Best Practices for Bolted Flange Joints

When assembling bolted flange joints, reliability engineers, industry experts, gasket manufacturers, and almost anyone with 'skin in the game' agree that utilizing best practices is paramount to overall joint integrity, reliability, and most importantly, safety. A great deal of time and resources have been devoted to identifying those best practices and to training plant maintenance personnel and contractors on proper flange bolt-up. ASME's post construction committee has detailed numerous methodologies for calculating target torque requirements for bolts in their PCC-1 publication (cf. Appendix J, Appendix K, and Appendix O). Yet, even with all this information available, the leading cause of joint failures and leaks on plants is still poor or improper installation. To mitigate the chance of flange failure it is therefore important to ensure the correct specifications and assembly practices are followed.

By Chris Morris, Teadit

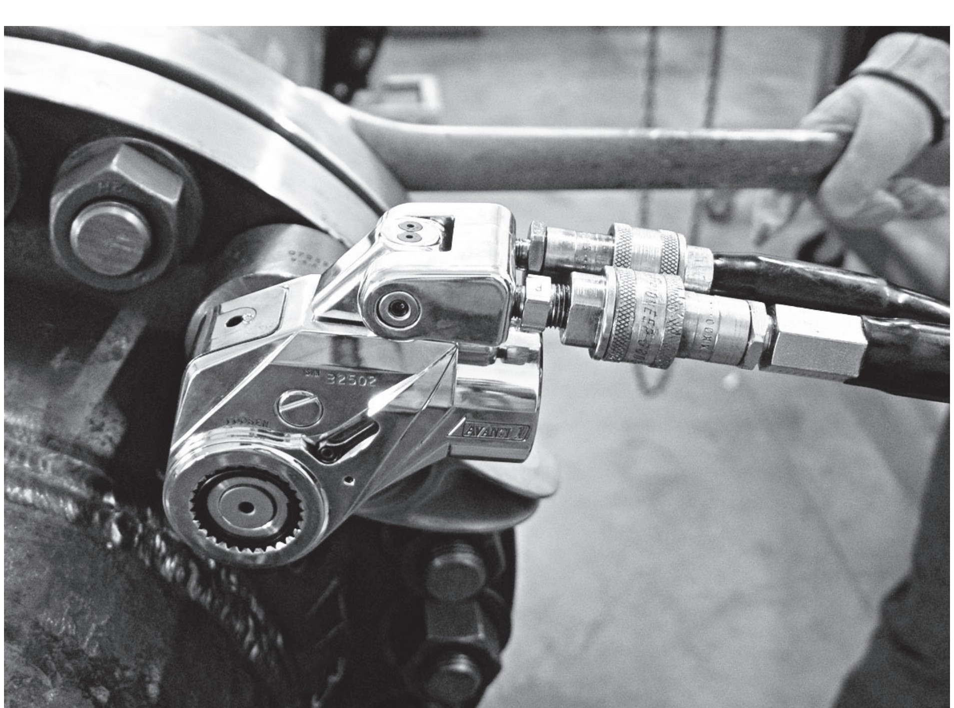
Despite the implementation of practices such as: utilizing new gaskets and fasteners, understanding the importance of thread and bearing surface lubrication, and using proper flange cleaning and inspection practices, many individuals still believe that a box wrench, some elbow grease, and experience are all that you really need. This equates to millions upon millions of dollars every year in down-time, lost efficiency, wasted product, fines, and maintenance costs.

Training classes tend to be populated with a number of 30-year veteran mechanics who believe that refresher training means free pizza and nap time. But just because nothing has gone wrong so far does not mean that danger is not lurking behind every one of the hundreds (or even thousands) of joints at a plant. Every time an individual steps foot in a plant, their life is literally in the hands of the mechanics and pipefitters who work there. As citizens, individuals trust that the plants in their communities are not exposing anyone to dangerous leaks; this is an awesome responsibility. Fluid sealing products manufacturers like to say that the right gasket, properly installed will last for the entire maintenance cycle of the system. In other words, if the specifications are correct, and best assembly practices are utilized, one can walk away from a flange bolt-up with the confidence of a job well done for the foreseeable future.

