Valve stem packing: optimum performance through correct installation

The importance of proper housing design, packing material and construction and the correct method for product installation cannot be overstated. Especially when considering ever tighter environmental controls and the drive for cost reductions in the valve industry and end user sectors.

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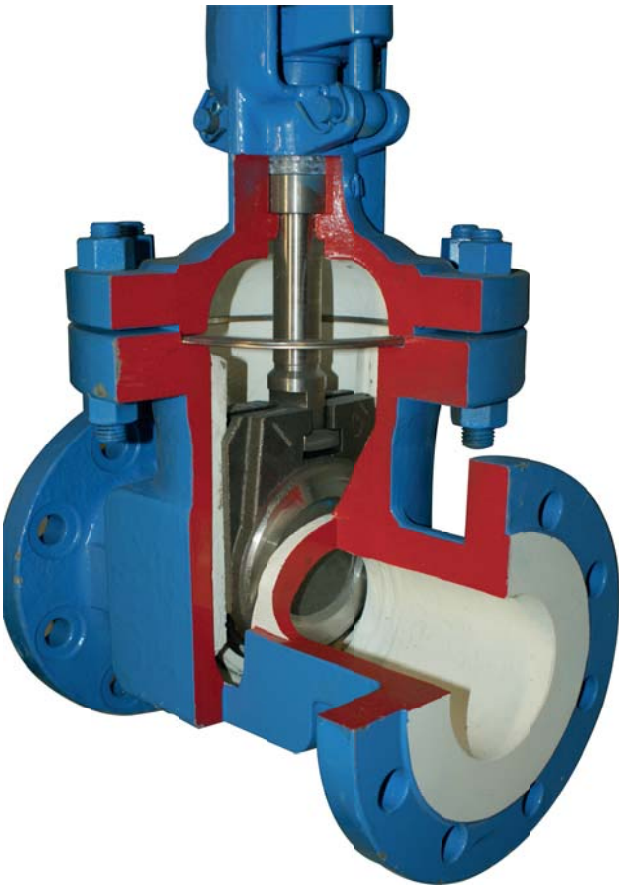
About the Author

Fugitive emissions control extends from leakage of hazardous volatiles - which are a risk to the surrounding environment - all the way to steam and other low temperature inert media, which through leakage can result in a loss of operating efficiency.
It is therefore crucial to tackle this issue at the root which is a proper housing design, choice of packing material and construction and the correct method for product installation.
Typically between four and six packing rings are used in a stuffing box cavity but as little as one or two rings can be used in a rotating stem to as many as seven rings for a rising stem. The rings can be made from braided length form packing or solid die-formed packing. Braided length form packing can be made to rings by wrapping the length around a mandrel/stem and cutting by knife at 45° (skive) or 90° (straight). Skive cut is the preferred method, to improve end-point interference through axial loading. It is important that every ring wraps all the way around the mandrel circumference; and preferably a tighter fit to the outside diameter than the inside diameter. A variation in ring density, through an excess of material at the split or absence of material at the split, will form a potential leak path.



Compression and load

During packing fitting each ring should be inserted and seated individually, until the complete set is installed. This procedure helps to reduce or even eliminate the need to re-pack or re-torque the set with improvements in uniform axial stress distribution, friction and leakage properties and hence enhance the service life of the packing set.
For instance, if a full packing set of five rings was installed all at once, through gland follower loading the end result would be a lot of compression on top of the ring set at the gland follower and little or no compression on the bottom at the media interface. Essentially, the sealing rings on the bottom have reduced axial loading, and in turn are doing less to keep the media from leaking out of the valve. A further issue would be overloading of the rings at the top of the set resulting in the higher potential for friction and ring damage (Figure 1). Test data shows, when using the proper installation technique, a packing set can have up to 20 per cent stress relaxation within 100 mechanical cycles. Without proper installation, the compressive stress would drop even further and can be reduced by around 60 per cent, at which point the seat stress would not be enough to ensure reliable sealing performance.

Temperature limitations

Packing and sealing materials have temperature parameters within which they work best. For instance, polytetrafluoroethylene (PTFE) is best used when valve temperatures are between approximately minus 101 and plus 232°C. When PTFE is exposed to higher temperatures, there is a risk of changes to the molecular structure or emissions of harmful gasses, which could lead to valve stem corrosion or even emissions of toxic PTFE fumes from the top of the valve gland follower.

These fumes can be harmful carcinogens and the subsequent softening and mass loss of packing material can also result in the leakage of hazardous application media or loss of production efficiency. Flexible graphite, on the other hand, has different temperature capabilities and is commonly rated from minus 196°C with an upper limit of 450°C in oxidising conditions.

