A new strategy to improve the stem sealing

Apuzzo Francesco

Carrara Spa

How to counter the usual valve packing relaxation

The current experimental and operative evidences show that the stem graphite sealing incurs a gradual relaxation that comes in the first weeks of work and after the first thermal cycle. A better knowledge of the product and some simple precaution can mitigate this effect with improved performance.

Information about the graphite stem packings

A graphite stem packing is composed ususally by die-formed flexible graphite rings and die-formed braided packing rings in different shape and combinations

Information about the graphite stem packings

Among the main technical specification for the packing qualification is recommended to refer to the ASTM F2191 and ASTM F2168 which qualify in details the main graphite yarns and the graphite foil attributes, introducing the correct terminology and classification terms because **“High Carbon content, Great chemical resistance in the range 0 ÷ 14 except the strong oxidizing and Great resistance to the high Temperature”** (the most famous attributes) could be insufficient to qualify the right graphite sealing.

Information about the graphite stem packings

ASTM F 2191: the packing classification

- Type yarns morfology
- Class level of detrimental material
- Grade inhibitor of corrosion (Y or N)

Information about the graphite stem packings

Yarns morfology

- Type I—Continuous carbon or graphite yarn.
- Type II—Staple carbon or graphite yarn.
- Type III—Braided flexible graphite.

Information about the graphite stem packings

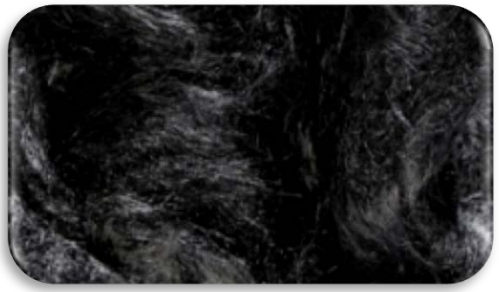
Type I and Type II

BCF: Bulked Continuous Filament Yarns

PAN yarns with thousand of continuous fibers

Staple Yarn: Discontinuous Filament Yarns

PAN or Rayon yarns with milion of discontinuous staple fibers



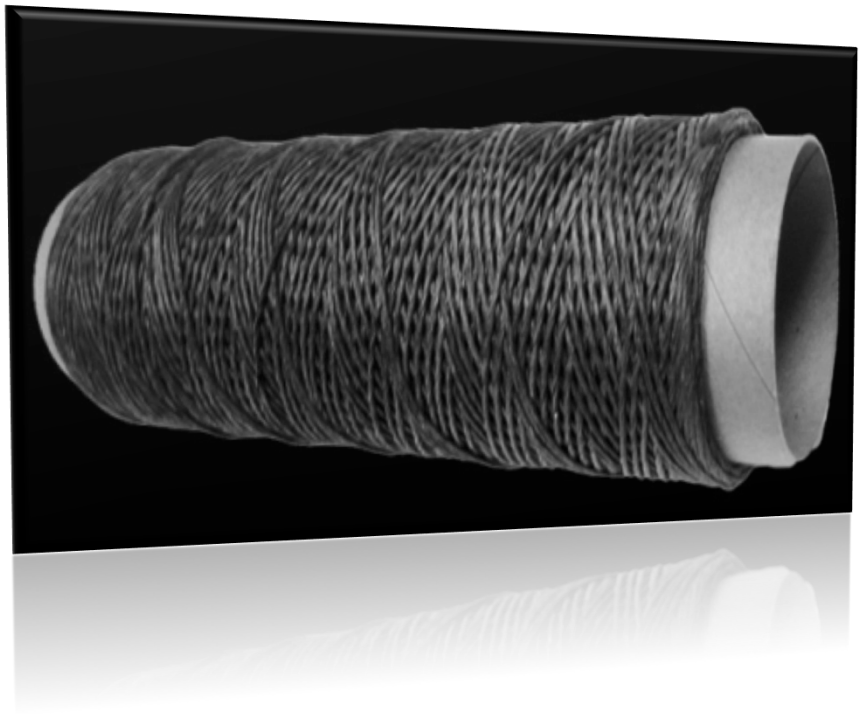
Oxidized PAN Fibers

Information about the graphite stem packings

Type I and Type II

Continuous carbon or graphite yarn - Staple carbon or graphite yarn.

