Fluid Sealing Association

STANDARD

FSA-MG-501-02
STANDARD TEST METHOD
FOR INWARD BUCKLING
OF SPIRAL-WOUND GASKETS

994 Old Eagle School Road, Suite 1019
Wayne, Pennsylvania 19087-1866
Phone: (610) 971-4850
Fax: (610) 971-4859
www.fluidsealing.com
Email: info@fluidsealing.com

For a complete list of FSA publications, please contact:

Fluid Sealing Association
994 Old Eagle School Road
Suite 1019
Wayne, PA 19087-1866
Phone: (610) 971-4850
Fax: (610) 971-4859
Email: info@fluidsealing.com
or visit our web site at: www.fluidsealing.com

FLUID SEALING ASSOCIATION STANDARD
FSA-MG-501-02

STANDARD TEST METHOD FOR INWARD BUCKLING OF SPIRAL-WOUND GASKETS

1. Scope

1.1. This test method provides a means of evaluating the inward buckling properties of spiral-wound gaskets. Inward buckling of gaskets is defined as the deformation of one or more metal windings and filler material towards the bore of the flange. This may result in the degradation of gasket seating stress to the point of leakage of the contained fluid. In some cases, the buckled windings can protrude into the media, which could cause a disruption in the flow path of the media or interference with attached equipment.

1.2. This test evaluates ambient conditions and one nominal size and pressure class. Changes in test conditions may produce different results.

2. Summary of Test Methods

2.1. The test method utilizes a test specimen compressed between the surfaces of two steel flange faces. Compressive loads are performed in three increments with the inside diameter of the gasket measured after each load condition. Loading is performed by systematically stretching the flange bolts using a hydraulic tensioner and verified with strain gages. The gasket inside diameter is measured using a dial indicator from a reference post near the center of the flange to the seal ID. See Figure 1.

3. Significance and Use

3.1. This method is designed to compare gasket designs under controlled conditions and to provide a precise measure of inward buckling.

3.2. This method provides an accuracy of .001 inches of inside diameter measurements.

4. Apparatus

4.1. *Flanges* – One 10 inch ANSI Class 300 raised face blind flange and one 10 inch Class 300 raised face weld neck flange bored for Schedule 40 (standard) pipe. The sealing faces are machined to 125 Ra (+/- 20%) spiral machined finish. Refer to ASME/ANSI B16.5 for other machining dimensions. The blind flange shall have a 3/8”-16 tapped hole in the center. Position of the center tapped hole is not critical. Into the hole a ¾” socket head shoulder screw with a 1 inch minimum shoulder length shall be installed on the machined face side of the blind flange. A thread-locking adhesive shall be used on the screw thread.

4.1.1. Radial lines shall be scribed or marked from the center post to the center of each bolt hole on the machined face of the blind flange. Radial lines from the center post to a position half way between each of the first 16 lines shall also be marked. These 32 radial lines shall be numbered in sequential order in a clockwise direction. These lines shall the points of measurement. See Figure 3.

4.1.2. As an option to 4.1.1, a ratcheting mechanism which incrementally rotates the Measurement Device in a repeatable manner may be used. The number of increments shall be a minimum of 32. See Figure 4.

4.2. *Bolts* – Sixteen 1 inch diameter by 5.5 inch length ASTM A193 B7 bolts are required. A strain gage capable of measuring the bolt stretch shall be mounted near the center of the non-threaded portion of each bolt. The strain gages shall be mounted according to the strain gage manufacturer's recommendations. The calibration of the bolts shall be accomplished as described in Section 8. Matching heavy hex nuts and machined flat washers shall be procured.

4.3. *Strain Gage Measuring Equipment* – A suitable voltage supply and volt meter capable of reading low voltage shall be used for measuring the strain gage output. A strain gage calibrator or computer data acquisition system could also be used. Since sixteen readings will be made, a switching box is suggested.

4.4. *Hydraulic Bolt Tensioner* - A commercial-grade hydraulic bolt tensioner shall be used to stretch the bolts up to 60,000 psi axial stress (approx. 33,060 lbf force based on root diameter). The user instructions shall be read and completely understood prior to use. Accuracy of load measurement shall be +/- 2%.

