FLUID SEALING ASSOCIATION FSA

From the voice of the fluid sealing industry

SEALING SENSE

What factors should be considered for stainless steel fasteners in bolted flanged connections?

This month's "Sealing Sense" was prepared by FSA member Joel Baulch.

In a bolted flanged connection using a sealing device, it is most important to understand that adequate loading must be realized to meet minimal seating requirements for the design. The July 2010 "Sealing Sense" discussed the primary considerations for fastener systems employed in a bolted flange assembly, including those for stainless steel.

With a gasketed assembly, the ratio of the compressive force to the sealing area must meet or exceed the stress required to generate an effective seal.

The use of higher strength stainless steel bolts is often required to allow for a greater targeted pre-stress and/or to meet chemical resistance, temperature or flange compatibility requirements.

This higher targeted load should take into account the relaxation of the assembly, including that of the gasket.

Fastener Standards

ASTM A193/193M (Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service) is widely used for industrial applications.

This specification includes bolt grades/classes, and its matching nut specification is ASTM A194/A194M.

Low alloy grades B7 and B16 are the most common selections for industrial applications, as they provide ample strength to allow for higher targeted loads.

However, when greater chemical or temperature resistance is needed or when closely matching coefficients of expansion of flange and bolting preclude the use of typical low alloy grades, stainless steel grades are often employed.

Austenitic stainless steels are characterized as having excellent corrosion resistance properties.

The design of a bolted flange connection entails numerous considerations, too many to include in this article.

Table 1. Mechanical properties

Bolt Grade Class	Bolt Grade	Size, in. (mm)	Tensile Strength, ksi (Mpa)	Yield Strength, min, 0.2% offset, ksi (Mpa)	Hardness, max
Class 1 and 1D	B8, B8M, B8P, B8LN, B8MLN B8C, B8T	all diameters	75 (515)	30 (205)	223 HB or 96 HRB*
Class 2	B8, B8P, B8N, B8C, B8T	3/4 and under (M20 and under)	125 (860)	100 (690)	321 HB or 35 HRC
		over 3/4 to 1, incl (over M20 to M24, incl)	115 (795)	80 (550)	
		over 1 to 1 1/4, incl (over M24 to M30, incl)	105 (725)	65 (450)	
		over 1 1/4 to 1 1/2, incl (over M30 to M36, incl)	100 (690)	50 (345)	
Class 2	B8M, B8MN	3/4 and under (M20 and under)	110 (760)	95 (655)	321 HB or 35 HRC
		over 3/4 to 1, incl (over M20 to M24, incl)	100 (690)	80 (550)	
		over 1 to 1 1/4, incl (over M24 to M30, incl)	95 (655)	65 (450)	
		over 1 1/4 to 1 1/2, incl (over M30 to M36, incl)	90 (620)	50 (345)	

*For sizes ¾ inches in diameter and smaller, a maximum hardness of 241 HB (100 HRB) is permitted.

However, some basic concepts should always be considered.

Grade Selection and Corrosion Resistance

Stainless steel bolts are identified in A193/193M as the B8 grade of alloys. The most popular grades are B8 (304SS) and B8M (316SS). For applications in which chemical resistance properties superior to those of 304SS are needed, 316SS is a next step. Its additional molybdenum content provides improved pitting and corrosion resistance. Other grades with even higher molybdenum content can be considered for more aggressive environments.

Classes of A193/A193M Stainless Bolting

What is not always recognized is that every grade has two classes. The difference between the two classes lies in the strain hardening process. While this process will not affect chemical properties, it will have a significant impact on mechanical properties.

For example, bolt grade B8 Class 1 material which is carbide solution treated has yield strength of 30 ksi (205 Mpa) for all diameters, while B8 Class 2 which is carbide solution treated and strain hardened has a yield strength of 80 ksi (550 Mpa) (for diameters over ¾).

Table 1, based on A193/193M values, shows stainless steel bolt grades and classes and their corresponding mechanical properties.

Typically, strain hardened Class 2 stainless steel fasteners will provide better results for corrosive service because of their higher yield

Figure 1. Galled stainless steel bolt

strength properties, especially when significant assembly load is required to generate the required gasket stress.

Effect of Elevated Temperatures on A193/A193M Stainless Bolting

Thermal effects can change the stability of the initial clamp load significantly.

After a pre-stress is applied to a fastener and the service is brought up to an elevated operating temperature, the bolt could move within its creep range and elongate further, causing a reduction in load. ASTM A453 Grade 660 bolts are a good option in applications where corrosion resistance, higher yield strength potential and retention of yield strength at elevated temperatures are all important.

Preventing Galling

Thread galling can be a problem with stainless steel fasteners if not properly addressed. Oxide build up between the threads can lead to fusion of the mating pieces (Figure 1) and prevent torque transfer to the assembly.

Galling can be prevented using three commonly-chosen strategies:

- Use the proper lubricant on the mating threaded parts.
- Reduce the installation speed so less heat is generated and the potential of cold welding is reduced.
- Select a coarse thread instead of a fine thread.

Summary

When stainless steel fasteners are the conclusive choice for a bolted flanged connection, ensuring that the grade is appropriate for the service conditions is important.

An adequate load must be delivered to effectively generate a seal. Select a grade and class that can maintain higher yield strength at operating temperature.

Properly lubricate and install the fasteners carefully so that galling of the threads is prevented.

Next Month: *Why do I need to complete an application questionnaire?*

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

P&S

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"Sealing Sense" is produced by the Fluid Sealing Association (FSA) as part of its 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 (ESA), the FSA also supports the 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 five with a specific product technology focus. As part of its mission, it develops 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* and the *FSA/ESA Gasket Installation Procedures*, which are available in eight languages. These are intended to complement the more detailed manufacturers' documents produced by the member companies.

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