Through consideration of material property data such as ash, chloride, sulphur, fluoride and other halogen content and an assessment of oxidised mass loss information provided by the graphite manufacturers, it is expected that graphite can reliably seal up to 450°C for fugitive emissions packing and up to 650°C steam service where oxidation is inhibited. Flexible graphite and PTFE can both be used in a wide range of application media between pH 0 - 14; with graphite having the added benefit of being suitable in some cases for fire-safe sealing.

Assessment of hazards and risk

For packing installation complete assessment of hazards and risk should be reviewed prior to starting work. The valve should be properly isolated to ensure safe working conditions and employees should wear the appropriate safety clothing and eye protection during this process. All the old packing must be carefully removed from the stuffing box with a packing removal tool (Figure 2).

Using a mirror the valve stem should be critically inspected for pitting or scoring and to ensure that no residue of the old packing remains. Refurbish if necessary.

To determine the correct packing size you need to measure the outside diameter of the stem, the inside diameter of the stuffing box bore and the depth of the stuffing box cavity.

The packing section is then calculated by ((OD-ID)/2) and the number of packing rings to suit the depth can be determined. The packing can be square cut on a mandrel of the same size as the stem (Figure 3) or 45° skive split using a packing cutting tool. Care should be taken not to stretch the packing along its length or squash the section, and focus should be on getting a clean cut without pickup of contamination or debris to the packing surface.

Individual rings

The packing length should never be wrapped in a coil into a stuffing box to fill the cavity and should always be individually

