

Type Testing of Process Valve Packing for Fugitive Emissions

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Introduction

The purpose of this API standard is to establish a uniform procedure for evaluation of process valve stem packing. The testing approaches defined within this standard provide a method for evaluating packing systems. This testing program shall provide a basis for the comparison of the emissions and life cycle performance of packing.

Use of this standard assumes the execution of its provisions is entrusted to appropriately qualified and experienced personnel because it calls for procedures that can be injurious to health if adequate precautions are not taken. This standard refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage of the procedure.

Type Testing of Process Valve Packing for Fugitive Emissions

1 Scope

This standard specifies the requirements for comparative testing of valve stem packing for process applications where fugitive emissions are a consideration. Packing(s) shall be suitable for use at service temperatures $-29\text{ }^{\circ}\text{C}$ to $538\text{ }^{\circ}\text{C}$ ($-20\text{ }^{\circ}\text{F}$ to $1000\text{ }^{\circ}\text{F}$). Factors affecting fugitive emissions performance that are considered by this standard include temperature, pressure, thermal and mechanical cycling, and corrosion.

This standard is not intended to replace type testing of valve assemblies or valve production testing.

This standard establishes requirements and parameters for the following tests:

- a) fugitive emissions;
- b) corrosion;
- c) packing material composition and properties;
- d) See Annex C (High Temperature Testing Procedure).

Test methods apply to packing for use in on-off valves with the following stem motion(s):

- a) rising stem;
- b) rotating stem; or
- c) rising and rotating stem.

2 Normative References

The following standards contain provisions that, through reference in this text, constitute provisions of this API standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ASME B16.5¹, *Pipe Flanges and Flanged Fittings*

ASME B16.20, *Metallic Gaskets for Pipe Flanges—Ring Joint, Spiral-wound, and Jacketed*

ASTM D512, *Standard Test Methods for Chloride Ion in Water*

ASTM D1179, *Standard Test Methods for Fluoride Ion in Water*

ASTM D4327, *Standard Test Method for Anions in Water by Suppressed Ion Chromatography*

MSS² SP-120, *Flexible Graphite Packing System for Rising Stem Steel Valves*

¹ ASME International, 2 Park Avenue, New York, New York 10016-5990, www.asme.org.

² Manufacturers Standardization Society, 127 Park St. NE, Vienna, VA 22180-4602, www.msshq.org



3 Terms and Definitions

For the purposes of this standard, the following definitions shall apply.

3.1

anti-extrusion ring

A ring of packing used at one or both ends of a packing set to prevent extrusion of packing material into clearances.

3.2

ambient temperature

Temperature that is between 15 °C (59 °F) to 40 °C (104 °F).

3.3

axial

In the direction of a shaft or stem axis.

3.4

bolt torque

The amount of twisting or turning effort (expressed as Nm, lbf-ft, or lbf-in.) required to turn the nuts on a gland flange; commonly used to determine the load that a gland flange exerts on a valve packing set.

3.5

braided packing

Packing typically constructed of intertwining strands of synthetic or natural fibers. Strands may consist of yarn or filaments, and may also include metallic materials.

3.6

bushing

Cylindrical spacer used to take up excess space in a stuffing box.

3.7

corrosion inhibitor

An ingredient added to packing that decreases the potential for galvanic corrosion in the stuffing box. Corrosion inhibitors may be classified as either passive or active.

3.8

die-formed packing

A valve stem packing typically constructed from ribbons of graphite tape or braided packing that has been subjected to pre-compression with tooling of a specific geometry. This process changes the shape and density of the material from its original free shape and natural density to a defined shape and higher density.

3.9

emissions

Gaseous leak given off by a piece of equipment. Used in reference to volatile organic hydrocarbons (VOCs) and expressed in parts per million volumetric (ppmv or ppm).

3.10

galvanic corrosion

An electro-chemical reaction that may occur between a metal and a material of a different chemical nobility, such as another metal, carbon, or graphite when both materials are exposed to an electrically conductive media.

3.11

gland

A movable part that is inserted into a stuffing box to compress a packing set or packing ring.