4.5. *Diameter Measurement Device* – An internal dial caliper or inside caliper micrometer shall be used to measure the distance between the center post mounted in the blind flange and the inside diameter of the test gasket. The device shall have graduations of .001 inch maximum. Since the gasket will be between the two flanges an additional spacer piece shall be used to fit between the flanges to contact the ID of the gasket. This spacer shall be approximately 1/8 inch thick and 1.50 inches diameter.

5. Hazards

5.1. Normal safety practices required for operation of machinery shall be observed by the personnel conducting and/or witnessing the tests.

5.2. A safety shield shall be installed between the operator and the flange assembly during bolt loading. The hydraulic tensioner will apply a large amount of force to the bolts. A malfunction of the tensioner may present a danger to the operator or observer. The operating and safety instructions of the hydraulic tensioner must be understood and followed. Also, excessive buckling of a gasket may present a danger.

6. Test Specimens

6.1. The test specimens shall be manufactured for 10 inch Class 300 raised face flanges. Three samples of each gasket type shall be tested.

6.2. The test specimens shall be inspected for surface irregularities, such as scratches, broken welds, or other deformations. Any irregularities shall be reported to the manufacturer prior to testing. The manufacturer shall determine the suitability of the samples for the test.

7. Preparation of Apparatus

7.1. The flange faces shall be cleaned and degreased with a cloth or soft metal brush. Brush strokes shall be in the direction of the machined grooves.

7.2. Bolts shall be cleaned and the threads greased with a thread lubricant. Contact surfaces of the fasteners and washers shall be greased.

8. Conditioning of Equipment

8.1. Prior to testing, the strain-gaged bolts shall be conditioned. To condition the bolts, a load equal to 80 % of the material yield strength (46,284 lbf) shall be applied and released a minimum of three times. A hydraulic tensioner or tensile machine may be used.

9. Conditioning

9.1. Gaskets shall be held at 65° – 75° F temperatures and 40 – 60 % relative humidity for 24 hours prior to use. If a humidity cabinet with gentle air circulation is not available, then place a tray containing a saturated solution of magnesium nitrate [$Mg(NO_3)_2$ $6H_20$] in the conditioning chamber at room temperature to provide the required relative humidity. Remove specimens one at a time, as required, for testing.

10. Procedure

10.1. The temperature of the test shall be 65 – 75 deg. F unless otherwise specified. Evaluation of materials at temperatures other than ambient may affect the gasket materials, fixture and strain-gaged bolts.

10.2. Position the bolts into the blind flange with the bolt threads and machined face of the flange pointing upward.

10.3. Center the test gasket on the blind flange between the bolts. Photograph the gasket in position for the test report.

10.4. Place the weld neck flange onto the test gasket, taking care not to cause damage to the strain gages or the wires that will extend out between the flanges. The wires should be marked or tagged to indicate which bolt is connected.

10.5. Assemble the lubricated flat washers and nuts to the bolts. The nuts shall be hand tightened. Check to verify that the flanges are properly positioned.

10.6. Record the strain gage readings of all sixteen bolts.

10.7. Using the diameter measuring device and spacer, measure the distance at each scribed line between the spacer (touching the gasket) and the center post. At the no load condition, care must be taken to not shift the gasket. Record the measurement to the nearest .001 inch. The measurement shall be made along the scribed radial line or at the increments of the ratcheting device (See para. 4.1).

10.8. Repeat the radial measurements for the remaining positions.

10.9. Using the hydraulic tensioner, load the bolts to 20,000 psi (11,020 lbf based on root diameter). Loading shall be accomplished by completing three cross pattern bolt tightening sequences followed by a rotational clockwise loading sequence. Each bolt shall be tightened during each sequence. The cross pattern shall be per ASME-PCC-1-2000, “Guidelines for Pressure Boundary Bolted Flange Joint Assembly”, paragraph 9 (bolts must be numbered clockwise 1 through 16) and Table 4 (cross pattern tightening sequence to be used). When each bolt is loaded, the strain gage reading shall be recorded. At the end of the loading sequence, the strain measurements of all bolts shall be recorded again. All bolt strains must be within +/-10% of their targeted strain value. If not, the tensioner shall be used to tighten individual bolts in a continual clockwise order until all the strains are within the range of +/- 10% with the tensioner removed.