- PAN Polyacrylonitrile
- Viscose Rayon



Information about the graphite stem packings

Type III - Flexible Graphite Strands

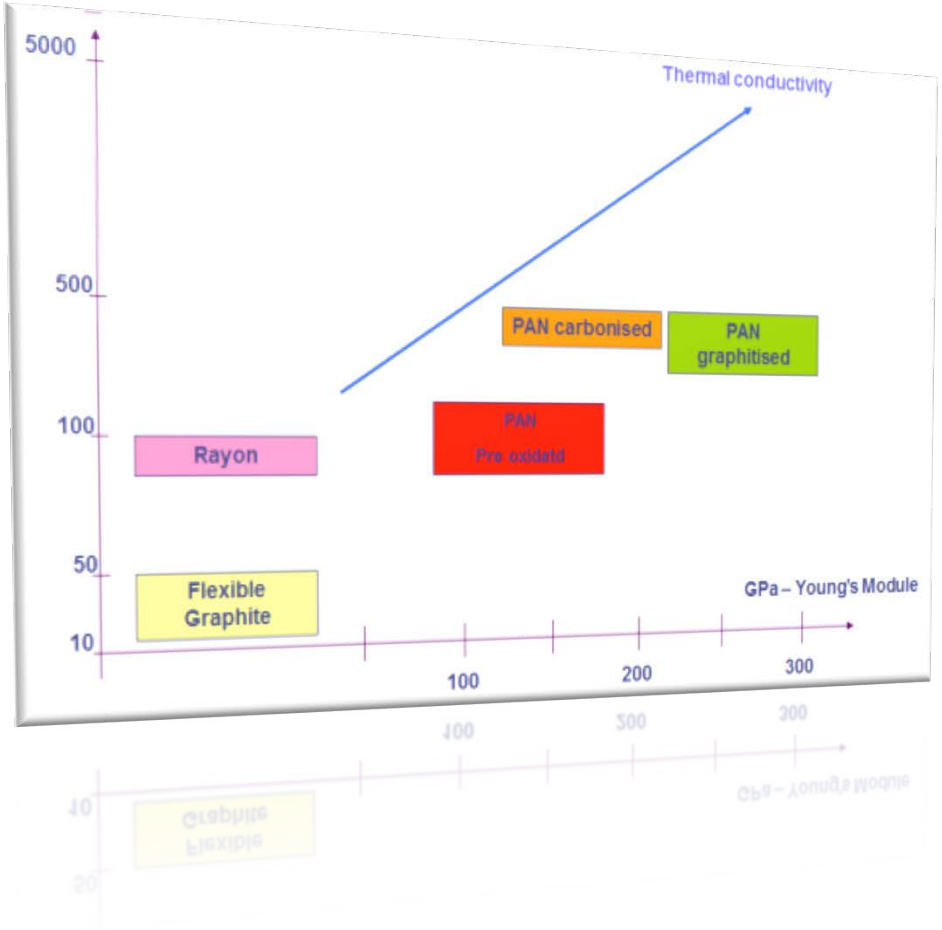
1 -Flake

3 - Strands

4 - Flexible Graphite Packing

2 - Foil

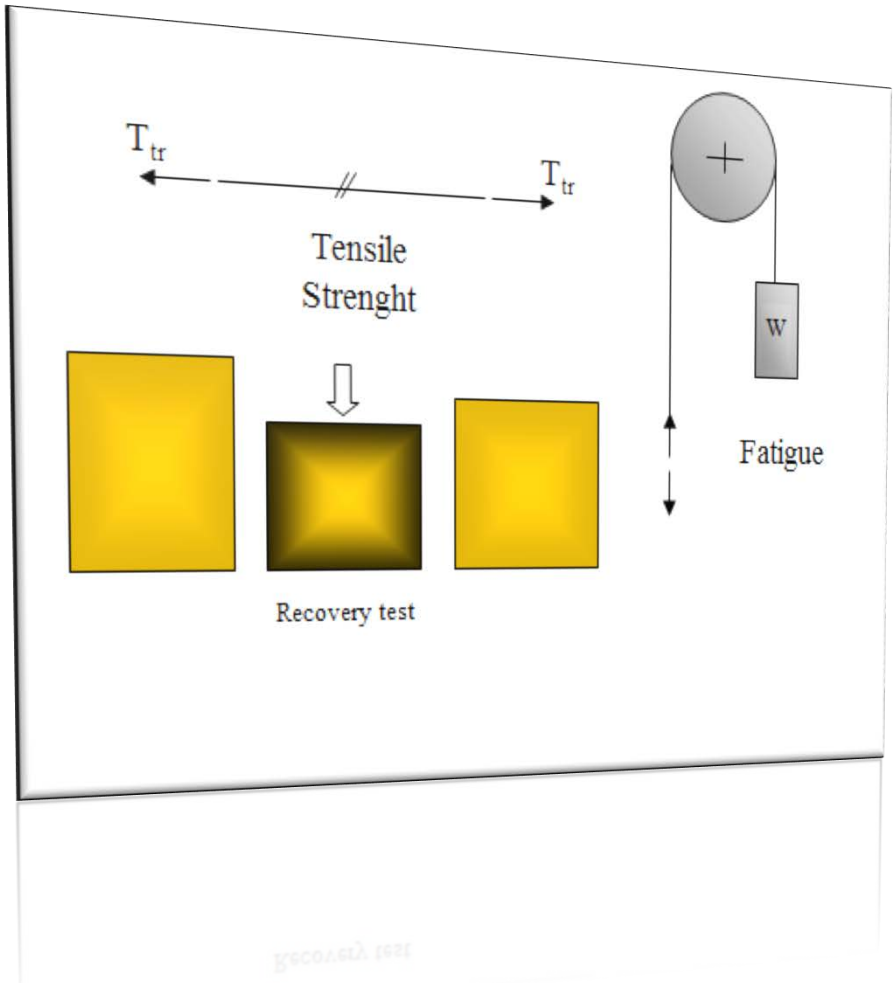
Information about the graphite stem packings



The diagram shows the relationship within Thermal Conductivity and Young's Module of different materials.

The recovery's gap it's dramatically evident.

Information about the graphite stem packings



The graphite Packing offers different behavior due to the different graphite yarns properties

Information about the graphite stem packings

Class – Level of detrimental material

TABLE 2 Detrimental Materials