3.12**gland flange**

The component used to retain the gland within the stuffing box and provide compression of the gland into the packing/stem seal to create load. The gland flange shall have two holes to receive the gland bolting. Slots for gland flange bolts shall not be used. The gland and gland flange shall be self-aligning. The gland shall have a shoulder at its outer edge so as to prevent complete entry of the gland into the packing box.

3.13**gland load**

The amount of load applied to a packing set.

3.14**gland flange stud**

A threaded rod or eye-bolt extending from a valve body against which the gland flange is tightened to compress a packing set.

3.15**leak**

Measurable amount of test fluid escaping from the test gland.

3.16**leak rate**

The quantity of test fluid passing through (or around) a seal in a given period of time.

3.17**mechanical cycle**

A motion of the stem simulating the movement of a valve obturator (such as disc or ball) from the fully closed position to the fully open position, and returning to the fully closed position. See also: stroke.

3.18**packing set**

A grouping of individual packing rings designed to fill the cavity of the valve stuffing box, with or without anti-extrusion rings.

3.19**pitting**

Surface cavities that occur on a metal as a result of galvanic corrosion. See also: galvanic corrosion.

3.20**rising stem valve**

A valve in which the movement of the stem is in an axial direction, with no rotation.

3.21**rotating stem valve**

A valve that will fully open or close with a nominal 90° rotation of the stem.

3.22**rising-rotating stem valve**

A valve in which the movement of the stem is in the axial direction and also has a 90° rotation to fully open or close.

3.23**static leak measurement**

Measurement of leakage taken when the stem is not moving.

3.24**stem**

A metal rod that connects the obturator (such as a disc or ball) of a valve to a handwheel, handle, or actuator.

3.25**stroke**

One half of a mechanical cycle starting from either a fully open or fully closed position. See also: mechanical cycle.

3.26**stuffing box**

A space into which a compression packing is inserted. Also known as a packing chamber.

3.27**stuffing box diameter**

The inside diameter into which packing is inserted; also called the stuffing box bore.

