GASKET INSTALLATION TRAINING E-BOOK

DURLON®
SEALING SOLUTIONS

TRAINING BENEFITS

- ✔ Learn about bolted flange connections
- ✔ Increase gasket life
- ✔ Reduce maintenance costs
- ✔ Become proactive to fugitive emissions & the environment
- ✔ Increase plant pipeline safety & reliability

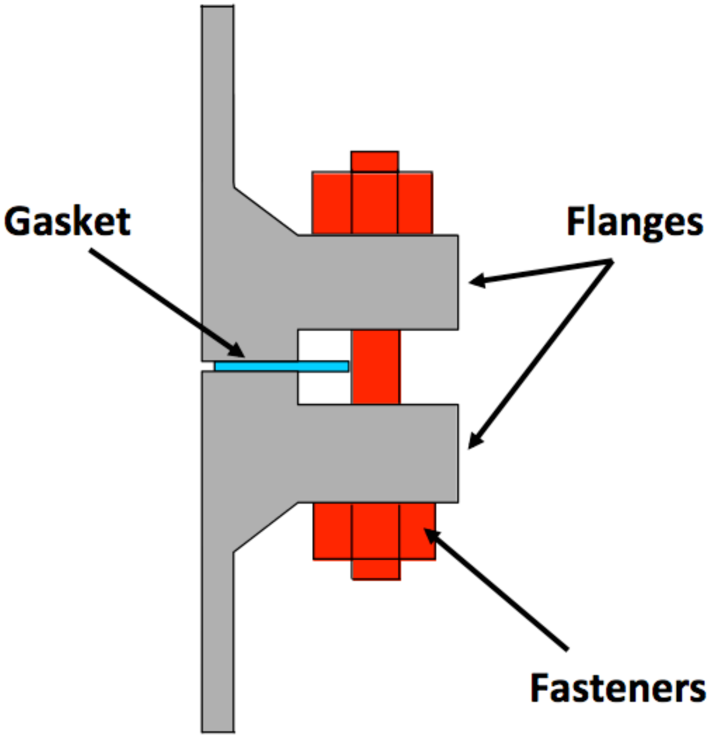
Contents

Joint Disassembly Warning

Prior to any joint disassembly, it is essential that plant procedures (lock-out and tag-out procedures) have been followed to depressurize and de-energize the system, including the removal of liquid head from the system, to ensure that the BFJA may be safely opened.

After reaffirming that all pressure on the joint has been released and the joint has been separated, proceed with bolt loosening and nut removal. Good general practice is to loosen the side of the joint away from yourself first to ensure in case of an accidental release that it is directed away from yourself.

Disassembly of a BFJA should be conducted in a similar fashion as the initial assembly. Bolts should be loosened in increments and also in a crisscrossed pattern to ensure an even unload. The first loosening should be done at approximately 50% of the original recommended torque. Once joint separation is achieved, proceed with the balance of the bolt loosening and nut removal. An aid such as a hydraulic or manual flange spreader may be used if necessary to separate the joint.

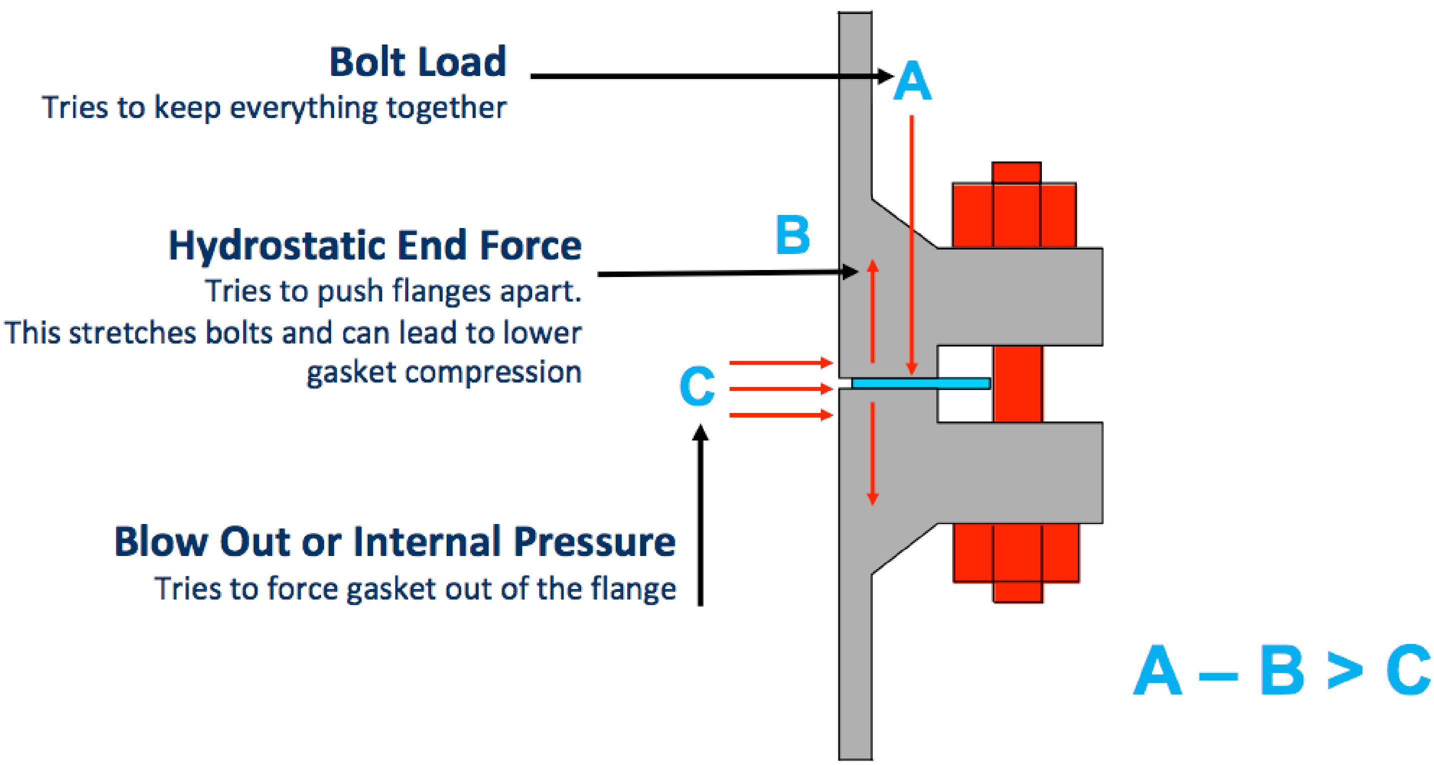


The Bolted Joint

Bolted joint failures can have many causes:

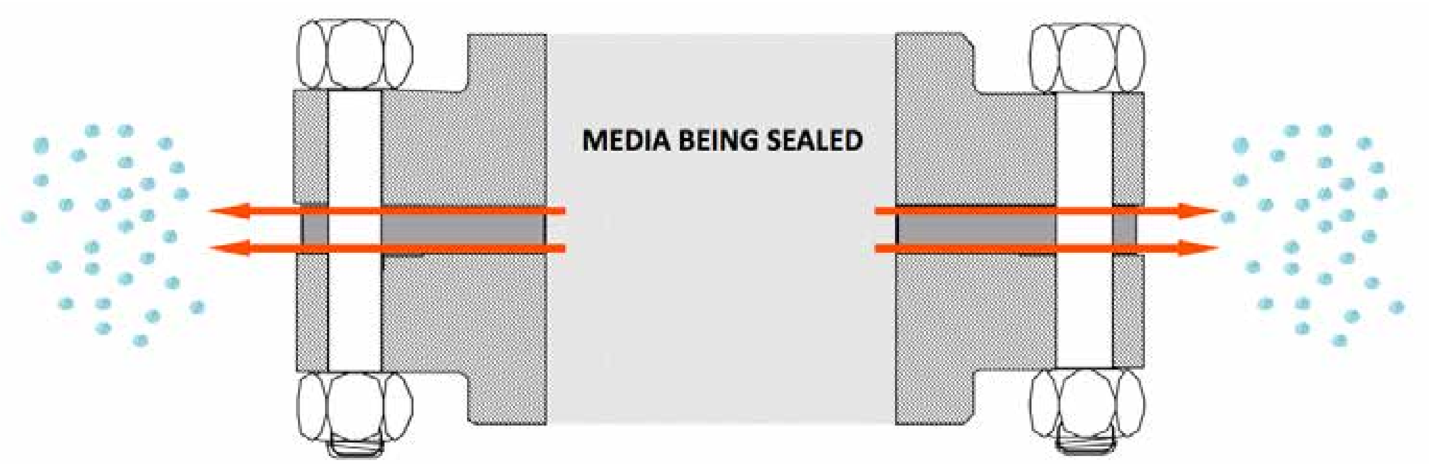
- Low bolt loads and/or gasket loading
- Weak fastening materials
- No torque control
- Inadequate lubrication of fasteners
- Poor installation
- Uneven gasket compression
- Poor flange design

Forces involved in the Bolted Joint



How/Where do Gaskets Actually Leak?

In both cases, tangential or permeation, the leakage is a result of either insufficient compression or a loss of compression on the gasket while in service.

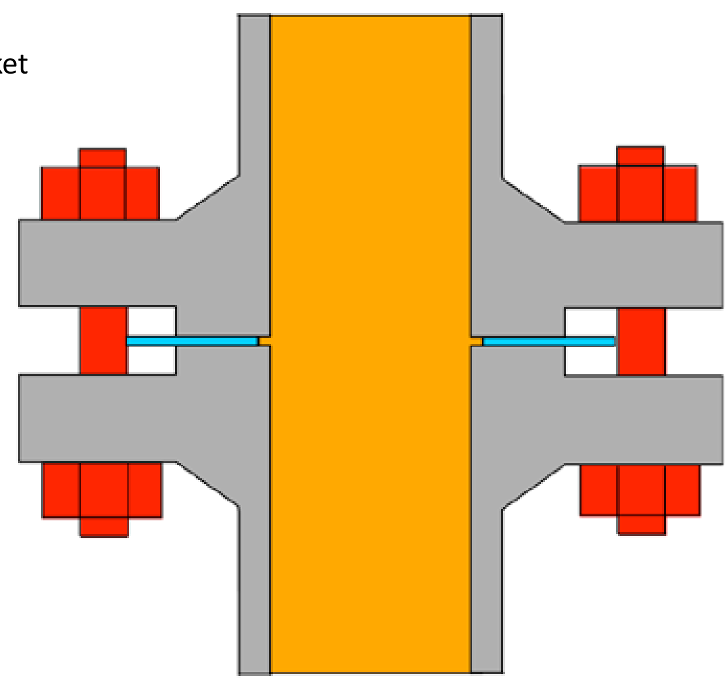


Permeation (through gasket body) leakage or Tangential (flange-surface interface) leakage

The Mechanics of a Bolted Joint

A force is applied by the bolts through the flange:

- This compresses and densifies the gasket
- Reduces porosity in the gasket
- Creates a sealing barrier at the gasket ID
- Prevents fluid from penetrating and degrading the gasket
- Creates a seal



As we already mentioned, during gasket installation the bolts are tightened, this in turn transfers the force applied by the bolts, through the flange to compress the gasket.

What most people are not aware of is that gasket materials are porous, be it compressed non-asbestos, PTFE's, flexible graphite, or spiral wound gaskets; they all have a certain amount of porosity.

This is why it's important that during the bolt tightening process a sufficient load is applied to not only compress the gasket but densify the gasket and reduce this porosity.

The Function of Bolts, Studs and Nuts

Bolt selection is important

For example, automobiles use SAE Grade 5 or Grade 8
- Designed for specific areas of a car
- Based on the clamping ability of the fastener

The clamping capability of a bolt is determined by its elasticity
- Elasticity is the ability of the bolt to return to its original shape after being deformed
- Becomes “spring like”

As already mentioned, the bolts in a flange system are designed to act like a spring. This spring-like effect is determined by the bolt’s elasticity, which means the bolt’s ability to not only be stretched but to be able to return to it’s original shape after the load on it is removed.

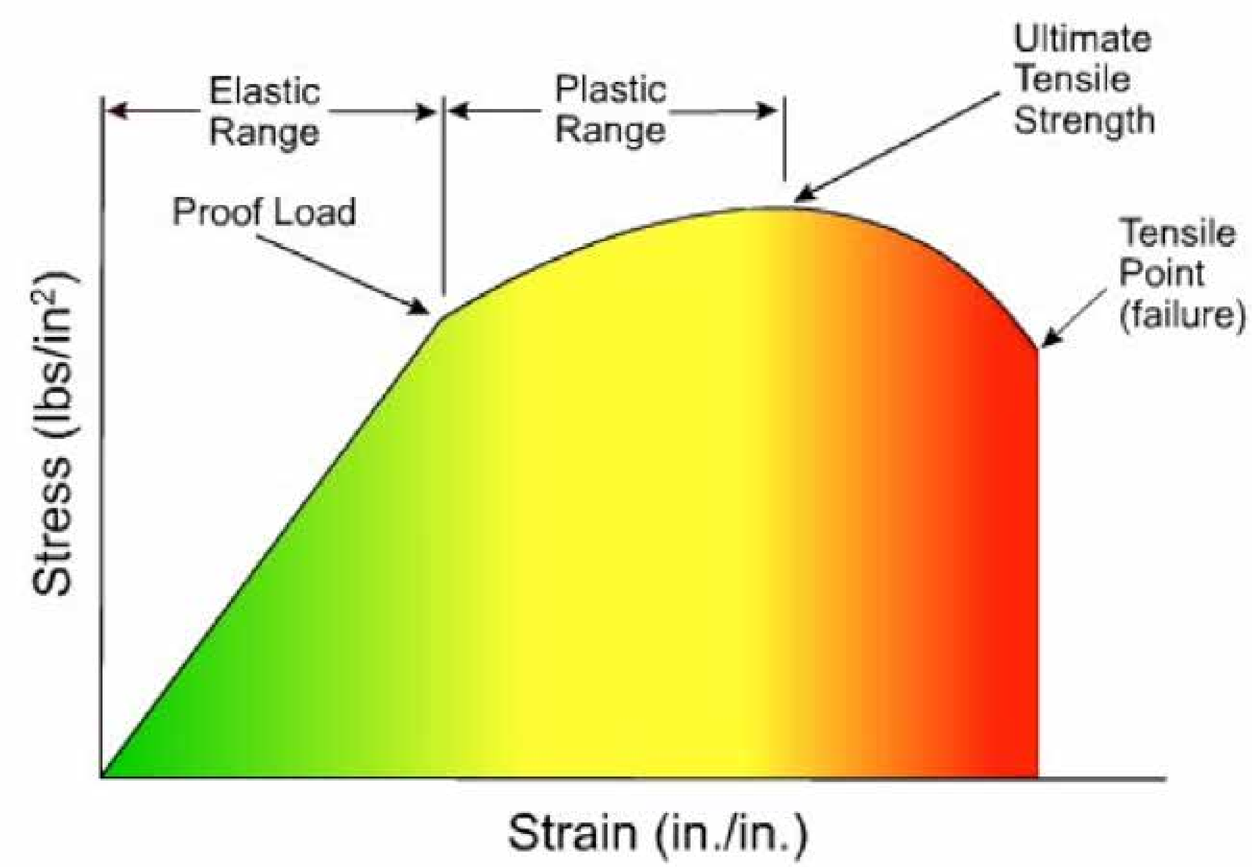
This is why selecting the correct grade of bolt is very important. You are also going to find that you customer, the end user, is more than likely unaware how important this can be.

