European Sealing Association e.V.

Specification for a Test Procedure for Packings for Rotary Applications

FLUID SEALING ASSOCIATION FSA

Publication N$^{o.}$ 020/2011

2011 December

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The **European Sealing Association (ESA)** is a pan-European organisation, established in 1992 and representing a strong majority of the fluid sealing market in Europe. Member Companies are involved in the manufacture and supply of sealing materials, crucial components in the safe containment of fluids during processing and use. The ESA is a non-profit-making trade association, registered in Neu-Ulm (D) as VR 713.

The **Fluid Sealing Association (FSA)**, established in 1933, is an international trade association. Member companies are involved in the production and marketing of virtually every kind of fluid sealing device available in the world today. FSA membership includes a number of companies in Europe and Central and South America but is most heavily concentrated in North America. FSA members account for almost 90% of the manufacturing capacity for fluid sealing devices in the NAFTA market.

Acknowledgements

The ESA and FSA are pleased to recognise the co-operation of the following Member Companies in the preparation of this document. Without their support, this document would not have been possible:

Beldam Crossley Ltd
Burgmann Packings Ltd
Cetim
A W Chesterton Company
Garlock Sealing Technologies
W L Gore and Associates
James Walker
Latty International s.a.
Teadit International Produktions GmbH

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Contents

Foreword

This specification gives details of a test procedure for packings to be used to seal the stuffing boxes of rotary equipment such as centrifugal pumps, mixers, agitators etc. It has been prepared by the Packings Divisions of the European Sealing Association (ESA) and Fluid Sealing Association (FSA) and is approved by these organisations as a suitable method of test.

1. Scope

This specification details a dynamic test method for compression packings generally of the types described in FSA/ESA publication 'Guidelines For The Use Of Compression Packings' when used to seal the stuffing boxes of rotary equipment. It gives guidance on the design of test equipment, standard test parameters and reporting criteria. It does **not** specify performance criteria which should be agreed between supplier and customer, but does define 3 leakage classes.

2. References

Attention is drawn to the following documents:
FSA/ESA Publication 'Guidelines for the Use of Compression Packings' (hereafter referred to as the Guidelines)

3. Test apparatus

The test apparatus shall be similar to the typical example shown in Figure 1 (see Appendix C) and shall consist of a suitable housing for retaining the test fluid and either one or more stuffing boxes to house the test packing. Each stuffing box shall be fitted with a gland spigot and suitable retaining plate capable of controlled axial adjustment. There shall be a test shaft mounted on suitable bearings and attached to a suitable drive mechanism.

The test apparatus shall also conform to the following additional requirements:

- ***(a)*** The shaft shall be capable of maintaining the shaft speed to within +/- 5%.
- ***(b)*** The test head shall be designed and constructed so as to maintain the housing bore alignment relative to the shaft axis within 0.10 mm.
- ***(c)*** The design of the test head and support shall ensure minimum vibration.
- ***(d)*** The surface finish of the housing bore shall be no worse than 1.6µm Ra and of the shaft shall be no worse than 0.4 µm Ra and the shaft shall be free of helical machine marks.
- ***(e)*** Shaft and housing shall be manufactured from corrosion resistant stainless steel (eg AISI 430, 316L etc) without surface coating and shaft hardness shall be 40 HRC minimum.
- ***(f)*** The tolerances on shaft and housing bore shall be h10 and H10 respectively in accordance with EN 20286-2 (ISO 286-2).

(g) The test fluid shall be circulated through the test housing at a rate such that the temperature of the test medium entering the housing remains constant within +/- 5 deg C and the outlet temperature is no more than 5 deg C higher than the inlet temperature.

(h) Means shall be provided for collecting and measuring the volume of fluid leakage during the test, the leakage from the shaft and housing bore sides shall be measured separately.

(i) Means shall be provided to measure the temperature of the fluid as it enters and leaves the test housing and the gland follower within 3 +/- 0.5 mm of the outer packing ring (ie packing temperature – see Note 1).

(j) Where possible means shall be provided to measure frictional power consumption of the packing. Ideally this should be achieved by continuous torque measurement (see Notes 2 & 3)

Note 1 – The probe shall be positioned in a blind hole drilled axially into the gland spigot.
*Note 2- If a **watt transducer** is used it must be such that it monitors both voltage and current and also accurately determines the phase relationship between them.*
*Note 3 – The value shall be reported as **Normalised Power Consumption** by taking the power in Watts divided by the packing contact area in square metres divided by the speed in metres per second – rationalised to **Ws/m^3***
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4. Pre-Test Procedure

4.1 Inspect the packing for conformity to its specification and measure and record its cross-section dimensions.

4.1.1 For pre-formed rings measure the radial cross-section of each ring at two diametrically opposite positions and record the average section of the whole set and the overall set depth.