Flange Maintenance

Care and Cleaning

Ensuring the integrity of the flange begins with flange maintenance and cleaning. Flanges need to be thoroughly cleaned to remove any debris and pieces of the old gasket material that have adhered to the sealing surface. This is typically the least popular part of the job, as some gasket materials can be particularly 'messy' to deal with. To counteract this, well-meaning maintenance personnel will apply greases, lubricants, or other release agents to the flange or gasket surface to prevent this adhesion. It cannot be stressed enough how dangerous this practice is and how detrimental it is to the gasket, regardless of size and type.



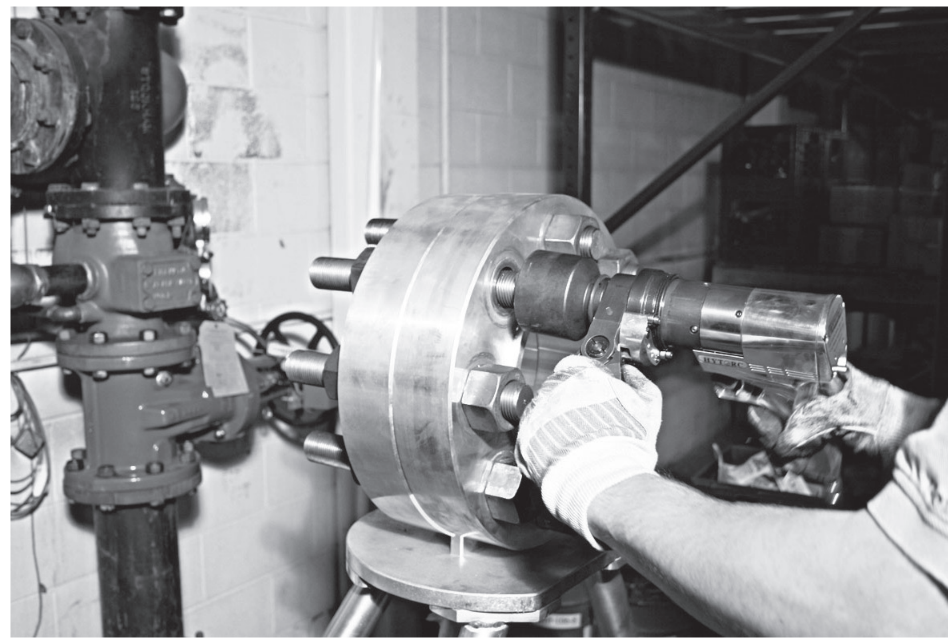
These foreign substances can and will negatively impact the gasket's ability to seal, and in most cases, prematurely degrade and damage the gasket itself, leading to leaks and other failures. Most gasket manufacturers do offer safe anti-stick treatment options for many of their gasket materials.

Once properly cleaned, the flange surfaces should be inspected for damage in the form of scratches, gouges, pitting, etc. that could prevent a reliable seal from being achieved. This inspection should also look for excessive gaps or misalignment of the flanges and should seek to ensure that they are flat and parallel to one another. It is important to keep in mind that, barring the use of a mythological 'pipe stretcher,' any force applied to push or pull misaligned flanges into alignment will add additional stresses to the piping system. This additional stress can lead to leaks and failures both up and downstream from the area being worked on. Additionally, if fasteners are to be reused, they should also be inspected for excessive wear and/or signs of overstressing that leads to yielding (that is a permanent deformation of the material).

Reassembly

Once the cleaning and inspection is complete, it is time for reassembly. Please note that a new gasket that is specified for the service, according to the plant's maintenance and engineering specifications, should always be used. The only exception to this rule is if the application requires a specialty seal that it designed and tested for reuse. However, most gaskets are not intended for multiple uses. If a gasket is to be reused, it is always recommended that it also undergo a thorough inspection by a qualified individual or that the manufacturer be consulted.