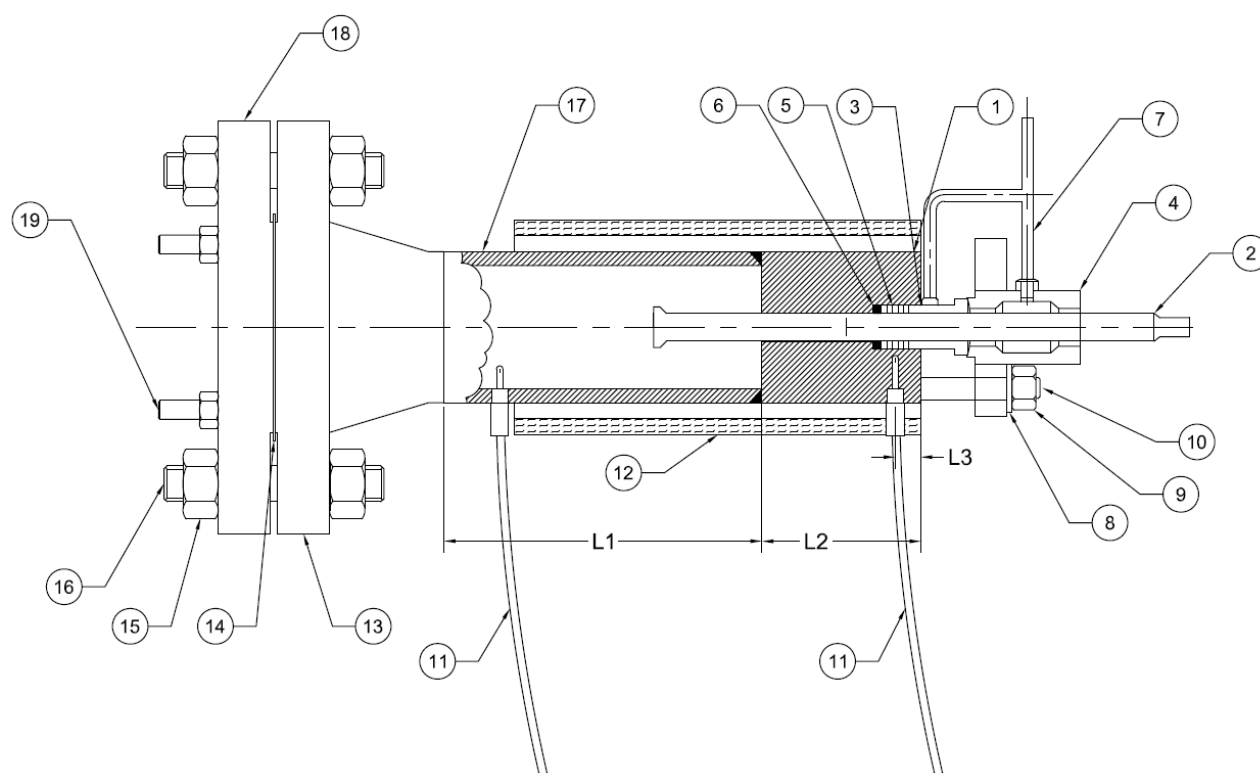
3.28**surface finish**

A measure of the roughness of a surface; typically expressed in microinches or micrometers.

4 Fugitive Emissions Test

4.1 Test Fixture

4.1.1 The test stand is constructed as a fixture designed to simulate a typical valve stuffing box. A test arrangement is shown in Figure 1. The test fixture shall orient the stem in a horizontal position and shall be constructed so as not to affect test results. The use of bushings is allowed as necessary. Test stands may be equipped with multiple test fixtures. Construction details shall be done in accordance with Annex A. All dimensions and tolerances in Table 3 are to be checked and verified prior to testing.



Key

- | | |
|--------------------------|-------------------------------|
| 1 bonnet | 11 thermocouple |
| 2 stem | 12 heating element |
| 3 gland | 13 bonnet flange |
| 4 gland flange | 14 gasket |
| 5 stem packing | 15 flange stud nut |
| 6 bushing | 16 bonnet studs |
| 7 leak detection fitting | 17 housing |
| 8 washer | 18 blind flange |
| 9 gland nut | 19 gas inlet and outlet ports |
| 10 gland stud | |

Figure 1—Fugitive Emissions Test Fixture

4.1.1.1 Test fixture components and dimensions shall be as follows in Table 1.

Table 1—Test Fixture Dimensions

Item	1/8 in. Packing Fixture	1/4 in. Packing Fixture
L1	127.0 mm (5.00 in.)	193.5 mm (7.62 in.)
L2	63.5 mm (2.50 in.)	139.7 mm (5.50 in.)
L3	15.88 mm (0.625 in.)	28.58 mm (1.125 in.)
Gland nuts	ASTM A194 Grade 2H	ASTM A194 Grade 2H

