Troubleshooting Bolted Flange Connection Leaks

Q. *How can I troubleshoot bolted flange connection leaks?*

A. One of the best available tools to aid in determining the cause of leakage in a bolted joint is careful examination of both the gasket in use when the leakage occurred and the joint itself.

If possible, note the location of the leak on the gasket and flange. It also is helpful to know whether the bolts are still tight or loose. However, this is not always possible to determine because bolts may have seized or been bound. Also, when removing bolts, all bolts may be affected once the first bolt has been removed.

Some of most common joint leakage mechanisms are given below, along with some remedies to prevent recurrence of the leakage.

Chemical Attack

Gasket is badly corroded

Corrosion of metal gaskets is probably more easily diagnosed than that of rubber or fiber gaskets. Damage to non-metallic gaskets can be misdiagnosed since mechanical and chemical attack might look similar.

Non-metallic gaskets can be crushed, which will typically cause splitting of the gasket in arcs that are parallel to the circumference of the gasket (as opposed to radial splits). Erosion of the gasket will cause gouging at the gasket ID, but the damage will be limited to one or two areas. Edges of eroded areas will be smooth, not ragged, and the surface at the ID will be concave.

If the damage is due to chemical corrosion, select a replacement material with improved corrosion resistance.

Mechanical Damage

Gasket is extruded excessively

Extrusion typically is seen with soft and semi-metallic gasket materials. If excess extrusion is observed with soft gaskets, select a replacement material with better cold flow properties or better load carrying capacity.

Figure 1. Non-metallic gasket showing chemical attack.

For semi-metallic gaskets, excessive extrusion can be reduced by: minimizing clearance between mating flange parts such as tongue and groove areas, bridging the clearance e.g., using guide rings with spiral wound gaskets, or with a gasket whose I.D. is greater than the flange bore diameter.

Gasket is extensively crushed

Non-metallic gaskets that have been subjected to extreme compressive loads will typically split to dissipate the applied stress, whereas a spiral wound gasket will exhibit severe buckling of the windings. A replacement should be selected with better load carrying capacity.

To prevent crushing of spiral windings, provide a means to stop over compression of the gasket by using an inner ring or re-design of the mating flanges.

Figure 2. Fiber gasket showing over compression.

Gasket is mechanically damaged due to overhang of raised face or flange bore

With this type of failure, it may be obvious that the gasket is not fitting properly into the flange.

Review the gasket dimensions and compare them with flange detail to verify gaskets have been properly sized. It is also important to ensure gaskets are properly centered in the joint to allow for uniform distribution of stress.

No apparent gasket compression achieved

Compare the available compressive load with the recommended load for the selected gasket type. If insufficient load is available, select a softer gasket material.

With gaskets that are recessed in a groove, a thicker gasket may be necessary. In some cases, it may be possible to reduce gasket area to allow higher seating load.

Gasket is substantially thinner on OD than ID

This condition is indicative of excessive "flange rotation" or bending.

The gasket dimensions should be altered to move the gasket reaction diameter closer to the bolts to minimize bending movement. It may be necessary to provide additional stiffness to the flange by means of adding back-up rings. Selection of a softer gasket material to lower required seating stresses, or a reduction of the gasket area to decrease seating stresses may also be necessary.

Gasket unevenly compressed around circumference

If the gasket appears to be unevenly compressed, the installation procedure should be re-evaluated. Improper bolting up may be to blame.

Also, make sure certain sequential bolt up procedures are followed. ASME PCC-1 recommends using a cross-pattern or "star" pattern to apply torque in stages and ensure stress is applied uniformly across the gasket.

Gasket thickness varies periodically around circumference, with compression higher near the bolt holes

This condition is indicative of "flange bridging" between bolts or warped flanges.

To correct the problem, provide reinforcing rings for flanges to better distribute bolt load. It also may be necessary to select a gasket material with a lower seating stress or provide additional bolts, if possible, to obtain better load distribution. If flanges are warped, re-machine the flanges or use a softer gasket material.

It is important to remember that a leaky joint is a joint failure, not necessarily indicative of a gasket failure. A joint consists of mating flanges, bolts, and a gasket. Specification of the correct gasket design and material for the pressure, temperature, process fluid, flange arrangement, as well as proper gasket installation procedures are vital to the success of the connection.

Next Month: *What factors should be considered when installing a spiral wound gasket?*

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

P&S

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