While it is incorrect to suggest that any one step is more important than another, the reassembly process is surely the least intuitive and requires perhaps more care. First, it is important to recognize that not all gasket materials are equal. What works well for one might destroy another and vice versa. In the gasketing world, stress (or force distributed over an area) is a major factor that is considered. For example, a force is generated with bolts that is then applied through the flanges over the sealing surface of the gasket. Generating adequate stress (typically measured in psi, or pounds per square inch) is critical to effective sealing. Too little stress, and the joint will leak. Conversely, too much stress can damage the flanges, gaskets, and/or bolts leading to failures as well. One of a flange's three components, the weakest of the three, will always control the amount of load that can be applied to the system. At the end of the day, principal goal is to adequately 'stretch' the bolts to generate an optimum clamping force for the joint.

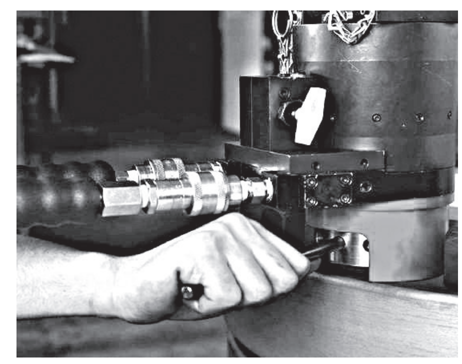


Torquing Vs Tensioning

A bolt stretch can be achieved in one of two ways: torquing the bolts (that is the required amount of work to generate a force to physically turn a wrench) or through tensioning. Which method is most effective or preferable depends greatly upon who is asked, as well as a number of important factors, including: the criticality of the application, accessibility, availability of the necessary equipment, and the expertise of the person(s) preforming the assembly. Apart from maligned box wrenches and impact guns, torque wrenches and other torque devices are more commonly used than hydraulic tensioners.

Torquing can be achieved through a variety of tools including: manual 'clicker' torque wrench, pistol grip torque wrench, hydraulic torque wrench, or electric torque tools. Regardless of one's choice of tools, torquing is the simplest method of achieving a desired bolt preload, and is commonly more cost-effective than alternatives like tensioning. Conversely, factors like the skill level and training of those performing the work, the calibration and maintenance of the tools, and most importantly, the accuracy of the K-factor (a unitless value that serves to adjust the required torque based on the estimated friction loss) are critical to determining and achieving the proper/desired bolt load. In worst-case scenarios, torquing can have up to a 30% plus or minus accuracy variance between calculated and actual bolt load.

Bolt or stud tensioning, as the name implies, produces axial load by pulling on a fastener with a tensioning tool using hydraulic pressure. While generally less common than torquing, hydraulic tensioning has become more



common for specific applications. Tensioning is especially effective on high-pressure flanges with large bolt diameters and critical joints, across industries such as oil and gas, wind, subsea, and power generation.

While tensioning is inarguably more precise (typically +/- 10% accuracy), it is less common as it is more expensive and more complicated than torquing. More specifically, it requires individuals who have been properly trained to run the specialized equipment to apply stud tensioning. Torquing, on the other hand, requires less training and torque wrenches are readily available in any industrial plant. If performed by an appropriately trained assembler, with proper lubrication and with calculations that include a proper (experimentally determined) K-factor, torquing can be significantly more accurate than 30%. It is not uncommon for well-trained craft assemblers to achieve +/- 15% accuracy, or better, with torquing.

Final Thoughts

Regardless of one's preferred methodology, the primary takeaway should be that well-documented assembly best practices and effective training will contribute to improved overall reliability and dramatic savings for a plant. Most importantly, it helps ensure the safety of a plant's employees, and a price cannot be put on that kind of peace of mind.

ABOUT THE AUTHOR

Chris Morris is a Sales Engineer for Teadit, supporting customers and commercial interests in the Ohio Valley and Northeast Regions. Chris is a degreed engineer with over 10 years of experience in the gasketing business who specializes in field support and engineered application solutions. He resides in Parkersburg, WV with his wife and children.