

SEALING SENSE

"Was It Really the Gasket?"

Over the years, the FSA Gasket Division has explored many specific sealing and gasketing issues in *Sealing Sense*. Regardless of all the insights provided, chances are that users of gaskets will be confronted at some point with a bolted flange connection that leaks. When this happens, those involved will (most of the time) still consider the gasket as the probable cause of leakage.

Our purpose this month is to share with our readers much of the experience of the gasket material manufacturers and to help the reader understand how other factors related to the gasket, but not the gasket itself, may contribute to the sealing difficulties they face.

The experience of most gasket material manufacturers suggests that a very high percentage of bolted flange connections that leak (perhaps 75 percent to 85 percent) do so as a result of non-gasket related factors. These factors usually relate to installation and assembly problems and limitations.

We will discuss some of the most typical circumstances gasket material manufacturers find that relate to installation and assembly issues resulting in leakage. But before moving forward, please accept and understand two fundamentals relating to flanged connections.

First, a bolted flange connection is a complex combination of many factors. All these various elements are inter-related and depend upon one another to achieve a successful result. Figure 1 shows the complexity of these relationships.

Second, the user must understand that one of the most important factors for success is correctly following the gasket installation procedure. Quoting from John H. Bickford's book, *An Introduction to the Design and Behavior of Bolted Joints*:

"That all important clamping force which holds the joint together—and without which there would be no joint—is not created by a good joint designer, nor by high quality parts. It is created by the mechanic on the job site, using the tools, procedures, and working conditions we have provided him with . . ." And further: "*The final, essential creator of the force is the mechanic, and the time of creation is during assembly. So it's very important for us to understand this process.*"

The industry has recognized the critical nature of installation and assembly for several years. Work began in 2001 to develop formal guidelines for flange assembler training and

certification. In September 1998, the original draft document, "Guidelines for Pressure Boundary Bolted Flange Joint Assembly," was created. Later known as *PCC-1-2000*, it was first available for purchase in April of 2001.

Today, a special working group of the ASME is undertaking an update of this document with focus on developing standard qualifications and requirements for the training and certification of flange assemblers. This process will be similar to that followed to train and certify welders, and is intended to ultimately be a revised Appendix A for *PCC-1*.

Actual Installation- and Assembly-Related Issues

Some of the most frequent issues dealing with the installation of a gasket and the assembly of a flange include:

Underloading of the Gasket

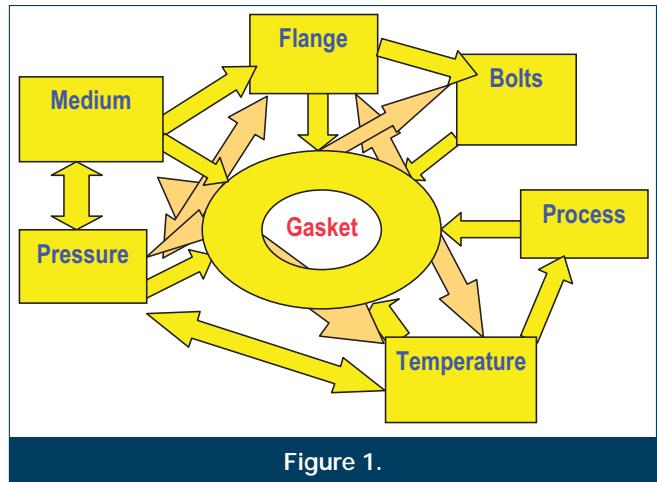
This may comprise a vast majority of the reasons a bolted flange leaks. There are many reasons for this to occur, including these most common ones:

- *Increased pressure and temperature create a loss of initial gasket load.* The higher the pressure and temperature, the more loss of the initial gasket load that occurs.
Solution: Before assembly, properly calculate the amount of torque required considering these two critical application conditions.
- *Misaligned flanges (whether axial or radial) make the bolt "work" to correct the misalignment instead of loading the gasket. The applied torque is reduced significantly, resulting in insufficient achieved bolt load or stress on the gasket.*
Solution: Try to bring the flanges into an acceptable alignment per ASME B31.3 (ref. *PCC-1* Appendix E).
Special tip: Bolts should pass freely through bolt holes!
- *Lack of lubrication may reduce the applied load you are targeting by as much as 50 percent.* Un-lubricated bolts develop lower force every time they are used, due to increased thread friction as the nut/bolt thread surfaces are "worked."
Solution: Once the proper lubricant is determined (being sure to check compatibility with process fluid, temperature and materials of construction), apply lubrication to threads and "working" surfaces, i.e., all internal and

external thread surfaces and nut and washer surfaces.