Element	Maximum Allowable Total Impurity Levels in parts per million (ppm)
Mercury (Hg)	10
Sulfur (S)	750
Total halogens (chlorine, bromine, and fluorine)	500
Chlorine (Cl)	250
Bromine (Br)	250
Fluorine (F)	250

Class 1—For use where detrimental material and lubricant content of the packing need not be controlled beyond normal manufacturing limits.

Class 2—For use where detrimental materials content must be controlled to limits specified herein.

Class 3—For use where detrimental materials content need not be controlled beyond normal manufacturing limits, and media temperatures do not exceed 500°F (260°C).

Information about the graphite stem packings

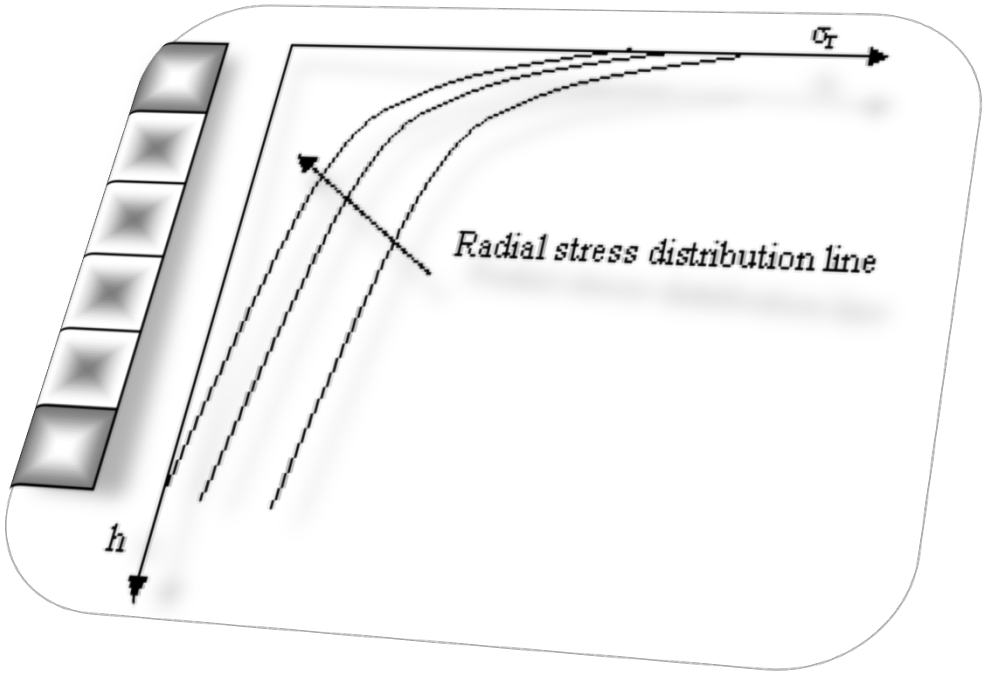
Grade – Inhibitor of corrosion (Y or N)