10.10. Repeat the strain gage and radial gasket ID measurements as described in steps 10.6 – 10.8.
10.11. Load the bolts to 40,000 psi (22,040 lbf) using the hydraulic tensioner as described in 10.9.
10.12. Repeat the strain gage and radial gasket ID measurements as described in steps 10.6 – 10.8.
10.13. Load the bolts to 60,000 psi (33,060 lbf) using the hydraulic tensioner as described in 10.9.
10.14. Repeat the strain gage and radial gasket ID measurements as described in steps 10.6 – 10.8.
10.15. Loosen the nuts using the hydraulic tensioner.
10.16. Paint a reference line on the gasket or guide ring OD and the flange at the same circumferential location with a paint marker or brush. These will be reference points.
10.17. Remove the upper flange, taking care not to interfere with the position of the gasket. Mark the test gasket OD and flange to indicate the bolt #1 position.
10.18. Assure that the reference points (10.16) of the gasket and flange are in alignment. If gasket is observed to have shifted eccentrically, re-position to approximate original position by inserting bolts into holes on blind flange and re-align reference points.
10.19. Photograph the gasket in position.
10.20 Inspect the inside gasket circumference for any buckle peaks that occurred between the scribed lines. The spacer shall be placed in contact with the innermost peak of such buckle along a radial linear orientation with the center post and buckle peak. If gasket shifts position, re-align per 10.18.
10.21 For each peak that occurred between the scribed lines, the radial distance from the spacer to the center post shall be measured to the nearest .001 inch and recorded.
10.22 Remove the gasket, clean the flanges and repeat the test for a total of three specimens per gasket type.

11. Calculation

11.1. The inward buckle is calculated as the change in radial measurements at each of the three loading conditions.

Buckle = (Initial Radial Length – Radial Length After Loading)

The initial radial length for the buckles measured in 10.21 shall be the average of the initial, no load (10.7) measurements along the two scribed lines adjacent (each side of) such buckle(s).

12. Report

12.1. Report the following information:
12.2. Identification of the sample gasket, including manufacturer, materials and dimensions.
12.3. Number of specimens used.
12.4. List of equipment

12.5. Change in radial measurements at each load step.
12.6. The maximum calculated buckle at each load step and its location.
12.7. Calculated magnitude of each buckle measured per 10.21
12.8. Photograph of gasket before and after test.

