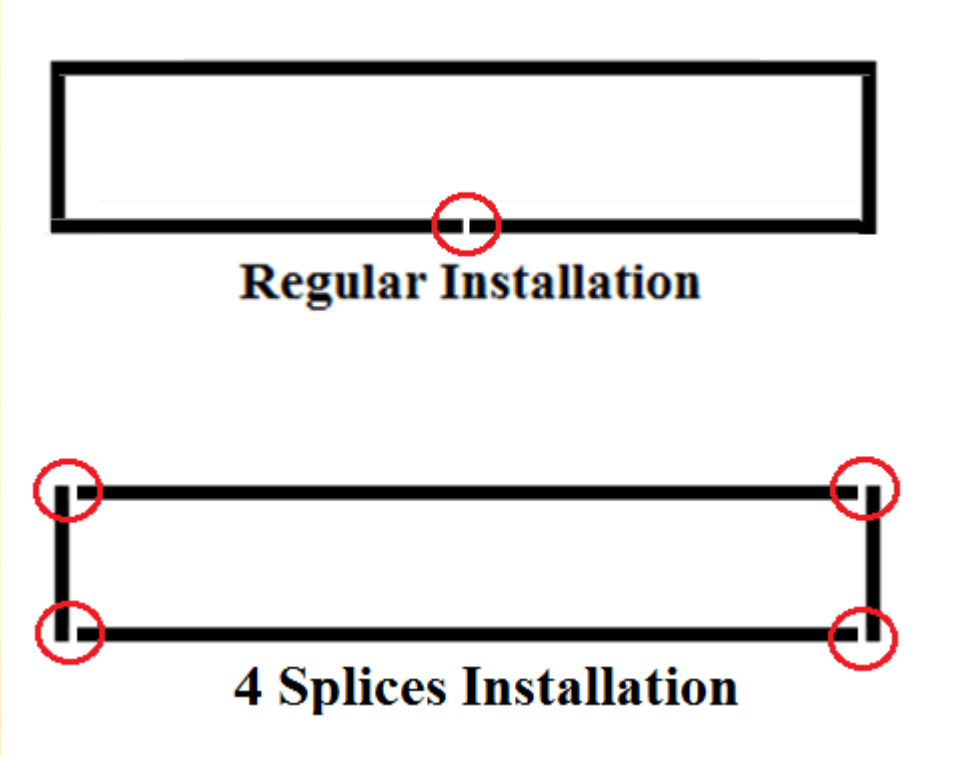




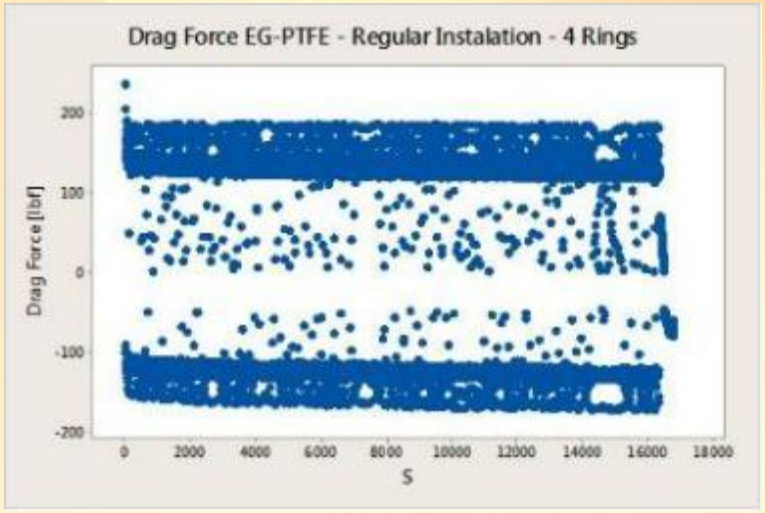
Regular vs Splices Installation

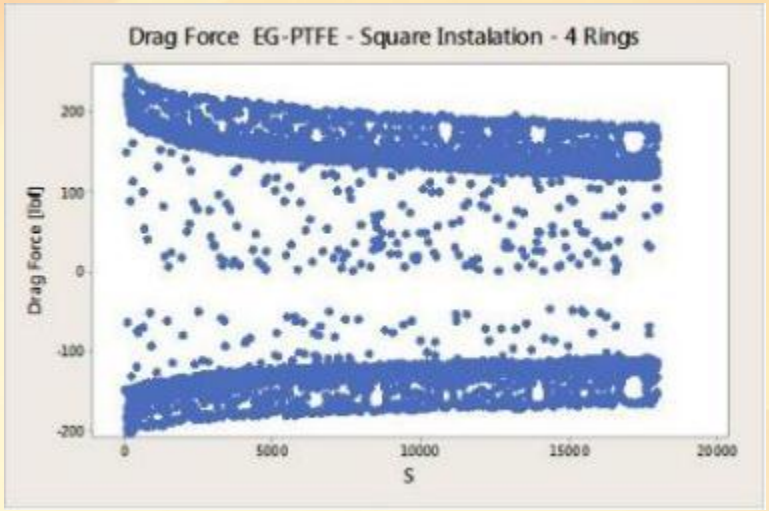
Further Analysis to evaluate the differences in installation:

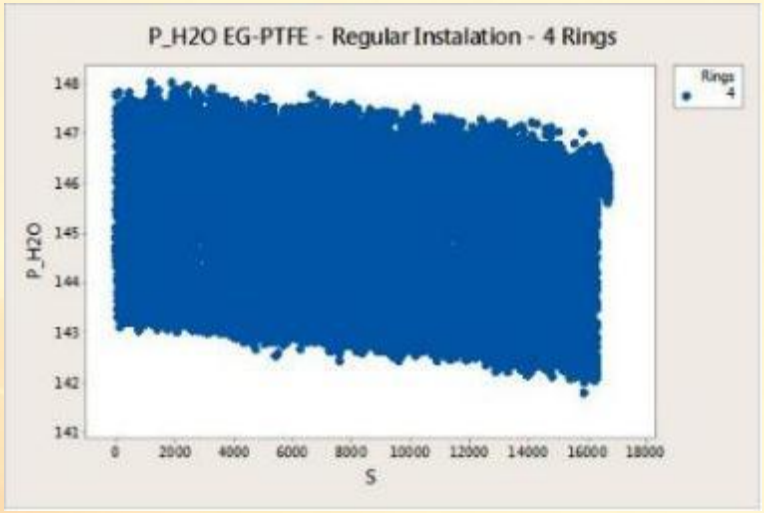
- Regular vs 4 splices Installation

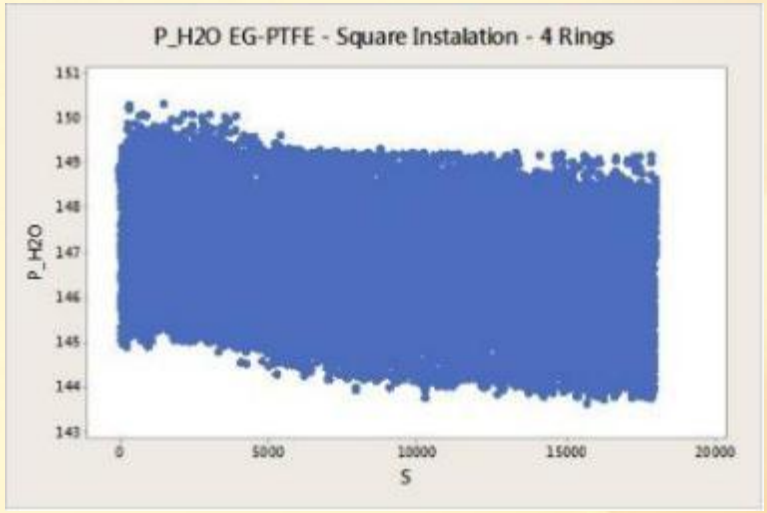


Regular vs 4 Splices Installation









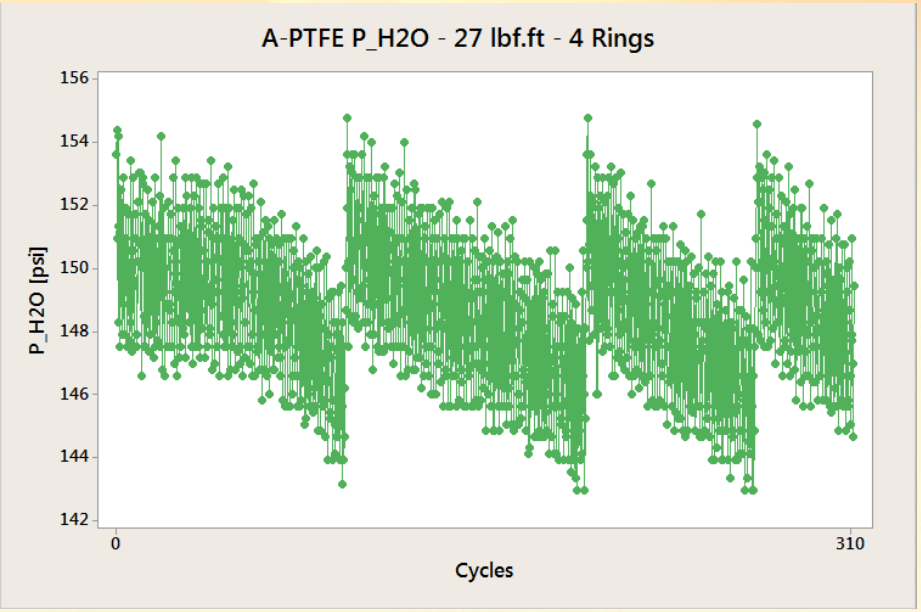
4 splices installation takes more time and have no influence on the results

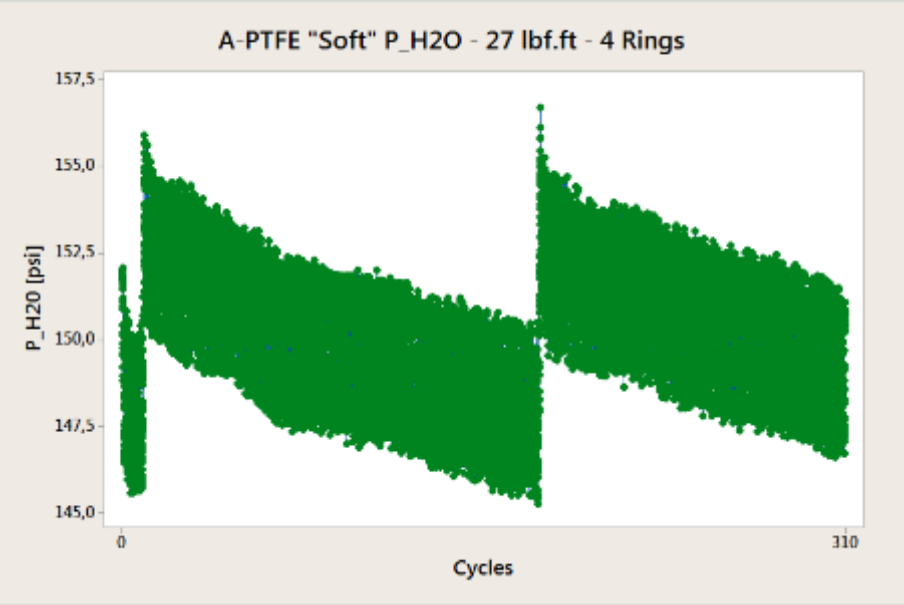
Special Packing Evaluation

- Special packing manufactured to evaluate if KGV's have specific sealability requirements

- Packing Style A-PTFE construction adapted to manufacture a packing with "softer" characteristics to try and make it easier to conform around the gate.

Regular vs Special Packing Sealability





Leakage: >300 mL/h

Leakage: <200 mL/h

The addapted construction did improve sealability

Conclusions

- Test device and procedure succesfully developed.
- Installation procedure have high impact on performance.
- Number of rings:
  - No influence on sealability
  - 4 rings showed much higher drag than 2 rings
- Friction vs Sealability
  - EG-PTFE: lowest friction force and good sealability
- “Soft” A-PTFE: better sealability than regular one

Future Studies: **Develop special packings for KGV’s**

EVALUATION OF PACKING DRAG AND SEALABILITY ON KNIFE VALVES

Thank you!

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