Installation of stuffing box packings

1. Selection of best suited packing style
2. Determination of correct packing cross section
3. Calculation of the correct length of packing rings
4. Cutting the packing rings
5. Inserting the rings into the stuffing box
6. Pre-compression of packing-ring-set
7. Start-up procedure
8. Adjusting the leakage to an acceptable level

1. Selection of best suited packing style

First, we have to look at all the possible factors influencing that choice:

- which style of equipment ?

  pump (rotary, piston)
  valve
  agitator, stirrer
  static application
  other ?

- condition of that equipment

  is it new or old ?
  is the shaft worn ?
  is the housing of the stuffing box worn or pitted ?
  is the gap between shaft and stuffing box too big ?
  is the shaft running true (centred) or eccentric ?
  is the cooling device functioning properly ?
  is the stuffing box dimensioned correctly ?

Tel: 0141 620 1666 Fax: 0141 620 1888
sales@williamjohnston.co.uk
www.williamjohnston.co.uk

(what we mean by that is: is the stuffing box designed for the ideal packing square section and the correct number of packing rings in regard to the application parameters ? App. 30% of packing failures have been attributed to problems with the stuffing box!)

2. Selection of best suited packing style, continued:

- physical characteristics of medium

  gas
  fluid
  - clean
  - dirty
  - abrasive (solids)
  - crystallising
  - hardening or sticky (glue, tar, sugar etc.)

- chemical characteristics of medium

  neutral
  aggressive
  acidic
  caustic
  oxygen

- temperature of medium

If the medium-temperature almost reaches the temperature limit of the packing, one has to bear in mind that the frictional heat between the turning shaft and the packing rings can - even under ideal conditions and depending on shaft-speed and style of packing - add app. 30 to 40° C to the medium temperature on the inside of the packing rings.

If the packing has poor heat-transmitting properties - i.e. a white PTFE-packing - then the temperature build-up at the shaft can be even higher and possibly fatal.

3. Selection of best suited packing style, continued:

- pressure of medium

The set of packing rings gets subjected to the prevailing medium pressure at the bottom of the stuffing box. To counter that pressure (and keep the leakage at an acceptable level) one has to exert pressure on the packing rings with the gland. This axial pressure gets partly transformed to radial pressure which forces the packing rings against the stuffing-box body and the shaft.

It therefore follows that the higher the medium pressure is, the higher the gland pressure has to be. BUT higher gland pressure results in higher radial pressure of the packing rings against the shaft, which in turn increases frictional heat....

- shaft speed (v)

In most cases our customers do NOT know the shaft speed. But since this is a crucial parameter for choosing the correct packing style, we have to determine it. Normally the customer knows the shaft diameter (D) and the r.p.m.
Therefore the formula to work out the shaft speed (v) in meters per second (m/s) is:

$$v = \frac{D\,(mm) \times 3{,}14\ (\P) \times r.p.m}{60.000}$$

The 60.000 in the above calculation stem from the conversion of minutes to seconds (60) and from millimetres to metres (1000).

One can clearly see, that all parameters like temperature, pressure and also shaft speed are interdependent. This is an important consideration when choosing a suitable packing.

It is obvious that there is more to choosing the best suited packing for a certain application than just replacing the currently used style from a competitor with a similar style from TEADIT!

WHO says that the packing the customer is presently using is really the best style (considering all technical and economic aspects) for this particular application ??

When choosing the best suited packing for a certain application together with a customer, it will be advisable to consider all his other packing applications as well. Maybe one can reduce the number of different packings needed in his operation by choosing one or two styles which will be suitable for all his applications ?

Even if those two styles are individually dearer than some of the styles he is using now, he might still be able to save a considerable amount of money by having to stock only one or two styles !

Stocking less styles also reduces the risk of choosing the wrong packing for a certain application.

2. Determining the correct packing cross section

Although this seems pretty obvious, the following points need to be considered:

There is equipment with imperial measurements being used in metric countries and vice versa. And 3/8“ is 9,525 mm and NOT 10 mm.