We said that bolts in a flange are designed to act like a spring and this spring-like effect is determined by the bolt’s elasticity.

As you can see, a fastener’s elastic range is the amount of stress that’s applied up to the proof load of the fasteners. We want to be within this range.

Now if we apply a stress that is too high the fastener can go from the elastic range, to a plastic range where it is permanently deformed. When this happens, the fastener is ruined.

If you have ever tightened a bolt to the point where it snaps, you’ve gone past the elastic range, past the plastic range, to the tensile point.

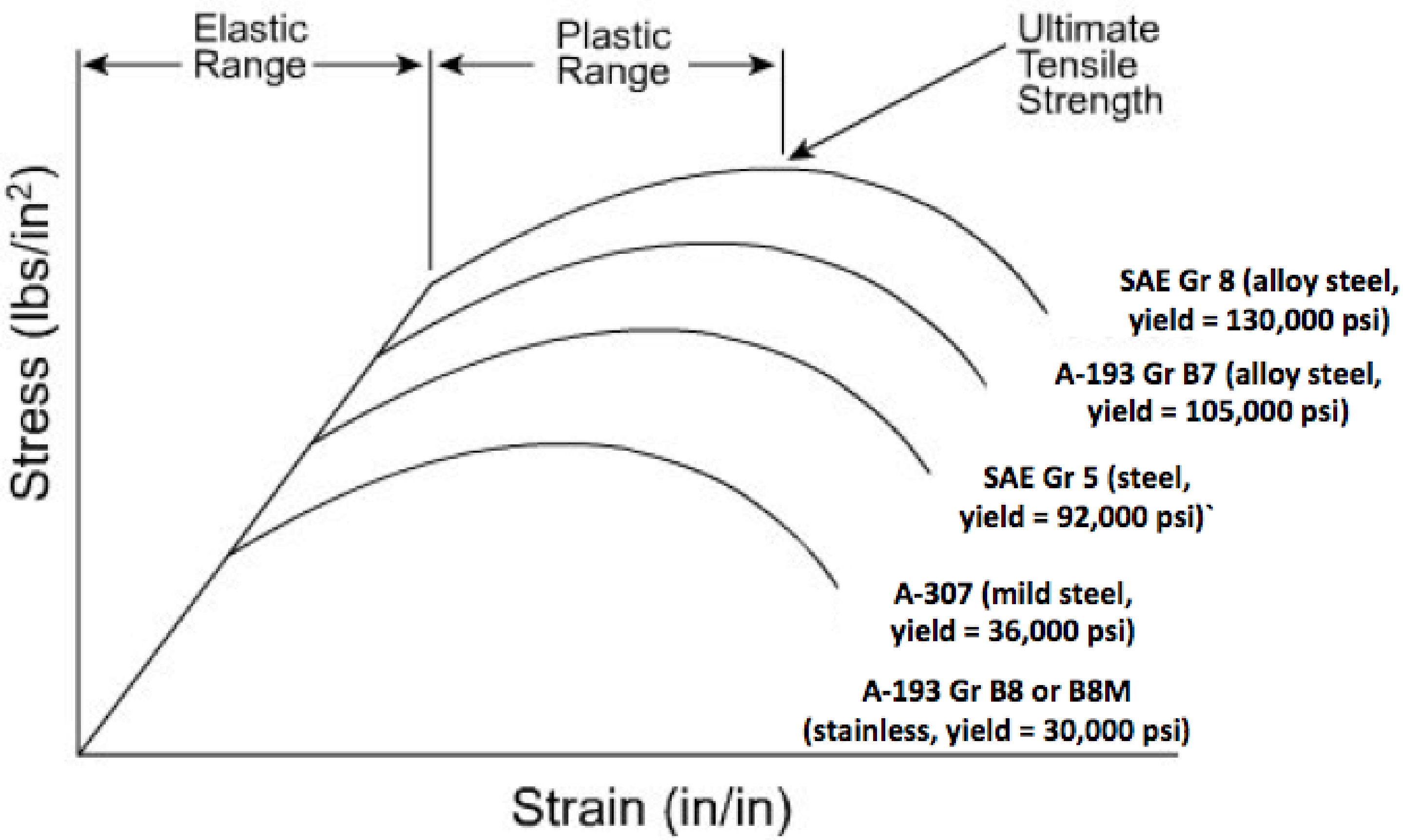


The Function of Bolts, Studs and Nuts

The bolt grade affects how much load can be placed on the gasket

The reason a weak fastener is problematic, is that when we calculate a torque we are looking at the relation of the total bolt area and the bolt strength vs. the gasket area. When a fastener is too weak, it cannot provide enough load to compress and densify the gasket and reduce porosity.

Examples:
A-193 Gr B8 or B8M (stainless, yield = 30,000 psi)
A-307 (mild steel, yield = 36,000 psi)
SAE Gr 5 (steel, yield = 92,000 psi)
A-193 Gr B7 (alloy steel, yield = 105,000 psi)
SAE Gr 8 (alloy steel, yield = 130,000 psi)



Lubrication:

- Reduces the amount of friction
- Friction works against you
- The lubricant should be applied to both the bolt threads, the nut threads AND on the nut flange facing
- Reducing Friction: Very important!