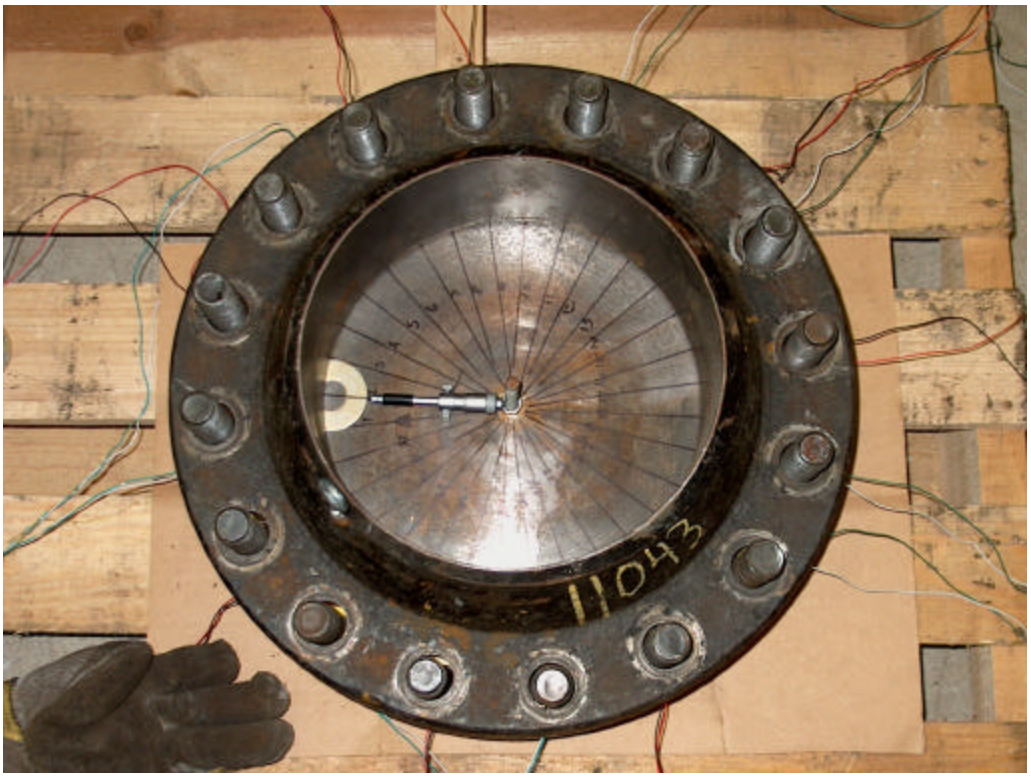

Figure 1. Measurement Positions Marked At and Between Each Bolt Hole

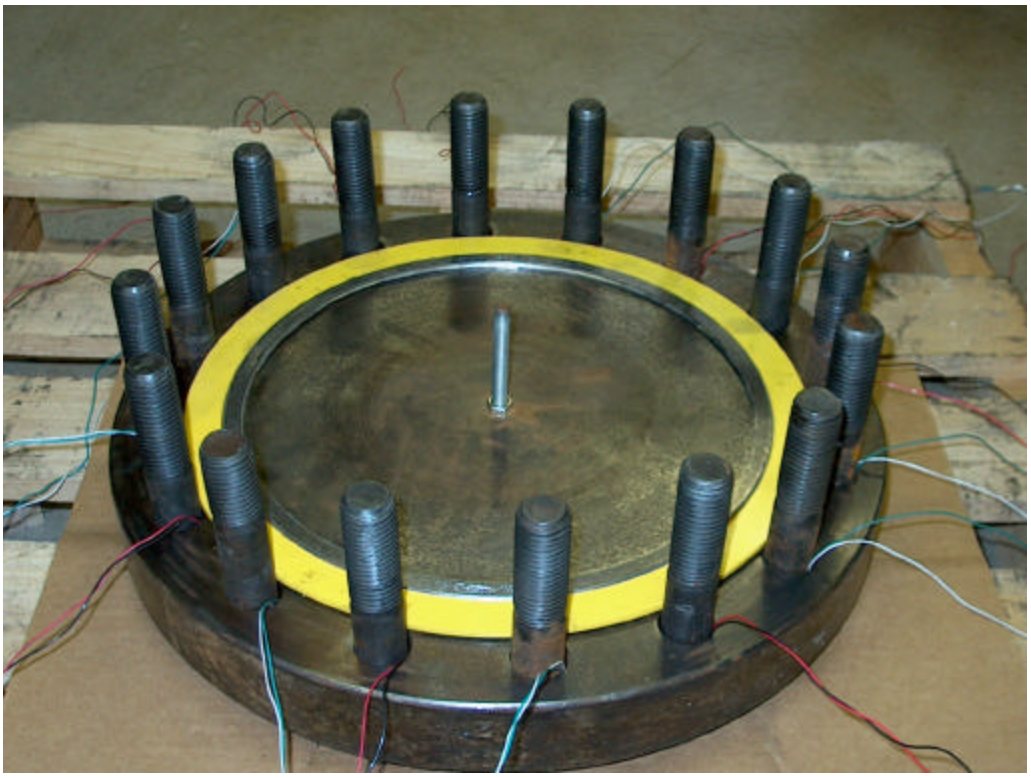

Figure 2. Strain-gaged Bolts and Gasket

Figure 3. Radial Measurement of Gasket Inside Dimension (top flange removed for photograph)

Figure 4. Radial Measurement of Gasket Inside Dimension Using Ratcheting Mechanism for Positioning (top flange removed for photograph)