European Sealing Association e.V.

What is the impact of packing friction on valve performance?

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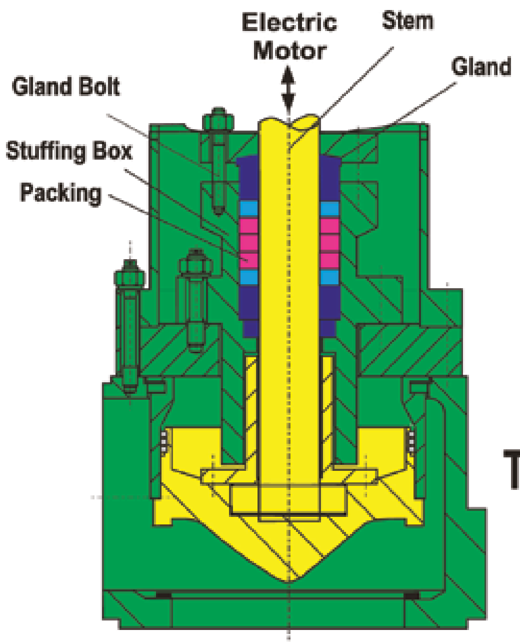
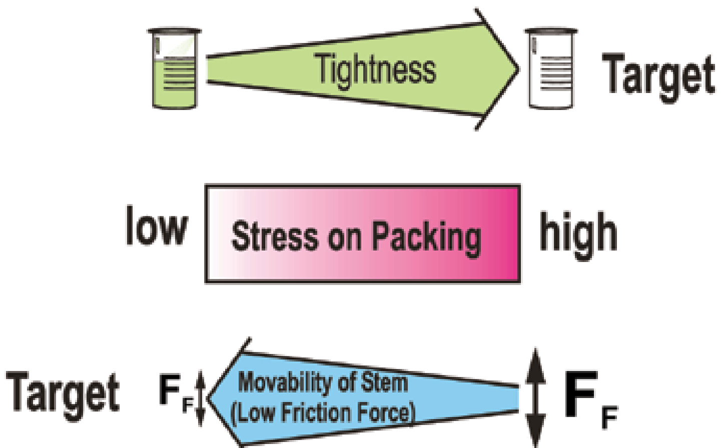




Conflicting requirements for the gland load

Gland Load

The efficient operation of valves and The efficient operation of valves and pumps is highly influenced by the friction caused by stuffing box packings during shaft or stem movement.

During the assembly of the stuffing box the packing is compressed axially to produce a radial contact and hence a force that controls leakage. This radial load has to produce a contact pressure on the shaft or stem and bore high enough to overcome the process fluid pressure.

The equipment shaft, spindle or stem drive mechanism has to readily overcome both static and dynamic or running friction during operation.

High packing friction can impede the equipment performance and efficiency by generating too much drag and heat. Excessive drag increases equipment power consumption and operating cost, and can ultimately result in equipment failure.

On the other hand low gland load leads in most cases to increased and unacceptable leakages.

Material

The friction force is influenced by the coefficient of friction between the packing material and the stem of the valve or shaft of pumps.

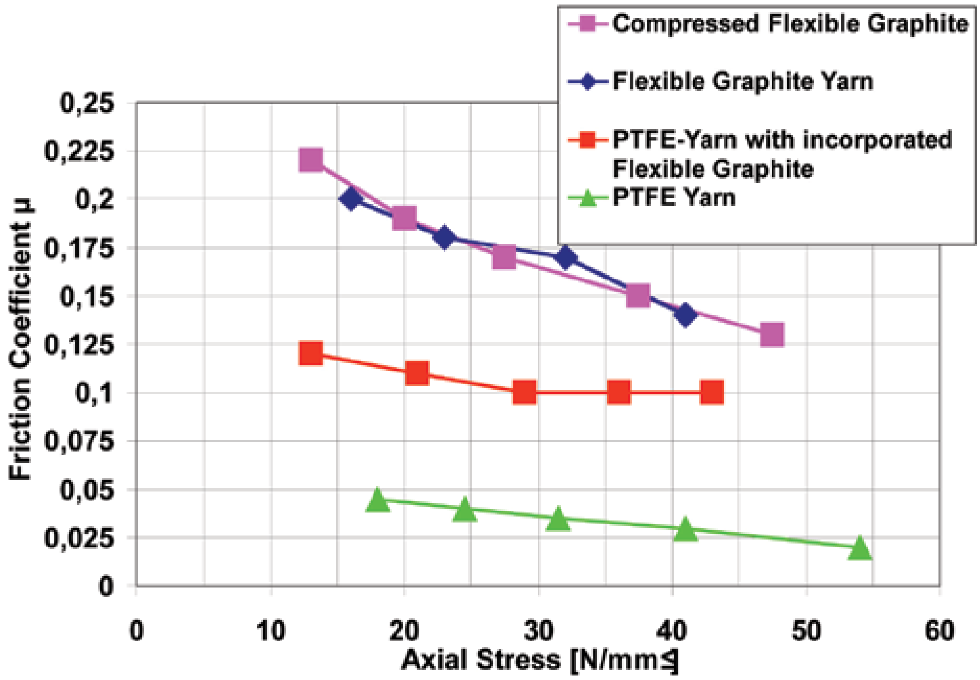
In general, the commonly used packing material PTFE has the lowest friction coefficient. Also the difference between the static or breakout friction and dynamic friction coefficients is less for PTFE packings than other materials. Increased temperatures reduce the friction of PTFE further to really low levels. The drawback is that it does not dissipate heat as effectively as flexible graphite.