Try to install a 10 mm packing in a 3/8“ stuffing box - especially if it is a hard packing - and you will quickly see what we mean !

On the other hand, if your customer uses a 12 mm packing for a 1/2“ (12,7 mm) stuffing box he will have a hard time to reach an acceptable level of leakage.

And to sell him an 18 mm or 20 mm packing for an actual 3/4“ (19,05 mm) stuffing box, will have even worse results !

3. Calculating the correct length of packing rings

There are three different diameters one could use to calculate the length of a packing ring:

a) the shaft diameter (also called the inner diameter or I.D.)
b) the stuffing-box-housing diameter (outer diameter or O.D.)
c) the “middle“ diameter (M.D.)

For the calculation of the length of a packing ring the shaft diameter is too small (resulting in too short a packing ring), the outer diameter is too big (resulting in too long a packing ring); only by using the middle diameter will you be able to calculate the correct length of a packing ring.

How do we find the middle diameter (M.D.)?
There are two ways:

a) M.D. = (I.D. + O.D.) ÷ 2, or
b) M.D. = I.D. + packing cross section

WILLIAM JOHNSTON
& COMPANY LIMITED
Tel: 0141 620 1666 Fax: 0141 620 1888
sales@williamjohnston.co.uk
www.williamjohnston.co.uk

Now it's quite easy to calculate the correct length (L) of a packing ring:

L = M.D. x 3,14 (¶)

IF one would calculate the length of a packing ring as shown above, one would get a ring which is a bit too long at the shaft, just right at the middle and a bit too short on the outside.

BUT due to the construction of a braided packing, each packing ring will get a little bit ***shorter*** when applying pressure on it. And the gland follower will exert quite considerable pressure on the installed packing ring !
Hence, the already existing small gap on the outside of the ring will get bigger and open the packing ring even more at the joint. This will lead to increased leakage or - if one tries to reduce that leakage - to more gland pressure than necessary.

We have said that higher gland pressure (axial pressure) will be partly transformed to radial pressure which will press the packing rings harder against the moving shaft, which in turn will result in higher friction and higher heat build-up, and ultimately to reduced packing life !

The solution is: the packing rings have to be cut a little longer than the result of the above calculation yields !

But there is still more to this:

Ideally we want the leakage on the inside - along the shaft - and not on the outside along the stuffing-box-housing. Leakage - or better: the presence of medium - along the shaft ***is*** necessary for lubrication and cooling of the packing rings. Under perfect conditions the shaft will run on a thin film of medium between the shaft and the packing rings, thereby reducing heat build-up and friction to an absolute minimum; which in turn will have a positive effect on packing life.

In order to facilitate the desired leakage along the shaft, and not along the stuffing-box housing, it is necessary that the packing rings shall cling tightly to the stuffing-box housing and not to the shaft.

This can be achieved by cutting the packing rings a few percent longer than the above calculation (L=M.D. x) actually yields !

If a packing ring is a little longer than M.D. x , then its length will have to be compressed a little during installation. This compression will create stress along the whole circumference of the packing ring, which will press the packing ring outwards against the stuffing-box body.

The axial gland pressure will reduce that force somewhat (see above), but enough of it will remain to achieve the desired effects:

a) the packing rings will NOT open at the joint

b) the packing rings will continually be pressed against the stuffing-box housing, reducing the unwanted leakage there, at the same time facilitating the desired leakage along the shaft.

Just how many percent should be added to the calculated length depends largely on the style of packing (soft or hard), the shaft diameter and the square section of the packing. It can vary between 2% and 7% !

However, it is absolutely necessary that the person cutting the rings tests the first ring he has cut directly on the shaft, checks if the joint closes properly and if there is just the right amount of "over-length" !

If he finds the ring to be too short (joint not closing), or too long (if he has difficulties fitting the ring), then he has to adjust the length according to his findings before he cuts the rest of the required rings!!

4. Cutting the packing rings

After having determined the correct length for the packing rings, they will now have to be cut from the spool.

