THE NEW STANDARD FOR GASKETED JOINT DESIGN: ASTM F2836

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Most in the industry know that gasketed, bolted flanged joints (BFJ's) used in fluid service are complex systems. In order to create a high performing BFJ, a designer needs to carefully consider not only the service conditions the BFJ will encounter but also the performance characteristics inherent to the components of the BFJ. The gasket itself is one of these critical components, and efforts to determine the performance characteristics of gaskets have been ongoing for decades. The newest of these efforts to quantify design constants for gaskets to be published in the United States is ASTM F2836-18: Standard Practice for Gasket Constants for Bolted Joint Design. The design constants produced by this method provide a more robust design capability over previous, antiquated design constants, such as the m & y factors.

Who is ASTM F2836-18 for?

ASTM F2836-18 (commonly referred to as the Room Temperature Tightness Test – ROTT) is a helium leakage testing and evaluation method which determines tightness-based design constants at room temperature for pressurized bolted flanged connections which are designed in accordance with ASME Boiler and Pressure Vessel Code. As such, ROTT applies mainly to all types of circular gasket products, including, but not limited to, sheet-type, spiral wound, solid metal, and jacketed gaskets.

The method itself consists of analyzing data from multiple gasket leakage tests in order to calculate three design constants for a particular model and size of gasket: Gb, a & Gs. These constants are used for a tightness-based design of BFJ's using design methods currently under development by an ASME Section VIII Special Working Group.

Testing Procedure

The ROTT test can be performed in a pair of appropriately sized flanges, using bolts to achieve varying gasket loads, or in a servo-hydraulic test stand such as amtec's TEMESfl.ai1 (see Figure A). In total, the procedure consists of two "High Pressure" (HP) tests at 6 MPa (870 psi) of helium and two "Low Pressure" (LP) tests at 2 MPa (290 psi) of helium, for a total of four tests on four different specimens. For the purposes of evaluation, different portions of the four tests are categorized as either "Part A" or "Part B" depending on the gasket surface stress loading sequence.

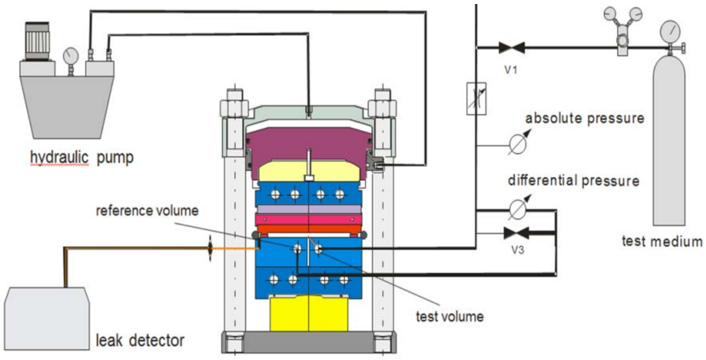

Figure A: amtec's universal test rig, the TEMESfl.ai1

Part A represents initial joint tightening and gasket seating processes. Each new level of gasket compression stress is higher than any previously applied stress. Part A test data is used to determine the required seating load.

Part B simulates the operating conditions by unloading the specimen to different gasket stress levels. Part B of the resulting leakage curve represents gasket unloading due to internal pressure, different thermal expansion and relaxation effects of a gasket during operation. Part B test data is used to determine the required operating gasket load.

Each HP test consists of both Part A and Part B sequences, while each LP test consists of only the Part A sequence.

Results Analysis & Gasket Characteristic Derivation

Two HP tests and two LP tests must be performed in order to determine the design constants. After these four tests, a verification procedure must be done to check whether the measured helium leakage demonstrates good repeatability within the HP and LP test pairs. Once acceptable repeatability is realized, one may proceed to use the data to produce the gasket constants Gb, a & Gs. The source of these values can be visualized on a combined plot of gasket stress versus the Tightness Parameter (an expression of leakage, see formula 1) on log scales for all four tests (see Figure B).

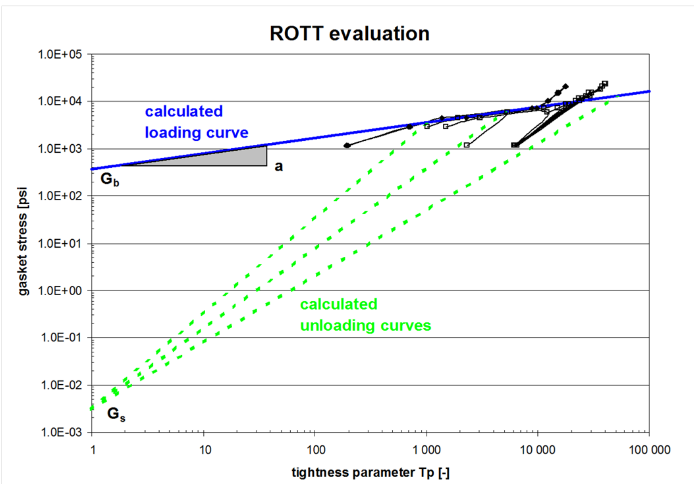

Figure B: log plot of stress versus leakage for all HP and LP tests

$$T_P = \frac{P}{P^*} \cdot \sqrt{\frac{L^*_{rm}}{L_{rm}}} \qquad (1)$$

P^*: Fluid pressure (MPa), P^*: reference pressure (0.1013 MPa), L_rm: mass leak rate (mg/s) of ROTT gasket specimens dimension; L_rm^*: unit mass leak rate (1 mg/s for a 150 mm gasket OD)

Gb and a are simply characteristics of the regression of the Part A (loading sequences) data set which delivers the highest value of R2 (least square method). Gb is the intercept of this regression line at Tp = 1, while a is the slope of this line.

The unloading-reload constant Gs is the stress intercept at Tp = 1 associated with the regressions of each reloading unloading sequence of the Part B (unload-reload sequences) data set.

Summary

The standard practice ASTM F2836-18 is the newest publication by an American standardization body aimed at producing gasket constants to be used in the design of gasketed BFJ's. The loading and unloading gasket stress sequences, combined with leakage testing at different internal pressures, create gasket constants that can characterize a gasket's performance over a broad range of installation and service conditions. The industry is already demanding these constants for gasket products while awaiting the publishing of the design equations as determined by the ASME Section VIII Special Working Group.