Flexible graphite shows acceptable values of the friction coefficients in both low and high temperature applications but with increased values for static friction in some cases. Often end rings of braided graphite or carbon yarn packing or wire-reinforced braided packing are used as "wiper rings" to reduce friction by minimizing the build-up of graphite on the moving surfaces. They also work well to inhibit packing extrusion and help to support the radial whip of the rotating or reciprocating shaft/stem.

At moderate temperatures the combination of PTFE and graphite shows good coefficient of friction: 0.15 to 0.05 for static and dynamic friction respectively.

Number of Rings

Often, the number of packing rings in the stuffing box far exceeds what is necessary for effective sealing. The use of too many rings increases the contact area on the shaft/stem and as a result, the packing drag prohibits the shaft/stem from moving effectively, even if it is air or motor-operated. The large number of rings generally increases both the static, or breakaway, friction and the dynamic, or running, friction. An excellent standard is to use four or five packing rings and to add elements such as solid carbon bushings or similar to fill the rest of the stuffing box where necessary.



Typical friction coefficients of different packing materials at room temperature

Packing Ring Cross Section

Square cross-section rings are used in the majority of dynamic applications. Some cone or wedge shaped moulded packings offer enhanced radial expansion capability at lower gland pressure, which could result in lower friction in valves that cycle several thousand times an hour. However, due to the narrow cross-section of some stuffing boxes, it may be difficult to design a cone or wedge packing to fit. Furthermore, if one is designed, it may be extremely difficult to install. While both the wedge and cone designs initially give low breakaway friction, studies show that there is little difference in running friction once packing consolidation is achieved. For quick turnaround and availability, square packing rings are more readily available and installation can be accomplished with less difficulty. Additional assembly benefit can be provided by using special bushes with increased height.

Lubrication

Braided packing friction can be reduced by the addition of suitable lubricants in the packing during the manufacturing process. However, these lubricants can be destroyed by excessive tightening of the packing or thermal decomposition from the operating conditions. Also, some chemicals can react with certain lubricants, causing the lubricants to quickly dry out and the packing to become brittle and abrasive to the shaft/stem.

Conclusion

Excessive packing friction adversely impacts valve performance and energy consumption, which translates to an increase in operating and equipment cost. Excessive packing friction may also increase equipment downtime due to packing failure and/or sudden equipment failure. Packing friction can cause major wear damage. It may also cause overloading of the equipment drive mechanism, which can cause overheating and damage to motors and actuators. The demand imposed at start-up by breakaway friction on the motor, air- or hydraulic-driven shaft/stem can be overwhelming. If the torque to overcome the packing friction exceeds the maximum power of the drive mechanism it may cause catastrophic failure and may even cause harm to the operator.

To mitigate excessive compression packing friction, consider the following:

1. Use the packing material and design that will seal without generating excessive friction.
2. Ensure that the equipment is in satisfactory operating condition.
3. Repack the equipment when the packing and gland are fully compressed if leakage is excessive. Do not install additional packing rings.

For more information on this topic see the following sections in the FSA-ESA Compression Packing Technical Manual: How packing works, Valve packing types, Pump packing types, Specialty equipment packing, Advances in compression packing, Protocol for proper packing selection and Definition and uses of compression packing.

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