Grade A—Treated with corrosion inhibitor.

(Zinc powder or barium molybdate)

Grade B—Without corrosion inhibitor.

Graphite stem packings mechanical behaviour

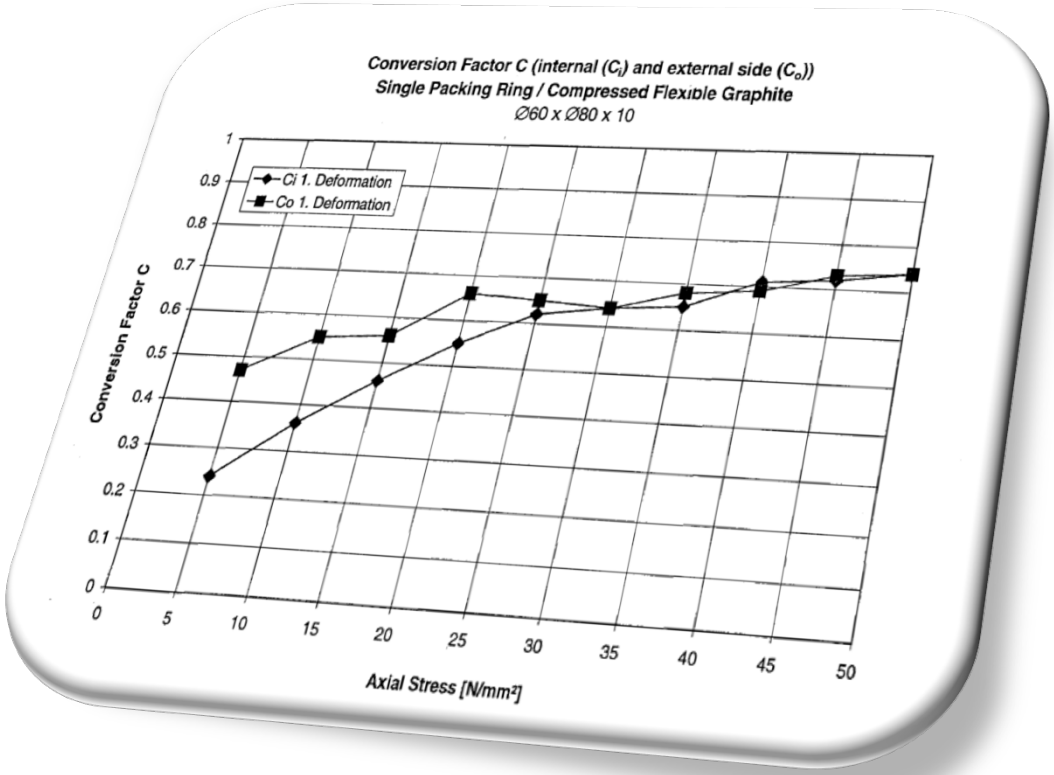


The involved parameters

- Radial stress σi conversion factors for wich
  - $\sigma_{ri} = C_i \sigma_a$
  - $\sigma_{ro} = C_o \sigma_a$
- Gland load
- Coefficient of friction
- Rings number