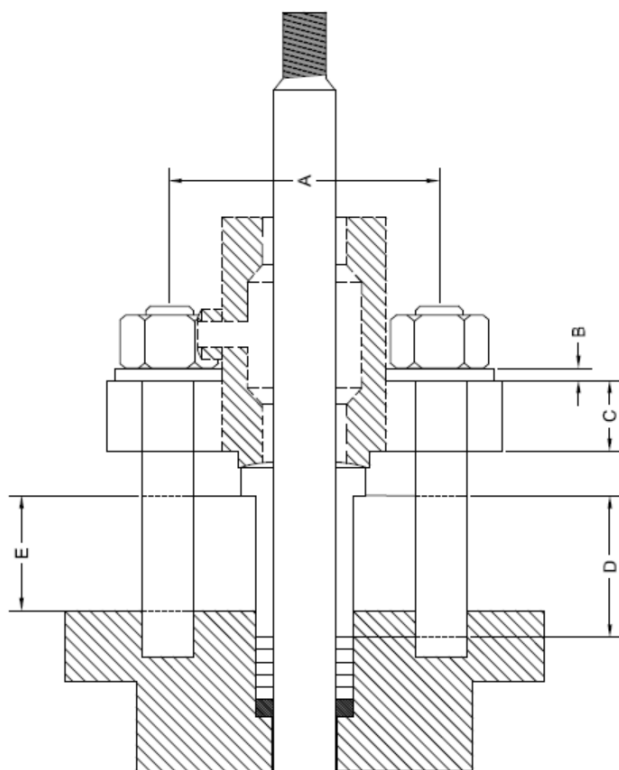


Figure 2—Test Fixture Bonnet

4.1.1.2 Test fixture bonnet dimensions as shown in Figure 2 shall be as follows in Table 2.

Table 2—Test Fixture Bonnet Dimensions

Item	1/8 in. Packing Fixture	1/4 in. Packing Fixture
A	48.79 mm (1.92 in.)	101.60 mm (4.00 in.)
B	3.18 mm (0.125 in.) max.	3.18 mm (0.125 in.) max.
C	25.4 mm (1.00 in.)	38.2 mm (1.50 in.)
D	25.4 mm (1.00 in.)	25.4 mm (1.00 in.)
E	Gland height shall be measured and recorded at beginning and end of test.	Gland height shall be measured and recorded at beginning and end of test.

4.1.1.3 Test fixture stem/stuffing box dimensions and tolerances shall be as follows in Table 3.

Table 3—Test Fixture Stem/Stuffing Box Dimensions

Item	$\frac{1}{8}$ in. Packing Fixture	$\frac{1}{4}$ in. Packing Fixture
Stem diameter	11.05 mm to 11.1 mm (0.434 in. to 0.437 in.)	25.2 mm to 25.4 mm (0.992 in. to 1.000 in.)
Stem straightness	Max. 0.04 mm per 300 mm (0.0016 in. per 12 in.)	Max. 0.04 mm per 300 mm (0.0016 in. per 12 in.)
Stem cylindricity	0.04 mm max. (0.0016 in. max.)	0.04 mm max. (0.0016 in. max.)
Stem surface finish	0.40 μ m Ra to 0.80 μ m Ra (16 μ -in. Ra to 32 μ -in. Ra)	0.40 μ m Ra to 0.80 μ m Ra (16 μ -in. Ra to 32 μ -in. Ra)
Stuffing box diameter	17.46 mm + 0.06 mm or – 0.0 mm (0.688 in. to 0.690 in.)	38.1 mm + 0.25 mm or – 0.0 mm (1.500 in. to 1.510 in.)
Stuffing box depth (including bottom spacer)	19.05 mm $\pm$ 1.57 mm (0.75 in. $\pm$ 0.062 in.)	34.9 mm $\pm$ 1.57 mm (1.375 in. $\pm$ 0.062 in.)
Stuffing box surface finish	3.20 μ m Ra + 1.25 μ m Ra or – 0.625 μ m (125 μ -in. Ra + 50 μ -in. Ra or – 25 μ -in.)	3.20 μ m Ra + 1.25 μ m Ra or – 0.625 μ m (125 μ -in. Ra + 50 μ -in. Ra or – 25 μ -in.)
Gland bottom machined flat	0.15 mm (0.006 in.) max.	0.15 mm (0.006 in.) max.
Gland to stuffing box diametrical clearance	0.06 mm to 0.19 mm (0.0025 in. to 0.0075 in.)	0.13 mm to 0.38 mm (0.005 in. to 0.015 in.)
Stem to gland (flange) diametrical clearance	0.25 mm to 0.38 mm (0.010 in. to 0.015 in.)	0.5 mm to 0.8 mm (0.020 in. to 0.030 in.)
Gland stud diameter	$\frac{3}{8}$ in.—16 UNC (2 pieces).	$\frac{5}{8}$ in.—11 UNC (2 pieces).

4.1.2 Mechanical Cycle

The test fixture shall be equipped with an actuator capable of stroking the test stem to simulate the mechanical cycle of a valve as follows.

- a) Rising stem
 - Rate: 3 mm to 5 mm (0.12 in. to 0.20 in.) per second.
 - Stroke ($\frac{1}{8}$ " packing): 25.4 mm $\pm$ 3 mm (1 in. $\pm$ 0.12 in.)
 - Stroke ($\frac{1}{4}$ " packing): 102mm +/- 3 mm (4 in. +/- 0.12 in.)
- b) Rotating stem
 - Rate: 10° to 15° per second
 - Rotation: 90° $\pm$ 5°
- c) Rising and rotating stem