BEST AVAILABLE TECHNIQUES

"Was it Really the Gasket?"

1. INTRODUCTION

Gaskets, in their present forms, have been in existence for well over 100 years. During this time, the selection and operation of gasketed joints has been the subject of numerous conference papers and books and a wealth of experience around this matter has been shared between manufactures and users of the gasket. Despite the insights provided, it is likely that users of gaskets will at some time be confronted with a flanged joint 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 our experience 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 typical problems relating to installation and assembly processes that can in result in leakage. There are two key fundamentals relating to flanged connections.

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

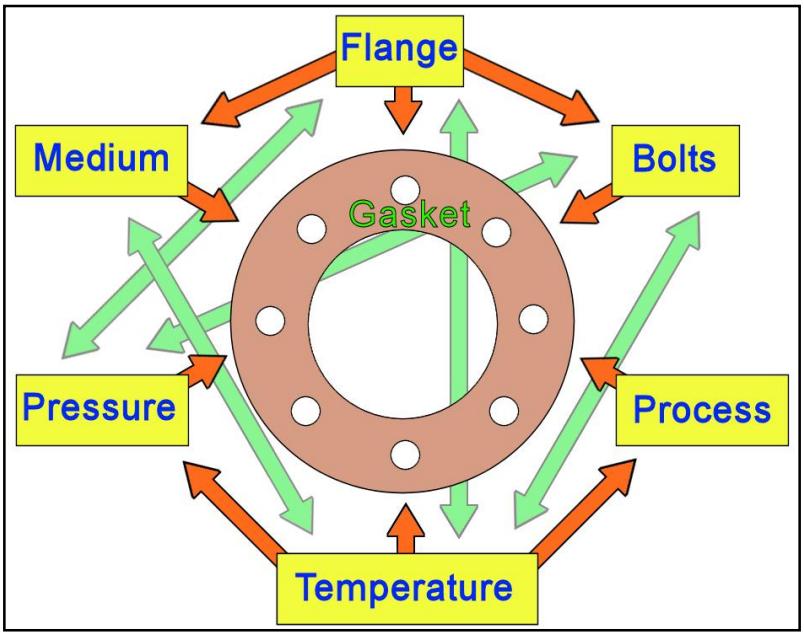

Figure 1

2. The reliability of the flanged joint depends critically upon competent control of the joint making process. 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. In Europe, the emphasis has been on ensuring that joint making is undertaken by trained and validated technicians and this has led to the publication of a new European Technical standard: TS EN 1591 Part 4 entitled "Qualification of the competency of personnel who and assemble and disassembly bolted joints". The standard provides a methodology for the training and assessment of technicians involved in the making and breaking of flange joints and can be viewed as being analogous to the training required for welders involved with pressure vessel work. Its publication demonstrates the importance placed upon the competent control of joint making process in ensuring leak-free performance from the flange.

2. INSTALLATION AND ASSEMBLY RELATED ISSUES

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

2.1 Underloading of the Gasket

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

- *Pressure and Temperature create loss of initial gasket load*. The higher the pressure and temperature, the more initial gasket load will decrease.
  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 insufficiently achieved bolt load or stress on the gasket*.
  Solution: Try to bring the flanges into an acceptable alignment. For advice on what is acceptable contact your seal provider. 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*. A lubricant, properly applied to a bolt, will reduce friction and bonding of the contact surfaces during tightening, increasing the resultant load on the gasket and decreasing the variability.
  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 note: Do not apply lubrication to the gasket as this may adversely affect the performance of the joint.
- *Re-used bolts may no longer be functional*. There are many related issues in this category:
  - Bolts in application tend to corrode unevenly, resulting in their inability to create even loads the next time they are tightened.
  - Over-torquing of stainless steel bolts (e.g. ASTM A193 B8 Class 1**)** is a common problem and may result in the bolt yielding. Subsequent use of the bolt may result in the gasket being underloaded or the bolt failing .

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 Stainless Steel bolts, upgrade to a higher strength bolt such as ASTM A193 B8 Class 2.

2.2. Uneven Compression of the Gasket

This frequently results from an improper torque pattern and / or 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: 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, especially with large diameter applications).

- A minimum of five passes should be performed, as in the example below.
- Measure the flange gap to determine if load on gasket is even.
- *Note*: Once in service, *do not retighten or hot re-torque* without consulting with site/corporate guidelines and *your gasket material manufacturer*.

Star-Pattern Tightening				**Circumferential Tightening**
Step 1 (Nm)	Step 2 (Nm)	Step 3 (Nm)	Step 4 (Nm)	Step 5 (Nm)
Finger tightening	120	180	360	360

Table 1: Example of correct torque method and installation technique for an application requiring 360 Nms of torque to seal the application correctly.

2.2. Gasket Exhibited Signs of Being Reused

Solution: Never re-use a gasket!

2.4. The Gasket from the Joint that Leaked was Thrown Out!

The failure mode of a leaking joint can often be quickly established by examination of the used gasket. In the hands of an experienced sealing engineer, a used gasket will frequently present the best opportunity for understanding the reasons for failure and will help to identify a possible solution.

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.

3. PLANT POLICY AND PROCEDURE REALTED ISSUES

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

3.1. Cost reduction initiatives in plants

This can sometimes result in sourcing of lower grade components. For example, lower strength bolts are frequently used as a cost reduction effort but this may prevent sufficient load being applied to the gasket.

3.2. Too little use of controlled tightening methods

Too little use of torque wrenches or other means of torque/load control for all installations. With stricter controls around the leaks and emissions from flanged joints, an installer can no longer depend upon "touch" or "feel" for installation accuracy.

3.3. Lack of standard, mandated installation procedures for outside contractors.

Reliable flange making requires that all individuals involved in the process are aware of their role and implement their duties correctly. Efficient systems and procedures, together with careful training and validation are essential, in what can be a hectic maintenance schedule.

Plant Policy and Procedure Related Issues Solution: Work with plant management to illustrate the long-term benefits of doing it right, 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.

4. SUMMARY

Remember that the gasket is but one of many reasons a bolted flange joint connection can leak. Even when all the complex inter-related 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.

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