Graphite stem packings mechanical behaviour

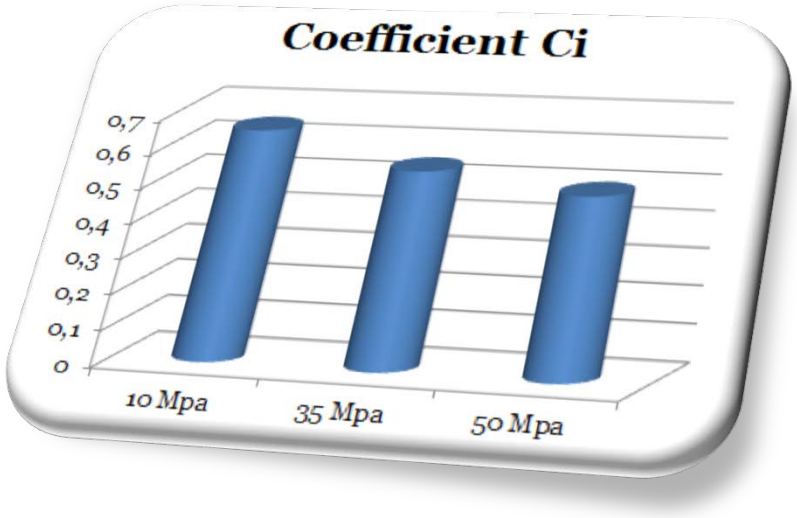
The recent finite element analysis (FEA) indicates that the ratio Ci/Co tends to 1 independently to the load and the vertical position across the stem. This result integrates the others experimental analysis for which this convergence comes after the load of 25 Mpa.



Source: MPA - Characteristics and Testing Technique for stuffing Box Packing

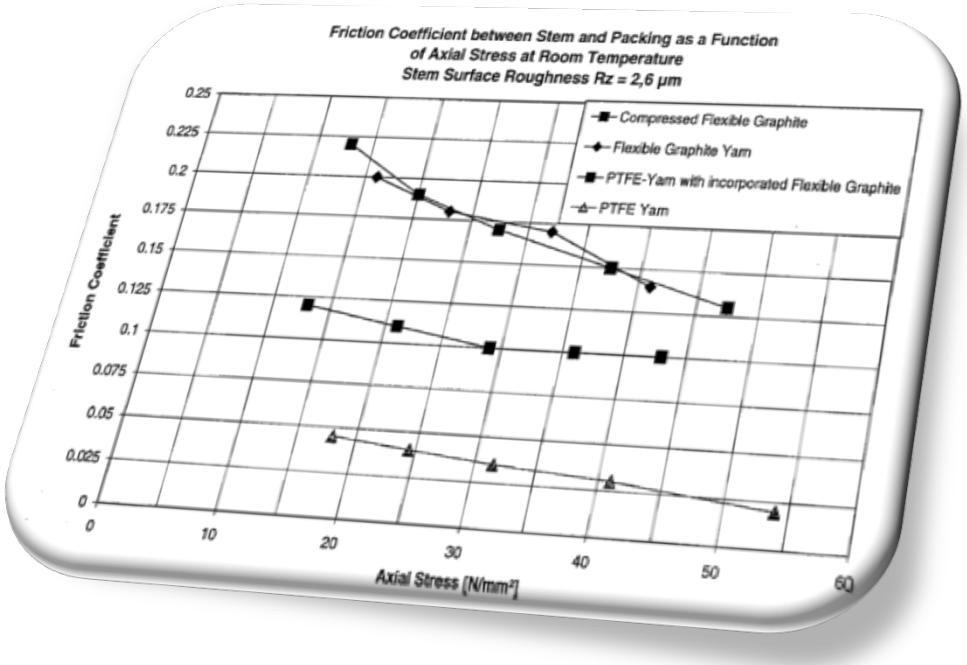
Graphite stem packings mechanical behaviour

The FEA allows to analyze the value Ci in correlation between the gland stress, the coefficient of friction and the rings number. It seems that Ci is weakly sensitive to the friction, increases with the rings number and, surprisingly, decreases with higher load. The coefficient appears insensitive to the packing relaxation.



