

# SEALING SENSE

## What is the impact of packing friction on equipment performance?

**P**acking friction plays an important role in the sealing of pumps and valves. Ideally, sealing is accomplished with the lowest practical frictional drag. Some frictional losses occur when the packing is compressed axially in the stuffing box to produce the radial contact 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 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.

### Material

The coefficient of friction varies between packing materials. Some inherently possess a low coefficient because of the nature of the raw material. Graphite is one example of a material with inherent low friction characteristics. In general, PTFE has the lowest friction coefficient, with graphite not far behind. At temperatures less than 500-deg F, PTFE packing exhibits the lowest friction coefficient. The drawback is that

### Friction Definitions

**Static friction** occurs when there is no relative motion between the packing and the mating surfaces including the shaft or stem. This type of friction is prevalent in manual valves. With no relative motion, this higher frictional force must be overcome when motion is attempted.

**Dynamic or running friction** occurs during relative motion between the packing and the shaft, spindle or stem. This frictional force has to be overcome by these rotating or reciprocating elements.

it does not dissipate heat as effectively as flexible graphite. Flexible graphite and graphite yarn produce low coefficients of static and dynamic friction. Flexible graphite exhibits a friction advantage in both low and high temperature applications. The combination of PTFE and graphite yields the best coefficient of friction: 0.15 to 0.05 for static and dynamic friction, respectively.

In some cases, 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.

### Number of Rings

Often, the number of packing rings in the stuffing box far exceeds what is necessary for sealing. Too many rings increase the contact area on the shaft/stem in excess of what is needed for effective sealing. 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 the static or breakaway friction as well as the dynamic or running friction. The best practice usually is to use five packing rings and a solid carbon bushing to fill the rest of the stuffing box.

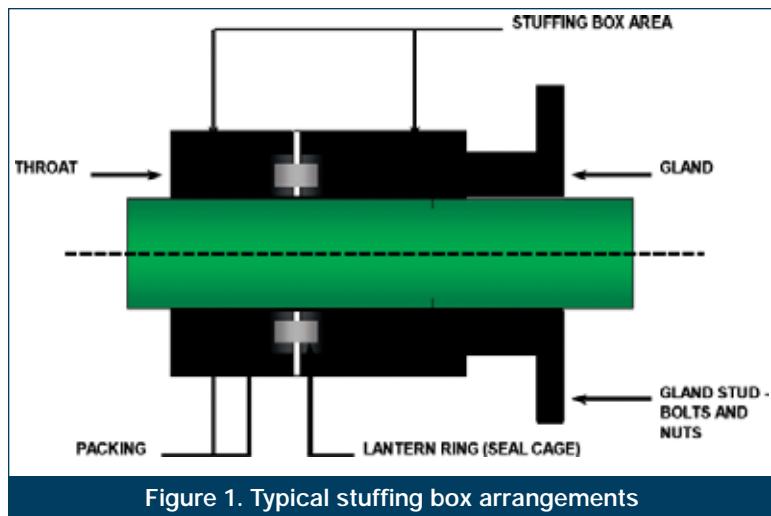


Figure 1. Typical stuffing box arrangements

## Packing Ring Cross Section

Square cross-section rings are used in the majority of dynamic applications. Cone-shaped molded packing made of the proper density provides superior radial expansion capability at lower gland pressure, which may be one reason why cone-shaped packing performs with low friction in valves that cycle several thousand times an hour. Due to the narrow cross-section of some stuffing boxes, it may be difficult to design a cone or wedge seal 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.

## 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 to certain lubricants, causing the lubricants to quickly dry out and the packing to become brittle and abrasive to the shaft/stem. Using

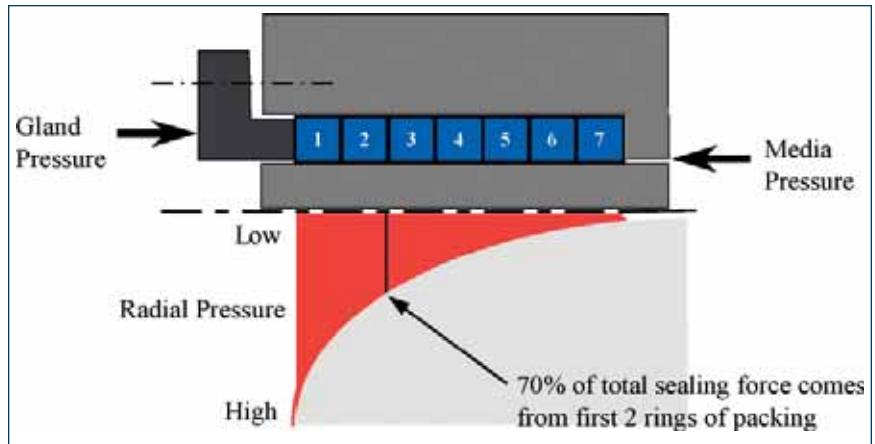


Figure 2. Packing radial pressure distribution

a clean external flush system will help cool and lubricate pump packing and reduce friction.

