SEALING SENSE

5th Anniversary

What are *m* and *y* gasket design constants, and how are they used?

This month's *Sealing Sense* was prepared by FSA Member Brian Hasha

ASME Boiler and Pressure Vessel code contains rules for the design and construction of unfired pressure vessels. The design of bolted flanges requires that gasket constants referred to as *m* and *y* be used in the calculation. The recommended values given for the gaskets listed in the code are non-mandatory. However, these constants, *y* (seating stress) and *m* (gasket factor), must be used in the code formulas unless the designer can justify the use of other values for these constants. Values for constants of specific gaskets are included in the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, Table 2-5.1. Additionally, gasket manufacturers publish *m* and *y* values for their own specific gasket materials and styles.

Bolted Flange Design Methodology

A flange must be designed to create sufficient compressive load on the gasket contact area to create an initial seal with essentially no pressure in the vessel. The gasket must conform to the flange surface and be sufficiently compressed to compensate for internal voids or spaces that could be detrimental to a seal. The gasket stress required to achieve this initial seal is considered the *y* constant. Values for *y* have changed through the years for some gaskets. The value given for spiral wound gaskets was previously lower than the current value of 10,000 psi.

The *m* value allows the flange designer to determine the compressive load on the gasket required to maintain tightness when the vessel is pressurized. This value is considered a multiplier or maintenance factor. This constant is intended to ensure that the flange has adequate strength and available bolt load to hold the joint together, while withstanding the effects of hydrostatic end force or internal pressure. The design intent is that the flange and bolting will hold the flanges together under pressure and exert an additional stress on the gasket of *m* multiplied by the internal pressure.

Bolt Load

Design Calculations

The designer calculates the load required to seat the gasket (related to *y*) and performs a second calculation using the *m* value and the design internal pressure. The flanges are then designed based on the larger of the two calculated values.

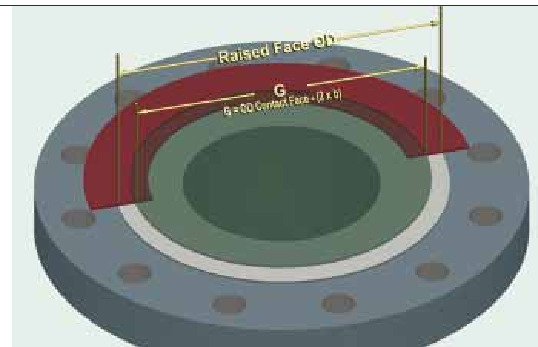

Figure 1. Load reaction Diameter G

The formulas used in the code to calculate the required total bolt load are as follows:

$$W_{m1} = .785\ G^2\ P + 2\ b\ \pi\ G\ m\ P$$

$$W_{m2} = \pi\ b\ G\ y$$

Operating Condition

In the first equation W_{m1} is called bolt load for operating condition. The first term in the equation, .785 G^2 P, represents the hydrostatic end force created by pressure P acting over the load reaction diameter, an area defined by a circle with diameter G (see Figure 1).

The second term in the equation for W_{m1} represents a residual load that is a multiple *m* of the pressure P acting over an effective gasket area determined by 2bπG, where b is the effective gasket width. The value of b is calculated from the gasket seating width, b_o. The values for b_o must first be calculated from equations shown in Table 2-5.2 of the code:

$$b = b_o \text{ when } b_o \text{ is} \le 1/4 \text{ in}$$

$$b = 0.5\ (b_o)^{1/2} \text{ when } b_o \text{ is} > 1/4 \text{ in}$$

For example, for a sheet gasket used on a raised face flange, the value b_o is calculated by taking the compressed width of the gasket (shown as the value N in Figure 2) and

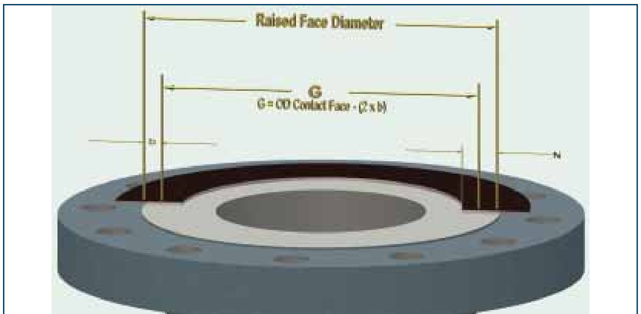

Figure 2. Bolt load parameters

dividing it by 2.

Table 2-5.2 in the ASME Code Section VIII, Division 1 illustrates various other loading scenarios used to calculate b_o.

Seating Condition

In the second equation for the seating condition, W_{m2} represents an effective gasket area given by πbG multiplied by the constant *y*. Note that this effective gasket area is half that of the gasket area used in the second term in the W_{m1} equation. Gasket manufacturers will often use the actual gasket area under compression multiplied by the *y* constant to determine a value for W_{m2} for purposes of determining bolt loads, but that is a discussion for another article.

Critical Considerations

There are some critical considerations when using the *m* and *y* constants in these equations. First, these equations were originally derived to assist in the design of flanged joints. They do not specifically address joint tightness. They are often used to help determine minimum required bolt loads for assembly purposes. They currently do not take into account potential joint relaxation due to temperature effects, torque scatter and the inherent inaccuracies involved in assembly. For assembly purposes, they are more of an indication of minimum load required, and may not correspond to a bolt load required to achieve a certain tightness level under a given set of operating conditions.

Current Status

The loading constants for many traditional gasket designs are published in Table 2-5.1 in the code. Many designs used in industry today are not shown in this table. The test procedure for the determination of these required loading constants was outlined in ASTM Standard F586, originally published in 1979. The standard was eventually withdrawn in 1998 as the development of new loading constants based on a load versus leakage test standard known as ROTT (Room Temperature Tightness Test) was developed.

Summary

Since there is currently no industry standard test to determine the *m* and *y* gasket constants, many gasket manufacturers have developed individual test procedures based on the ASTM F586 test method. There is no approved ASME alternative to the code that requires use of these constants. The FSA's Gasket Technical Committee is developing a test procedure to fill this void. Until an alternative design method evolves and as long as *m* and *y* are used, a test standard will be needed to ensure consistency in the reported values of these constants for gasket materials.

Next Month: *What are the basics of gas lubricated seals?*

We invite your questions on sealing issues and will provide best efforts answers based on FSA publications. Please direct your questions to: sealingsensequestions@fluidsealing.com.

P & S

Fluid Sealing Association

Sealing Sense is produced by the **Fluid Sealing Association** as part of our commitment to industry consensus technical education for pump users, contractors, distributors, OEMs and reps. As a source of technical information on sealing systems and devices, and in cooperation with the **European Sealing Association**, the FSA also supports development of harmonized standards in all areas of fluid sealing technology. The education is provided in the public interest to enable a balanced assessment of the most effective solutions to pump systems technology issues on rational Total Life Cycle Cost (LCC) principles.

The **Gasket Division** of the FSA is one of six with a specific product technology focus. As part of their mission they develop publications such as the *Metallic Gasketing Technical Handbook* as well as joint publications such as the newly revised ESA/FSA *Flange Gaskets – Glossary of Terms, and Guidelines for Safe Seal Usage - Flanges and Gaskets* as well as the FSA/ESA *Gasket Installation Procedures*, which are available in eight languages. These are intended to complement the more detailed manufacturer's documents produced by the member companies.

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