Graphite stem packings mechanical behaviour

The coefficient of friction is not constant and decreases for higher load. The difference between the braided packing and the flexible graphite die-formed rings is minimal



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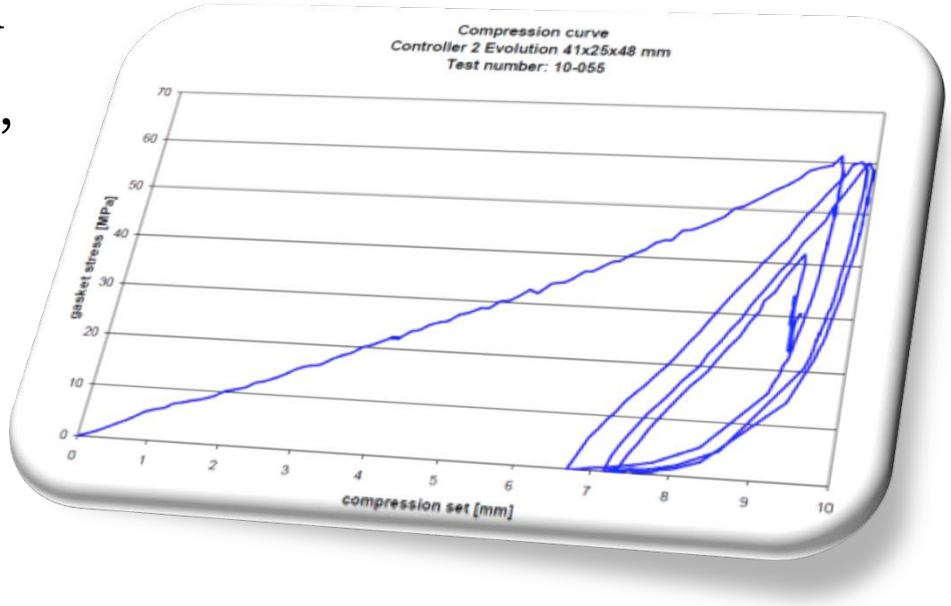
Graphite stem packings mechanical behaviour

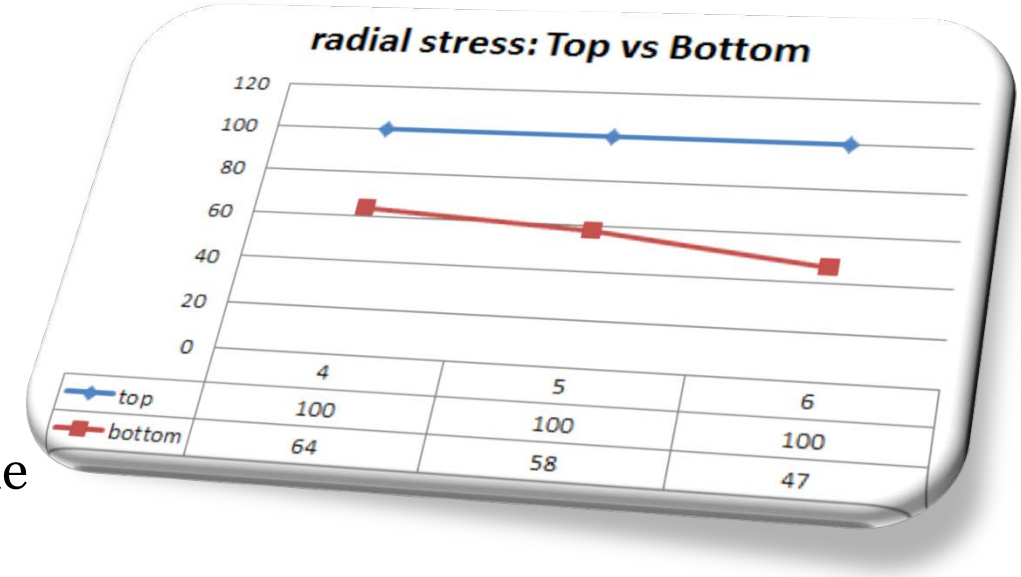
The compression curve (rif: stem packing 6 rings, 2 braided wiper and 4 die-formed flexible graphite rings), shows that the lost deformation is around 15%. It should be appropriate improves the packing installation procedure for a better sealing behavior .



Graphite stem packings mechanical behaviour

The radial compressive stress decreases along the stem and the stuffing box room.