If pump packing has lost its lubrication from over-tightening, it is imperative to back out the gland bolt to allow the process fluid to leak around the shaft. This will provide lubrication and cooling between the packing and the shaft.

## Conclusion

Excessive packing friction adversely impacts pump and 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

## Fluid Sealing Association

*Sealing Sense* is produced by the **Fluid Sealing Association** as part of our commitment to industry consensus technical education for pump users, contractors, distributors, OEMs and reps. *This month's Sealing Sense was prepared by FSA Member Alfred Cooper.* As a source of technical information on sealing systems and devices, and in cooperation with the **European Sealing Association**, the FSA also supports development of harmonized standards in all areas of fluid sealing technology. The education is provided in the public interest to enable a balanced assessment of the most effective solutions to pump technology issues on rational total Life Cycle Cost (LCC) principles.

The **Compression Packing** division of the FSA is one of six with a specific product technology focus. As part of their mission they develop publications such as the new joint FSA/ESA *Compression Packing Technical Manual* and *Pump & the Valve Packing Installation Procedures* pamphlet. These are primers intended to complement the more detailed manufacturer's documents produced by the member companies. In addition to English, they are available in a number of other languages, including Spanish and German.

The following members of the **Compression Packing** division sponsor this *Sealing Sense* series:

A. W. Chesterton Co.  
Carbon Etc.  
Daikin America, Inc.  
DuPont Performance Elastomers L.L.C.  
Empak Spirotallic Mexicana SA de CV  
Garlock Sealing Technologies  
GrafTech International Holdings, Inc.  
Greene, Tweed & Co. /Palmetto, Inc.  
John Crane  
KC America  
Latty International S.A.  
Leader Global Technologies  
Lenzing Plastics GmbH  
Manufacturas Multiples Industriales SA de CV  
Nippon Pillar Corporation of America  
SEPCO - Sealing Equipment Products Co.  
SGL Technic Polycarbon Division  
Slade, Inc.  
Teadit International  
Teijin Aramid USA, Inc.  
W.L. Gore & Associates, Inc.  
YMT/Inertech, Inc.

failure and/or sudden equipment failure. Packing friction can cause major wear damage to the pump shaft or sleeve. It may also cause overloading of the equipment drive mechanism, which can cause overheating and damage to pump or valve motors. The demand imposed at start-up by breakaway friction on the packed pump 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. Employ additional cooling and lubrication by injecting lubricant into pump packing through the lantern ring.
4. Allow appropriate leakage of the fluid, at least 60 drops per minute in most pump applications, to provide a film of lubrication between the packing and the shaft.
5. Repack the equipment when the packing and gland are fully compressed if leakage is excessive. Do not install additional packing rings.
6. To control pump packing leakage, make gland adjustments at 15-minute intervals, tightening one flat at a time.
7. After installing pump packing and slightly hand-tightening the gland, start and stop the pump a few times before restarting.
8. Ensure that the packing width follows the rule of thumb of shaft/stem diameter to packing width ratio less than or equal to 4 ( $SD/PW \leq 4$ ), otherwise the packing might not seal properly.

*For more information on this topic see the following sections in the newly published 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.*

**Next Month:** *How do plant pipe strain problems affect my sealing system?*

*We invite your questions on sealing issues and will provide best efforts answers based on FSA publications. Please direct your questions to:*

*sealingsensequestions@fluidsealing.com.*

P&S

## POWER YOUR PLANT with SKINNER POWER SYSTEMS

### THE ONE SOURCE FOR YOUR TOTAL TURBINE NEEDS!

Producing quality original equipment up to 1850 HP is only half of Skinner Power Systems story. We also service all kinds of turbines, especially Skinner, Dean Hill, Wing, and Manubat steam turbines since we built them over the past century. Our turbines are backed by our commitment to prompt service and support worldwide.

We have extensive experience in repairing and rebuilding subassemblies, parts and entire machines to their original specifications.

Call us at 814-868-8500 or visit our website [www.skinnerpowersystems.net](http://www.skinnerpowersystems.net) to learn more about our capabilities.



SKINNER POWER SYSTEMS LLC  
8214 Edinboro Road  
Erie, Pennsylvania 16509 U.S.A

Please visit us @Booth #682  
at the Pump Symposium

circle 142 on card or go to [psfreeinfo.com](http://psfreeinfo.com)