Using a TEADIT packing cutter makes cutting easier and quicker and *reduces* the chance of mistakes.

Winding a PTFE-thread-seal-tape around the packing at the area where the packing is to be cut prevents the ends from fraying.

There are two correct ways of cutting a length of packing:

a) with a 70° angle
b) with a 45° angle

Experience has shown, that a 45° cut yields the best results. But there are two different ways to cut with a 45° angle:

a) 45° axial
b) 45° radial

(See drawing "A" on separate sheet !!)

This shows clearly, that cutting 45° against the shaft (axial) results in the best possible blockage of the flow of the medium !

How to put the packing down on the packing cutter?

This can be done in two ways, of which only one is correct:

The natural curvature (bend) of a packing - which has been wound around a spool for a few weeks or months - should be taken advantage of by bending it that same way around the shaft. IF one puts the packing wrongly (with a 90° twist) onto the packing cutter, then one would still have the correct 45° cut BUT one would have to twist the packing 90° against its natural curvature in order to install it correctly into the stuffing box (see sketch A). The result would be a twisted (distorted) packing ring, which will lead to reduced effectiveness of the packing set.

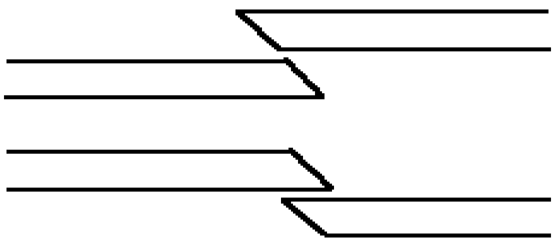
(See illustration "B" on separate sheet !!)

5. Inserting the rings into the stuffing box

Insert packing ring with the joint first. Watch out that the correct end is at the top:

correct

wrong



Press each ring separately down to the bottom of the stuffing-box (using a semi-sleeve made of wood or similar material)

Stagger joints 360° divided by number of rings, or at least 90°.

6. Pre-compressing packing set

After all rings are installed, the whole set of rings needs to be compressed *before* start-up of equipment. This serves to settle the packing rings in the stuffing box, get rid of possible hollows or gaps and close the joints properly.

Rotary pumps: for the pre-compression of the packing rings in rotary pumps, no complicated calculations are necessary. There is no leakage to control yet. Just tighten the gland enough to compress the set of rings in a way that all gaps and hollows will be closed.

Piston pumps and valves: tighten the gland with app. 5N/mm^2 (700 PSI). We recommend the use of a torque wrench or a similar device.

After pre-compressing the packing set, loosen the bolts again and retighten with fingers only.

The packing set is now well prepared for start-up.

7. + 8. Start-up procedure and adjustment of leakage

The first few minutes after start-up have a deciding influence on the life of a packing !

Start up pump (open valve(s) beforehand)

The medium will enter the stuffing box through the gap at the bottom and exert an upwards (axial) pressure on the packing rings which are blocking its way. That medium-pressure has basically the same effect on the packing rings as the gland pressure ! The axial medium-pressure gets converted to radial pressure which causes the packing rings to press against the stuffing box body and the shaft, thereby automatically reducing the initial leakage !

Naturally, some of the medium will - and should - almost immediately after start-up get past the packing rings and leak out at the gland. Another part of the medium will penetrate the packing rings (the gaps, crevices and fissures which there are between the braids) and make them swell a little. Because the packing rings cannot swell axially, they will do so in the radial direction, which - automatically - reduces leakage even further.

It is important to understand that the medium pressure alone can reduce the leakage to the desired level or even below that (careful, heat build-up), so that the bolts will have to be loosened a little until enough leakage is restored.

However, if after a certain time (the longer one can wait for the packing rings to adjust, the better) the leakage is still too much, the bolts should be carefully tightened to reduce the leakage to an acceptable level.

Too little leakage causes unnecessary friction and heat build-up which can destroy the packing or will at least shorten its life.

Leakage is necessary !