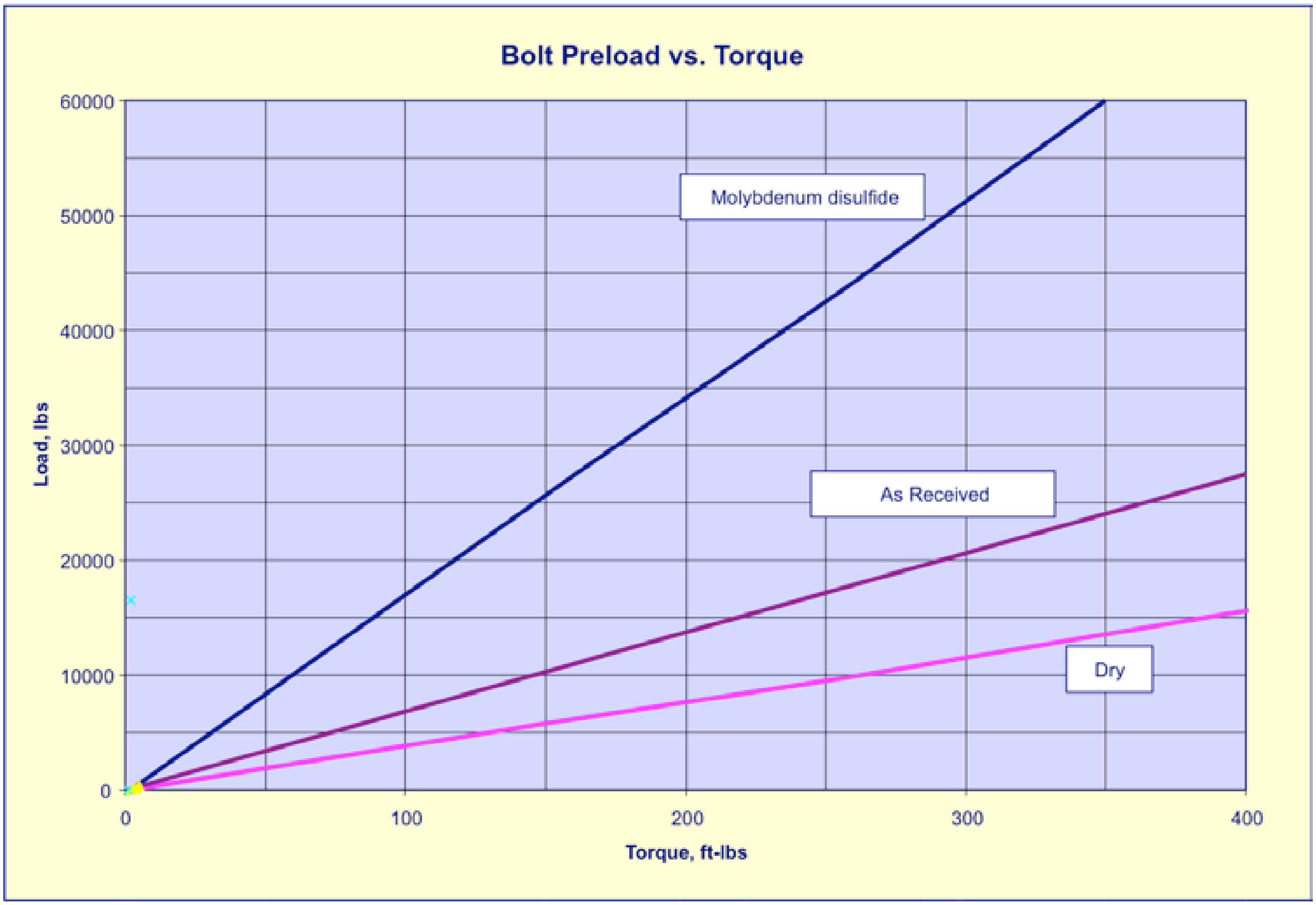
Friction works against you, so it's very important that a lubricant be used.

This torsional force is greater with bolts (with heads) than studs, where both ends are free to turn.

The Function of Bolts, Studs and Nuts

Below is an illustration of the effect of lubrication.
For example, suppose you are using a torque wrench set to 200 ft-lbs.
If the fastener is dry with no lubricant, at 200 ft-lbs the load on the bolt would be ~8,000 lbs
If the fastener is lightly oiled (as received), at 200 ft-lbs the load would be ~13,000 lbs.
If you are using a very efficient lubricant such as a moly paste the load would be ~34,000 lbs.
A significant difference.
So you can see that lubrication and different lubricants can greatly affect the effort you put into tightening the fasteners. In each case the nut would have felt tight but your effort was being bound up by friction.

In other words without a lubricant, your effort is wasted.



Evaluating Joint Failures

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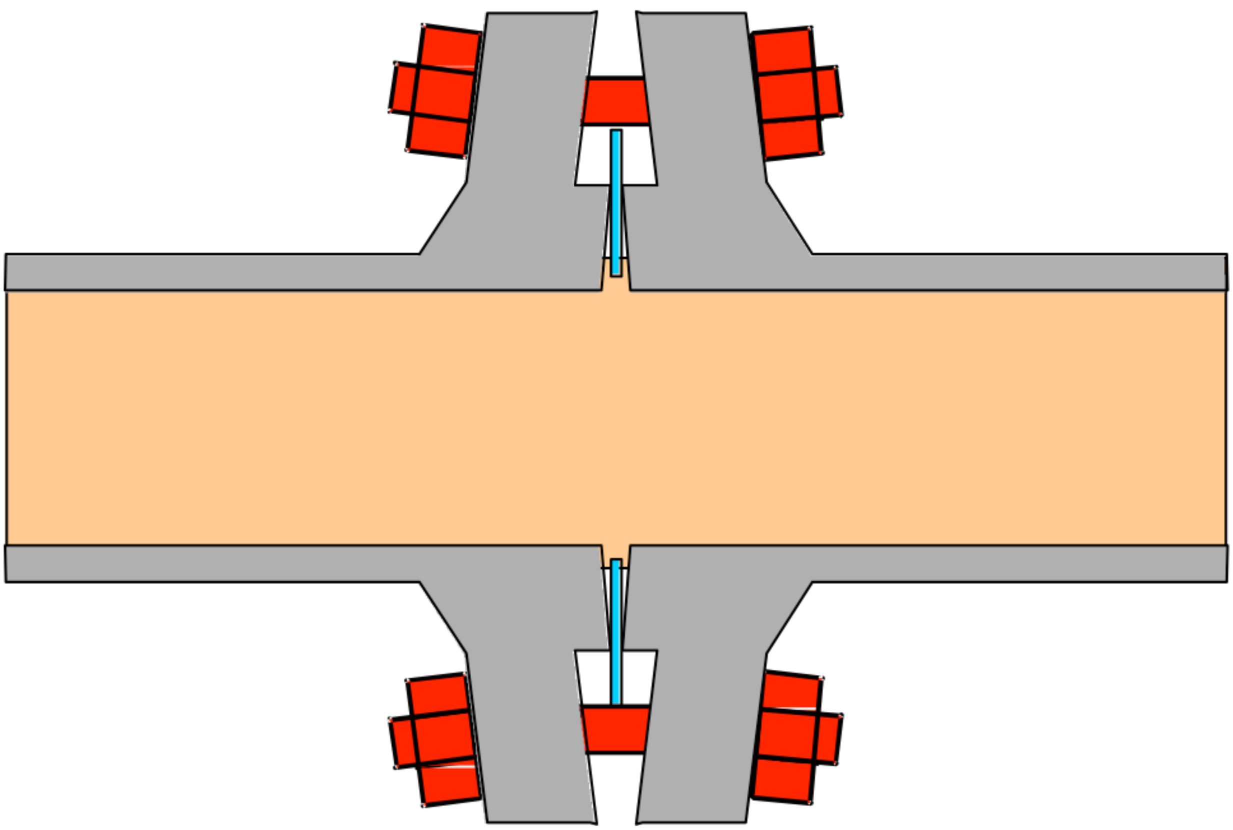
Joints fail, not just gaskets and with usually more than one cause:

- Gasket
- Flanges
- Fasteners
- Friction (lubrication)
- Installation

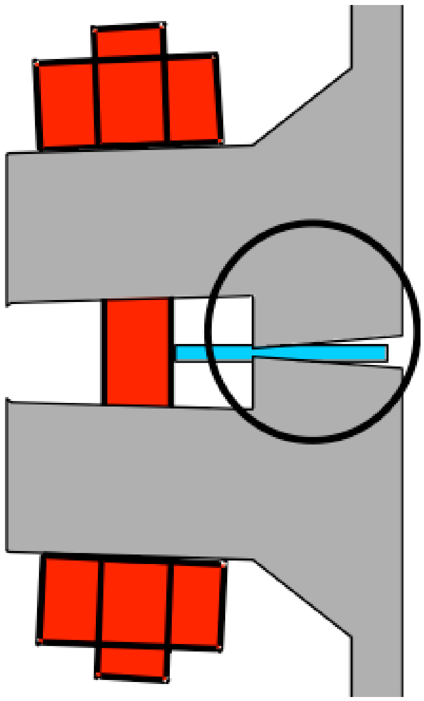
Improper Gasket Installation

Over-tightening - Flange Rotation

This is an over simplification of over tightening that can occur on some Class 150 flanges because they are lightweight. In the industry we call this flange rotation since the outside edges of the flange "rotate" toward each other as illustrated here.