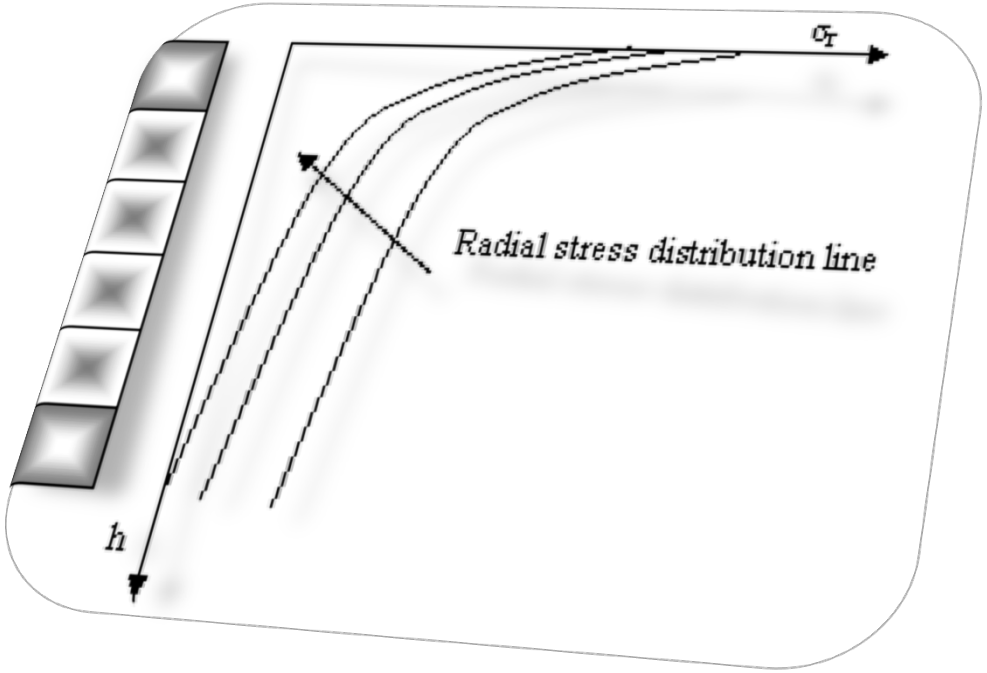
The gap between the Top and the Bottom rings depends also to the number of ring which composes the sealing kit.



Graphite stem packings mechanical behaviour

The radial compressive stress curve changes because:

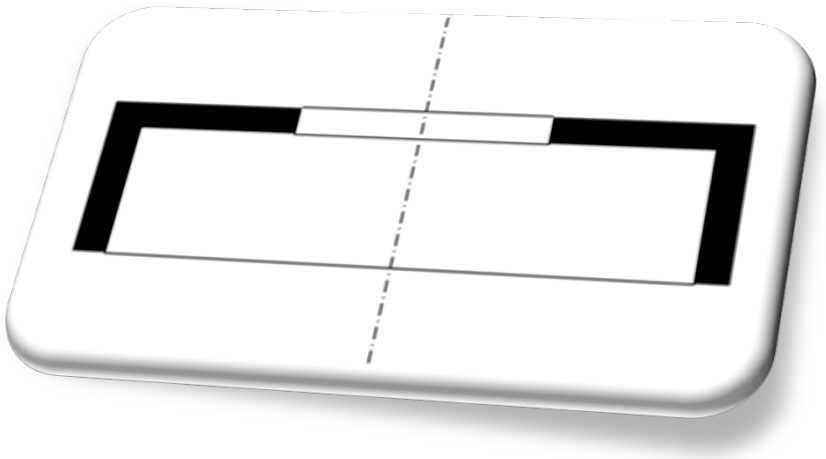
- Material Relaxation
- Thermal cycles
- Machanical Cycles