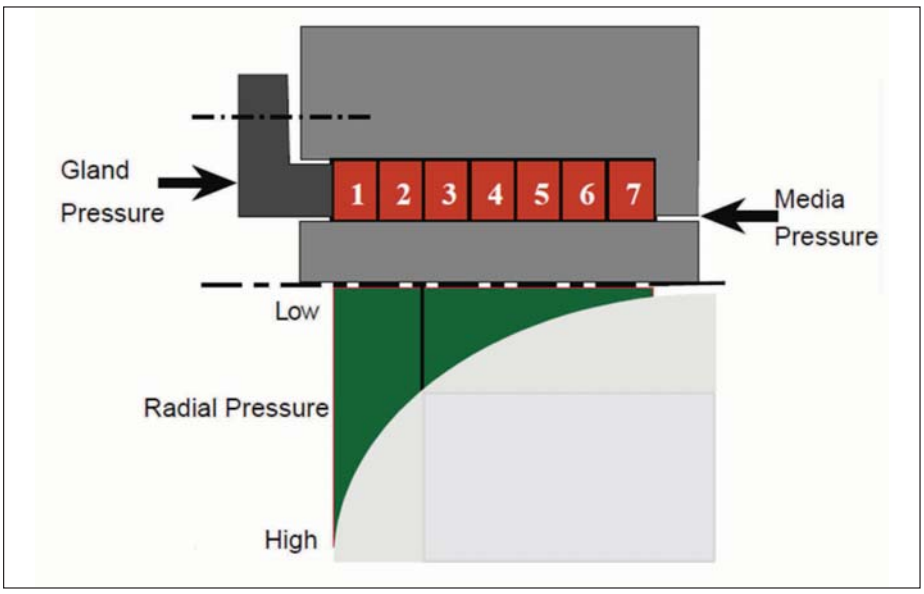


Figure 1

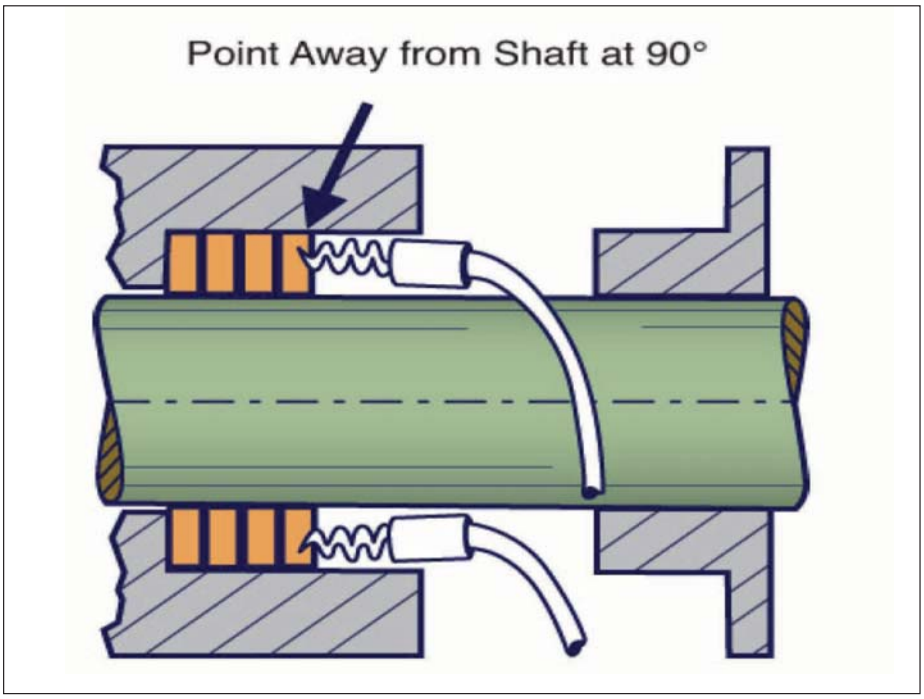


Figure 2

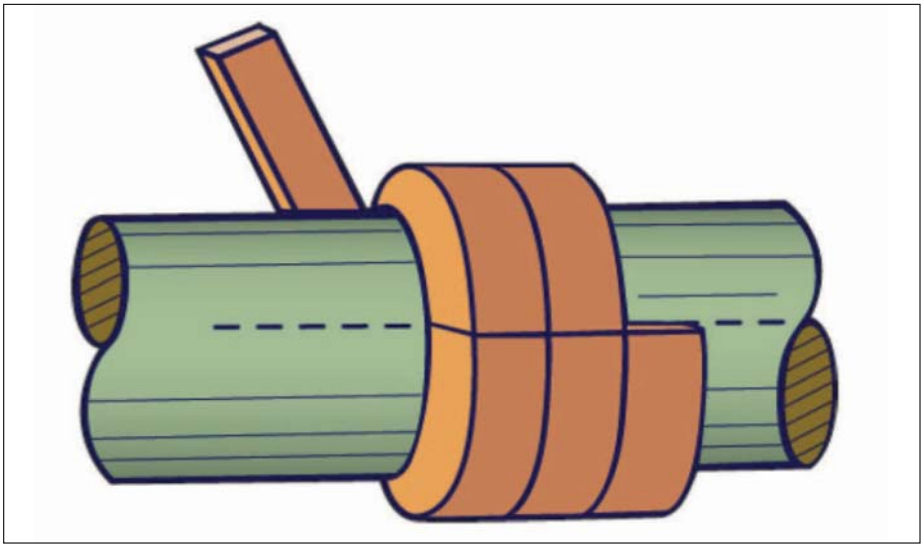


Figure 3

cut/moulded rings. Preference is to cut the packing into individual rings using a packing length cutter for 45°skive (Figure 6) to promote end joint interference on loading.
Cut each ring and check to make certain that it fits in the stuffing box; where the ends inserted cleanly together and is tighter fit to the stuffing box bore rather than stretch fit the inside diameter. Each additional ring for the set should be cut identically to the first.
Pre-moulded rings are commonly available and require no on-site cutting, and help for ease of handling and installation. The valve gland studs, nuts and washers should be inspected and replaced if damaged. The studs and nuts should be lubricated. To achieve proper fugitive emissions