Effects of Over Tightening



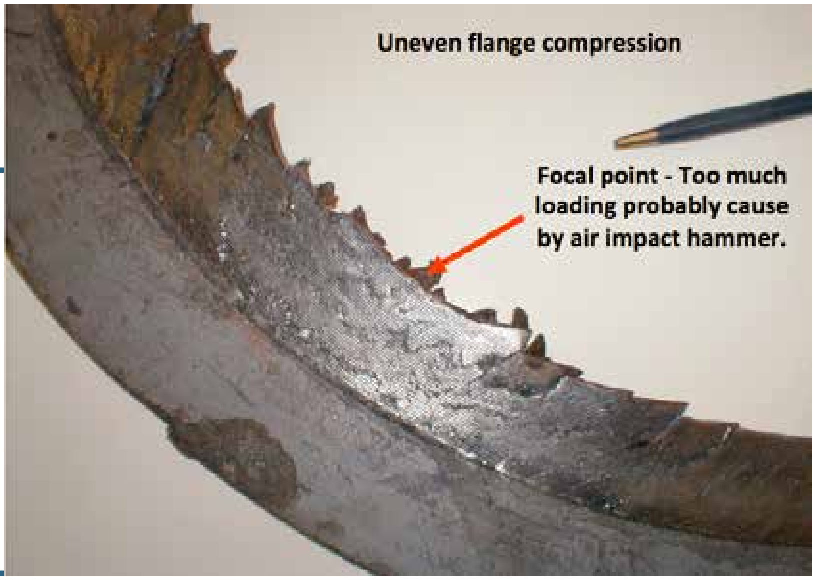
- Reduces The Gasket Contact Area
- Crushes The Gasket toward OD
- Allows fluid to penetrate gasket ID leading to deterioration of gasket
- Damages The Flanges
- Result: Leakage

This happens in Class 150 flanges because they are lightweight and not thick enough when a high stress is applied. Besides damaging the flanges, this over tightening can damage the gasket and lead to leakage.

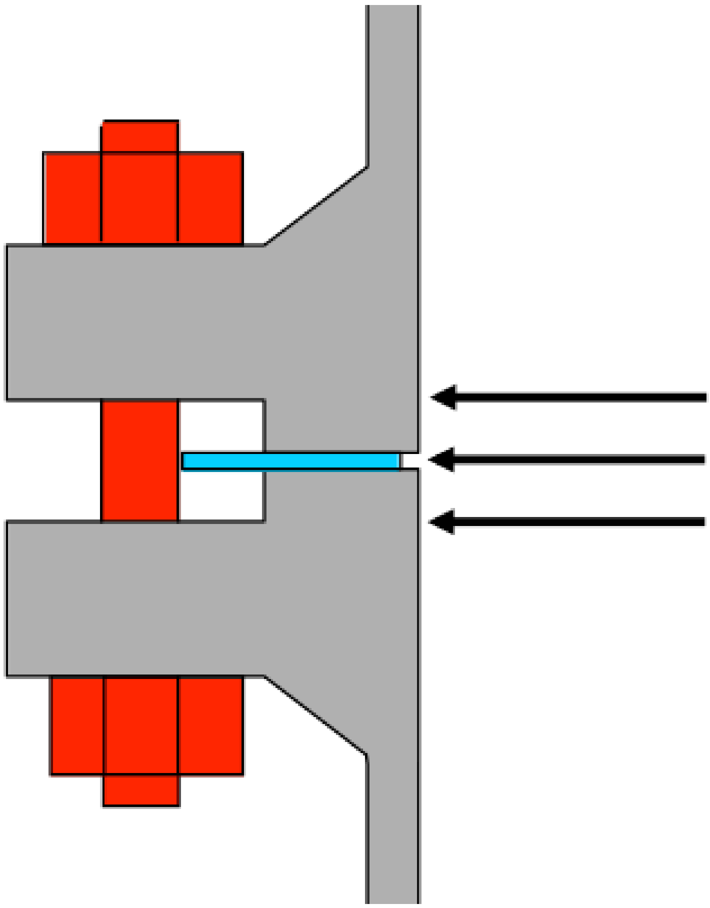
Cut almost entirely around the gasket at the OD of the raised face due to severe over-tightening (flange rotation).

This gasket was received from a VCM plant. It's a 10" Class 150 ring gasket that leaked. It was cut approximately 270 degrees around by the outside edges of the mating raised faces on the flanges.

This gasket is an example of possibly several things: The first is a lack of good procedures. A high stress was applied, most likely with an air impact, or a very long cheater bar.
Here we are looking at the focal point where the stress that was applied. As you can see the jagged edge on the gasket ID goes in opposite directions from the focal point.



Effects of Under Tightening



- Allows fluid to penetrate gasket ID leading to deterioration of gasket
- Under-loading can lead to blow-out or leakage
- Unloading caused by temperature or pressure cycling can have the same effect