4.1.2 For rings cut from length form material the rings shall be cut with a 'skive' (diagonal) cut in accordance with the method stated in the Guidelines and the dimensions shall be recorded as in clause 4.1.1 after cutting the rings to size.

4.2 Measure and record the shaft and housing bore diameters and their surface roughness using a suitable comparator gauge*.*

4.3 Weigh each ring and record the weight of the set.

5. Installation

Install **4 rings** of packing in each stuffing box following the procedure specified in the Guidelines, Section VIII ' Packing the pump correctly' (Clauses 3) to 5) inclusive) as follows:

Install one ring at a time. Make sure it is clean and has not picked up any dirt in handling.
Seat rings firmly (except PTFE filament and graphite yarn packings, which should be snugged up very gently, then tightened gradually after start up).
Joints of successive rings should be staggered and kept at least 90 degrees apart. Each individual ring should be firmly seated (no axial gaps between the rings) with a tamping tool, or suitable split bushing fitted to the stuffing box bore. When enough rings have been fitted so that the nose of the gland will reach them, individual tamping should be supplemented by the gland.

After the **4th** ring is installed, take up gland bolts finger tight or very slightly snugged up. Do not jam the packing into place by excessive gland loading.

Lantern or spacer rings shall not be fitted between packing rings.

6. Test Conditions

6.1 Temperature
All tests shall be carried out at ambient temperature ie the fluid shall enter the test housing at 20 $^{+10}/_{-5}$ ºC.

6.2 Test medium
The test medium shall be **clean** water.

6.3 Shaft diameter
The shaft diameter shall be between **40 - 65 mm** inclusive.

6.4 Packing cross section
The nominal packing cross-section shall be between **9.5 - 12.7 mm** inclusive.

6.5 Surface Speed
Packings shall be tested at one standard speed rating:

Standard speed	(S1)	=	between **8 and 9 m/s** inclusive

6.6 Pressure
Packings shall be tested at one standard pressure rating, and the pressure shall be monitored within the test housing:

Standard pressure (P6)	=	**6 bar**

6.7 Leakage class
There shall be 3 leakage classes, where the average leakage during the 100 hour test period (that is, excluding the break-in period) is as follows:

L1	=	less than or equal to 5 ml/min
L2	=	less than or equal to 15 ml/min
L3	=	less than or equal to 30 ml/min

6.8 Additional Tests
Any additional tests carried out under different conditions (eg other media, higher temperature etc) shall be reported separately.

7. Test Procedure

7.1 Break-in period

Note – careful adherence to the break-in period procedure is critical to optimum packing performance.

Pressurise the test housing and rotate the shaft at the selected test speed. Adjust the compression on the packing to allow liberal leakage (around 15 to 30 ml/min) as it beds in and then adjust compression to give the desired leakage class, without causing excessive or fluctuating packing temperature. Record the total number of any adjustments to compression and the total compression applied during the break-in period. Record the leakage rate at the end of the break-in period (measure the leakage over a 5 minute period and record the average).

Typically the total break-in period will be of less than 1 hour duration but this can be extended in order to achieve stable performance. The actual duration shall be recorded.

7.2 Test duration

At time zero, that is, after the end of the break-in period (ie once the packing is exhibiting stable leak rate and temperature) record the power consumption (when possible) and temperatures as specified in clause 3.

The packing shall then be tested **continuously** for a standard **duration period of 100 hours**

7.3 Result recording

Record the accumulative leakage, power consumption (if applicable) and gland temperature at least twice per 24 hour period and at the end of the test period (plus, prior to, and after, gland adjustments, see clause 7.4 below).

7.4 Gland adjustments

Excluding the break-in period, a **maximum of 3 gland adjustments** may be made during the test period itself and the accumulative leakage, power consumption and gland temperature shall be recorded immediately prior to each adjustment and 30 minutes thereafter. No gland adjustment shall be made less than one hour before completion of the total test period.

7.5 Number of tests

A minimum of 2 complete tests shall be carried out for each packing type.

