

PROPER FLANGE BOLTING

Flanges

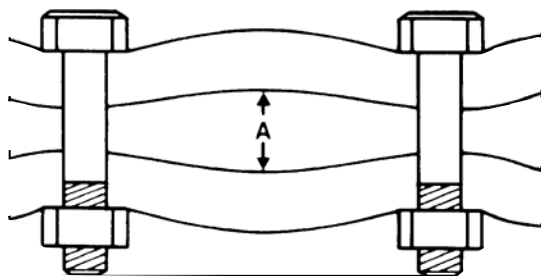
In theory, if it were possible to have two perfectly mated flanges with total effective contact at all points, a gasket would not be required to effect a seal. Obviously since this is not possible, a gasket is required and its function is to seal two imperfect surfaces.

There are limits on the degree of flange surface imperfections that can be sealed successfully with a gasket. Large nicks, dents and gouges must be avoided, since a gasket cannot seal against them properly. Also, a gasket cannot seal improperly aligned flanges.

Another problem is waviness in the flanges and warped or bowed flanges. This can be caused by heat during the manufacturing or welding process, internal stress and excessive bolt loads during installation. See figure 1.

To obtain a satisfactory seal, it is necessary that basic procedures are followed during installation. These procedures are of fundamental importance for a successful operation no matter what style of gasket or type of bolting materials are used. **While these flange installation procedures may seem elementary, they are extremely important and should be carefully followed.**

Figure 1



A - Bowing of flange due to too high bolt load

Flange Installation Procedures

1. Inspect the flanges. Check for tool marks, dents, scratches or corrosion. Look for pitting and any other defects which would make sealing impossible. Repairs must be made before bolting.
2. Inspect the gasket. Verify to be sure the gasket is of the proper material and style. Look for defects or damage.
3. Inspect and clean bolts, nuts and washers. Verify to be sure they are of the specified material.
4. Lubricate the bolt threads and the nut contact surfaces. This cannot be overstressed. The use of an anti-seize compound should be considered to facilitate subsequent disassembly. The better the lubricant, the more consistent the actual achieved bolt stress at installation will be.
5. Center the gasket on the flange. This is extremely vital when raised faced flanges are used.
6. Tighten the bolts approximately 30% to the final torque following the sequence shown in Figure 2 (shown on next page). If the correct tightening sequence is not followed, the flanges can be misaligned, making it impossible to have uniform seating of the gasket. Numbering the bolts may be helpful in following the bolt sequence.
7. Repeat step 6, elevating the torque to 50 to 60 percent of the final torque.
8. Continue tightening in the recommended sequence until the final torque value is reached. Each bolt normally has to be tightened more than once.
9. All gaskets relax after seating. Retightening is recommended 24 hours after installation to compensate for the relaxation. On high-pressure or high-temperature applications, it is recommended that the flanges be retorqued to the required stress after 24 hours at **operating pressure and temperatures** to compensate for any relaxation.

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Gaskets

Gaskets are used to create a static seal between two flanges and to maintain that seal under operating conditions. Proper gasket selection is critical and must be considered during the design and engineering process of any system.

Once the type of material and style of gasket is determined, proper installation is critical to achieve "seating" of the gasket. A seal is effected by compressing the gasket material and causing it to flow into the imperfections on the flanges so that intimate contact is made preventing leaking of the joint. The most common method of effecting a seal on a flange joint is through compression force applied by bolting.

Torque

Torque is a twisting force. When applied to a bolt it is generally expressed in foot pounds. The formula for torque is $T = R \times S$ where:

R = radius or length of lever
S = pounds pull on scale

Properly fastened studs and bolts achieve their holding power from the tension (or torque) that is derived from the mating of the external and internal threads subject to the elastic limit of the material.

What torque to apply is a generally asked question, but the answer depends on the variables of material, threads, and lubrication, if any. ***As previously stated the designer of the flange system normally specifies the required torque.***

Bolting

A bolt is a spring. It is an elastic member which has been stretched to develop a load by elongating its length. It must not be over-elongated (over-strained), or the elastic limit of the steel will be exceeded. The bolt then deforms and with continued loading (stressing) will quickly fail.

To avoid such problems with bolt tightening, the use of a torque wrench is recommended. ***The designer of the flange system normally specifies the torque required to achieve a proper seal.***

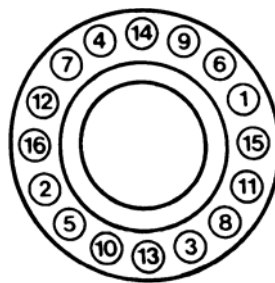
The inch-per-inch relationship demonstrates that the longer the bolt, the more it must be strained to yield a desired load; thus, the more follow-up or comeback there will be in actual inches. This is highly desirable, since most gasketing materials tend to remold, to relax, to take a permanent set. This is called the creep-relaxation phenomenon.

The more follow-up of spring provided by the bolt, the better the retention of stress on the gasket to maintain a leakproof joint. In the same respect, a smaller diameter bolt must be strained more to develop the same load. With the smaller diameter bolt, there is a serious danger that it may be over-strained and stressed beyond the elastic limit, and finally broken. The smaller bolt, within its elastic limit, could give the same additional follow-up as the larger diameter bolt of greater length.

Bolting Patterns

Regardless of the number of bolts, this circular bolt pattern with modification, will provide the correct tightening sequence.

Figure 2



Circular Multi-Bolt Installation Pattern