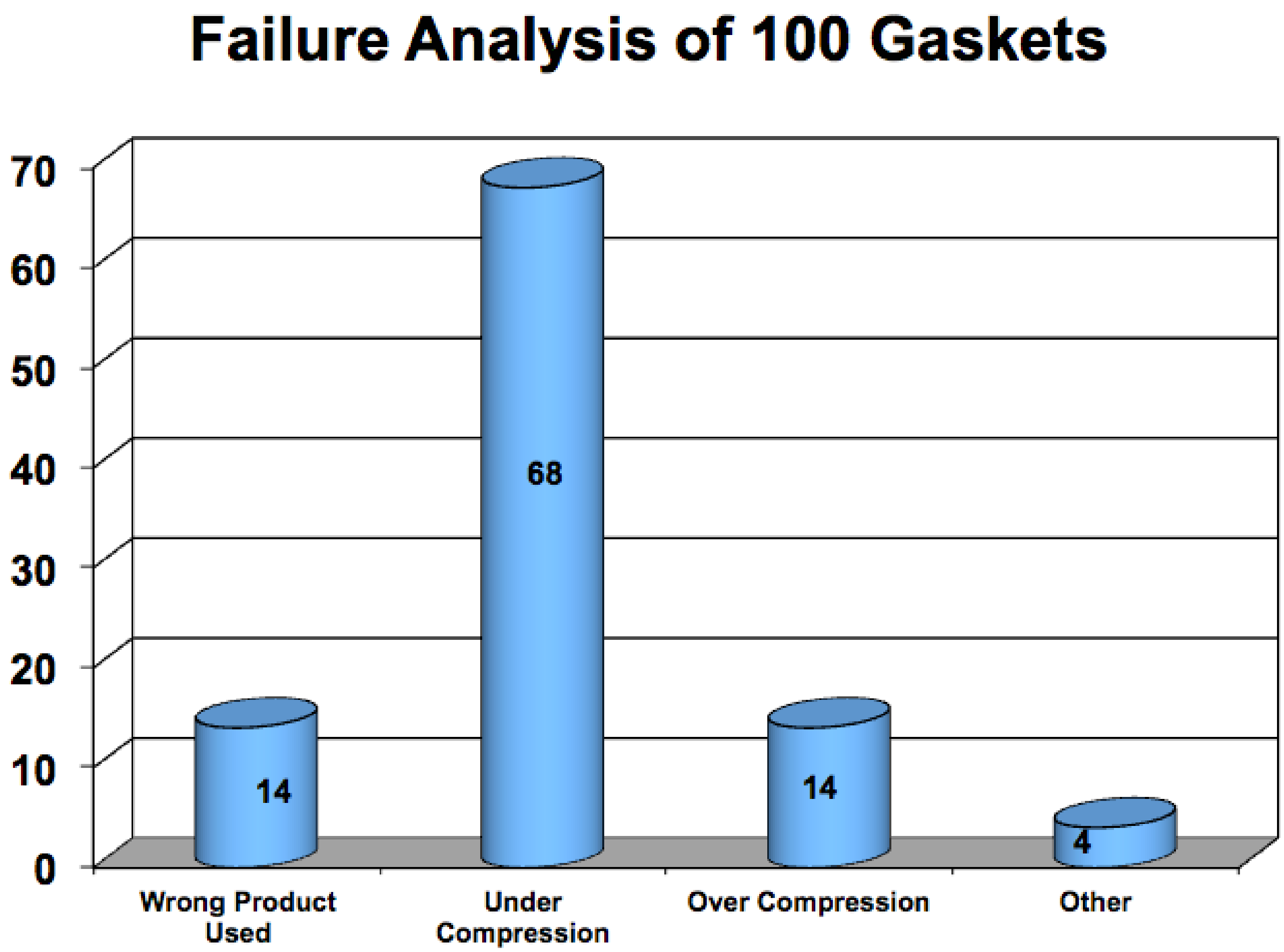
The opposite of overloading is under-tightening. This is where insufficient load is applied, which allows fluid to penetrate and degrade the gasket. Remember all gaskets are porous and they require a sufficient load to seal.

Installation and Assembly

Approximately 75-85%* of all bolted flange joint failures relate to uncontrolled gasket installation and joint assembly practices.* Taken from FSA Sealing Sense, January 2008. Pumps and Systems Magazine

This is an over simplification of over tightening that can occur on some Class 150 flanges because they are lightweight.

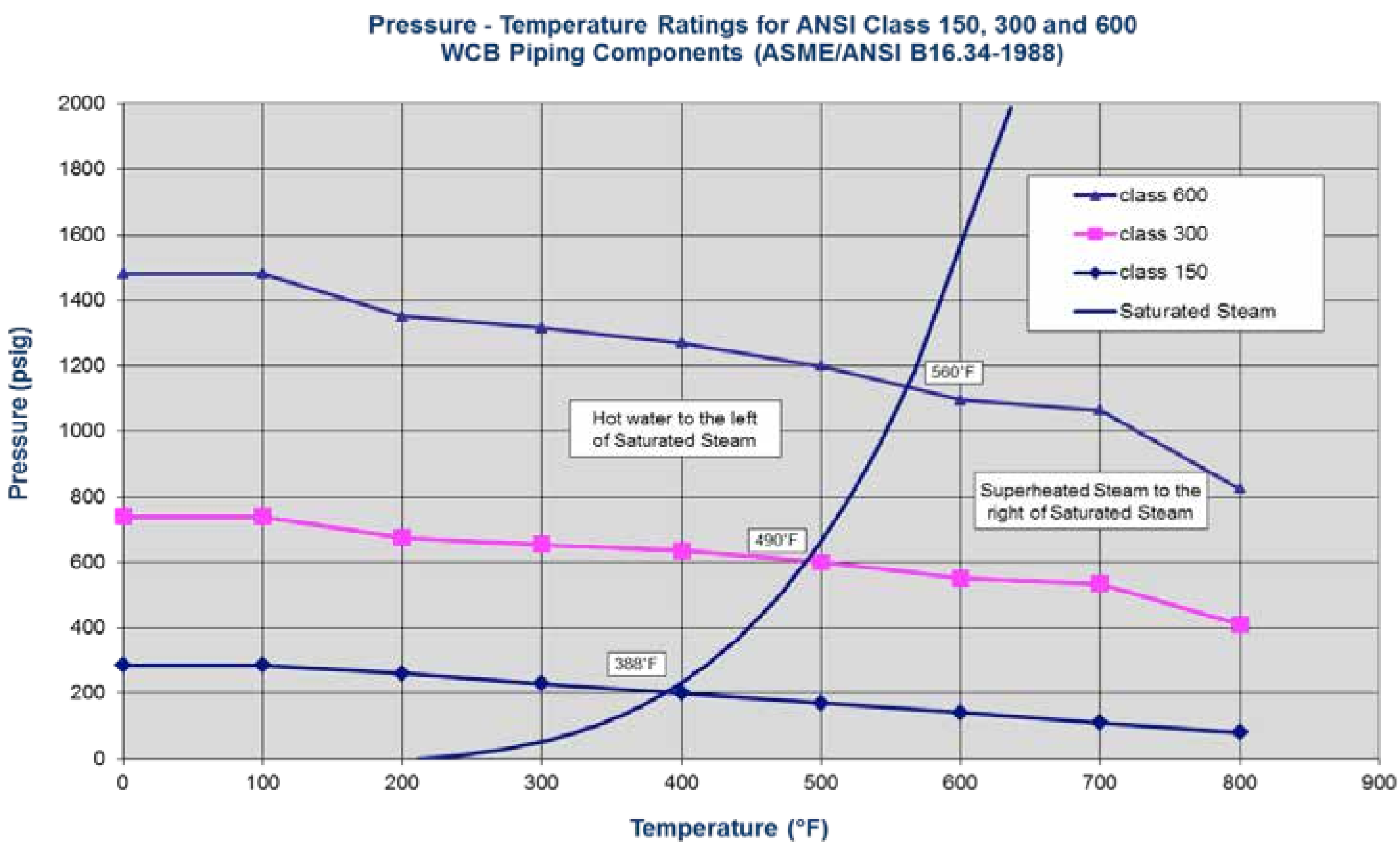
A lack of compression on the gasket was by far the most common occurrence in the FSA survey.



Pressure Classes

For industrial flanges as defined in ASME/ANSI it's important to realize the differences between the pressure classes. Looking at the chart we see Class 150, Class300 and Class 600 plotted by the working pressure on the y-axis vs. the temperature on the x-axis.

We have also included a graph for saturated steam as a reference. To the left of the saturated steam curve is hot water, while to the right is superheated steam. Notice for each Class that as the temperature increases the allowable working pressure decreases. The highest allowable working pressure for each Class is at ambient temperature. This relationship is true for not only flanges, but for valves, piping, and pumps, as well as for gaskets.