Special notes:

1. Do not apply lubrication to those already coated with lubricant.
 2. Do not apply lubrication to the gasket.
- *Reused bolts may no longer be functional.* There are many related issues in this category:
 1. Fasteners in the field tend to corrode unevenly, resulting in the inability to create even loads the next time they are tightened.
 2. When Stainless Steel bolts are used (frequently associated with standard grade ASTM A193 B8 **Class 1** SS bolts), yielding bolts as a result of over-torquing is one of the most common problems.
 3. SS bolts are soft and do not break off like carbon steel bolts once yield strength is exceeded. Frequently they will “squeal” or “squeak” when yielded. Once yielded, the load actually DECREASES upon further efforts to tighten.
Solution: Use new fasteners of the proper material and grade to increase your chances of successfully sealing the bolted flange connection, especially when used in problem areas, intermediate and critical services. With regard to SS bolts, upgrade to ASTM A193 B8 Class 2 to assure higher yield strength closer to that of alloy steel bolts ASTM A193 grade B7.



Uneven Compression of the Gasket

This frequently results from not using the proper torque pattern and too few passes when initially assembling the bolted flange connection. Gaskets are often fully compressed on one side while the other side has little-to-moderate compression, indicating the installation process was one where bolts were tightened on one side of the flange first and then tightened on the other side.

Solution: Take the time to perform the installation correctly!

- Use a multiple-pass, star (cross) pattern of applied torque to seat the gasket properly. (Note: Alternative methods are currently being explored and in practice by some companies,

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. *This month's Sealing Sense was prepared by FSA Member Charles Miskell.* 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 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 their mission they develop publications such as the *Metallic Gasketing Technical Handbook* as well as joint FSA/ESA publications such as *Guidelines for safe seal usage—Flanges and Gaskets* and *Gasket Installation Procedures*. These are primers intended to complement the more detailed manufacturer's documents produced by the member companies.

The following members of the **Gasket Division** sponsor this *Sealing Sense* series:

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especially with large diameter applications.)

- A minimum of four passes should be performed, as in the example below. (Refer to PCC-1 Tables 2 through 4.)
- Measure the flange gap to determine if load on gasket is even.
- Once the target torque is reached through the correct star pattern procedure, the installer should wait approximately four hours. *Note:* During that four-hour wait, the entire assembly must be torqued to the original target torque level because bolts, flanges and gasket materials all relax and initial torque decreases.
- After the four-hour wait, apply a final circumferential torque at the final torque target.
- *Note:* Once in service, *do not retighten or hot re-torque* without consulting with site/corporate guidelines and *your gasket material manufacturer.*

Gasket Exhibited Signs of Being Reused

Solution: Never reuse a gasket!

The Gasket from the Joint that Leaked was Thrown Out!

- Remember, the gasket frequently “tells you a story”!
- Please contact your gasket material supplier or local distributor and request they return your used gasket to the manufacturer for proper analysis.

Solution: Keep the gasket and return it to the *gasket material manufacturer* for analysis and comment. *Note:* Caution must be observed to be sure all hazardous substances have been neutralized on this gasket. It should be bagged and tagged with all application information listed on the label (pressure, temperature, media, torque applied, etc.) before returning it to the manufacturer.

Star-Pattern Tightening					Circumferential Tightening	
Step 1 (ft-lb)	Step 2 (ft-lb)	Step 3 (ft-lb)	Step 4 (ft-lb)	Step 5 (ft-lb)	Step 6 (ft-lb)	Step 7 (After four hours of waiting) (ft-lb)
Finger tightening	90	180	270	360	360	360

Example of correct torque method and installation technique for an application requiring 360 ft-lbs of torque to seal the application correctly. *Special Note:* This procedure does not quite follow the PCC-1 procedure, as there are additional steps in this example.



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Plant Policy and Procedure Related Issues

This typical group of problems relates more to plant philosophy towards sealing issues:

- *Sourcing of lower grade components due to cost reduction initiatives in plants*—For example, Grade 5 bolts are frequently used as a cost reduction effort (yield strength of only 85,000-psi).
 1. ASME vessel and piping codes and gasket material manufacturers recommend the use of ASTM A193 grade B7 for alloy steel bolts and studs (a yield strength of 105,000-psi).
 2. For SS fasteners, use ASTM A193 grade B8 **Class 2** (a B8 Class 1 bolt is soft and has a yield strength of only 30,000-psi).
- *Too little use of controlled torque wrenches or other means of torque/load control for all installations*—With EPA demanding tighter flanges and leak-free results on fugitive emissions, an installer can no longer depend upon “touch” or “feel” for installation accuracy.
- *Lack of standard mandated installation procedures for outside contractors.*

Solution: Work with plant management to illustrate the

long-term benefits of doing it right the first time using the proper tools, i.e., the proper equipment as defined by industry associations. Try to “isolate” test situations where such practices can be measured to prove the results of less downtime, less loss of product and a safer working environment. Be sure contractors are properly instructed and trained. Use the guidelines of *PCC-1* as the proper tool to accomplish this.

Summary

Remember that the gasket is but one of many reasons a bolted flange joint connection can leak. Even when all the complex interrelated components of a bolted joint flange connection work in perfect harmony, the single most important factor leading to success or failure of that bolted flange connection will be attention given to proper installation and assembly procedures by the person installing the gasket. If done properly, the assembly will remain leak-free for the target life expectancy.

Next Month: *How can I troubleshoot expansion joint failures?*

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

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