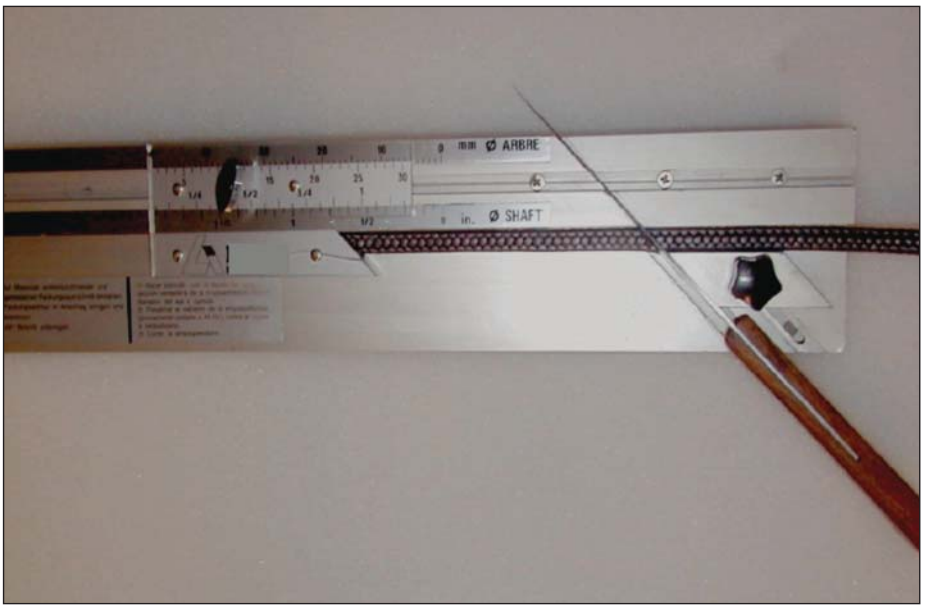


Figure 6

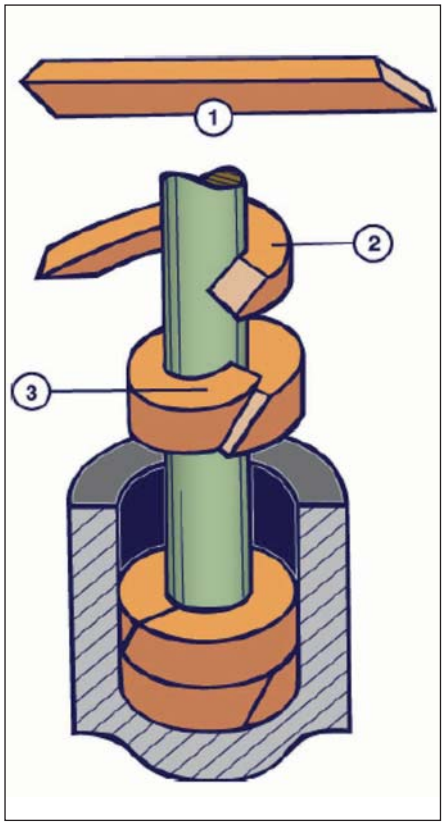


Figure 4

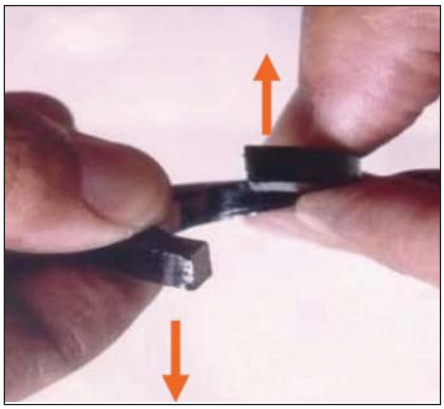


Figure 5

control is critical to ensure the use of a torque wrench and to follow the packing suppliers fitting procedures.

Cycle the valve stem

The stuffing box should still be clear of contaminates or greases. Insert the first ring into the stuffing box, noting the location of the split. The split ends should be inserted first before the remainder of the ring being inserted. For installation of die-formed rings of flexible graphite, each ring should be opened in a helix form (Figure 5) to be fitted round the stem to prevent packing damage. Each ring must be properly seated to the stuffing box base prior to the installation of the next ring. If the gland follower is not long enough to reach the bottom of the stuffing box, a tamping tool or an extension ring should be used during this installation step.
Lubrication should not be used on the seal unless otherwise specified. Load the first ring to the required packing stress according to the manufacturer's specifications. Repeat this procedure for all remaining rings inserting one at a time. Be certain that the split location for each ring is positioned at 90° to 180° rotation from the previous ring (Figure 4). It is important to dynamically cycle the valve stem from three up to ten times, from open to closed, to properly seat the packing set. During this process there will be some relaxation of the packing set. The packing set will need re-torqued again to the manufacturer's recommended value after the valve has been cycled, to take up any further relaxation. After the valve has been in service under normal operating conditions, the packing set should be re-torqued one final time to help overcome any further stress relaxation.

Emission clamp down

Through proper product installation, an improvement can be expected for the decay of axial to radial force translation though the set. This will help to support longer term reliability for sealing performance and frictional load distribution. By doing so, the fugitive emission sealing performance of a valve and process efficiency can be improved significantly.
In the 1970s, it was acceptable for packing to lose a few drops a minute in each valve. Today's government legislation is directed towards the clamp down in emissions and there are specifications and controls in place for the identification, reduction and control of fugitive emissions on valves.
In addition, there is the added focus from valve manufacturers and end customers to have valves tested and validated to specifications such as ISO 15848-1, API624 & API641.
A good packing fitting procedure is the difference between achieving a pass or fail, which is reflected in the added value for one valve supplier against the next in the market. Personnel involved in the fitting and maintenance of valve packings need to be trained in the best practice and many reputable packing manufacturers offer guidance. In addition the ESA and FSA have published a handy pocket guide on the methods to use which is available at http://www.emaxcloud.com/europeansealing/FSA_ESA_Packings_Installation_Procedures/index.html#/1/