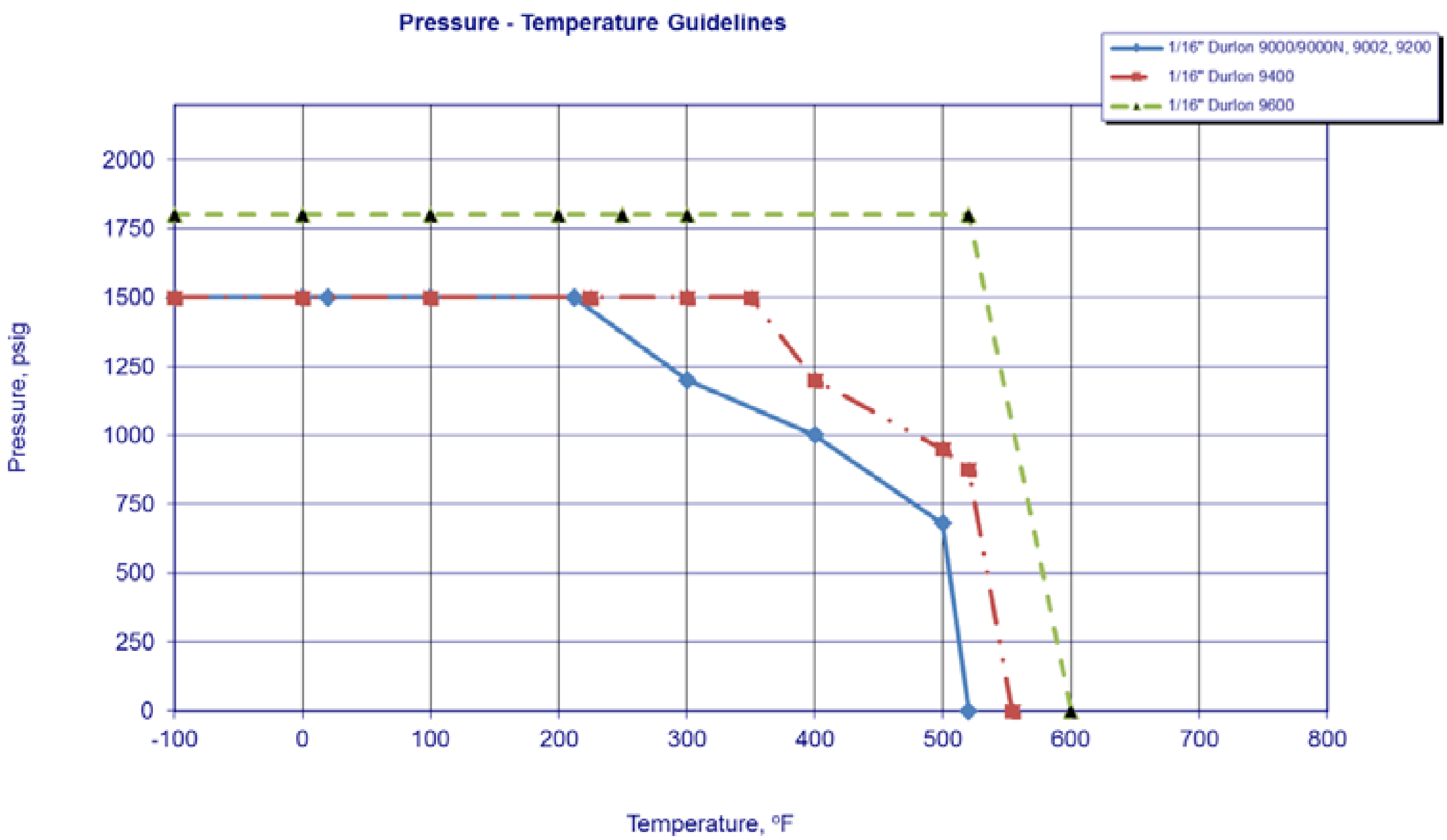


Pressure vs. Temperature Charts

The term we use to describe this relationship called the Pressure-Temperature Factor, or PT Factor. You get this factor by multiplying the pressure x's the temperature.

From the graph you can see that the PT Factor is not a constant, but a moving target. Some gasket manufacturer's advertise one PT Factor for their materials but the PT Factor at 500 degrees is much lower than it is at 100 degrees.

The important thing to remember here is that most non-asbestos sheet gaskets are limited to Class 300 and below. They should not be used above Class 300 without contact the gasket manufacturer.



Gasket Installation Includes

Making sure system is at ambient
- Temperature and depressurized
- Be sure company or some lockout/tagout procedures are followed

Inspection
- Flange condition
- Flange alignment
- Condition of fasteners
- Making sure flange surfaces are cleaned

Always use a new gasket
- A used gasket can take a compression set and not seal or be damaged

Never use more than one gasket in a flanged joint at a time.

Follow proper installation technique.

The following are instructions on the proper installation of a gasket on flanged connections.

1. Clean & Examine
- Remove all foreign material and debris
- Examine fasteners for defects
- Examine flange surfaces
- Replace components found to be defective

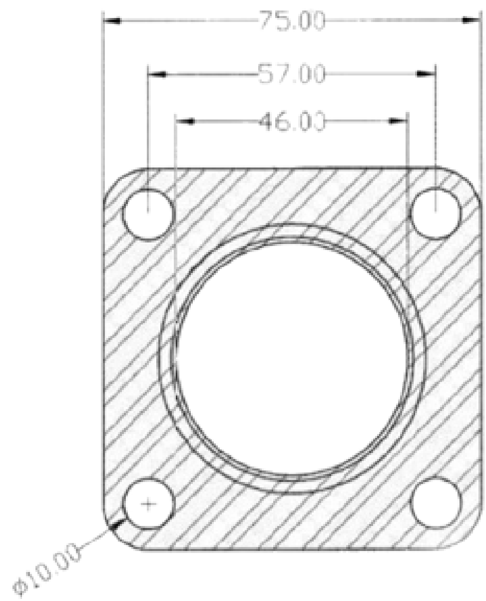
Examine flange surfaces for warping, radial scores, heavy tool marks, or anything prohibiting proper gasket seating

2. Align Flanges

- Align flange faces and bolt holes
- Do not use excessive force
- Use proper alignment tooling
- Report any major misalignment

3. Install Gasket

- Assure gasket is specified size and material
- Examine gasket for defects
- Carefully insert and center gasket between flanges
- Do not use release agents
- Bring flanges together ensuring the gasket is not pinched or damaged



4. Lubricate Load-Bearing Surfaces

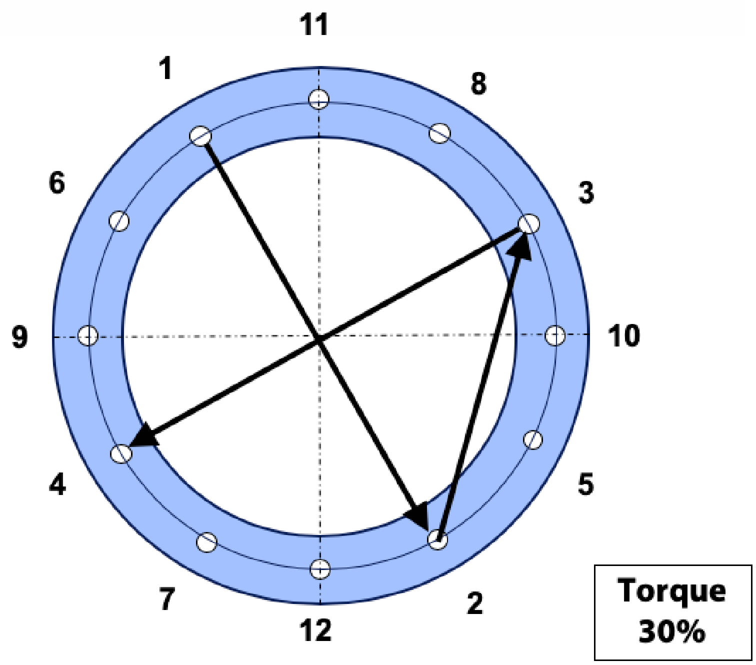
- Use approved or specified lubricants only
- Liberally apply lubricant uniformly to all thread, nut, and washer load-bearing surfaces
- Ensure lubricant doesn't contaminate the flange or gasket face