The eveidence is in the needed to re-tighten the packing

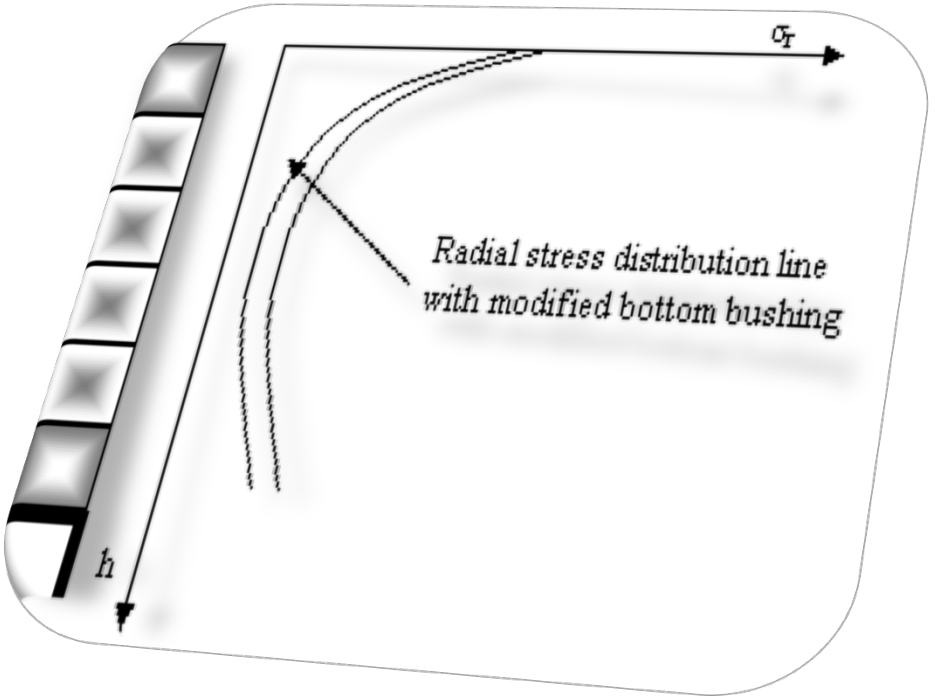
Graphite stem packings mechanical behaviour

In order to reduce this effect and armonize the compressive stress curve it is possible to introduce in the system a convex bushing which push up the packing from the bottom.



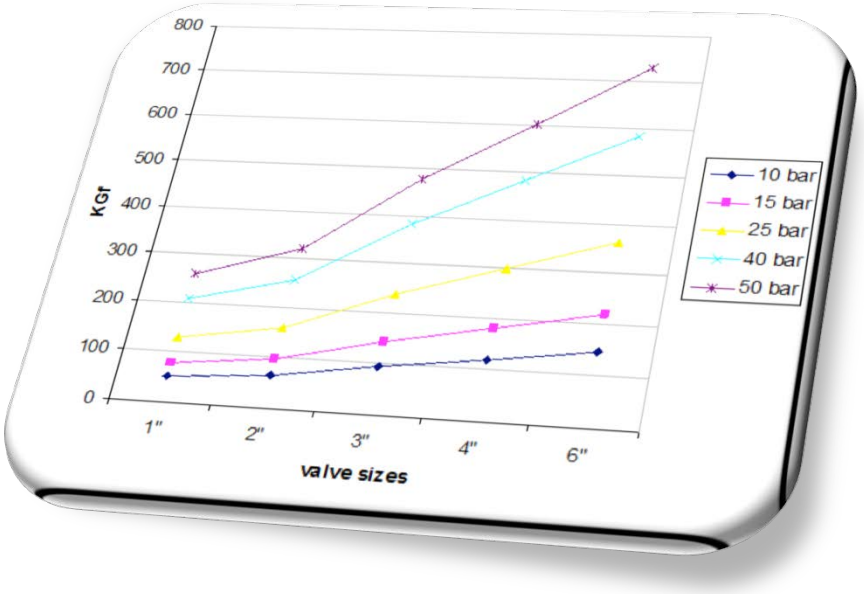
Graphite stem packings mechanical behaviour

The better and enhanced compressive stress in the bottom rings improves the sealing and offers reliable self adjustements which reduce the relaxation troubles and the valve actuation effect.



Graphite stem packings mechanical behaviour

Any disadvantage occurs in the use of a convex bushing if the clearances are in accordance to the standard specifications.
The effectiveness of the convex bushing grows faster both in association with the surface than with the pressure



Conclusions

The introduction in the system of the new element does not solve the regression problem in the small valves (rating 150 lbs) even if some benefit is detectable.

In the medium and big sized valves, the effect of the bottom force becomes more and more evident, improving the efficiency of the sealing starting from the 150 lbs rating.

From 2.500 psi rating and upper, the evidence of the bottom force is considerable and changes the quality of the sealing reducing also the actuation stress.

Conclusions

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In the medium and big sized valves, the effect of the bottom force becomes more and more evident, improving the efficiency of the sealing starting also from the 150 lbs rating.

From 2.500 psi rating and upper, the evidence of the bottom force is considerable and changes the quality of the sealing reducing also the actuation stress.

THANK YOU

APUZZO FRANCESCO

Eng.apuzzo@carrara.it