7.6 Test completion

At the end of the test period the packing, including any packing residue adhering to the shaft or housing shall be removed. The packing and residue shall be dried for a minimum of 4 hours at 80 ºC and then allowed to cool naturally to room temperature and reweighed. The condition of the packing shall be reported including weight loss/increase and compression. The condition of the shaft shall also be recorded.

One ring of unused packing from the same manufactured batch shall be retained for future reference for a minimum period of five years.

8. Reporting

8.1 Record all test data on a seal test report form (an example is shown in Appendix A) and graphically (an example is shown in Appendix B)

8.2 Publishing of results

When publishing results for consumption by potential users the average results for a minimum of two tests shall be reported and the following data must be included:

Standard reference (ie ESA PD001/2010) and Issue Number

Packing type.

Test duration - the actual duration shall be quoted

Test speed - the actual speed shall be quoted.

Test pressure - the actual pressure shall be quoted.

Leakage class achieved.

Average gland temperature during test duration (excluding the break-in period).

8.3 The complete test report shall be made available to users on request.

Appendix A

Pump Test report according to ESA PD001/2011

Company:_____ **Test Date: ___/___/**

Set Information **Test Ref:** _____

Packing Name _____

Length form or Die-form Rings_____

Set dimensions (mm) I/D _____ O/D_____ Depth_____

Set weight (g) _____

Shaft and housing inspected and cleaned ☐

Shaft surface roughness (µm) _____ Bore surface roughness (µm) _____

Actual shaft diameter (mm) _____ Actual bore diameter (µm) _____

Shaft speed

8-9 m/s; precisely _____m/s Other _____m/s

Test Pressure

6 bar; precisely _____bar Other _____ bar

Test Duration

100 hrs ☐ Other _____ hrs

Break-in period results

Total duration (min)	Total number of adjustments	Total compression applied (mm)	Leakage rate at end (ml/min)

Record leakage rate at end over 5 minute period and report the average figure

Test period results

Time (h)	Accumulative compression (mm) after break-in	Accumulative leakage (ml)		Power (W) Consumption	Temperature (°C)			Adjustment (**X** here if the reading is associated with a gland adjustment)
		Shaft	Gland		Gland	Inlet	Outlet	
Start	0	0	0					
End								

Set weight dry (g): _____ % weight loss: _____

Set height after (mm): _____ % height loss: _____

Average leakage rate (ml/min): ___Shaft leakage (ml/min): ___Gland leakage (ml/min):___

Average gland temperature (°C): _____

Normalised average power consumption (Ws/m^3)*: _____

Packing condition at end of test: (please **X**)

Condition	**None**	**Slight**	**Heavy**
Surface hardening/glazing			
Extrusion			
Fraying			

Shaft condition at end of test: (please **X**)

Condition	**None**	**Slight**	**Heavy**	**Rough**
Visible wear				
Colour change				

Comments:

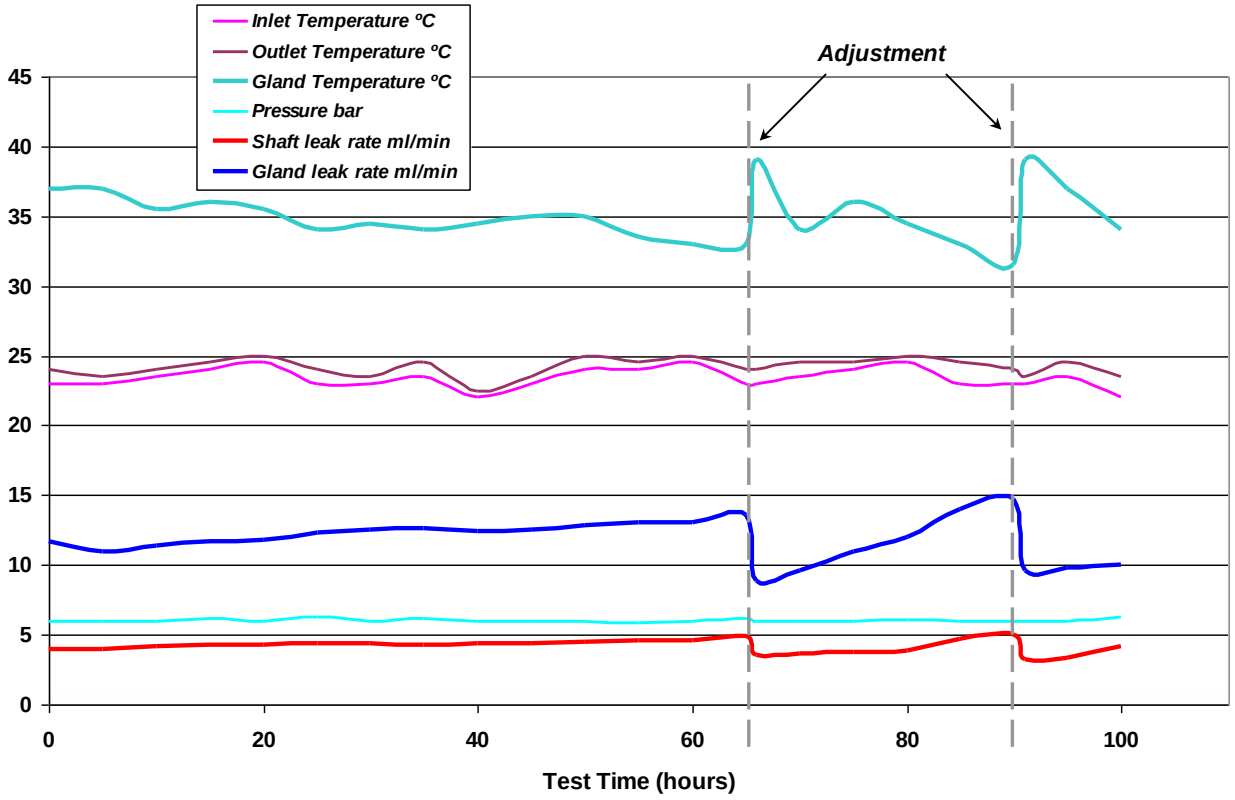
_____
_____
_____
_____

Signature: _____

** see clause 3(j) Note 3*

Appendix B

Typical Graphical Representation of Results



Appendix C

Figure 1 Typical Test Arrangement (Schematic)

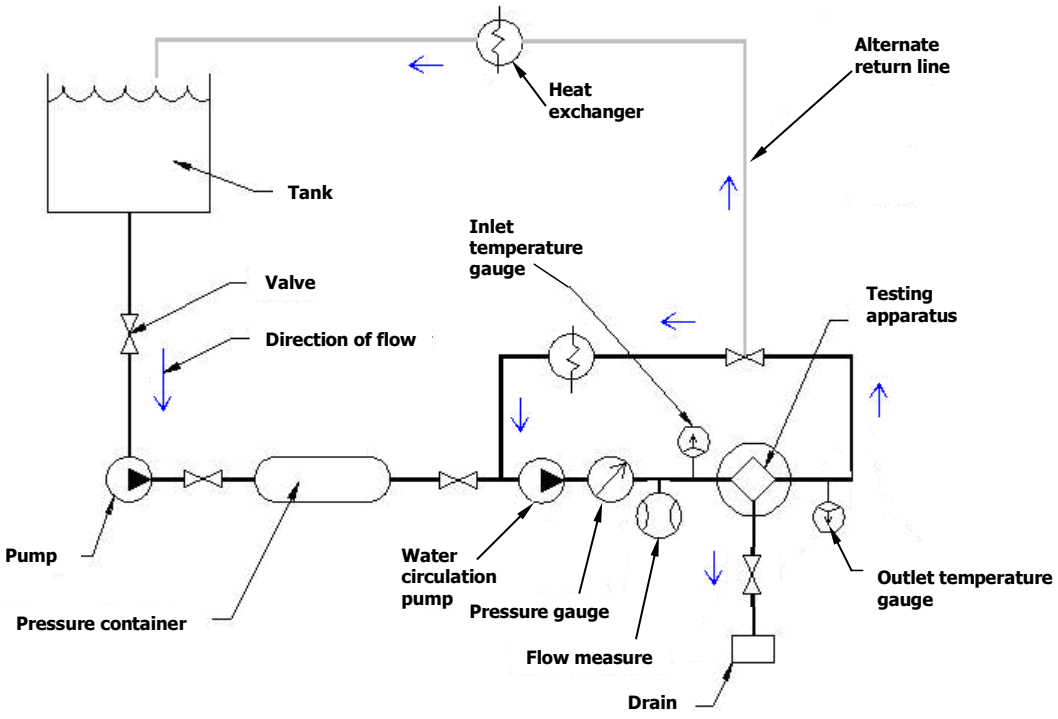


Figure 2 Typical Test Apparatus (Schematic)