5. Install and Tighten Bolts

- Always use a calibrated, controlled tensioning device when possible
- Consult with your gasket supplier for the gasket manufacturer’s torque specifications
- Always torque nuts in a cross bolt tightening pattern

Step 1
Tighten all nuts initially by hand or small hand wrench for large bolts

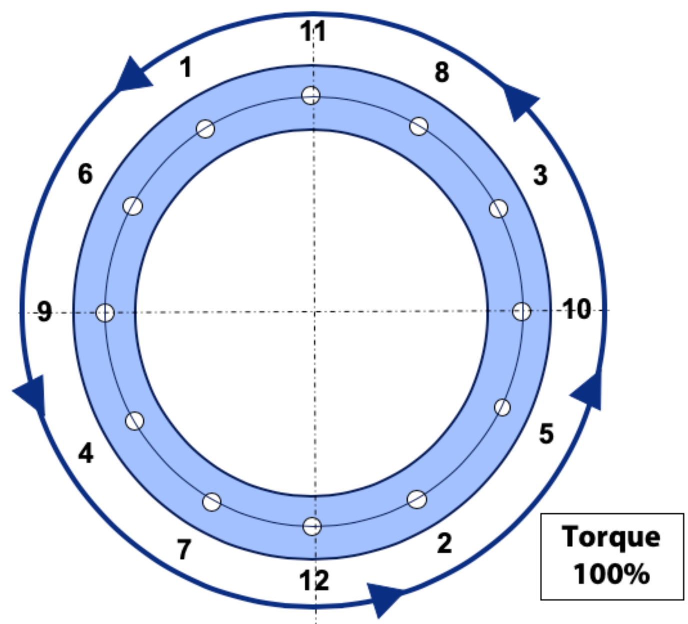
Step 2
Torque each nut to approximately 30% of the final desired torque



Step 3
Torque each nut to approximately 60% of the final desired torque

Step 4
Torque each nut to final torque using the same cross bolting pattern

Step 5
Apply at least one final torque to all nuts in a rotational direction until torque is uniform



6. Re-tightening
Re-tighten nuts at ambient temperature after 12-24 hours
Always re-tighten when system is exposed to aggressive thermal cycling
Consult with the gasket manufacturer for specific recommendations on re-tightening under “hot” conditions

Effect of Proper Gasket Installation

- Increased Gasket Contact Area
- Uniform Gasket Compression
- Increased Gasket Life
- Reduced Maintenance Costs
- Reduced Leakage

By using good installation practices you achieve several things:

- Most importantly you increase the life of the gasket, and
- Secondly, reduced leakage means reduced maintenance, which leads to more productivity and higher profit for the plant.
- This means your customer’s workplace is more productive and in these times that is very important!

Leaks are:

✔ Dangerous

✔ Health and safety concerns

✔ Expensive

✔ Lost production

✔ Increased maintenance

✔ Fines Preventable!

✔ Installation is very important

Bolt Tightening Worksheet

Location/Identification: ____ Nominal Bolt Size: ______________

Gasket Contact Surface Finish on Flange: _____________; Lubricant Used: ____________________________

(Initial each step.)

____ 1. Be sure system is at ambient temperature and depressurized. Follow local safety rules.

____ 2. Visually examine and clean flanges, bolts, nuts and washers. Replace components if necessary.

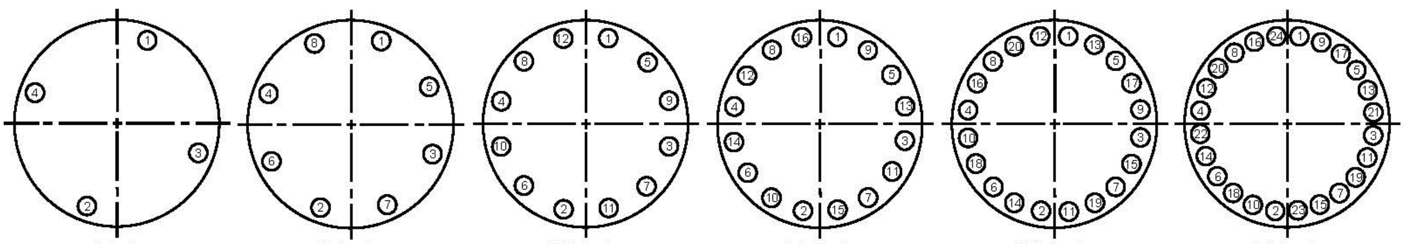
____ 3. **Lubricate bolts, nuts, and nut bearing surfaces.** Use of hardened steel washers are recommended.

____ 4. Install new gasket. DO NOT REUSE OLD GASKET, OR USE MULTIPLE GASKETS.

____ 5. Number bolts in cross-pattern sequence according to the appropriate sketch below.

____ 6. **IMPORTANT! HAND TIGHTEN NUTS, then using a hand wrench SNUG BOLTS 1/8 to 1/4 turn, following the appropriate cross pattern tightening sequence for the number of bolts below.**

____ 7. Starting at the #1 bolt, use the appropriate cross-pattern tightening sequence in the sketch below for Rounds 1, 2, and 3 (each sequence constitutes a "Round").



4-bolt 8-bolt 12-bolt 16-bolt 20-bolt 24-bolt

Final Torque: _______ ft-lbs

LUBRICATE, HAND TIGHTEN, PRE-TIGHTEN BOLTS

Round 1 - Tighten to ________ ft-lbs - **1st torque** value in torque chart* (30% of final torque)

Round 2 - Tighten to ________ ft-lbs – **2nd torque** value in torque chart (60% of final torque)

Round 3 - Tighten to ________ ft-lbs - **Final torque** value in torque chart (100% of final torque)

*Refer to torque chart on next page

Check gap at 90° intervals around the flange between each of these rounds. Larger flanges may require checking the gap in smaller intervals. If the gap is not reasonably uniform, make the appropriate adjustments by selective bolt tightening before proceeding.

___ **Rotational Round** - 100% of Final Torque (same as Round 3). Use ROTATIONAL, clockwise tightening sequence, starting with Bolt No. 1, for at least two complete rounds and continue until no further nut rotation occurs at 100% of the Final Torque value for any nut.

___ **Retorque** - Short-term bolt preload loss can occur between four to twenty-four hours after initial tightening due to bolt relaxation and/or gasket creep. Repeating the Rotational Round recovers this loss. This is especially important for PTFE gaskets.

Joint Assembler: ____ Date: ________________________

For torque questions, or tightening patterns for large diameter flanges, contact info@durlon.com

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